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Heal Talk

A Journal of Clinical Dentistry

Editorial

From The Desk of Guest Editor.....

Future of Oral Healthcare: The Era of Advanced Dental Treatment

At present, the pitch of dentistry is undergoing an exemplar shift. The advancements in dental treatment is not just about treating various diseases but it can be referred to as forecasting, preventing and making the care personalized to a great extent for the patients.

The automated and related practices of treating dental diseases have evolved into a technologically driven, data based & patient centric domain. The general and specialty dentistry are now redefining their roles with these advancements. The tools available at our disposal are more powerful and precise than ever such as biomimetic materials and guided tissue regeneration to Artificial Intelligence, 3D printing and salivary diagnostics.

The digital dentistry has witnessed the most transformative developments. Intraoral scanning, computer aided design and manufacturing (CAD/CAM) and 3D printing are streamlining the workflows, enhanced accuracy and thus improving patient comfort. Same day crowns, digitally guided implant placement and fully digital orthodontics are no longer the exception but are becoming the standard.

Artificial intelligence is another edge revolutionizing the diagnostics, treatment planning and risk assessment. AI-powered radiographic interpretation tools are already demonstrating higher consistency and in some cases, greater diagnostic sensitivity than human clinicians. Machine learning models trained on vast data sets are now capable of predicting caries risk, periodontal disease progression and even systemic links from oral health indicators.

Meanwhile, regenerative dentistry is turning science fiction into clinical reality. Stem cell based therapies and bio-engineered scaffolds offer the potential for true biological repair of dental tissues. Research into enamel regeneration, pulpal revascularization and periodontal regeneration is rapidly progressing from bench to chairside.

The integration of salivary diagnostics is also bringing a more systemic lens to oral healthcare. Saliva based tests for markers of inflammation, microbial load, and even oncogenic activity are paving the way for earlier detection and more comprehensive care models.

However, this new landscape comes with new responsibility. The integration of advanced technologies requires rigorous training, moral oversight and an unwavering commitment to evidence based practice. It also demands that we address the digital divide to ensure enhanced innovation rather exacerbating the health equity.

As we look ahead, the question is no longer whether we will adopt these advanced modalities but how we will do so effectively and responsibly. Clinicians must remain lifelong learners and our academic institutions must adapt curricula to prepare the next generation for a dental profession that is as much digital and data-driven as it is clinical and manual.

Ultimately, advanced dental treatment is not about the technology itself; it is about enhancing outcomes, preserving natural dentition and improving lives.

We stand on the tip of a new era, one in which precision oral health is not only possible but also expected. The future of dentistry is bright, and it is our duty to ensure that its light reaches every patient, everywhere.

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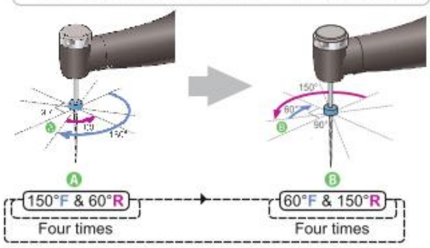

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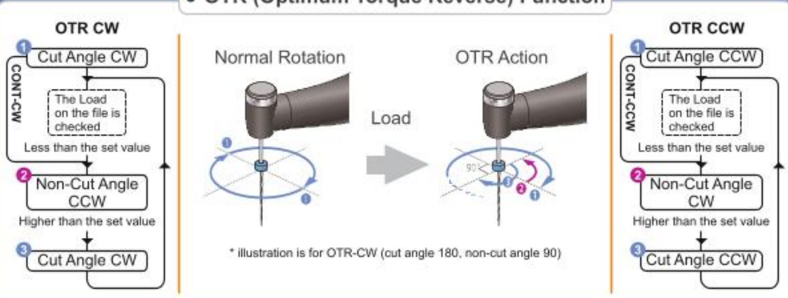

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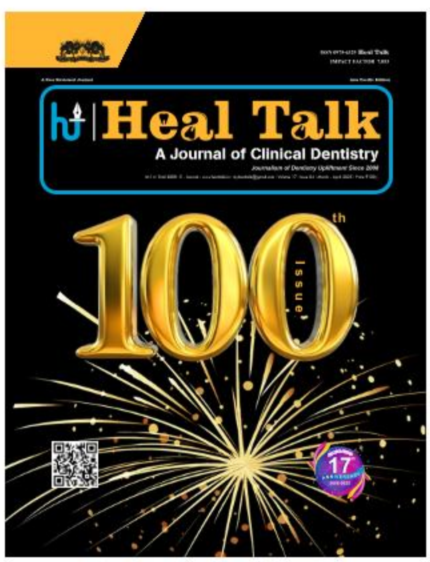

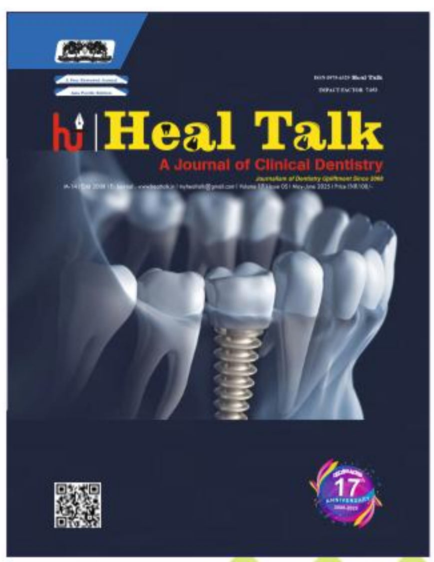

Recent Advances In Endodontic Access Preparation

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Endodontic access cavity preparation is often considered the initial stage of endodontic treatment. Conservative treatment with removal of some or all the coronal pulp may be considered where there is vital but inflamed pulp remaining (pulp cap, partial or full pulpotomy with calcium silicate cements), allowing comprehensive care, including restoration, in one visit.

The cornerstone of endodontic treatment is predictably accessing the coronal part of the pulp to identify the main root canal anatomy and commence bio-mechanical disinfection of the root canal system. The era of minimally invasive dentistry has led to the development of new access cavity designs.

Access cavity preparation is the key to successful orthograde endodontic treatment. The "ideal" access cavity typically described in endodontic textbooks usually depicts easily identifiable canal entrances at the base of a large pulp floor. For many years, access cavity was practiced by removing the entire roof of the pulp chamber to better visualize the pulpal floor, as well as to ensure canal identification, straight line access, shaping, irrigation, and obturation. Meanwhile, numerous studies have demonstrated that this kind of access cavity results in a significant loss of tooth structure, lowering the fracture resistance of the treated teeth.

Minimally invasive endodontics embodies a paradigmatic shift in the discipline, advocating the meticulous preservation of natural tooth structure by judiciously downsizing the preparation of the access cavity, canal taper, and apical size.

Earlier endodontic access cavities used to be standardized based on the type of tooth, but with technological advancement in endodontic techniques, 3D diagnostic procedures, incorporation of the dental operating microscope, and loupes that provide magnification and better illumination, the cavity design is now primarily determined by the unique pulp chamber morphology of the tooth being treated. The minimally invasive concept emphasizes the imperative to preserve the structural integrity of the original tissues, minimizing harm to patients and maximizing the natural self-healing power of the central immune system to fight against disease. Amongst the several concepts introduced, the core aspect concentrates in maintaining the pulp chamber roof the so called soffit and the peri-cervical dentine as much as possible in order to ultimately improve the tooth's survival.

In the following years, the popularity of minimal access cavities has started to grow and other more radical design types such as "ninja" and truss, that aim to preserve the dentinal bridge between two or more small occlusal cavities prepared to access the root canal orifices of multi-rooted teeth, were also proposed without any scientific support. The rapid spread of these less invasive access cavities triggered the attention of researchers and clinicians and, four years after the Clark and Khademi proposal, its effect on the fracture resistance of teeth was tested experimentally for the first time. Krishan et al. (2014) evaluated the impact of access cavity size on the fracture resistance of incisors, premolars, and molars by combining a micro-computed tomographic (micro-CT) analysis with the conventional maximum load to failure approach. Although the authors found that the minimal access cavity conveyed some benefit in increasing the fracture resistance of teeth, it was also associated with the risk of compromising the quality of canal instrumentation.

In physiologically young teeth, the peri-cervical dentin (PCD), undermined dentin, dentino-enamel junction (DEJ), axial wall of the DEJ, and cervical enamel, which have been deemed of high value with regard to tissue type, becomes crucial to maintain appropriate strength and fracture resistance.

For the past few decades, the need for the conservation of tooth structure has been increasing in dentistry, especially in the preventive and restorative parts of dental treatment. Minimally invasive dentistry has given rise to contracted endodontic cavities (CECs). They've been put out as an alternative to conventional endodontic access cavities intended to maintain the mechanical integrity of the tooth.

Several access cavity (AC) designs involving minimum tooth tissue removal have been developed in the recent decade for gaining admission to pulp chambers during root canal therapy. Endodontic modern access cavity designs have lately been developed to reduce tooth structural loss. The debates should not be over whether to completely or partially unroof the pulp chamber roof, or whether to drill a ninja access cavity or use truss access; ultimately, the outlines of the access cavity are influenced by anatomical issues, skills, and the tools and methods used to open, clean, shape, and obturate various root canal systems. The maintenance of the peri-cervical dentin is the most important aspect in retaining the normal function, esthetics, and durability of the treated tooth. Previous research has shown that utilizing more limited access cavity designs improves the fracture resistance of endodontically treated teeth and reduces the need for more complex, more expensive post-endodontic restorations. In recent years, the conventional approach to endodontics has been challenged by minimally invasive endodontics.

Rationale for Minimal Access Cavity Preparation

The minimally invasive paradigm prioritizes the preservation of the structural integrity of the original tissues, underscoring the importance of maintaining the tooth's natural architecture. The most efficacious approach to achieving this objective is by partially preserving the pulp chamber roof, thereby reducing cusp flexion and concomitantly preventing damage to the tooth's structural integrity. Minimally invasive endodontic access cavities play a crucial role in maintaining the long-term survival of endodontically treated teeth (ETT) by avoiding unnecessary dentine removal, thereby enhancing the resistance of ETT against tooth fracture. Studies have consistently demonstrated the efficacy of minimally invasive procedures in improving the clinical properties of defective restorations. For instance, a two-year recall examination conducted by Gustavo Moncada et al. revealed that treatments such as sealant application, repair, and refurbishing significantly improved the clinical properties of defective amalgam and resin based composite restorations, effectively increasing the longevity of the restorations while minimizing the need for extensive procedures. This study unequivocally demonstrated that marginal sealing of restorations is a minimally invasive treatment that may be employed as an alternative to the replacement of restorations with localized marginal defects. Moreover, minimally invasive procedures have been shown to be effective in preventing and arresting early carious lesions, although their efficacy is diminished in the case of large lesions due to the challenges posed by dentin composition and bacterial persistence. Enhancing the antimicrobial properties of these interventions is crucial for optimal efficacy. The materials employed in these procedures are prone to hydrolytic and enzymatic degradation, which can lead to treatment failure. Therefore, enhancing the biostability of these materials is essential to extend their lifespan and delay the need for surgical intervention. Consequently, augmenting the antimicrobial and anti-degradative properties of minimally invasive techniques is imperative to improve their effectiveness and expand their range of applications.

Techniques and Methods

Access cavity preparation is delineated as "the opening prepared in a tooth to gain ingress to the root canal system for the purposes of cleansing, shaping, and obturating". This inaugural technical step of root canal therapy necessitates profound comprehension of both the internal and external dental anatomy; a subpar execution can severely compromise the localization, negotiation, debridement, disinfection, and obturation of root canals.

The following techniques are employed in minimally invasive cavity preparation:

1. **Mechanical High/Low Speed Rotary Systems**
   - Fissurotomy burs.
   - Polymer burs (smart burs).
2. **Chemomechanical Cavity Preparation Systems**
   - Application of Carisolv agent.
   - Application of Papacarie agent.

1. Air Abrasion.
2. Ultrasonics and Sono Abrasion.
3. Atraumatic Restorative Treatment (ART).
4. Ozone Therapy. Laser Application
5. Antibacterial Photodynamic Therapy (APDT).

With the advent of novel dental restorative materials and strides in adhesive dentistry, a refined understanding of the caries process, the tooth's potential for remineralization, and changes in caries prevalence and progression, the management of dental caries has transitioned from G.V. Black's paradigm of "extension for prevention" to a "minimally invasive" approach.

Traditional Access Cavity (TradAC)

In posterior teeth, this involves complete removal of the pulp chamber roof, followed by achieving straight line access to the canal orifices, with smoothly divergent axial walls, so all orifices are visible within the outline form. In anterior teeth, straight line access is obtained by removing the pulp chamber roof, pulp horns, and the lingual shoulder of dentine, extending the access cavity to the incisal edge.

Conservative Access Cavity(ConsAC)

Treatment with conservative endodontic cavities (CEC) increases tooth fracture resistance but impairs canal instrumentation in the long run. Despite the fact that CEC was shown to increase the risk of canal instrumentation failure only in the molar distal canals, it maintained the coronal dentin and improved the fracture resistance of mandibular molars and premolars.

In posterior teeth, preparation typically begins at the central fossa of the occlusal surface and extends, with smoothly convergent axial walls, only as far as necessary to detect the canal orifices, preserving part of the pulp chamber roof. In anterior teeth, the entry point is moved from the cingulum towards the incisal edge on the lingual or palatal surface, creating a small triangular or oval shaped cavity, conserving the pulp horns and maximal peri-cervical dentine.

Truss Access Cavity

Trials using more conservative access cavity designs, such as the Truss access cavity, have previously been found to increase endodontically treated teeth's fracture resilience and minimize the need for elaborate, more expensive post-endodontic restorations. "Truss" access cavity is a Conservative endodontic access cavity (Conservative Endodontic Access Cavity (CEC)) technique. Its aim is to keep the dentinal bridge in place between two or more small cavities made to access the canal orifice(s) in each multirooted tooth root. Separate cavities are formed in the mandibular molars to approach the mesial and distal canal systems, whereas, in maxillary molars, the mesio- and disto-buccal canals are accessed via one cavity, while the palatal canal is addressed through another.

Ultra Conservative (ninja)access Cavity Designs/ Conservative Access Cavity With Divergent Walls (ConsAC.DW)

This variant of Conservative Access Cavity(ConsAC) is executed with divergent walls.

Ultra-Conservative Access Cavity (UltraAC): These cavities are initiated as described in ConsAC but without further extensions, maintaining as much of the pulp chamber roof as possible.

Ultra-Conservative Access Cavity at Incisal Edge (UltraAC.Inc): In anterior teeth exhibiting attrition or a pronounced concavity on the lingual aspect of the crown, access is performed in the middle of the incisal edge, parallel to the long axis of the tooth.

Endodontically treated teeth may have increased fracture strength as a result of this minimally invasive procedure. Cone beam computed tomography imaging was used to find all of the canals, preserving the dentin in the process. The access outline form was created by drawing a line from the outer canal surface at the furcation level to the outer canal surface at the orifice level on the outer canal wall. At the most deep point of the occlusal surface, a diamond round bur can be utilized to open the cavity perpendicularly. Using a steel round bur to penetrate the pulp after reaching the dentin, the cavity should next be gently enlarged buccolingually with a fissure bur after the pulp chamber has been reached. The cavity's mesiodistal width should be 2 mm, while the buccolingual width is adjusted to 3 mm.

Caries Driven Access

Several access cavity designs utilizing minimum tooth tissue removal for gaining admission to pulp chambers during root canal therapy have been described in the previous decade.

Caries Driven Access Cavity

Caries is removed and all remaining dental structures are preserved. Included in this is the soft structure, which may be described as the bottom of an architectural feature like a wall or a ceiling corner.

Restorative Driven Access Cavity

Access to the pulp chamber is achieved in restored teeth with no caries by removing all or part of the current restorations while maintaining all feasible residual tooth components. A diagnostic radiograph that shows the anatomy of the tooth and the morphology of the root canals are required to prepare minimally invasive access cavities because it offers a first orientation about where the pulp chamber and root canals are located. One of the most challenging aspects of using minimally invasive access cavities is determining where to place root canals due to the restricted view of the pulp chamber floor that may be provided. Rover *et al*. (2017) observed traditional access cavity found more second mesio-buccal canals in maxillary molars than conservative access cavity. While using ultrasonic troughing in combination with magnification, there was no difference between the two methods.

To be continued……………………….

(It's a review of literature and not an original article)

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Nanotechnology & Nanorobotics in Orthodontics: A Review on Revolutionizing Tooth Movement & Care

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Abstract

Nanotechnology, a science of manipulating materials at the atomic and molecular level, has revolutionized healthcare, including dentistry and orthodontics. Its integration into orthodontics offers advancements in treatment efficiency, patient comfort, and precision. Applications such as nano-enhanced adhesives, nanocomposites, coated orthodontic appliances, and nanorobot-assisted procedures are shaping the future of orthodontics. Nanorobots promise accelerated tooth movement, smart brackets with real-time feedback, and plaque control, though biocompatibility and ethical concerns remain. This review explores the evolution, current applications, and future prospects of nanotechnology and nanorobotics in orthodontics, emphasizing their potential to transform orthodontic care.

Keywords

Nanotechnology, Nanorobotics, Orthodontics, Smart Brackets, Nano-materials

Introduction

Nanotechnology refers to the manipulation of matter on an atomic, molecular, and supramolecular scale, typically within 1–100 nanometers. The concept was first introduced by Richard Feynman in 1959 in his talk "There's Plenty of Room at the Bottom." In dentistry, nanotechnology has given rise to nanodentistry, which employs nanomaterials, nano-biosensors, and nanorobots to enhance preventive, diagnostic, and therapeutic procedures. Orthodontics, a specialty focused on correcting malocclusions and improving oral function, has seen promising developments in nanotechnology applications. This review summarizes its current applications and future trends.

Current Applications of Nanotechnology in Orthodontics

Nanotechnology in orthodontics has led to significant material and procedural improvements. Current applications include:

1. **Control of Oral Bio-film:** Incorporation of silver, titanium dioxide, and silica nanoparticles in adhesives and coatings helps reduce bacterial adhesion and prevent white spot lesions.
2. **Nanocomposites for Bonding:** Nano-filled composites improve bond strength, reduce polymerization shrinkage, and enhance aesthetics.
3. **Coated Brackets and Archwires:** Nano-coatings with MoS_2 and WS_2 reduce friction and improve efficiency during tooth movement.
4. **Nanotechnology in Miniscrews:** TiO_2 nanotube coated mini-screws loaded with bio-active agents enhance stability and reduce inflammation.
5. **Nano-modified Elastomeric Ligatures and Power Chains:** Integration of antibacterial nanoparticles like silver decreases plaque formation without compromising mechanical properties.
6. **Shape Memory Polymers and LIPUS Devices:** SMPs offer improved aesthetics and continuous light forces; LIPUS promotes bone remodeling and reduces root resorption.

Nanorobots in Orthodontics

Nanorobots are theoretical nanoscale machines capable of performing tasks at the cellular and molecular level. In orthodontics, they could accelerate tooth movement by remodeling periodontal tissues, deliver drugs locally, and prevent root resorption. Smart brackets integrated with nanomechanical sensors provide real time feedback, impro-

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ving force application precision. Nanorobotic dentifrices could continuously maintain plaque free environments by metabolizing trapped debris. Although still conceptual, advances in nano-robotics promise minimally invasive, efficient orthodontic care.

Futuristic Era and Recent Advances

The integration of AI and robotics with nanotechnology is paving the way for advanced orthodontic solutions. Technologies like Graphy's Tera Harz Smart Robot automate aligner production, while shape memory polymers and nanostructured surfaces improve appliance performance. Emerging concepts such as AI-guided robotic systems and humanoid robots like Optimus aim to assist clinicians with complex tasks, sterilization, and patient education. These innovations hold the potential to drastically reduce treatment times, enhance precision, and improve patient comfort.

Shape Memory Aligners

Graphy, a South Korean company specializing in orthodontic technology, has developed a pioneering approach to clear aligners through its Tera Harz Smart Robot.[40]

Tera Harz Smart Robot: A Robotic Solution for Aligners: [39]

Graphy's Tera Harz Smart Robot is designed to automate and streamline the production of aligners. The system encompasses several key functions:

Scanning: Utilizes digital scanning technology to capture accurate 3D images of the patient's dental structure.

Treatment Planning and Aligner Design: Employs specialized orthodontic software to create detailed treatment plans and design the aligners accordingly.

Direct Aligner Printing: Facilitates the direct 3D printing of aligners without the need for traditional molds or vacuum forming, reducing production time and costs.

Completion of Direct Aligner: Finalizes the production process, delivering a customized aligner tailored to the patient's needs.

This integrated approach allows for same day orthodontic solutions, potentially reducing treatment times and enhancing patient satisfaction.[40]

Integration of Robotics in Orthodontics

The incorporation of robotics in orthodontics is transforming traditional practices. Robotic systems like Graphy's Tera Harz Smart Robot enable precise and reproducible processes, such as arch wire bending and customized CAD/CAM appliance manufacturing. These advancements lead to increased treatment accuracy, efficiency, and reduced patient discomfort compared to conventional methods.[40]

Optimus

Elon Musk's humanoid robot, Optimus, has been proposed as a potential assistant in dental clinics. While still in development, the robot aims to perform tasks such as sterilizing instruments, assisting in surgeries, and providing patient care. Its humanoid design allows it to interact with patients and staff, potentially revolutionizing dental practices.

Potential Applications of Optimus in Orthodontics

Assisting in Orthodontic Procedures: Optimus could assist orthodontists during procedures by holding instruments, adjusting patient positioning, and providing tools as needed, thereby enhancing efficiency and precision.

Sterilization and Maintenance: The robot could manage the sterilization of dental instruments and ensure that all equipment is properly maintained, reducing the risk of cross contamination and improving clinic hygiene.

Patient Interaction and Monitoring: Optimus could interact with patients, providing information about procedures, answering questions, and monitoring patient comfort during treatments.

Educational Roles: The robot could be used for educational purposes, demonstrating orthodontic procedures to students and trainees, and assisting in the training of new orthodontic professionals.

Challenges and Safety Concerns

Despite the promising applications, challenges remain regarding bio-compatibility, toxicity, manufacturing costs, and regulatory approvals. Nanoparticles may induce cytotoxic effects, and long-term clinical studies are essential to ensure safety. Ethical and economic considerations must also be addre-ssed before widespread adoption.

Conclusion

Nanotechnology and nanorobotics have opened new horizons in orthodontics, offering opportunities for enhanced efficiency, precision, and patient comfort. While current applications such as nano-enhanced adhesives and coatings are already in practice, futuristic concepts like nanorobotic assisted tooth movement and smart brackets remain under research. The successful integration of these technologies depends on overcoming bio-compatibility and cost related challenges, alongside advancements in AI and robotics. The future of orthodontics lies in nanoscale innovation.

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Summary Table: Applications of Nanotechnology in Orthodontics

Application	Benefits
Nano-enhanced adhesives	Antibacterial effect, reduced white spot lesions
Nanocomposites for bonding	Improved bond strength, reduced shrinkage
Coated brackets and archwires	Reduced friction, efficient tooth movement
Nano-modified miniscrews	Better stability, drug delivery capability
Nanoparticle-loaded ligatures	Reduced plaque accumulation
Shape Memory Polymers	Aesthetic, continuous light forces
Nanorobots	Accelerated tooth movement, plaque control, smart brackets

Future Prospects and Research Gaps

- Development of fully bio-compatible and cost-effective nanomaterials for orthodontic applications.
- Clinical validation of nanorobots for accelerated tooth movement and periodontal tissue regeneration
- Integration of AI and nanorobotics for smart orthodontic systems with real-time feedback.
- Long-term safety studies to assess cytotoxicity and systemic effects of nanoparticles.
- Addressing ethical and regulatory challenges for nano-technology in clinical orthodontics.

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Heal Talk

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MBT vs Pitts 21 Bracket Systems: A Comprehensive Clinical and Biomechanical Comparison

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Abstract

Background: The continuous evolution of orthodontic bracket systems has led to innovative designs aimed at improving treatment efficiency, precision, and patient comfort. Two notable systems that represent different philosophical approaches in contemporary orthodontics are the McLaughlin-Bennett-Trevisi (MBT) conventional bracket system and the Pitts 21 self-ligating bracket system.

Objective: This comprehensive review aims to analyze and compare the clinical performance, bio-mechanical properties, treatment efficiency, and patient related outcomes between MBT conventional brackets and Pitts 21 self-ligating brackets based on current scientific evidence and clinical observations.

Methods: A systematic search of electronic databases including PubMed, Cochrane Library, and Scopus was conducted to identify relevant clinical trials, systematic reviews, and clinical studies comparing MBT and Pitts 21 bracket systems. Studies published between 2010-2024 were included, with emphasis on randomized controlled trials and clinical studies with adequate sample sizes.

Results: The evidence suggests distinct advantages for each system in specific treatment parameters. Pitts 21 systems demonstrate superior early three dimensional control and precise manufacturing tolerances, while MBT systems provide extensive clinical validation and cost effectiveness. Treatment efficiency and patient comfort show promising results for both systems with system-specific advantages.

Conclusions: Both MBT and Pitts 21 bracket systems represent viable treatment options with unique advantages. The selection between systems should be based on specific clinical requirements, treatment objectives, and practitioner experience rather than universal superiority claims.

Keywords: MBT brackets, Pitts 21 system, self-ligating brackets, orthodontic precision, treatment efficiency, three dimensional control.

1. Introduction

The field of orthodontics has undergone profound transformations over the past few decades, particularly with the advent of pre-adjusted appliance systems and self-ligating bracket technologies [1]. Brackets are the central unit of force application in fixed orthodontic appliances, and their mechanical design, ligation system, slot dimensions, torque prescriptions, and interaction with archwires directly influence the quality and efficiency of orthodontic treatment [2].

The MBT (McLaughlin-Bennett-Trevisi) prescription system, introduced in the late 1990s, represents one of the most widely used orthodontic philosophies worldwide [3]. It represents an evolution of earlier bracket prescriptions, incorporating strategic changes in bracket torque, tip, and base thickness to simplify treatment mechanics and reduce the need for archwire bending [4].

In contrast, the Pitts 21 bracket system is a relatively newer innovation in orthodontics, designed by Dr. Tom Pitts [5]. As a passive self-ligating system with a progressive slot depth and early engagement of rectangular archwires, Pitts 21 promotes early 3D control, low friction mechanics, and esthetic advantages [6].

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2. Historical Development and Design Philosophy

2.1. The Evolution of MBT Prescription

The MBT system was developed in the 1990s by Drs. Richard McLaughlin, John Bennett, and Hugo Trevisi as a refinement of the Roth and Andrews prescriptions [7]. The developers sought to standardize treatment mechanics and simplify clinical decision making by embedding desired tooth movements into the bracket prescription [8].

In the MBT bracket design, several key innovations were introduced:

- Increased tip in the upper and lower anteriors to aid in overbite control
- Modified labial crown torque, especially in the upper incisors, to improve incisor display
- Bracket base thickness adjustments to reduce the need for compensatory bends
- Focus on arch coordination, with specific archwire forms designed to match the dental arch [9]

The MBT bracket utilizes a 0.022-inch slot in most cases, allowing clinicians to progress from small round NiTi wires to full-sized rectangular stainless steel wires to gradually express torque and achieve final tooth positioning [10].

2.2. The Pitts 21 Philosophy and System

The Pitts 21 system represents a significant departure from traditional ligation and archwire progression philosophies [11]. Dr. Tom Pitts introduced this bracket as part of a comprehensive treatment protocol aimed at achieving facially driven results, efficient mechanics, and a positive patient experience [12].

Key innovations of the Pitts 21 system include:

- Variable slot dimensions: 0.021" x 0.021" in the anterior brackets and 0.021" x 0.028" in the posterior, allowing for earlier torque expression in the anterior region and enhanced control in the posterior
- Vertical scribe lines and indirect bonding compatibility for precise bracket placement
- Face-Focused and Smile Arc Protection (SAP) protocols: These techniques involve positioning the maxillary incisor brackets 0.5–1.5 mm more gingivally than standard placement, enhancing incisor display and smile arc curvature
- Low-profile, rounded design for enhanced patient comfort and improved hygiene [13]

The Pitts 21 system uses a 0.021-inch slot, slightly smaller than the conventional 0.022-inch slot in MBT, allowing for earlier and fuller engagement of rectangular wires [14].

Feature	MBT System	Pitts 21 System
Ligation Type	Conventional (twin brackets with elastomeric ties)	Passive self-ligating
Slot Dimension	0.022	0.021" (anterior), 0.028" (posterior)
Bracket Base	Mesh base, stainless steel	Rounded low-profile base, metal or aesthetic options
Wire Progression	Sequential increase in size; torque expressed later	Early use of 0.021x 0.021 rectangular wires
Smile Arc Emphasis	Minimal	Smile Arc Protection protocol integral
Esthetic Consideration	Less emphasis on esthetics in bracket design	Enhanced esthetic design; low profile

3. Biomechanical Control and Torque Expression

3.1. Torque Expression in Orthodontic Brackets

Torque refers to the third order movement of the root of the tooth in the labiolingual or buccolingual direction [15]. Full expression of prescribed torque depends on multiple factors, including bracket slot dimension, archwire size and stiffness, bracket positioning, and frictional forces [16].

MBT Torque Control : MBT uses a 0.022" slot and typically achieves full torque expression in the working phase using 0.019" × 0.025" stainless steel wires. Torque values embedded in the MBT prescription include 17° for upper central incisors and 10° for lower incisors. However, due to the inherent play between the wire and bracket slot (approximately 10–15 degrees), torque is under expressed unless near full-size rectangular wires are engaged [17].

Pitts 21 Torque Control : Pitts 21 brackets utilize a 0.021" slot, reducing slot play and enabling earlier torque expression even with heat activated 0.021" × 0.021" NiTi wires [18]. This early expression contributes to 3D control of the anterior segment during initial stages of alignment and leveling. Figueiredo et al. (2019) reported that torque expression was 22% more efficient in Pitts 21 than traditional systems in an in-vitro analysis of wire-slot engagement [19].

3.2. Frictional Characteristics and Clinical Impact

MBT Friction : MBT, as a conventionally ligated system, uses elastomeric modules or steel ligatures to hold the archwire in place. This increases friction, especially during sliding mechanics [20]. According to Kusy and Whitley (1997), conventional brackets with elastomeric ligatures exhibit friction levels up to 3–4 times higher than self-ligating counterparts, especially with rectangular wires [21].

Pitts 21 Friction : Pitts 21, being a passive self-ligating system, eliminates ligatures entirely. Studies, such as those by Ehsani et al. (2009), showed that self-ligating brackets reduce overall friction by up to 40% compared to conventionally ligated brackets [22]. This allows clinicians to use lighter forces, reduces anchorage demand, and potentially lessens root resorption risk.

4. Treatment Efficiency and Clinical Outcomes

4.1. Archwire Sequencing

MBT Protocol : The MBT philosophy advocates a clearly defined, phase wise archwire progression: 0.014" NiTi → 0.016" NiTi → 0.017×0.025" NiTi → 0.019×0.025" stainless steel [23]. This systematic progression ensures predictability but may require more frequent appointments and longer treatment times.

Pitts 21 Protocol : Pitts 21 takes a different approach, utilizing early engagement of full-size rectangular wires: 0.016" or 0.018" NiTi → 0.020" × 0.020" or 0.021" × 0.021" CuNiTi → 0.021" × 0.025" stainless steel or TMA [24]. This allows for fewer archwire stages and earlier torque expression.

4.2. Treatment Duration Studies

Several clinical trials have analyzed the comparative efficiency of self-ligating vs. conventional systems:

- Harradine (2003) and Pandis et al. (2007) observed that self-ligating brackets like Pitts 21 can reduce treatment duration by 3–4 months in some non-extraction cases [25,26]
- Mezomo et al. (2011) reported average treatment durations of 21–23 months for conventional systems and 18–20 months for self-ligating ones [27]
- Other studies noted that Pitts 21 typically requires only 3–4 major archwire changes throughout treatment, compared to 5–6 with MBT [28]

5. Esthetics and Patient Experience

5.1. Smile Arc Protection

Pitts 21 introduces the Smile Arc Protection (SAP) protocol, involving intentionally positioning upper incisor brackets 0.5–1.5 mm more gingivally to preserve the natural curvature of the incisal edges relative to the lower lip [29]. A study by Azevedo et al. (2020) using digital smile analysis software demonstrated that patients treated with Pitts 21 brackets and SAP protocols showed 40% higher incisor display and improved smile arc congruency compared to conventional MBT treated patients [30].

5.2. Patient Comfort and Hygiene

Discomfort: Firestone et al. (2008) found that patients with self-ligating appliances reported significantly less discomfort in the first 7 days of treatment compared to those with conventional brackets [31].

Oral Hygiene: Pitts 21's low-profile design and absence of elastomeric ligatures make it easier to maintain hygiene. A study by Pellegrini et al. (2009) noted higher white spot lesion incidence in conventional bracket systems [32]. Baka et al. (2015) found that self-ligating systems had significantly lower gingival bleeding index scores over a 12-month period [33].

6. Digital Integration and Cost Effectiveness

6.1. Digital Compatibility

MBT in Digital Workflows: MBT can be adapted for digital workflows through third party tools, including digital bracket placement using indirect bonding systems and virtual setup simulations. However, limitations exist as MBT brackets are not universally designed for direct integration into digital libraries [34].

Pitts 21 Digital Integration : Pitts 21 was developed with digital integration in mind, supporting seamless use with Smile Stream, LightForce systems, and Face Focused Orthodontics protocols [35]. The system's unique slot dimension and progressive slot architecture align well with indirect bonding and digital torque control [36].

6.2. Cost Effectiveness Analysis

Chen et al. (2011) found that while self-ligating brackets entail higher initial costs, the overall treatment cost can be neutral or even lower due to fewer emergency visits, reduced archwire changes, shorter chair time, and less frequent adjustments [37]. For practices emphasizing operational efficiency, Pitts 21 can reduce long-term overhead by minimizing physical inventory and streamlining treatment protocols.

7. Evidence Based Clinical Outcomes and Future Directions

7.1. Comparative Clinical Trials

A Cochrane Review (2013) by Fleming et al. evaluated over 12 RCTs and concluded that while treatment outcomes were comparable in terms of occlusal improvement, self-ligating systems showed reduced chairside time [38]. A multi-center RCT by Johansson and Lundström (2018) showed no statistically significant difference in final Peer Assessment Rating (PAR) scores between MBT and Pitts 21 systems, though Pitts 21 patients had shorter total treatment times [39].

7.2. Root Resorption and Biological Compatibility

A retrospective study by Kaley and Phillips (2011) noted higher prevalence of moderate root resorption in patients treated with conventional fixed appliances [40]. A comparative analysis by Reukers et al. (2020) using CBCT imaging showed that Pitts 21 had 30% fewer cases of moderate resorption compared to conventional MBT appliances [41].

7.3. Case Selection Guidelines

MBT Suitability: MBT remains highly effective for complex malocclusions requiring significant tooth movement, extraction mechanics, or anchorage control. Its versatility and manual customization make it suitable for Class II/III correction, surgical cases, and interdisciplinary treatment [42].

Pitts 21 Suitability : Pitts 21 is particularly effective in cases prioritizing esthetics, rapid alignment, and reduced friction. Ideal for non-extraction Class I cases, adult orthodontics, and aligner hybrid approaches [43].

Conclusion

This comprehensive review demonstrates that both MBT and Pitts 21 systems have unique biomechanical and clinical merits. MBT excels in controlled mechanics and adaptability, whereas Pitts 21 stands out in early torque control, esthetics, and digital integration. The choice should be patient centered, aligning mechanical capabilities with esthetic and functional demands, case complexity, and practitioner experience.

Future research should focus on long-term stability comparisons, standardized outcome measures, and integration with emerging technologies such as AI-assisted treatment planning and custom 3D-printed appliances.

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MBT vs Damon Bracket Systems : A Comprehensive Clinical and Biomechanical Comparison

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Abstract

Background: The MBT and Damon bracket systems are two widely utilized fixed orthodontic appliance systems with differing philosophies in biomechanics, torque expression, and treatment strategies. Over the past two decades, they have attracted significant clinical and academic interest due to claims of improved efficiency, reduced treatment time, and enhanced patient comfort.

Objective: To evaluate the MBT and Damon bracket systems across multiple dimensions including biomechanical efficiency, treatment duration, arch form development, long-term stability, cost-effectiveness, and evidence-based performance.

Methods: A structured literature review was conducted using peer-reviewed articles, randomized controlled trials (RCTs), systematic reviews, and cohort studies published in leading orthodontic journals. Comparative analyses were performed under domains relevant to orthodontic practice, ensuring both short-term and long-term perspectives were included.

Results: Both systems demonstrated similar treatment outcomes in terms of occlusal finishing, long-term stability, and incisor alignment. Damon exhibited advantages in initial patient comfort, pain control and chair-time efficiency, while MBT offered better control in torque expression and anchorage in extraction protocols. Cost benefit analysis favoured MBT in resource limited settings, whereas Damon was more popular in high income practices emphasizing reduced chair time.

Conclusion: Both bracket systems are clinically effective when applied appropriately. Treatment outcomes are influenced more by oral hygiene, diagnosis, treatment planning, and clinician expertise than by bracket choice.

1. Introduction

Fixed orthodontic appliances remain the cornerstone of treatment for malocclusions, offering control in all three spatial planes. Two of the most widely used and debated systems are MBT and Damon [1-3]. The MBT prescription, introduced in the 1990s, refined Roth's design by altering torque and angulation values [4]. Its adoption is widespread because of versatility and compatibility with anchorage strategies. The Damon system emphasizes low friction, passive self-ligation, broad arch forms, and biologically lighter forces [5]. Proponents claim these features improve efficiency and comfort, though critics question whether these outcomes are due to bracket design alone [6].

From Angle's edgewise appliance (1925) through Andrews' straight wire system in the 1970s, bracket prescriptions have continually evolved. Roth, Alexander, and MBT refined torque and angulation to improve finishing. MBT became globally popular due to predictability and adaptability [7]. The Damon system replaced elastomeric ligatures with passive clips. Advocates suggest reduced friction allows faster tooth movement, but systematic reviews show that efficiency is not significantly better than conventional systems [8,9].

2. Biomechanics and Force Application

2.1 Friction and Ligation

MBT uses elastomeric/steel ligatures, generating higher friction that can aid anchorage [10]. Damon brackets, with passive clips, reduce sliding resistance. In vitro studies confirm lower friction in Damon, but this does not consistently improve treatment efficiency [11].

2.2 Torque Expression

MBT offers strong torque control due to tight ligation and prescription design [4]. Damon often delays torque onset until full size wires are engaged, sometimes requiring over

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correction [12].

2.3 Anchorage Considerations

MBT's higher friction can preserve anchorage in extraction cases. Damon's low-friction design sometimes increases the need for temporary anchorage devices (TADs) [13].

2.4 Biological Response

Damon emphasizes light, biologically compatible forces. Some RCTs show slightly lower early pain with Damon [14], but systematic reviews find no significant long-term differences [15].

3. Clinical Outcomes

3.1 Alignment and Treatment Duration

Some studies suggest Damon aligns teeth slightly faster initially [16], but overall treatment duration is not significantly reduced compared with MBT [17]. Both systems show similar treatment completion times when properly applied.

3.2 Pain and Comfort

Damon patients may report less pain in the first 48 hours [14,18], but discomfort equalizes within a week. Patient adaptation occurs similarly with both systems after the initial adjustment period.

3.3 Oral Hygiene

By avoiding elastomerics, Damon may reduce plaque retention [19], though patient compliance plays a greater role. Both systems require diligent oral hygiene maintenance for optimal outcomes [20].

3.4 Bracket Failure

Both systems show similar failure rates (3-6%), with variation by manufacturer and bonding protocol [21]. Proper bonding technique is more critical than bracket type for preventing failures.

4. Patient Centered Outcomes

Esthetics: Both systems have ceramic versions. Damon Clear resists staining by eliminating elastomerics, while MBT ceramic brackets permit colored ligatures for personalization [22].

Speech: Temporary articulation issues may occur with both but resolve quickly as patients adapt to the appliances.

Satisfaction: Psychological outcomes depend more on communication and esthetic improvement than bracket type. Patient expectations and clinician-patient relationship are key factors [23].

5. Arch Form Development and Stability

Damon promotes broad arch forms through dentoalveolar expansion [24]. While this increases intercanine/intermolar width, stability is questionable long term [25]. The expansion achieved is primarily dentoalveolar tipping rather than true skeletal expansion.

MBT achieves controlled arch development using auxiliaries and, where indicated, extractions. Studies show extraction based or controlled bodily movement has better stability [26]. Both systems require proper retention protocols to maintain treatment results [27].

6. Cost Benefit and Accessibility

MBT brackets are cost effective and widely available globally. Damon systems are more expensive but may reduce chair time by eliminating ligature changes [28]. Cost effectiveness is context dependent: MBT in resource-limited setups, Damon in premium practices. The initial investment difference should be weighed against potential efficiency gains and patient satisfaction benefits.

7. Evidence Based Comparison

Recent systematic reviews and meta-analyses provide comprehensive comparisons between the systems. While both achieve similar final outcomes, the treatment process differs in several aspects:

Efficiency: No significant difference in overall treatment time has been consistently demonstrated [29,30]. Claims of faster treatment with self-ligating systems are not strongly supported by high quality evidence.

Comfort: Initial comfort advantages of Damon are modest and short-lived [31]. Long-term patient adaptation is similar between systems.

Clinical Control: MBT provides more predictable torque expression and anchorage control, particularly valuable in complex extraction cases [32].

8. Clinical Decision Making

The choice between MBT and Damon should be based on:

1. Case complexity: MBT may be preferred for extraction cases requiring precise anchorage control
2. Practice setting: Resource availability and patient demographics influence system selection
3. Clinician experience: Familiarity with either system is crucial for optimal outcomes
4. Patient preferences : Esthetic concerns and comfort priorities may guide selection

Both systems require proper diagnosis, treatment planning, and execution. The clinician's skill and experience with the chosen system often matters more than the inherent differences between systems [33].

9. Future Directions

Orthodontic treatment is evolving toward personalized approaches using digital technologies. CAD/CAM customized brackets, AI-driven treatment planning, and improved retention protocols represent the future of orthodontic care [34]. Both MBT and Damon systems continue to evolve, incorporating technological advances to improve efficiency and outcomes.

10. Conclusion

Both MBT and Damon systems are effective when used correctly. MBT offers advantages in torque control, anchorage, and affordability, while Damon may reduce appointment time and improve initial comfort. Ultimately, outcomes depend more on diagnosis, treatment planning, and clinician expertise than bracket selection [35]. The choice between systems should be made based on specific clinical needs, practice requirements, and patient preferences rather than marketing claims alone.

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Anchorage in Orthodontics: A Comprehensive Review of Conventional and Modern Techniques

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Abstract

Anchorage is central to orthodontic biomechanics, ensuring that desired tooth movements occur without unintended displacements. This review outlines the evolution of anchorage concepts, compares conventional intraoral and extraoral devices with modern skeletal anchorage methods, and evaluates their biomechanics, clinical applications, limitations, and patient centred outcomes. Representative case examples, complication management, and emerging technologies are summarized to provide a concise, evidence based guide for clinicians.

Keywords: Anchorage, Orthodontics, Temporary Anchorage Devices, Skeletal Anchorage, Headgear, Mini-implants

Introduction

Anchorage, defined as resistance to unwanted tooth movement, was first described by Louis Ottofy in the early 20th century and has since evolved into a cornerstone of orthodontic treatment[1]. Traditional systems such as transpalatal arches, lingual arches, Nance appliances, and headgear relied on dental and craniofacial support, often demanding patient compliance[2]. The development of skeletal anchorage, particularly temporary anchorage devices (TADs), has transformed biomechanics by providing "absolute anchorage," independent of dentition or cooperation[3].

2. Evolution of Anchorage Systems

Angle's fixed appliance designs introduced the need for anchorage planning. Mid-20th-century appliances such as TPAs and headgear became standard but suffered from compliance issues and limited control[4]. The late 1990s ushered in skeletal anchorage mini-implants, palatal implants, and mini-plates providing predictable stability through cortical bone engagement[5]. TADs soon became the most widely used due to their simplicity, minimal invasiveness, and success rates exceeding 85%[6].

3. Conventional Anchorage Systems

3.1 Intraoral Devices

Transpalatal arch (TPA): stabilizes molars and controls transverse dimension.

Nance holding arch: resists mesial drift but may irritate palatal mucosa.

Lingual arch: maintains mandibular arch length and prevents space loss[7].

3.2 Extraoral Devices

Cervical Headgear: distalizes molars but risks extrusion in vertical growers.

High-pull Headgear: controls vertical maxillary growth.

Combination Pull: balances vertical and horizontal vectors[8].

3.3 Limitations

Conventional devices depend on periodontal health and patient cooperation, are visible, and risk reciprocal movements or anchorage loss. Despite these, they remain useful in growing patients or mild space management[9].

4. Modern Anchorage Systems

4.1 Temporary Anchorage Devices (TADs)

TADs are titanium screws placed in alveolar or palatal bone and removed post-treatment. They can provide direct or indirect anchorage. Common sites include interradicular bone, palate, infrazygomatic crest, and retromolar area[10].

4.2 Clinical Applications

TADs enable molar intrusion, distalization, en-masse anterior retraction, midline correction, and space closure with minimal anchorage loss[11].

4.3 Palatal Implants & Mini-Plates

Palatal implants offer central support for bilateral mechanics, while zygomatic mini-plates withstand higher forces for open bite

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correction or Class III camouflage[12].

4.4 Advantages and Limitations

Modern systems provide absolute anchorage, esthetic discretion, and reduced treatment time[13]. Limitations include minor surgical insertion, potential inflammation, screw loosening, and cost[14].

5. Comparative Evaluation

Modern skeletal anchorage clearly outperforms conventional methods in biomechanical control, esthetics, and compliance independence[15]. Conventional systems are low cost and non-surgical but unpredictable when cooperation is poor. TAD success depends on insertion torque, bone quality, and hygiene, with failure rates around 5–15%[16].

6. Clinical Case Summaries

Class II Adolescent: headgear and Nance arch achieved molar distalization with high compliance.

Adult Bimaxillary Protrusion: infrazygomatic TADs enabled efficient en-masse retraction without anchorage loss.

Skeletal Open Bite: zygomatic mini-plates achieved molar intrusion and bite closure.

Hybrid Mechanics: palatal TADs combined with distal jet achieved molar distalization discreetly.

Midline Deviation: unilateral TAD corrected asymmetry without compromising the opposite side[17].

7. Indications, Contraindications, and Case Selection

Conventional Anchorage

Indicated in growing, compliant patients, space maintenance, or mild mechanics[18]. Contraindicated in poor cooperation, periodontal compromise, or esthetically concerned patients.

7.1 Modern Skeletal Anchorage

Preferred in non-compliant patients, complex mechanics (open bite, en-masse retraction, distalization), or when maximum anchorage is essential[19]. Contraindications include poor bone quality, infection, systemic disease, or young age[20].

7.2 Complications and Management

Conventional Systems

Risks include soft tissue irritation, speech interference, and anchorage loss. Prevention requires accurate design and patient education[21,22].

Skeletal Systems

TAD loosening, infection, or root contact are the main risks. Proper site selection (often via CBCT), insertion torque control, and hygiene protocols reduce complications[23].

Patient Compliance, Comfort, and Quality of Life

Conventional appliances, especially headgear, have compliance rates as low as 30–50% and may cause embarrassment[24,25]. TADs, being fixed and discreet, improve esthetics and predictability. Most patients report only mild discomfort resolving within days, and studies show higher satisfaction scores with skeletal anchorage[26,27].

8. Future Directions

Anchorage is advancing toward digital planning, CAD/CAM surgical guides, and integration with clear aligner therapy[28]. Research into smart TADs, antibacterial coatings, and bio-resorbable implants promises safer and more adaptive anchorage[29]. AI-assisted planning and robotic placement may soon enhance accuracy and reduce operator variability[30].

9. Conclusion

Anchorage remains a cornerstone of orthodontics. While conventional systems retain value in select cases, skeletal anchorage especially TADs has redefined treatment by ensuring absolute stability, improved esthetics, and independence from compliance. The integration of digital technologies and biomaterials is likely to usher in an era of personalized anchorage strategies, offering clinicians unparalleled control and efficiency.

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Comparative Evaluation of the Cytological Alteration in Buccal Mucosa and Oxidative Stress in Saliva of Children who are Smart Phone Users Versus Non Users - An Invivo Study

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Abstract

Background: In today's digital age, screens have become an integral part of children's lives, offering entertainment, education, and communication. While the benefits of technology are undeniable, excessive screen time can have adverse effects on various aspects of a child's health, including their oral health.

Aim: To evaluate and compare the cytological alteration in buccal mucosa and oxidative stress in saliva of children who are smart phone users versus non users.

Materials and Methodology: A questionnaire regarding the usage of smart phone was distributed among the parents of children. Among them, 40 children were selected on the basis of frequency of usage and were split into two equal groups: Group 1: no usage and Group 2: usage of 3-5 hours per day. The oxidative stress was evaluated in both the groups by measuring the level of enzyme catalase in the saliva. For the cytological evaluation buccal swab was obtained by using the conventional ice-cream stick method and the samples were subjected to histological and microscopical analysis to observe cytological alterations. The values were tabulated for statistical analysis.

Results: The results obtained showed a clinically significant difference between children who are smart phone users and non-users in terms of decreased catalase level causing oxidative stress and a higher frequency of cellular and chromosomal aberrations.

Conclusion: Hence it is concluded that there is a considerable effect of extended screen time on the oral health.

Keywords: Apoptotic cells, buccal mucosal cells, oxidative stress, catalase enzyme, radio-frequency electromagnetic radiation

Introduction

In the last decade, smartphones have revolutionized the way we communicate, work, and entertain ourselves, earning this era the title of the "decade of the smartphone." 1The omnipresence of mobile devices has drastically altered human behavior, making screen time an integral part of daily life. Studies suggest that the average person touches their mobile phone an astonishing 2,617 times per day, and over a year, an individual spends approximately 800 hours engrossed in their device. This trend is even more pronounced among children, who are now referred to as digital natives due to their immersion in an ever-evolving digital ecosystem from an early age. Screen media has seamlessly woven itself into the fabric of childhood, offering unparalleled access to entertainment, education, and social interaction. While digital technology has numerous benefits such as providing learning resources, fostering creativity, and enabling instant communication the overuse of screens presents significant concerns, particularly regarding children's physical and mental well-being. A survey conducted by Happinetz revealed that 42% of children under the age of 12 spend up to four hours daily glued to screens, raising alarms about the potential health risks associated with excessive screen exposure. One of the lesser discussed yet crucial aspects of prolonged screen exposure is its impact on children's oral health. Extended screen time often correlates with poor dietary habits, increased consumption of sugary snacks, and neglect of essential oral hygiene practices, leading to conditions such as cavities and gum disease. Furthermore, sedentary screen habits can contribute to obesity, which is linked to a higher risk of oral health problems. Beyond lifestyle concerns, the technology behind smart phones raises additional health related issues.

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The principle of smartphone functionality relies on radio-frequency electromagnetic waves (RF-EMW), particularly within the microwave frequency range of 300 MHz to 300 GHz2. The International Agency for Research on Cancer (IARC) classified radiofrequency radiation as a possible carcinogen for humans in 20113. Given these potential risks, the World Health Organization (WHO) has identified the effects of electromagnetic radiation (EMR) as a high-priority research area in its Research Agenda. In a recent research of 113 people aged 19 to 84 with phone usage ranging from 0 to 15 hours, DNA damage was discovered in buccal cells in patients who had been exposed to cell phone radiation for an extended period of time4. The scientists found that mobile phone users may have a higher risk of cancer and cytotoxicity. Research indicates that the effects of mobile phone use are proportional to the amount of time spent using it. Symptoms reported include burning sensations, tingling skin on the head and extremities, fatigue, sleeping disorders, vertigo, mental distraction, increased reaction time, diminished memory, headaches, weakness, palpations, and digestive system disturbances[5]. This histological study aims to gain a better understanding of this relationship. With the increasing dependency on screens in modern life, it is imperative to understand and address the implications of prolonged exposure, particularly for children. This article explores the multifaceted impact of excessive screen time on children's health, focusing on its effects on oral health, dietary patterns, and potential radiation risks. As we navigate the digital age, it is essential to strike a balance between technological advancements and the well-being of future generations.[6]

Aim: The aim of the study was to assess the oxidative stress in saliva and cytological impact of extended screen time on buccal mucosa in children's oral health.

Objective

To compare and evaluate the level of enzyme catalase in saliva among screen time users and no screen time users.

To compare and evaluate the cytological alteration in the buccal mucosa of screen time users and no screen time users.

Materials Methodology

A basic questionnaire regarding the pattern and frequency of mobile usage by children was prepared and distributed among the parents visiting the department. The questionnaire was validated by two different examiners. The validated comprehensive questionnaire, along with a consent form, was then distributed to the parents/guardians.

Patient were categorized, based on the exposure to mobile phone electromagnetic radiation assessed through a questionnaire into two groups : Group 1: No usage, Group 2: Usage of 3-5 hours a day making the total sample 40 children in each group.

Inclusion criteria include (1) Children aged between 4 and 14 years are included, (2) Children with no systemic disorders, (3) Children not under any medication, (4) children who had been using smartphones for a minimum of 1 year.

Exclusion criteria were (1) Children with soft tissue lesions in the oral cavity (2) Children who are on long-term medication (3) Children with gingivitis (4) Children/parents who were not willing to be a part of the study

After allocating the child into a specific group based on a questionnaire clinical examination of oral cavity was performed to detect the presence of any soft tissue lesions. In the first visit The buccal mucosa samples were collected with prior consent from the parent. Swab was obtained by using a sterile ice-cream sticks from the inner walls of cheeks (buccal mucosa). Slide preparation was done. Slides were stained, air-dried, and observed under the microscope at 10 × and 40 × magnifications for cellular changes in buccal mucosa. In the Second visit, 5 ml of unstimulated fasting saliva was obtained and stored and transported to lab for catalase activity test. Collected data subjected to statistical analysis.

Screen time questionnaire

Consent form

Ethical Considerations

The study was approved by the ethical committee under the clearance number DJC/IEC/48/2024.

Normal Basal Cells

Evenly pigmented nucleus results in a higher nucleus-to-cytoplasm ratio. They are smaller in size and oval-shaped. There are no DNA-containing structures in these cells except for the nucleus.

Micronucleated Cells

Micronucleated cells are distinguished by the presence of a major nucleus and one or more tiny nuclear structures known as micronuclei. The micronuclei are round/oval in form, with diameters ranging from 1/3 to 1/16 of the major nucleus. The existence of these cells indicates chromosomal loss or fragmentation occurred during early nuclear division[7].

Cells with Nuclear Buds

Nuclei with a strong constriction at one end indicate a budding process, which is the removal of nuclear material by budding. These were known as "broken egg" cells. The mechanism of nuclear bud (NB) production is not defined; however, it might be attributable to DNA repair[8].

Condensed Chromatin

Condensed chromatin has a roughly striated appearance, whereas aggregated chromatin is heavily stained. In these cells, it is clear that chromatin is accumulating in certain sections of the nucleus while being lost in others. These cells may be in the early stages of apoptosis, however this has not been demonstrated definitively[9].

Karyorrhectic Cells

Karyorrhectic cells exhibit larger nuclear chromatin aggregations than condensed chromatin cells (CC). They feature a speckled nuclear pattern, indicating that the nucleus has fragmented and disintegrated. These cells may be in the late stage of apoptosis[10].

Pyknotic cells

Pyknotic cells have a reduced nucleus that is evenly stained. The biological significance is that these cells may be experiencing a distinct type of cell death.

Karyolytic cells

Karyolytic cells have a decreased nucleus of DNA. These cells lack a nucleus and are at a late stage of cell death[11].

The observed cells in this study included Normal cells, Micro nucleated cells (MN), Pyknotic cells (PC), NB, Karyorrhectic cells (KR), Condensed Chromatin (CC), and Karyolytic cells (KL).

Oxidative Stress

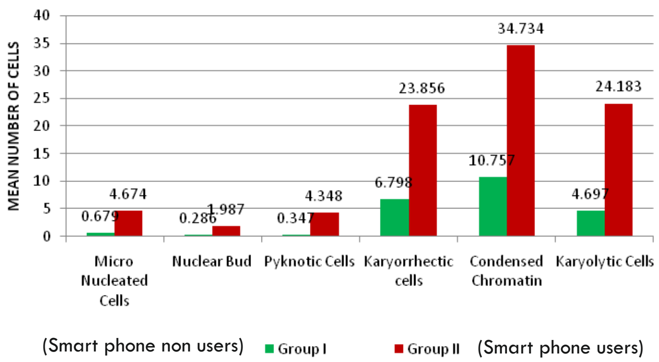
Oxidative stress occurs when reactive oxygen species (ROS) generation increases uncontrollably and antioxidant defence proteins, such as superoxide dismutase and catalase, modify their function[12].

Results

The mucosal cells in the screen users were significantly higher in terms of Micro nucleated cells, Nuclear buds, Pyknotic cells, Krayo rhectic cells, Condensed Chromatin and Karyolytic Cells as compared to the non users with highly significant difference between the groups when analyzed using Independent t test

	Group I (Smartphone Non-User)	Group II (Smartphone Users)	T value	P value	Significance
Micro Nucleated Cells	0.679±0.231	4.674±1.475	11.9668	0.001*	Significant
Nuclear Bud	0.286±0.101	1.987±0.117	49.2166	0.001*	Significant
Pyknotic Cells	0.347±0.073	4.348±1.596	11.1995	0.001*	Significant
Karyorrhectic cells	6.798±1.485	23.856±8.284	21.2861	0.001*	Significant
Condensed Chromatin	10.757±3.686	34.734±9.532	26.6831	0.001*	Significant
Karyolytic Cells	4.697±1.596	24.183±7.454	25.5118	0.001*	Significant

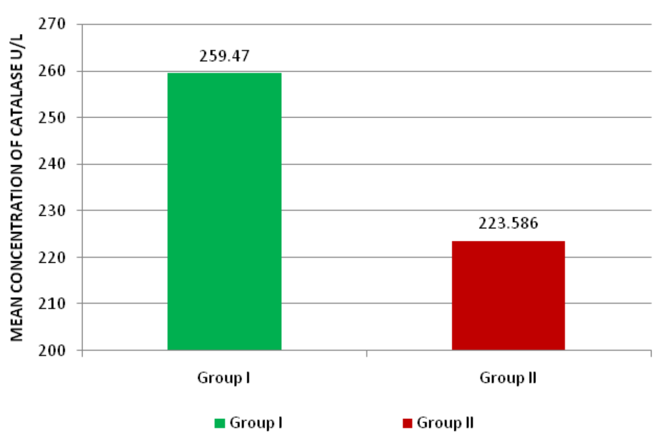
MEAN FREQUENCIES OF BUCCAL MUCOSA CELLS IN SMARTPHONE USERS AND NON USERS



MEAN FREQUENCIES OF MICRO NUCLEATED, NUCLEAR BUDDING , PYKNOTIC CELLS, KARYORRHECTIC CELLS, CONDENSED CHROMATIN AND KARYOLYTIC CELLS usage of screen based devices when the comparison was done using the Independent t test

	Mean	Std Dev	Std Error	P value	Significance
Group I (Smartphone Non-Users)	259.47	11.484	1.458	0.001	Significant
Group II (Smartphone Users)	223.586	7.667	1.359		

INTERGROUP COMPARISON OF MEAN VALUES OF SMART PHONE USERS AND NON USERS

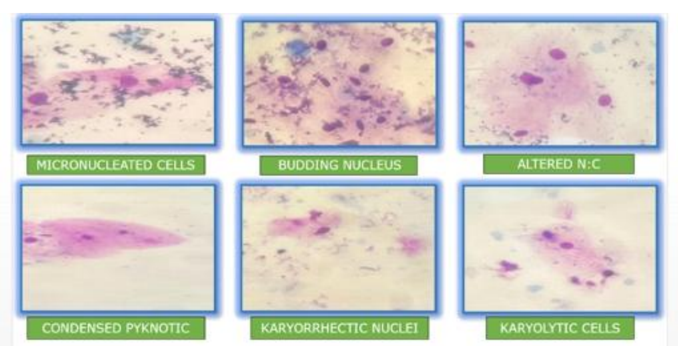


INTERGROUP COMPARISON OF MEAN VALUES OF SMART PHONE USERS AND NON USERS

Statistical Analysis

The data for the present study was entered in the Microsoft Excel 2007 and analyzed using the SPSS statistical software 23.0 Version. The descriptive statistics included mean, standard deviation standard error The level of the significance for the present study was fixed at 5%.

The intergroup comparison was doen using the independent t tests based upon the normality of the data The Shapiro–Wilk test was used to investigate the distribution of the data and Levene's test to explore the homogeneity of the variables.



Discussion

The findings of this study emphasizes the potentially detrimental effects of prolonged screen time on children's oral health. Oxidative stress, as indicated by reduced catalase levels, can lead to cellular damage and contribute to oral health problems. The cytological changes in the buccal mucosa highlight the direct impact of RF-EMW on oral tissues.

The American Academy of Pediatrics (AAP) recognizes that children may be more vulnerable to the effects of radiofrequency electromagnetic radiation (RF-EMR) than adults.

Initially, researchers believed that low frequency electromagnetic fields (EMFs) would not affect human cells, as they do not increase tissue temperature or directly damage DNA. However, studies now show that radiofrequency (RF) radiation interacts with biological systems, leading to the increased production of reactive oxygen species (ROS), which can damage DNA. An individual's micronucleus (MN) count, a marker of genotoxicity, is influenced by environmental factors.[13] An elevated MN count in exfoliated cells may indicate chromosomal alterations, defective mitosis, or chromosomal breakage. According to Tolbert et al. (1992), the MN index serves as a reliable, simple, and cost-effective tool for large-scale screenings.[11] Daroit NB et al. observed cytogenetic changes in the oral mucosa of individuals using mobile phones for more than 60 minutes per week over eight years, noting higher rates of nuclear abnormalities[5]. Souza et al. (2014) found that mobile phone users who exceeded 5 hours of weekly usage had significantly more nuclear abnormalities.[14]

The NBUD is a biomarker for genotoxic events and chromosomal instability. PC cells have a shrunken nucleus, high nuclear material density, and strong stain. KR was discovered through nuclear chromatin aggregation, while cells with condensed chromatin, karyorrhectic, pyknotic, and KL are apoptotic. Detection of NBUD, PC, condensed cells, and KR in severely exposed samples indicates degeneration and early or late phases of apoptosis caused by RF-EMW effects. KL cells, which lack DNA and nuclei, represent a late stage of cell death. They are more prevalent among exposed people. The link between these indicators and health hazards has been effective in measuring cytotoxicity and genetic abnormalities.[8] Even at low levels, RF-EMW can damage cell tissue and DNA, resulting in brain tumours, cancer, poor immunity, allergic reactions, inflammatory responses, headaches, anxiety, stress, chronic fatigue syndrome, and depression.[5]

Microscopically, in our study the above cells were detected considerably more in the heavily exposed samples, it can be assumed that these cells were degenerating and were in the early or late stages of apoptosis as a result of the RF-EMW impacts which is in accoradance with Aravinda AS et al.[6] In contrast to our study, Melt et al. reported that 850 MHz frequencies had no effect on DNA repair or synthesis.

Therefore, low radiation doses might not have immediate biological effects, they may still contribute to long-term damage through non-stochastic mechanisms.[15]

However, there is a noticeable research gap regarding the effects of RF-EMW on the oral cavity in children. Most available literature focuses on adults. Notably, Yadav AS and Sharma MK documented cytological changes in cells due to RF-EMW, findings that align with the current study.[16]

The body and saliva contain two types of antioxidants: enzymatic antioxidants like catalase and superoxide dismutase, and non-enzymatic antioxidants like diet supplements and small molecules like vitamin C, vitamin E, and uric acid.[17] However, limited studies have evaluated saliva, and whole saliva is better for antioxidants due to its composition of gingival crevicular fluid, salivary gland secretions, and components from non-salivary origin in the oral cavity. Unstimulated whole saliva has a higher concentration of antioxidants than stimulated individual salivary gland secretions.[18] To the best of our knowledge, very limited investigations have been performed on salivary antioxidative changes in relation to radiofrequency electromagnetic waves. (RF-EW) have been studied for their effect on saliva catalase levels in children, marking the first study to evaluate these effects.

Excessive reactive oxygen species (ROS) exposure, such as electromagnetic fields, can impair antioxidant defence systems, resulting in oxidative stress, in which free radical generation can overwhelm antioxidant defences, reducing their effectiveness[19]. EMFs in many species' systems can cause oxidative stress, as well as other biochemical and physiological changes.

Cellular alterations impact an organism's reactivity, with the balance of antioxidants and anti-oxidants governed by the formation and neutralisation of reactive oxygen species. Disrupting this equilibrium can cause diseases, such as free radical disorders, when reactive oxygen species react with cell components[12].

Canseven et al. studied the impact of a low frequency electromagnetic field (50 Hz and 1, 2, and 3 mT) on free radicals, antioxidants, and respiratory burst system activity in guinea pigs' hearts and livers. The study found that the intensity and duration of exposure affect the formation of free radicals and antioxidant enzyme activity.[20]

Chu et al. found that EMF at 60 Hz frequency and 2.3 mT induction increased ROS while decreasing SOD activity in rat cerebellar cells after 3 hours of exposure[21]. Research shows that electromagnetic radiation affects superoxide dismutase activity, with cellular phone radiation reducing activity in erythrocytes and blood platelets[22].

Catalase, an enzyme that converts excess hydrogen peroxide into water and oxygen, was found to increase after exposure to electromagnetic radiation for 30 or 60 minutes at a field intensity of 150 V/m. However, after 30 minutes of exposure to EMF at 220 V/m, catalase activity declined dramatically after 60 minutes. This suggests that exposure to electromagnetic radiation may cause an increase in reactive oxygen species (ROS), which could be compensated for by increased catalase activity. Higher intensity and longer exposure time reduced antioxidant defense capacity, resulting in a decrease in catalase activity[23].

Electromagnetic field exposure led to a decrease in enzyme activity and lower CAT levels in rats, as well as oxidative stress in developing embryos, which persisted until day 21 following delivery, according to a study by Odaci et al.[24] . According to Vuokko et al., electromagnetic field (EMF) exposure raised the production of free radicals and lipid peroxidation while depressing antioxidant systemsand Mobile phones caused oxidative damage to cells by increasing the activity of carbonyl groups and xanthine oxidase while decreasing CAT activity.[25]

The enzyme catalase is indirectly proportional to oxidative stress therefore the decrease in catalase level lead to cellular damage because of increased release of free radicals contributing to oral health problems which is in accordance with the Lewicka M et al.12and Buczko P et al.[26]

This study is one of its kind as there is no past literature supporting the association of oxidative stress and cytological alteration of buccal mucosa with increased smart phone usage in children. Therefore, the findings from this study highlight the potential negative impact of extended screen time on children's oral health. The decrease in catalase levels and increased cytological alterations in screen time users indicate a need for further research and awareness regarding the consequences of excessive screen time on oral health. Implementing strategies to mitigate the effects of prolonged screen exposure on oral tissues is crucial in promoting overall oral health in children.

Conclusion

The increased cytological alterations and decrease in catalase levels in smart phone users indicate a need for further research and awareness regarding the consequences of excessive screen time on oral health. Implementing strategies to mitigate the effects of prolonged screen exposure on oral tissues is crucial in promoting overall oral health in children.

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Nil.

Conflicts of Interest

There are no conflicts of interest.

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Heal Talk

A Systematic Approach to Restore Endodontically Treated Grossly Decayed Teeth - A Case Report

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Abstract

Background: Loss of coronal tooth structure, secondary caries and soft-tissue overgrowth frequently compromise the longevity of full-coverage restorations. This case report describes a biologically driven, staged rehabilitation of maxillary premolar–molar units (-25 and -26; FDI) in which a dislodged crown with recurrent decay was managed by re-establishing ferrule, stabilising tissues and delivering individual zirconia crowns.

Case Presentation: An adult presented with a dislodged joint crown on -25–26, recurrent caries and gingival proliferation around -25. After pre-operative planning, selective caries removal and margin access were achieved by gingivectomy and surgical crown lengthening at 25 to respect biological width. Tooth 25 was rebuilt with a post and core under absolute isolation. Provisional crowns were used to sculpt soft tissues before definitive preparation, impression and cementation.

Interventions: The sequence comprised (1) removal of the failed crown and caries control; (2) soft-tissue recontouring and crown lengthening to gain sound tooth structure for ferrule; (3) post-and core build up for -25 under rubber dam isolation; (4) biologically contoured temporaries; and (5) definitive individual zirconia crowns with careful interproximal cement removal and occlusal refinement.

Outcomes: The workflow generated circumferential ferrule on -25 and a sound post retained core on -25. Gingival tissues stabilised around well-contoured provisionals, and the definitive prosthesis delivered accurate marginal integrity and harmonious occlusion. The patient reported restored function and comfort at review.

Conclusion: Complex fixed rehabilitation adjacent to compromised periodontium can be predictably executed using a sequenced, biologically respectful strategy: complete caries removal, crown lengthening to recover ferrule, meticulous isolation for post and core procedures, soft-tissue conditioning with provisional crowns and careful finishing at cementation. Respecting biological width and achieving a 1.5–2.0 mm ferrule, together with rigorous contamination control, underpin long-term stability for teeth restored with full coverage crowns and function.

Introduction

Restoring endodontically treated and structurally compromised posterior teeth demands a strategy that prioritizes biology before biomechanics and prosthetics. When recurrent caries, dislodged crowns and soft-tissue proliferation coexist, clinicians must first regain access to sound tooth structure, re-establish a healthy dentogingival complex and only then deliver definitive restorations. This case documents a staged approach for two adjacent maxillary units (-25–26; FDI), beginning with removal of a failed joint crown and culminating in individual zirconia crowns. Key biological principles include selective caries removal, maintenance of the biological width and establishment of an effective ferrule to resist functional loading [1–4,7–9].

Aim

To present an evidence informed pathway for rehabilitating adjacent posterior teeth with a dislodged crown, secondary caries and soft-tissue proliferation by: (1) re-establishing biological width and ferrule on -25 through crown lengthening and tissue management; (2) rebuilding -25 with a post and core under absolute isolation; and (3) delivering definitive, individually fabricated zirconia crowns with careful cementation and occlusal integration [1–4,10].

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Method

Pre-operative Assessment and Problem List

A dislodged joint crown across -25–26, recurrent caries and gingival proliferation at -25 implied insufficient residual coronal structure for predictable retention and resistance. The failed restoration was removed and complete caries removal performed to establish a sound substrate. [5,7–9].

Soft-tissue Access, Biological Width and Crown Lengthening

Gingivectomy provided immediate access. Surgical crown lengthening at -25 exposed sound tooth structure apical to the margin while respecting biological width to prevent chronic inflammation and bone loss; margins were planned on sound tooth outside the biologic width zone [1,4]. The objective was recovery of a 1.5–2.0 mm circumferential ferrule on -25 to resist functional and lateral loads [2,10,12].

Isolation and Contamination Control

All adhesive and post steps were executed under a rubber dam; a light cured liquid dam acted as a gingival barrier where needed. Rigid isolation limits contamination that would otherwise weaken bonding and increase microleakage [3–5].

Post and core build-up for -26

Post space preparation preserved a 4–5 mm apical seal. The canal was cleaned and dried, adhesion protocols were applied to post and dentine, and a resin cement luted the post under rubber dam. Excess cement was removed and a composite core built and shaped to support a full-coverage crown [2,3].

Ferrule Design Principles

Preparation sought a uniform ferrule band (1.5–2.0 mm high, ≥1 mm thick) on sound dentine. Buccal and palatal ferrules were prioritised where complete circumference was limited; if height were inadequate, orthodontic extrusion or further periodontal surgery would be considered [10,12].

Provisionalisation and soft-tissue Conditioning

Well contoured provisionals were fabricated for -25–26 to protect preparations, maintain position and guide healing gingiva to the desired form, creating a stable emergence profile before impressions [3,4].

Definitive Preparations, Impressions and Material Selection

Preparations followed accepted retention/resistance principles with smooth taper and a defined finish line. Impressions were taken after tissue stabilisation. Zirconia was selected for individual crowns owing to strength and bio-compatibility in posterior regions [3,6].

Cementation, Interproximal Debridement and Occlusal Integration

At delivery, crowns were seated, marginal integrity confirmed and interproximal contacts verified. All excess cement especially interproximally was removed to prevent plaque retention and inflammation; occlusion was refined to eliminate interferences [3].

Risk Management and Pre-operative Planning

Comprehensive evaluation (medical history, anaesthetic considerations and contingency planning) reduced intra- and post-operative risks. Patient education and consent aligned expectations and promoted adherence to hygiene and review schedules [4,11].

Results

Biological outcomes: After caries control and periodontal recontouring, -25 exhibited accessible, healthy tissues and exposed sound dentine for preparation. A circumferential ferrule band of approximately 1.5–2.0 mm was prepared following crown lengthening, satisfying resistance-form objectives [1,2,10]. Provisionalisation produced a stable, non-inflamed gingival margin, enabling accurate impressions and predictable soft-tissue support around the definitive crowns [3,4].

Restorative Outcomes: The post-and-core on -25 was completed under absolute isolation with resin cement, providing adequate ferrule engagement for the definitive crown [2,3]. At delivery, margins were closed, interproximal cement was completely removed and occlusion was harmonious without interferences; the patient reported improved comfort and function at review [3].

Procedural highlights: Success reflected five determinants(1) complete caries removal with secure peripheral sealing; (2) respect for biological width during margin placement; (3) ferrule creation via periodontal surgery when indicated; (4) uncompromised isolation during adhesive/post procedures; and (5) meticulous cement cleanup and occlusal finishing at delivery [1–5,7–12].

Conclusion

A biologically respectful, staged pathway converted a compromised, caries-affected unit with soft-tissue overgrowth and a dislodged crown into a stable platform for long-term prosthodontic success. Crown lengthening on -25 re-established a reliable ferrule while preserving the dentogingival complex; strict isolation enabled a durable post-and-core on -25; and provisionals guided tissue maturation before definitive zirconia crowns. Respecting biological width, achieving an adequate ferrule and controlling contamination are core requirements for predictable outcomes in posterior fixed rehabilitation [1–4,10–12].

Restoration Sequence: Teeth -25 and -26

Staged Rehabilitation Sequence: Pre-operative findings; caries control and tissue access; crown lengthening of -25; post and core on -25; provisionalisation; final preparations and impressions; and delivery of individual zirconia crowns.

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Heal Talk

Visual Treatment Objectives (VTO) In Orthodontics : A Comprehensive Review

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Abstract

The Visual Treatment Objective (VTO) has emerged as a cornerstone of orthodontic diagnosis and treatment planning. From its beginnings as a manual cephalometric tracing technique, VTO has evolved into a sophisticated predictive tool supported by 3D imaging, artificial intelligence, and integrated digital workflows. This review explores the historical development of VTO, with emphasis on its early adoption, evolution through 2D and 3D methods, and its clinical implications in modern orthodontics. Particular attention is given to the limitations of early methods and the progressive refinement of predictive accuracy through technological advances.

Introduction

Orthodontic treatment planning has always depended on a combination of scientific evidence, clinical experience, and predictive modeling. Successful orthodontic therapy does not merely involve aligning teeth but requires careful consideration of growth, skeletal relationships, and soft tissue adaptation. This makes prediction a fundamental aspect of treatment planning. The Visual Treatment Objective (VTO) was conceptualized as a diagnostic aid to simulate future treatment outcomes and provide clinicians with a guide for decision making before actual clinical intervention [1].

Ricketts was among the first to emphasize the significance of prediction in orthodontics, integrating cephalometric analyses with visualized treatment objectives. [2] His contributions in the 1950s and 1960s provided a foundation for predictive orthodontics. The VTO initially involved manual tracings on cephalometric radiographs, allowing orthodontists to reposition skeletal and dental components to forecast treatment outcomes. These early methods, while groundbreaking, were dependent on population averages and operator skill, thereby limiting their precision.

Over time, clinicians such as Bench and Holdaway introduced refinements that expanded the scope of VTO beyond skeletal patterns, including soft tissue considerations and facial esthetics[3,4]. The integration of soft tissue analysis marked a shift from purely mechanical objectives to a more holistic approach considering facial balance and harmony. As orthodontics became increasingly interdisciplinary, VTO also found application in surgical planning, prosthodontics, and restorative dentistry [5].

The introduction of computer assisted methods in the 1980s and 1990s further transformed VTO, improving reproducibility and accessibility. Early software like Quick Ceph and Dolphin Imaging automated cephalometric tracings and treatment simulation [6,7]. While still based on 2D images, these digital tools improved efficiency and allowed easier communication with patients. However, the limitations of 2D prediction models persisted, especially in their inability to capture transverse discrepancies or provide accurate soft tissue predictions [8].

In recent years, advances in imaging such as cone beam computed tomography (CBCT), stereophotogrammetry, and intraoral scanning have enabled the transition to three-dimensional (3D) VTO. This allowed for the creation of virtual patients, providing a more comprehensive visualization of skeletal, dental, and soft tissue structures [9]. These innovations not only improved diagnostic accuracy but also enhanced interdisciplinary collaboration in fields such as orthognathic surgery, cleft care, and esthetic dentistry [10].

Despite its advancements, VTO is not without limitations. Predictive models still struggle with soft tissue response, long-term growth changes, and biologic variability.

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Additionally, issues of cost, radiation exposure, and the need for standardized protocols remain challenges to widespread adoption [11]. Nevertheless, VTO continues to play a pivotal role in orthodontics as a guiding tool that supplements clinical judgment and enhances patient communication [12].

Historical Development of VTO

The origins of VTO can be traced to Ricketts' seminal work in the late 1950s and 1960s, where he proposed systematic methods to predict growth and treatment outcomes using cephalometric analysis [2]. His technique involved creating tracings that could be manipulated to anticipate changes in skeletal and dental structures. This innovation represented a paradigm shift in orthodontics, allowing clinicians to visualize the end result of their treatment plans on paper.

Bench [3] expanded upon this concept in the 1960s by developing clinical applications of VTO for case analysis, further popularizing its use in orthodontic practice. Holdaway [4] later highlighted the importance of incorporating soft tissue analysis into VTO, emphasizing the role of facial esthetics in treatment objectives. His work underscored the limitations of purely skeletal predictions and paved the way for a more patient-centered approach.

During the 1970s and 1980s, acetate tracings and manual cephalometric superimpositions became standard practice in orthodontics. Orthodontists like Magness [13] introduced simplified methods such as the mini-VTO, which focused on specific skeletal and dental corrections. However, manual techniques were prone to operator error and lacked reproducibility, which limited their reliability in complex cases.

The late 1980s and early 1990s saw the introduction of computer-assisted VTOs. Deblock et al. [14] and Toepel-Sievers [15] demonstrated that computerization improved efficiency and reduced subjectivity. Dolphin Imaging and other commercial software programs allowed orthodontists to conduct virtual setups and simulate extractions or surgical interventions. Although these tools were significant advancements, they were still confined to 2D perspectives.

The 21st century ushered in the era of 3D VTO with the advent of CBCT, digital models, and stereophotogrammetry. This technological leap enabled the construction of a “virtual patient,” integrating dental casts, CBCT scans, and soft tissue surface data [9]. Software platforms such as Dolphin 3D, Maxilim, and V-Works facilitated accurate simulation of orthodontic and surgical procedures [16]. These advances improved diagnostic precision and interdisciplinary collaboration, especially in complex cases like craniofacial deformities and orthognathic surgery [17].

Recent innovations include AI-driven VTOs that use machine learning algorithms to analyze large datasets and predict individualized outcomes [18]. Dynamic or 4D VTOs are also being developed, which incorporate time as a variable to simulate treatment progression and growth changes [19]. These tools mark the latest stage in the historical development of VTO, pointing toward a future of highly individualized and adaptive treatment planning.

2D Approaches in VTO

Two dimensional (2D) cephalometric prediction methods formed the foundation of the Visual Treatment Objective. For decades, orthodontists relied on 2D cephalograms to visualize treatment outcomes, primarily because lateral cephalometric radiographs were widely available, inexpensive, and standardized. These methods provided the first practical framework for clinicians to predict skeletal and dental changes before initiating treatment.

Ricketts [2,3] pioneered the systematic use of cephalometric analysis for predictive purposes. His methods used angular and linear measurements to simulate changes in skeletal and dental structures. The VTO process typically involved tracing a lateral cephalogram on acetate paper, repositioning teeth and skeletal landmarks to approximate expected outcomes. Bench [4] expanded these ideas, while Holdaway [5] emphasized integrating soft tissue considerations into predictions.

The classical 2D VTO process involved:

1. Cephalometric tracing of skeletal and dental landmarks.
2. Repositioning landmarks to simulate orthodontic movements.
3. Predicting growth changes based on averages.
4. Superimposition to compare predicted vs. baseline positions [20].

Simplified versions such as the Mini-VTO (Magness [14]) made the method more practical for clinical use.

Applications

Extraction vs. non-extraction decisions [21].
Growth modification planning.
Orthognathic surgical simulation [22].
Patient communication.

Limitations

Could not analyze the transverse dimension [9].
Accuracy highly dependent on operator skill.
Based on averages poor individual prediction [23].
Weak reliability for soft tissue response [24].

Transition to Digital 2D

In the 1980s–90s, computer assisted programs like Dolphin Imaging and Quick Ceph automated VTOs [7,8]. These improved reproducibility and allowed digital overlays, though accuracy remained limited. Burstone et al. [25] introduced soft tissue prediction algorithms, but studies showed variability between predictions and outcomes [26].

Even today, 2D cephalograms remain popular due to low cost and availability, often serving as the first step in treatment planning, before advancing to 3D models [27].

3D Approaches in Visual Treatment Objective (VTO)

The shift from 2D to 3D prediction marked a turning point in orthodontics. The availability of cone beam computed tomography (CBCT), stereophotogrammetry, and digital model integration allowed for construction of a “virtual patient” where skeletal, dental, and soft tissue data could be combined for treatment simulations [28]. Unlike 2D VTO, which ignored asymmetries and transverse discrepancies, 3D VTO enabled accurate assessment in all three planes of space [29].

Imaging Technologies in 3D VTO

CBCT: Provided volumetric data for skeletal and dental structures with minimal distortion [30].

Stereophotogrammetry: Captured high resolution soft tissue images for facial analysis [31].

Intraoral Scanning: Enabled digital impressions to be integrated with skeletal data [32].

Workflow of 3D VTO

1. CBCT and digital dental models are acquired.
2. Data sets are merged to reconstruct a virtual patient.
3. Simulation software (Dolphin 3D, V-Works, Maxilim, etc.) is used to visualize skeletal movements, orthodontic mechanics, and surgical changes [33].

Applications of 3D VTO

Orthognathic Surgery: More accurate prediction of soft tissue changes and skeletal corrections [34].

Cleft and Craniofacial Care: Assists in interdisciplinary planning [35].

Complex Orthodontic Cases: Asymmetries and transverse discrepancies evaluated in detail [36].

Limitations of 3D VTO

Higher radiation exposure compared to lateral cephalograms [37].

Cost and availability of CBCT and 3D software [38].

Soft tissue predictions, while better than 2D, remain imperfect due to biological variability [39].

Clinical Applications of VTO

1. **Growth Prediction**

VTO helps forecast skeletal changes during active growth, aiding in interceptive orthodontics [40].

2. **Extraction vs. Non-Extraction Decisions**

By simulating tooth movement, orthodontists can visualize arch length discrepancies and decide whether extractions are required [41].

3. **Orthognathic Surgery Planning**

In collaboration with surgeons, VTO provides visualization of skeletal repositioning, helping anticipate esthetic and functional outcomes [42].

4. **Interdisciplinary Dentistry**

VTO is applied in prosthodontics, implantology, and esthetic dentistry where skeletal dental relationships must be evaluated before restorative work [43].

5. **Patient Communication**

Perhaps one of its most powerful applications, VTO enables orthodontists to show patients a visual representation of expected outcomes, improving acceptance and compliance [44].

Advantages and Limitations of VTO

Advantages

Enhances precision in treatment planning [45].

Improves patient doctor communication [44].

Facilitates interdisciplinary collaboration [46].

Enables simulation of alternative treatment plans.

Limitations

Predictions are not 100% accurate due to biological variability [47].

Growth changes are difficult to forecast individually [48].

Dependence on imaging quality and operator expertise [49].

Cost and radiation (in 3D methods) remain concerns [37].

Recent Advances in VTO

Artificial Intelligence and Machine Learning

AI has introduced individualized prediction models by analyzing large datasets [50]. Neural networks can simulate treatment outcomes with greater accuracy than traditional cephalometric averages.

Dynamic (4D) VTO

Beyond 3D simulations, researchers are developing time based (4D) simulations that model progression of growth and treatment effects over time [51].

Digital Integration

Integration of VTO with CAD/CAM surgical splints, aligner software, and virtual reality platforms is transforming orthodontic planning into a highly immersive experience [52].

Conclusion

The Visual Treatment Objective (VTO) has played a pivotal role in orthodontics for more than six decades, serving as a bridge between diagnosis and anticipated outcomes. From Ricketts' manual cephalometric tracings in the 1950s to today's AI-driven 3D and 4D simulations, VTO has continuously evolved in scope, precision, and application. While 2D approaches provided the foundation for predictive orthodontics, their limitations in soft tissue accuracy, growth variability, and transverse assessment necessitated the shift toward 3D methods.

Modern imaging and digital technologies have transformed VTO into a powerful tool for interdisciplinary treatment planning, surgical simulation, and enhanced patient communication. Despite remarkable progress, challenges remain particularly in predicting soft tissue responses and long-term growth patterns. High costs, radiation exposure from CBCT, and lack of standardized protocols also restrict its universal application.

Looking ahead, integration of artificial intelligence, machine learning, and dynamic modeling promises to further refine predictive accuracy and individualization. Future VTOs are expected to evolve into fully interactive, patient specific simulations that support precision orthodontics. Thus, while clinical judgment and biological variability will always play a role, VTO remains an indispensable adjunct, offering orthodontists both a scientific framework and a communicative tool to achieve optimal functional and esthetic outcomes.

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Expanding the Horizon : Evidences in Maxillary Expansion Treatment

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Abstract

Maxillary Transverse Deficiency (MTD) is a common orthodontic condition characterized by a reduced transverse dimension of the maxillary arch, affecting both dental and skeletal structures. Its prevalence ranges from 13–23% in children and up to 30% in adults. The condition arises from multi-factorial causes, including genetic, developmental, traumatic, and iatrogenic factors, and may be associated with nasal septum deviation. This review explores the etiology, diagnosis, treatment modalities, and bio-mechanical implications of various expansion techniques including Slow Maxillary Expansion (SME), Rapid Maxillary Expansion (RME), Mini-screw Assisted Rapid Palatal Expansion (MARPE), and Surgically Assisted Rapid Palatal Expansion (SARPE). Based on the evidences, treatment modality must be customized considering skeletal maturation and specific dental needs.

Keywords: Maxillary Expansion; Rapid Maxillary Expansion; Slow Maxillary Expansion; MARPE; SARPE.

Introduction

Transverse discrepancies in the maxillary arch are among the most frequently encountered challenges in orthodontics. These abnormalities, often manifesting as posterior crossbites or arch constriction can affect both the dental occlusion and skeletal harmony of the craniofacial complex. While various techniques exist to correct MTD, selection of the appropriate treatment modality depends upon the age, growth stage, and type of malocclusion.

For more than a century, transverse deficiencies of the maxilla have been treated using various forms of expansion therapy. The concept was first introduced by Angell in 1860 and later brought into mainstream orthodontics by Haas in 1961[1].

Although initially met with criticism, maxillary expansion has become a well established, straightforward and reliable treatment method. To correct transverse discrepancies, the palate is often widened using a combination of orthodontic and orthopedic forces.

Interestingly, different studies have elicited varied effects of maxillary expansion on sagittal and vertical dimensions based on lateral cephalometric measurements. Haas (1961) and Davis and Kroman (1969) stated that the maxilla moved downward and forward. Silva Filho et al (1991) found that the maxilla rotated downwards and backwards but did not change sagittally.

Wertz (1970) and Dreskin (1977) concluded that the maxilla moved downward and backward in some patients and downward and forward in others following RPE. Wertz (1970) established that the maxillary incisors retrocline following RPE Sandikcioglu and Hazar in (1997) inferred maxillary incisors proclined following RPE.

Sarver and Johnston (1989) found maxilla moved backward in some bonded RPE cases. Sevil Akkaya et al (1999) stated that the maxilla moved forward and the mandible moved backward following RPE with an increase in ANB angle and mandibular plane angle.

Isao Shundo et al (2012) witnessed spontaneous expansion of the mandibular arch concurrent with maxillary expansion in the early mixed dentition patients with maxillary incisor crowding was seen following slow maxillary expansion with quad helix.

Saori Endo et al (2016) found significant decrease in the mandibular plane angle in hyperdivergent patients following quad helix appliance. Jared K. Corbridge et al (2016) affirmed substantial decreases in buccal bone thickness and increases in lingual bone thick-

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ness following slow maxillary expansion treatment.

Clinical Relevance of Maxillary Expansion

Maxillary expansion plays a critical role in the correction of transverse maxillary deficiencies, which are commonly associated with posterior crossbites, V-shaped narrow palatal vault, crowding, and airway obstruction. Expansion therapy not only improves occlusal function and dental alignment but also has significant effects on nasal airflow and airway volume, contributing to better respiratory function in select patients .

Liptook identified basic clinical features, including difficulty with nasal breathing, the volume of the nasal cavity reduced, breathing from the mouth, a narrow hard palate, and cone-shaped hypertrophy. The existence of at least two clinical features mentioned previously designates skeletal or dentoskeletal malocclusion and demands treatment which focuses on enlarging the transverse maxillary measurements.

Patient's age is of utmost importance when selecting treatment appliances. By the age of six years, normal palatal development is almost complete. Post puberty, the mid-palatal suture gradually becomes interdigitated, eventually making separation difficult. The posterior teeth are not able to move during the application of heavy or rapidly accelerating forces. Therefore, the forces are concentrated in the mid-palatine suture. The suture splits open when the forces exceed the limit required for sutural resistance and tooth movement, whilst the teeth barely move.

In addition to constriction of the periodontal ligament fibers, the alveolar process is bent by appliance, anchor teeth tipping, and the mid-palatine suture is opened gradually and other maxillary sutures [2]. Maxillary expansion impacts various surrounding structures, including the mid-palatine suture, palate, maxilla, mandible, temporomandibular joint, and both upper anterior and posterior teeth. Additionally, it can affect speech and hearing.

In 1886, According to Plaff, Lohman, and Derichsweiler, the first rhinologist, Eysell of Berlin suggested the possibility of separation of the maxillae influencing the inner conformation of the nose. He was met with utter skepticism on the part of his confreres and eventually gave up on the idea [3].

In 1903, G.V.I. Brown stated that with the aid of pressure which is gently applied resulting in no pain but little inconvenience, it is possible in all young persons to force the maxillaries apart by separating the median suture extending between the incisor teeth and through the part of the hard palate. This was in accordance to the evidence that central incisors were moved apart without any attachment to them or by direct pressure being applied to them.

Intranasal measurements were made by Wright, on over thirty patients treated for nasal insufficiency by rapid expansion procedures. The distance between antral walls below the inferior nasal concha and found incremments up to 6.5 mm. Evidence showed increased width and from slight to marked improvement in intranasal respiration [4].

Following Brown's method, Willis reported a case of a female unable to do physical work because of difficulty in breathing. Using Brown's technique he separated the maxillae in three weeks to a distance that allowed the passing of a lead pencil barrel between the central incisors. This was appreciated through the illustrations of plaster models.

Types of Maxillary Expansion

Currently, four main techniques are commonly used for maxillary expansion:

1. Slow Maxillary Expansion (SME)
2. Rapid Maxillary Expansion (RME)
3. Mini-screw Assisted Rapid Palatal Expansion (MARPE)
4. Surgically Assisted Rapid Maxillary Expansion (SARPE)

Indications for Maxillary Expansion

Maxillary expansion is indicated in the following cases:

1. Transverse Maxillary Deficiency

Often presenting with unilateral or bilateral posterior crossbite .

2. Dental Crowding

Expansion can create additional space to alleviate moderate anterior crowding without extractions .

3. Nasal Airway Obstruction / Mouth Breathing

Expansion may improve nasal airflow by increasing nasal cavity volume .

4. Class III Malocclusion (Compensatory Cases)

When the transverse discrepancy contributes to the Class III appearance.

5. Obstructive Sleep Apnea (In Pediatric Cases)

As part of airway-focused orthodontic management.

Anatomy and Growth of the Maxilla

The maxillary complex is attached to the cranial base thereby there is a strong influence of the latter on the former. Although there is no sharp line of demarcation between the cranium & maxillary growth gradients, yet the position of the maxilla is dependent upon the growth at spheno-occipital & spheno-ethmoid synchondroses.

The growth of nasomaxillary complex comprises of two aspects with regard to the displacement in the position of the maxillary complex. Firstly, Primary displacement occurs in a forward direction. This occurs due to the growth of the maxillary tuberosity in a posterior direction. This results in the whole maxilla being carried anteriorly. And the Secondary displacement, which occurs in a downward & forward direction as the cranial base grows [5].

Maxilla is related to cranium at least partially by the, fronto-nasal suture, fronto-maxillary suture, zygomaticotemporal suture zygomaticomaxillary suture, pterygopalatine suture. These sutures are all oblique & more or less parallel with each other. The growth in these areas would serve to move the maxilla downward & forward.

The tenacity of circum maxillary attachments due to buttressing is strong postero-superomedially and postero-superolaterally.

A palatine bone forms an intimate relationship with maxilla to form complete hard palate (or) floor of nose and greater part of lateral wall of nasal cavity.

It articulates anteriorly with maxilla through transverse palatal sutures and posteriorly through pterygoid process of the sphenoid bone.

The interpalatine suture joins the two palatine bones at their horizontal plates and continuous as inter maxillary sutures.

These sutures forms the junction of three opposing pairs of bones: the pre-maxillae, maxilla, and the palatine. The entire forms mid-palatal suture [6].

These sutures forms the junction of three opposing pairs of bones: the premaxillae, maxilla, and the palatine. The entire forms mid-palatal suture.

The maxilla is connected to the cranium and cranial base by a number of sutures:

- Nasomaxillary Suture
- Frontomaxillary Suture
- Zygomaticotemporal Suture
- Lacrimomaxillary Suture
- Ethmoidomaxillary Suture

- Vomeromaxillary Suture

Mid Palatine Suture plays a key role in R.M.E. Shape of suture varies with age

1. Infancy - Y-shape
2. Juvenile - T-shape
3. Adolescence - Jigsaw puzzle

As sutural patency is vital to R.M.E, it is important to know when does the suture closes by synostosis. On an average 5% of suture in closed by age 25 yrs. Earliest closure occurs in girls aged 15 yrs.

Slow Maxillary Expansion (SME)

Slow palatal expansion is a method employed to correct a narrow upper arch by gradually widening it transversely. This technique, also known as dentoalveolar expansion, utilizes appliances to broaden the palate. Although the expansion primarily affects the dental structure, noticeable skeletal changes also occur. The tissues surrounding the maxilla experience reduced resistance, and bone formation increases at the mid-palatine suture[7].

Research has demonstrated that slow expansion ensures excellent post-expansion stability. A force of 10-20 newtons, generating 450-900 grams of force, is applied to the upper arch, which is insufficient to separate a maturing suture. With slow maxillary expansion, the upper arch width increases by 3.8 to 8.7mm, applying 900 grams of force at a rate of 1mm per week. Appliances used for slow maxillary expansion are categorized into removable and fixed types. Examples of removable devices include the Active Plate, Schwartz Appliances, and Coffin Springs, while fixed appliances include the Niti Palatal Expander, Quad Helix, and Spring Jet.

The quad helix expander, originally introduced by Ricketts, is designed to deliver expansion at a slower rate with a comparatively less rigid construction.

Its mechanism of action involves gradual palatal expansion by moving the maxillary molars buccally, rotating them distally, and activating the anterior arms to expand the premolar and canine regions. This approach is considered more physiologic than rapid maxillary expansion and may be associated with reduced relapse.

Boysen et al found that the quad helix can also produce a greater anterior expansion, resulting in an improved arch form, by taking the advantage of the anterior arms that delivers a "sweeping action"[8].

Rapid Maxillary Expansion (RME)

According to the Cohen hypothesis, termination of growth is unrelated to closure of the sutures. Even if 95% of the growth of the maxilla ends at 7 years of age, the suture may not already be closed[9]. The various technologies that can be used to analyze the maxillary expansion include occlusal radiographs, multi-slice low dose CT, micro-CT, ultrasound, CBCT, hand and wrist method, cervical vertebrae method and fractal analysis. In some adults, the distribution of maturation stages revealed that the midpalatal suture may remain in a non-fused state. This suggested that the chronological age should not be the only factor used to determine whether SARPE or conventional RME can be performed in adult individuals.

An RME treatment performed in adults whose midpalatal suture is already ossified could induce a bending of the circum-maxillary structure, compression of the periodontal ligament, resorption of the buccal root in the posterior teeth, perforation of the buccal alveolar bone, severe pain, periodontal side effects and gingival recession in the maxillary molar area.

As the separation of the maxillae progressed, it can be hypothesized that they were moved in an outward and possibly upward direction. The midpalatal edges of the maxillary palate moved in an outward direction as well. This combination of events not only resulted in a widening of the nasal cavity, but also a flattening of the roof of the oral cavity. On a lateral headplate this might extend an impression of a dropping or lowering of the nasal floor as illustrated by Haas. In actuality, it may possibly be a tilting of the nasal floor as the maxillae are moved in a lateral direction. This combination of reactions to the orthopedic procedure could conceivably result in a flattening of the palatal vault.

It has been expressed by Haas that patients clinically subjected to this procedure feel pressure in the vault of the palate, in the region of the alveolar processes, and in the frontonasal region. Some patients indicate a sensation of some pressure in the region of the cheeks and a spot slightly posterior to this area. Interestingly enough, this clinical reaction could be somewhat corroborated by the histologic reactions of the various remote sutures studied.

The sutures in the nasal area showed the greatest reaction to the maxillary expansion procedure. As the maxillae are separated at the level of the palate, the more superior aspects of these bones are changing in relation to adjacent bones. This explains the pressure that has been noted, clinically, at the bridge of the nose. The sutures in the area of the nasal complex were obviously disrupted. The second most active suture was found to be the zygomatic-maxillary suture and some adjustment was noted in as remote an area as the zygomatico- temporal suture[10].

It could be hypothesized that the zygomatic bone was being moved as well as the maxillary bone. One could assume that the maxillary bones could move or slide along the maxillary-zygomatic suture permitting the development of a greater width to the maxillary palate. However, the fact that adjustment was noted in the zygomaticotemporal suture, even though it was minimal in nature, would tend to indicate that the zygomatic bone is being moved as well.

Understanding individual variability in the fusion of the mid palatal suture is essential in identifying prospectively which late adolescent or young adult patient can have RME as a less invasive alternative to surgically assisted expansion. The midpalatal suture has been described as an end to end type of suture with characteristic changes in its morphology during growth.

In the infantile period, Melsen reported that the midpalatal suture is broad and Y-shaped in its frontal sections. The ossification process in the midpalatal suture starts with bone spicules from suture margins along with "islands" (ie, masses of acellular tissue and inconsistently calcified tissue) in the middle of the sutural gap. The formation of spicules occurs in many places along the suture, with the number of spicules increasing with maturation and forming many scalloped areas that are close to each other and separated in some areas by connective tissue.

Concomitantly, interdigitation increases; then fusion occurs earlier in the posterior area of the suture, with progression of ossification taking place from posterior to anterior, with resorption of cortical bone in the sutural ends and formation of cancellous bone.

The start and the advance of fusion of the midpalatal suture vary greatly with age and sex. Persson and Thilander observed fusion of the midpalatal suture in subjects ranging from 15 to 19 years old. On the other hand, patients at ages 27, 32, 54, and even 71 years have been reported to have no signs of fusion of this suture. Such findings indicate that variability in the developmental stages of fusion of the midpalatal suture is not related directly to chronologic age, particularly in young adults. Thereby it is justifiable enough to say that skeletally, more of anterior expansion occurs and in terms of dentoalveolar we see greater transverse expansion in the posterior precisely the molar region, keeping into account the two individual variable entities i.e skeletal and dentoalveolar changes [11].

SARPE has the similar advantages with the conventional RME. However, notable disadvantages of SARPE include potential for pressure related non-infectious frank necrosis (occurred in approximately 1.8% of cases), bleeding and infection during surgery, joint pain, periodontal problems, recurrence and the need for surgery and hospitalization. In adult individuals whose midpalatal suture is already closed, SARPE should be performed instead of RME. Therefore, the maturation phase of the midpalatal suture must be accurately determined [12].

Elements of Growth

Growth at the mandibular condylesproduces a forward component of the chin, not a downward, nor a downward and forward component. It is only when the vertical increments of facial growth begin to assert their influence on condylar growth through occlusal contact that a downward and forward direction of the the chin is produced.

Thus, it can be said that condylar growth is pitted against the combined vertical elements of the growth. The final vector of growth of the chin is a resultant of the struggle between horizontal growth and vertical growth, in other words, between condylar growth and vertical growth of the molars.

These vertical "elements" of growth are specific areas where the increments tends to occur which produces an increase in facial height. They are as follows: (1) growth at nasion and in the corpus of the maxilla which produces an increase in the distance from nasion to anterior nasal spine and causes the maxillary molars and posterior nasal spine to move away from the sella-nasion plane, (2) growth of the maxillary posterior alveolar processes causing the molar teeth to move awayfrom the palatal plane, and (3) growth at the mandibular posterior alveolar processes causing the molar teeth to move occlusally [13].

The dorsal migration of the gleaned fossa is a significantfactor in many cases and tends to cancel out the growth of the condyles; thus, in a sense it is arrayed on the side of vertical growth.

Clockwise rotation of the mandible is a result of more posterior vertical growth than condylar growth, the point of rotation being the condyles. When vertical growth exceeds horizontal growth, (condylar growth) pogonion cannot keep pace with the forward growth of the upper face and the mandibular plane must become steeper.

The question stands, what effect does this type of growth have upon treatment? Discernibly enough this condition would not help reduce the ANB angle, and it would not aid in correction of a Class II molar relation. However, it would tend to help correct the vertical overbite of the incisors.

Many such growth patterns actually do reduce the vertical overbite, perhaps the majority do not. There is ample evidence to show that a predominance of vertical growth of the face facilitates the correction and retention of vertical overbite.

Counter clockwise rotation of the mandible is a result of more condylar growth than combined vertical growth. This type of rotation is nearly always accompanied by a forward movement of pogonion and an increase in the facial angle.

Hence, variation in growth at the condyles and at the molar area is responsible for the rotation of the corpus of the mandible.

In a study conducted by Pradeepraj et al, patients with a predominantly vertical growth pattern showed advanced skeletal age and dental age when compared with chronological age. Hence skeletal parameters such as Anterior facial height and posterior facial height would be more pronounced in case of vertical growers in comparison to their chronological age [14]. The pattern was the same for both male and female subjects. Delayed skeletal age and dental age as compared with chronological age were seen in horizontal growers. The pattern was the same for both male and female subjects. When the skeletal age was compared with the dental age of the subjects in each group, the vertical groups showed advanced dental age in both male and female subjects; the horizontal groups showed more advanced skeletal age in both male and female subjects. Thereby it was concluded that orthodontic therapy should be started earlier in patients with a predominantly vertical growth than those with a predominantly horizontal growth pattern.

Nasion Point Dynamics

Nasion is one of the three points which establish the angular relation of the maxilla to the mandible when ANB, which most clinicians employ to record this information, is used. Therefore, if this is an important link in the diagnostic chain of cephalometric analysis and if nasion does change regularly and to a significant extent, the introduction of this third variable could make ANB a poor reflection of apical base relationship. Freeman indicated this in his thesis and emphasized the importance of considering "the anteroposterior relation of the maxilla (point A) to the cranium (represented by point N).

Moore believed that variation, not constancy, was the rule. One significant observation was that two points, nasion and the pterygomaxillary fissure, previously thought to be relatively stable in all individuals, were proved to be highly variable during growth of some individuals [15].

In a study with particular emphasis on positions of point A in the changing facial configuration, Baber and Meredith found that, with reference to nasion, the location of point A lies more inferiorly with increasing age [16].

Moreover, Enlow described facial growth and included a detailed description of the frontal region. He noted that the forehead grows in a generally anterior and slightly superior direction which is accomplished by a process of resorption and deposition at the surfaces of the laminae, combined with an expanding diploe, producing a distinct drift of the forehead in an anterior direction.

Mini-screw Assisted Rapid Palatal Expansion (MARPE)

The MARPE appliance, introduced by Dr. Won Moon and colleagues, is an innovative adaptation of the traditional RME appliance and represents a major advancement in the correction of transverse malocclusions. It has established itself as a reliable and effective nonsurgical alternative for young adults.

Micro-implant Assisted Rapid Palatal Expansion (MARPE) appliances have been developed to direct expansion forces specifically to the midpalatal suture while minimizing stress on the dentoalveolar structures. Among these, the Maxillary Skeletal Expander (MSE), first introduced around 2003, has undergone significant refinement over time. The MSE is uniquely designed to deliver expansion forces more posteriorly against the zygomatic buttress and pterygopalatine sutures, as well as more superiorly to the mid palatal and other superiorly positioned peri-maxillary sutures.

Unlike other mini-screw assisted RPE designs, the jackscrew in the MSE is positioned between the maxillary first molars, medial to the zygomatic buttress. For optimal stability, bicortical engagement anchoring into both the palatal and nasal cortical bone layers is recommended. This approach minimizes the risk of implant tipping within the bone and helps reduce internal strain [17].

With MSE, the lateral force vectors generated during expansion are directed closer to the zygomatic buttress. Since the rotational fulcrum is positioned farther away, the expansion achieved is more translational in nature. As a result, unwanted effects such as lateral rotation of the maxillary halves, clockwise mandibular rotation, and subsequent bite opening can be significantly reduced.

Appliance Position

- **Anteriorly:** Distal to the third rugae along the anterior palate increases the primary stability due to thick palatal bone, propagating the forces to the naso-maxillary complex.
- **Middle:** On the flat palatal but thinner bone surface of second premolar region. This promotes a close contact area with the jackscrew but significantly increases the risk for bicortical penetration.
- **Posteriorly:** Immediately anterior to the soft palate, at the region of the first permanent molar. This results in an increased orthopaedic effect due to the resistance offered by the pterygoid plates.

Surgically Assisted Rapid Palatal Expansion (SARPE)

Brown (1938) was the first to propose SARPE as a treatment approach for TMD. The technique is founded on the principles of distraction osteogenesis later described by Ilizarov (1987). In SARPE, distraction forces are transmitted and applied to the bone using either tooth-borne or bone borne devices. It has proven to be a reliable method for managing TMD, producing stable and clinically effective long-term dental and skeletal changes [18].

These skeletal changes are also manifested in the facial soft tissues. The most frequently reported effects include increased lateral projection of the cheeks and widening of the nasal base. Variations in treatment arise from differences in surgical techniques, the type of appliance used to achieve expansion, and the specific expansion protocol followed. Recent systematic reviews, however, have reached varying conclusions regarding the necessity of pterygoid plate separation. In addition, the impact of SARPE on nasal airway volume has also been the subject of recent investigations.

Indications of SARPE[19]

1. To increase the maxillary arch perimeter, correct posterior crossbite and when no additional surgical jaw movements are planned.
2. To widen the maxillary arch as a preliminary step, even when further orthognathic surgery is anticipated helping to reduce risks, inaccuracies, and instability linked with segmental maxillary osteotomy.
3. To create space for a crowded maxillary dentition in cases where extractions are not indicated.
4. To correct maxillary hypoplasia associated with cleft palate.
5. To reduce wide black buccal corridors when smiling.

Conclusion

Interceptive treatment when paired with appropriate rehabilitation, can help restore normal growth and jaw function. Generally, the older the patient, the more pronounced the dental effects and the less significant the skeletal changes. RME, often performed with tooth/tissue-borne appliances (such as Hyrax or Haas), produces immediate results by applying heavy forces over a short duration.

In contrast, SME typically involves appliances like a coil spring or quad helix, which use continuous, low forces over a longer period, and are considered to offer a more physiological approach with better sutural stability.

Expansion of the maxilla and maxillary dentition can be achieved through various approaches. The choice of method is largely determined by the underlying skeletal and dental pattern and selecting the appropriate type of expansion can significantly enhance the effectiveness of the overall treatment plan.

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Exploring Vestibuloplasty Modalities: A Case Series of Three Patients

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Abstract

Introduction: Vestibuloplasty is a surgical procedure aimed at increasing the depth of the oral vestibule by adjusting soft tissue attachments, facilitating improved oral hygiene. A sufficient vestibular depth is essential to prevent food accumulation and support effective oral hygiene practices. Various techniques can be used to achieve this, including submucosal vestibuloplasty, secondary epithelial vestibuloplasty, and soft tissue graft vestibuloplasty.

Case Presentation: This report compares three different vestibuloplasty techniques: the conventional technique, laser assisted vestibuloplasty and technique incorporating electro-cautery assisted vestibuloplasty. The primary endpoints for comparison were pain perception on days 1, 3, and 7, and clinical outcomes assessed after 1 week and 21 days.

Results: The results indicated that the traditional technique resulted in the greatest increase in vestibular depth among the three methods. Pain levels reported by patients were comparable across all techniques. The laser-assisted technique offered advantages such as precision, hemostasis, and the absence of sutures.

Conclusion: Our findings indicates that the traditional technique provides the most significant increase in vestibular depth, with all three techniques exhibiting similar pain levels. The laser assisted approach offers distinct benefits like hemostasis and no requirement for sutures, whereas the electrocautery assisted vestibuloplasty is straightforward and time efficient. Each technique for vestibuloplasty presents a unique set of advantages and disadvantages and the choice of technique depends on individual patient needs, surgical goals, and available resources.

Keywords: Laser, L-PRF, Pre-prosthetic surgery, Vestibuloplasty, Visual analogue scale

1. Introduction

Periodontal plastic surgery procedures aim to address various issues affecting the gums, alveolar mucosa, and bone, such as defects arising from anatomy, development, trauma, or plaque-related diseases. These procedures not only serve aesthetic purposes but also contribute to maintaining optimal oral hygiene. The oral vestibule refers to the cavity within the mouth, bordered medially by the teeth and gingiva, laterally by the cheek and lip mucosa, and apically by movable and immovable mucosal borders. Vestibular depth is measured either from crest of lip or from coronal border of the attached gingiva to depth of mucobuccal fold.[1] Adequate vestibular depth is crucial for ensuring proper oral hygiene, as a shallow vestibule can lead to food accumulation and hinder the maintenance of oral cleanliness. Additionally, when combined with inadequate attached gingiva, shallow vestibules may result in marginal tissue pulling and gingival recession, exacerbating plaque accumulation, gingival inflammation, tooth mobility, bone loss, and further gingival recession. Furthermore, an appropriate vestibular depth is essential for the retention and stability of removable dentures.[2] Vestibuloplasty, a surgical procedure, aims to deepen the oral vestibule by altering soft tissue attachments. Several techniques are employed to deepen shallow vestibules by modifying soft tissue attachments. These include submucosal vestibuloplasty, secondary epithelial vestibuloplasty, and soft tissue graft vestibuloplasty. Periodontal procedures in the new millennium have moved on from being extensively aggressive to minimally invasive. Recent advancements in intraoral surgical techniques include use of lasers with the advantages like greater precision and a relatively bloodless surgical field. In this case report, we compare

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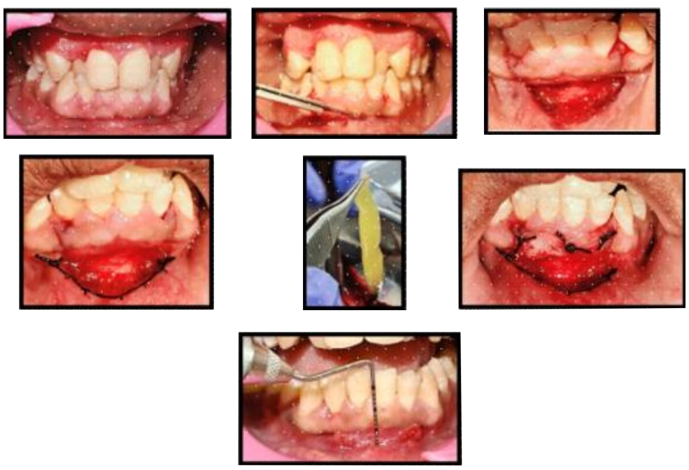
three different vestibuloplasty techniques: conventional surgical vestibuloplasty, vestibuloplasty using diode lasers, and electro-cautery assisted vestibuloplasty without sutures. Each technique offers unique advantages and considerations, contributing to the growing body of knowledge in the field of periodontal plastic surgery.

2. Case Presentation

Case 1

A 25-year-old female presented to the Department of Periodontics and Implantology with the chief complaint of difficulty in brushing teeth on the lower front teeth region for the past six months, also complained of rapid accumulation of deposits over that area presenting with diastema. On clinical examination, the patient had gingival recession in relation to lower incisors and reduced vestibular depth in the lower anterior area. After two weeks of non-surgical periodontal therapy, vestibulo-plasty with conventional technique was performed (Figure 1). Under local anaesthesia, horizontal incision using No.15 blade was placed at mucogingival junction from lower left to right canine which was followed by supraperiosteal dissection up to the desired vestibular depth. The mucosa on the inner aspect of the lip was carefully undermined, following which a leukocyte platelet-rich fibrin (L-PRF) membrane was adapted and stabilised onto the periosteum at the depth of the vestibular sulcus using non-resorbable 5-0 sutures. In addition, a further L-PRF membrane was secured over the attached gingiva with the intent of increasing its thickness and enhancing the quality of the peri-gingival soft tissues. The raw area over the alveolar bone was left to heal by secondary intention. Coe pack periodontal dressing was placed for wound protection.



Case 2

A 21-year-old female presented to the Department of Periodontics and Implantology, reporting of bleeding from her lower front teeth region for the past 1 year and diastema that was unesthetic. The patient was having non-contributing medical history. Upon examination, visible plaque and calculus deposits were observed along with inflamed marginal gingiva and inter-dental papilla in the mandibular anterior region. Positive bleeding on probing was noted. Overall oral hygiene was satisfactory except for the lower anterior labial region, where inadequate vestibular depth and a positive frenal pull were evident around lower left canine to right canine. A vestibuloplasty procedure was performed utilizing a diode laser with a wavelength of 810 nm. The soft tissue laser was operated in surgical mode at a power of 3 watts (Figure 2). An initial incision was made along the muco-gingival junction from the right lower canine to the left lower canine. Subsequently, all muscle fibers were meticulously dissected, including the labial frenum using laser, and the vestibule was deepened to achieve the desired depth. Saline irrigation was performed, and a coe-pack dressing was applied along with detailed post-operative instructions

Case 3

A 28-year-old male presented to the Department of Periodontics and Implantology, reporting deposition and bleeding from his lower front teeth and gum recession. He also mentioned difficulty in maintaining regular oral hygiene, hindering toothbrush movement. The patient did not have prior dental history. Intraoral examination showed a shallow vestibule and spacing between lower front teeth, with a positive tension test on the lower front teeth. Following phase I therapy, a electrocautery assisted vesti-buloplasty was planned to address the shallow vestibule. For vestibuloplasty, a horizontal incision was made at the muco-gingival junction from lower left canine to right canine followed by supraperiosteal dissection to achieve the desired vestibular depth using loop electrode. The labial mucosa was then undermined. The incision was sutured, and a periodontal pack was applied deep into the vestibule after ensuring adequate hemostasis (Figure 3).

Post-surgical instructions were provided for all the cases, and the patients were prescribed antibiotics (Cap Amoxycillin 625 mg two times a day for 5 days) and analgesics (Tab Ibuprofen 400 mg two times a day for 3 days). Tooth brushing was restricted at the surgical site for the first week, with extraoral cold compression recommended for the first day. 0.2% chlorhexidine mouth rinse was instructed till 4 weeks after surgery. Coepak was removed 10 days after the surgical procedure and the patient was asked to maintain meticulous oral hygiene. All the patients were reviewed on day 1,3 and 7 and examined for pain using visual analogue scale and clinical outcomes were assessed on day 7 and day 21.

3. Results

An increase in vestibular depth was attained by all the three procedures. In the traditional technique described in case 1, significant gain in vestibular depth was observed during the postoperative reviews at day 7 and day 21. Patient experienced mild pain and swelling in the first two days after surgery, with relief starting on the fifth day. Healing progressed smoothly, without scar tissue formation, and there was a substantial gain in vestibular depth. Patients pain perception was measured using visual analogue scale (VAS) on day 1, 3 and 7. When the diode laser was used, patients experienced notable swelling and pain, as well as difficulty eating, for the first 5 days. However, these symptoms improved thereafter. Although the 7-day postoperative review showed a good increase in vestibular depth without scar tissue formation, there was a slight reduction in the gained depth when reviewed at 21 days. The third technique which involved electrocautery assisted vestibuloplasty, achieved a vestibular depth gain. Patients were advised to apply an astringent locally, and by the 3rd week, patients reported symptomatic improvement and resolution of scar tissue. All patients experienced pain, swelling, and difficulty eating for the first 5 days postoperatively. The VAS score for all techniques obtained on day 1,3, and 7 is enumerated in Table 1.

VAS score	Conventional technique	Lasers	Electrocautery
Day 1	5	6	6
Day 3	4	5	5
Day 7	2	3	4

Table 1: Pain perception using visual analogue scale assessed on day 1,3,7.

4. Discussion

Vestibuloplasty, also known as sulculoplasty, is a surgical intervention that aims to alter the relationship between the gingiva and mucous membrane. The procedure can involve deepening the vestibule, repositioning the frenulum or muscle attachments, and expanding the zone of attached gingiva.[3] It is used to address issues such as preventing further gingival recession, restoring attached gingiva, enhancing vestibular depth, improving plaque control, and boosting resistance to masticatory trauma. Additionally, vestibuloplasty can be performed for cosmetic purposes and to create a better base for dentures in edentulous patients, thereby improving retention and stability. In cases where tension from the frenulum affects tissue around implants, leading to inflammation and recession, vestibuloplasty can help alleviate the issue. The major therapeutic goals of mucogingival surgery are esthetics, treatment of hypersensitivity and prevention of root surface caries. It was believed that an "inadequate" zone of gingiva would (a) facilitate subgingival plaque formation because of the improper pocket closure resulting from the movability of the marginal tissue and (b) favour attachment loss and soft-tissue recession because of less tissue resistance to apical spread of plaque associated gingival lesion. It was also considered that a narrow gingiva in combination with a shallow vestibular fornix might (a) favour the accumulation of food particles during mastication, and (b) impede proper oral hygiene measurement. Hence, vestibular deepening should be considered where patients experience discomfort during brushing and chewing.[4] There are some contraindications to consider before proceeding with vestibuloplasty, such as significant bone loss after traumatic tooth extraction, notable bone resorption due to periodontitis, alveolar bone atrophy following tooth removal, and patients with severe systemic illnesses. Careful assessment of these factors is crucial to ensure successful outcomes and minimize risks. Vestibuloplasty techniques are categorized into three main types: mucosal advancement vestibuloplasty, secondary epithelization vestibuloplasty, and grafting vestibuloplasty.[5] Table 2 outlines the various techniques of vestibuloplasty.

Main Category	Sub-classification / Techniques
1. Mucosal Advancement Vestibuloplasty	• Closed submucosal vestibuloplasty • Open submucosal vestibuloplasty
2. Secondary Epithelialization (Re-epithelialization Vestibuloplasty)	• Kazanjian's technique • Clark's technique • Lipswitch technique
3. Grafting Vestibuloplasty	• Mucosal grafts (palatal/oral mucosa) • Skin grafts (split-thickness / full-thickness)
4. Other Techniques	• Laser vestibuloplasty • Electrocautery vestibuloplasty

Table 2 : Classification of Vestibuloplasty Techniques

Clark's technique, introduced by Clark in 1953, is a secondary epithelialization vestibuloplasty method used in cases where there is adequate bone, but the mucosa is either insufficient or of poor quality. The technique is based on the principle that exposed connective tissue surfaces contract, while those covered with epithelium contract less, and exposed bone surfaces do not contract. Proper undermining and fixation of the epithelial flap are necessary to prevent soft tissues from reverting to their original position, which requires some overcorrection. The conventional Clark's technique has been effective, resulting in a significant increase in vestibular depth with minimal wound contracture and relapse. However, the surgical process is complex, time consuming, and requires a high level of expertise.

In contrast, laser surgery provides several benefits, including precise incisions, a bloodless field, less requirement of local anaesthesia, and shorter procedure time.[6] It also creates an aseptic environment and eliminates the need for sutures. Despite these advantages, patient reported more postoperative discomfort, and there was a slight reduction in gained depth by the 21st day postsurgery. The high cost of laser equipment and potential hazards associated with its use raise questions about its routine application in oral surgical procedures.

In the third case, using electrocautery was used to compare the healing and VAS score In a recent study conducted by Karas et al. (2023), the outcomes of diode laser and conventional surgery were compared in terms of vestibular depth gain. The study revealed that conventional surgery resulted in a higher vestibular depth gain compared to diode laser surgery. Furthermore, low level laser therapy (LLT) did not demonstrate any significant benefit in promoting mucosal wound healing.[7]

Patients were evaluated on the 1st, 3rd, and 7th days postsurgery. The study found that patients treated with laser reported lower pain and discomfort, as measured by visual analogue+ scale (VAS) scores, compared to those who underwent the procedure with a scalpel. Additionally, the laser group exhibited improved healing outcomes.[8]

Bhullar et al. compared pain perception following vestibular extension procedures using three different techniques: scalpel, laser, and cautery. The study supported the use of electrocautery in soft tissue procedures, such as vestibular depth extension, as it provided better patient perceptions of pain and discomfort than scalpel and laser techniques.[9]

A retrospective study by Neckel compared vestibuloplasty outcomes using laser and scalpel techniques, finding no significant difference in vestibular height gain between the two methods. However, patient perceptions slightly favoured laser treatment over scalpel.[10]

Although most studies suggest that laser techniques offer better patient pain perception and improved surgical outcomes, our findings indicates that conventional technique produced better outcomes. Furthermore, both techniques demonstrated similar levels of pain perception.

5. Conclusion

This case report explores three distinct methods for increasing vestibular depth: the traditional technique using scalpel, the use of lasers, and electrocautery assisted vestibuloplasty. Each method has its own set of advantages and disadvantages. The greatest increase in vestibular depth was achieved with the traditional technique. Patients reported similar levels of pain across all three techniques. Electrocautery was less time consuming as compared toother techniques used. The laser approach offers several benefits, including hemostasis, precision, and the elimination of the need for sutures. Each technique for vestibuloplasty presents a unique set of advantages and disadvantages and the choice of technique depends on individual patient needs, surgical goals, and available resources. When compared to other studies our findings showed better vestibular depth gain with traditional technique and comparable pain score with all three methods.

6. Limitations

In this case report we have compared only one case in each category which provide only limited evidences. Further comparative studies with large sample sizes are required to gather more substantial evidence on each technique's efficacy and safety.

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Heal Talk

Healing Efficiency Unveiled : Comparing Cyanoacrylate and Sutures In Third Molar Extractions

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Abstract

Objective - This prospective clinical study compared the clinical outcomes of N-butyl-2-cyanoacrylate tissue adhesive and 3-0 silk sutures for wound closure following mandibular third molar surgeries.

Material and Methods: Ten patients aged 18–35 years with symmetrical impacted mandibular third molars were randomly divided into two groups: Group A (tissue adhesive) and Group B (Silk Sutures). Clinical parameters, including pain, bleeding, swelling, and wound healing, were assessed postoperatively on Day 1 and Day 7 using visual analog scales and standardized criteria. Statistical analysis was conducted using independent t-tests and chi-square tests.

Results: On Day 1, the adhesive group demonstrated significantly lower pain and bleeding scores compared to the suture group, indicating superior immediate outcomes. Wound healing was also significantly better in the adhesive group, with 100% of cases showing good healing, in contrast to 40% in the suture group. By Day 7, swelling reduction was significantly greater in the adhesive group, reflecting faster recovery and improved patient comfort. Long-term healing outcomes were comparable between the two groups. N-butyl-2-cyanoacrylate tissue adhesive provided several advantages, including reduced operating time, easier application, and improved postoperative comfort due to its bacteriostatic properties, superior hemostasis, and reduced swelling. Additionally, the adhesive eliminated the risk of needle prick injuries, contributing to greater patient satisfaction and better cosmetic results.

Conclusions : These findings suggest that N-butyl-2-cyanoacrylate tissue adhesive is a reliable and efficient alternative to silk sutures for wound closure in mandibular third molar surgeries, offering benefits for both clinical outcomes and patient recovery.

Introduction

Wound closure in any surgical procedure aims to promote primary healing. The goal of wound closure should be to achieve precise wound approximation, decrease the risk to the patient, easy handling and working properties of the wound closure material, and most importantly is low infection rate. [1] Mandibular third molar removal is a routine procedure performed in the dental office. Most surgeons agree that surgical time, trauma, and difficulty level of the impacted 3 rd molar are important factors in assessing post operative pain, swelling, bleeding, and trismus. After the removal of the impacted mandibular third molars, the conventional method is to suture the surgical wound.[2]

A variety of suture materials are commercially available that may be divided into absorbable and non-absorbable and categorized as monofilament and multi-filament variants. There are different forms of intraoral suture materials including nylon, silk, cotton, polyglecapron, polylactic acid, and polyglycolic acid. Certain materials can interfere with optimal wound healing and cause excessive scar formation. The optimal suture should have high tensile strength, knot security, and be easy to handle.[3]

Absorbable suture material, e.g., polyglactin 910 (Vicryl) has been used in many operative procedures. Vicryl is considered a safe, non-toxic, non-immunogenic product. Polyglactin 910 is available both uncoated and coated; triclosan is typically used for coating (Vicryl plus) [4]. Suturing in this area is not always easy, due to in accessible areas, time consumption, and the requirement of good suturing skills [2]. It is also known that suture material increases the risk of wound sepsis by serving as an adhesive foreign body[5]. To overcome these disadvantages, an alternative to the suture tissue adhesive such as cyano-

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acrylate bio-adhesive has come into use.[2]

Cyanoacrylateglue is the general term for the quick bonding super glues used as two separate liquids, one for pouring into the mold and another used sparingly as a hardener in the case of cyanoacrylate glue, the hardener is water. cyanoacrylate glue is placed on a dry surface the glue does not bond with the surface. But with the slightest amount of water, which could include the moisture in the air, the glue's molecules react and form a tight chain between the bonded surfaces. cyanoacrylate glue generates its heat for faster curing. This heat may damage the soft tissue and hamper its blood supply. To avoid this; manufacturers have incorporated long chains of a methyl group due to which the polymerization process is elongated and the rate of heat generation is prolonged. Polymerization of the material occurs within10–15 seconds.[6]

Surgical glues should have some essential requirements, such as adequate adhesive strength, polymerization also in a moist environment, bio-compatibility, and gradual resorption without foreign body response.[7]

N- butyl Cyanoacrylate is used as a surgical dressing on extraction wounds, fixation of mandibular fractures, healing of intra-oral wounds, fixation of free gingival grafts & healing of periodontal flaps [8]. They are recommended for their hemostatic and anti-inflammatory features and high adhesion ability in a moist environment [9].

Cyanoacrylate has theoretical advantages over conventional suture closure in that no dressing needs to be applied over the incision, it is immediately water proof, no suture has to be removed and patients are often more satisfied with the cosmetic result[10].

Material and Methods

The Oral and Maxillofacial Surgery Department of Shree Bankey Bihari Dental College and Research Centre in Ghaziabad, Uttar Pradesh, India, undertook a prospective randomized trial.

Sample Size

A study was conducted involving ten patients aged 18 to 35 years, without any gender restrictions. The selection criteria were based on preoperative OPG indicating the presence of impacted mandibular third molars. The participants were then categorized into two groups, namely Group A (n-butyl-2-cyanoacrylate) and Group B (3-0 silk sutures,) each consisting of 5 Individuals.

Group A :- "The closure was performed using n-butyl-2-cyano-acrylate adhesive after the surgical removal of the impacted third molar.".

Group B :- The closure was performed using 3-0 silk sutures after the surgical removal of the impacted third molar.

Inclusion Criteria

- Impacted Mandibular Third Molars
- Age of patient – 18 - 35 yrs of Age
- Class I and class II impacted mandibular third molars (Pell & Gregory Classification)
- Position A and Position B impacted mandibular third molars (Pell & Gregory Classification)
- Patient who was willing to participate in the study.

Exclusion Criteria

Age of Patient – Above 35 years of age

- Class III impacted mandibular third molars (Pell & Gregory Classification)
- Position C impacted mandibular third molars (Pell & Gregory Classification)
- Medically Compromised Patient
- Compromised Bone Health
- Pregnant Females
- Any bony pathology related to impacted mandibular third molar
- Patient's Allergic to any component of the Material used.
- Not willing to participate in the course of Study.

This study was conducted from November 1, 2023 to June 10, 2024).

The study was conducted at the Department of Oral and Maxillofacial Surgery, Shree Bankey Bihari Dental College and Research Centre in Ghaziabad, Uttar Pradesh, India, undertook a prospective randomized trial.

All participants have read and signed informed consent form.

The study protocol was approved by the by the Ethical Committee of Shree Bankey Bihari Dental College and Research Centre in Ghaziabad.

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Group A

Figure -1(Pre-operative OPG)

Figure - Adhesive Placed

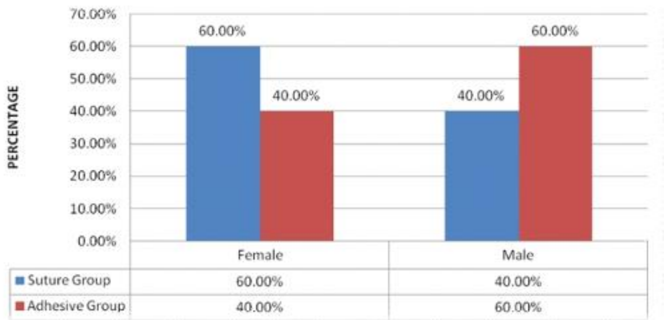
Group B

Figure - 15 (Pre-operative OPG)

Figure - Suture Placed

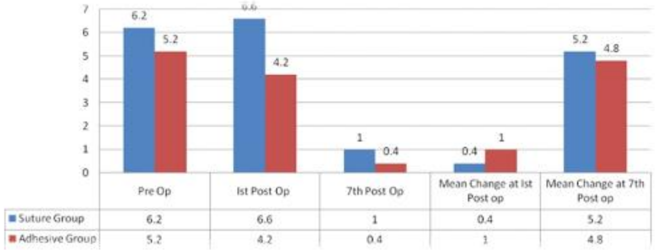
Result

Gender Distribution of Study Subjects



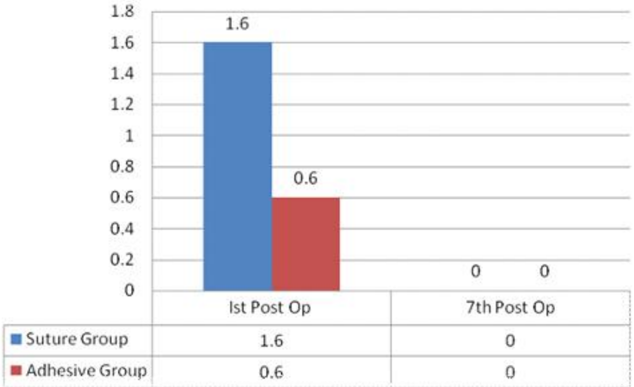
Intergroup Comparison of Mean Change In Pain Scores at Different Time Intervals

	Pre Op		Ist Post Op Day		Change at Ist Post op Day		P value
	Mean	SD	Mean	SD	Mean	SD	
Suture Group	6.20	1.303	6.60	1.516	-0.40	1.816	0.011 (Sig)
Adhesive Group	5.20	1.483	4.20	0.836	1.00	1.732	
	Pre Op		7th Post Op Day		Change at 7th Post op Day		P value
	Mean	SD	Mean	SD	Mean	SD	
Suture Group	6.20	1.303	1.00	1.000	5.20	1.788	0.749 (Non-Sig)
Adhesive Group	5.20	1.483	0.40	0.547	4.80	1.923	



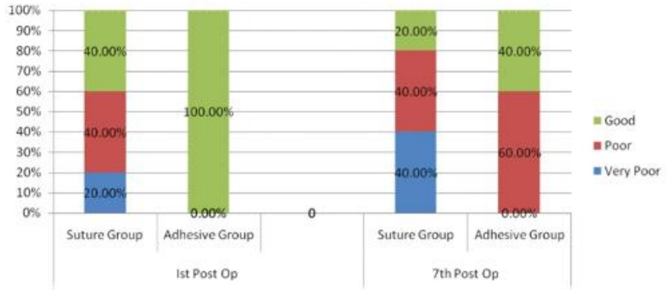
Intergroup Comparison of Bleeding Scores at Different Time Intervals

	Ist Post Op		
	Mean	SD	P value
Suture Group	1.60	1.140	0.001 (Sig)
Adhesive Group	0.60	0.894	
	7th Post Op		
	Mean	SD	P value
Suture Group	0.00	0.000	1.000 (Non-Sig)
Adhesive Group	0.00	0.000	

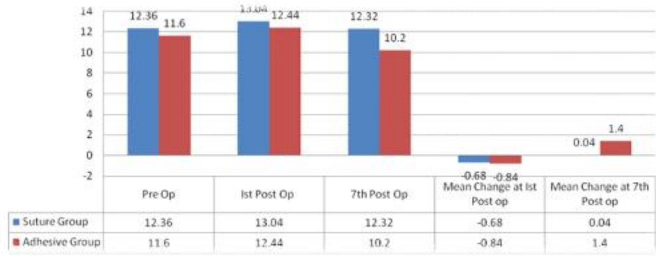


Intergroup Comparison of Healing Scores between the Sutuer and Adhesive Group at Ist and 7th Post Operaive Day

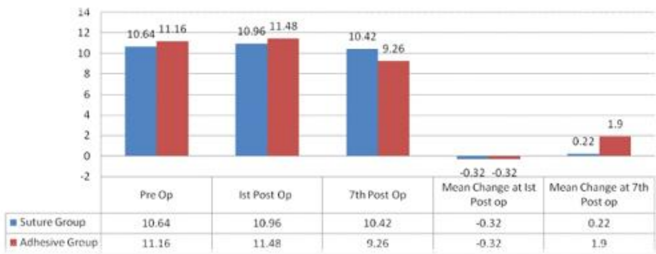
		Very Poor	Poor	Good	P value
Ist Post Op day	Suture Group	1	2	2	0.012 (Sig)
		20.0%	40.0%	40.0%	
	Adhesive Group	0	0	5	
		.0%	.0%	100.0%	
		Good	Very Good	Excellent	P value
7TH Post op Day	Suture Group	2	2	1	0.282 (Non-Sig)
		40.0%	40.0%	20.0%	
	Adhesive Group	0	3	2	
		.0%	60.0%	40.0%	



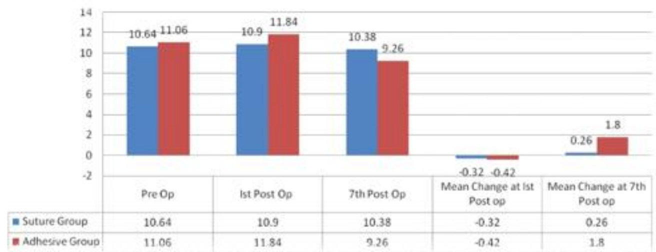
Intergroup Comparison of Change In Swelling Scores at Ist and 7th Post Op Day – EG



Intergroup Comparison of Change In Swelling Scores at Ist and 7th Post Op Day –TM



Intergroup Comparison of Change In Swelling Scores at Ist and 7th Post Op Day –TP



Discussion

Wound healing is a complex, multi-phase process that can be influenced by various factors. This study focused on evaluating the effectiveness of N-butyl-2-cyanoacrylate (a tissue adhesive) compared to 3-0 silk sutures in intraoral wound closure following mandibular third molar surgery. The findings highlight several important insights and improvements that come from using cyanoacrylate in place of sutures.

One of the key findings is the significantly reduced wound closure time when using cyanoacrylate, in line with previous studies (Gogulanathan et al., 2015), which reported a decrease in operating time when using fibrin sealant compared to suturing. This can translate into a reduction in overall surgical duration, potentially minimizing complications associated with longer procedures (Lars Anderson et al., 2010). Additionally, cyanoacrylate provided quicker hemostasis, with significantly lower bleeding scores on the first postoperative day, confirming its superior hemostatic properties as reported in other studies (Al-Belasy and Amer, 2012).

Regarding postoperative pain and swelling, this study found that the adhesive group experienced significantly lower pain scores at Day 1, though this difference was not as marked by Day 7. Swelling was also significantly reduced by Day 7 in the adhesive group, suggesting that the tissue adhesive may help to minimize inflammatory responses compared to sutures. This finding aligns with Mahat et al. (2010), who reported less swelling in the sutureless group. However, the postoperative bleeding was notably lower in the adhesive group, further supporting the hemostatic advantage of cyanoacrylate (Ghoreshian et al., 2012).

The healing rates, although better in the adhesive group on Day 1, showed no statistically significant difference between the groups by Day 7, suggesting that both techniques ultimately allow for comparable long-term healing. The results regarding wound dehiscence and infection showed no significant difference, indicating that both methods are similarly effective in preventing wound complications over time. However, the bacteriostatic properties of cyanoacrylate offer an additional advantage in reducing the risk of infection, as suggested by Giray et al. (1997).

While cyanoacrylate demonstrated notable advantages in terms of wound closure time, pain relief, bleeding control, and swelling reduction, it did not show a statistically significant difference in long-term healing or the occurrence of wound infections. This could be due to the natural course of healing and the relatively short follow-up period in this study.

Conclusion

In conclusion, N-butyl-2-cyanoacrylate tissue adhesive provides a highly effective, efficient, and patient friendly alternative to silk sutures for intraoral wound closure. It offers significant advantages, particularly in reducing surgical time, improving hemostasis, and enhancing postoperative comfort. Given the results, tissue adhesive can be considered a preferable option in mandibular third molar surgeries, though further studies with longer follow-up periods are needed to confirm its long-term outcomes and safety.

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The Art of Subperiosteal Tunneling - VISTA Technique in the Smile Zone: A Case Report

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Abstract

Gingival recession in the anterior esthetic zone presents both functional and cosmetic challenges. Traditional root coverage procedures often involve multiple incisions and limited predictability. The Vestibular Incision Subperiosteal Tunnel Access (VISTA) technique offers a minimally invasive alternative that enhances graft stability and esthetic outcomes. This study explores the effectiveness of the VISTA technique combined with Platelet-Rich Fibrin (PRF) membrane for the treatment of Cairo's RT1 multiple gingival recession. VISTA, a minimally invasive approach, uses a single vestibular incision to create a subperiosteal tunnel, allowing precise placement of PRF membranes. PRF, derived from the patient's own blood which used to enhance healing by promoting tissue regeneration. Clinical outcomes showed significant root coverage, increased gingival thickness, and improved keratinized tissue width. Patients experienced minimal discomfort and high esthetic satisfaction. The combination of VISTA and PRF offers a biologically driven, patient friendly solution for managing recession defects in the esthetic zone with predictable and favorable results.

Introduction

Gingival Recession is defined as the displacement of marginal gingiva apical to the cemento-enamel junction (CEJ).1 It is characterized by the apical displacement of the gingival margin, exposing the root surface due to trauma, inflammation, or anatomical predisposition.[2] The prevalence of gingival recession tends to increase with age and is influenced by various local and systemic factors such as aggressive brushing, periodontal disease, malocclusion, frenal attachments, insufficient keratinized tissue, and iatrogenic issues like restorative overhangs.[3] Indications for surgical intervention include esthetic concerns, defect progression, hypersensitivity, and hygiene challenges.[4] Though often asymptomatic, it can impair both function and esthetics, affecting patient comfort and oral hygiene.[4,5] This case report presents a minimally invasive technique Vestibular Incision Subperiosteal Tunnel Access (VISTA) introduced by Dr. Homa Zadeh in 2011 involving a single incision at the maxillary frenum and subperiosteal tunneling to facilitate coronal repositioning of the gingiva.[6]

The purpose of this case report is to evaluate clinically, the efficacy of the novel and minimally invasive VISTA in combination with PRF in the treatment of gingival recession defects.

Case Report

A 52 years old male patient reported to the Department of Periodontics, Institute of Dental studies & Technologies, Modinagar with a chief complaint of poor esthetics and hypersensitivity in upper front tooth region due to exposed root surfaces. To treat Cairo's RT1 maxillary anterior gingival recession, VISTA technique combines with PRF membrane was planned for root coverage.[7] At his initial visit, thorough scaling and root planing was performed, patient instructed to maintain the oral hygiene and recalled after 2-weeks.

Surgical Procedure

In the VISTA approach, a vestibular access incision was made using no.15 BP blade, in the midline of the maxillary frenum, which provide access to the entire anterior maxilla. Subperiosteal tunnel was created by passing the incision through the periosteum and inserting a periosteal elevator between the periosteum and bone through the vestibular access incision. To mobilize gingival margins and facilitate coronal repositioning, the tunnel was extended at least one or two teeth beyond the teeth requiring root coverage. In order to achieve a low tension coronal repositioning of

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the gingiva, the tunnel was sufficiently elevated beyond the mucogingival junction as well as through the gingival sulci of the teeth being augmented. Subperiosteal tunnel extension was carried out interproximally under each papilla without making any surface incisions.[6]

Cairo's RT1 recession defects at Maxillary left and right central Incisors respectively.

Following a Midline Frenum incision, a subperiosteal tunnel was created extending through the gingival sulci ofthecentral incisors and beyond the mucogingival junction to allow for tension-free coronal repositioning of the gingival margins.

Freshly prepared platelet rich fibrin (PRF) membrane was trimmed to fit the dimensions of recipient site and the width was adjusted to extend at least 3-4 mm beyond the bony dehiscence's overlying the root surfaces.[8] The PRF membrane was carefully inserted into the subperiosteal tunnel and repositioned below the gingival margin of each tooth. The membrane and mucogingival complex were then advanced coronally and stabilized in the new position with a coronally anchored suturing technique.[9] Direct interrupted sutures at approximately 2-3 mm apical to the gingival margin of each tooth were placed using 3-0 silk suture.[10] Sutures were tied, and the knots positioned at the mid coronal point of each tooth and stabilized by placing composite stops. Periodontal dressing was placed to cover the surgical site. Patient was prescribed analgesics for pain and 0.2% solution of CHX rinse 3 times a day for 14 days. Suture removal was done after 14 days.[10]

Following placement of PRF membrane within the subperiosteal tunnel.

The Midline incision was approximated and sutured primarily with multiple 5-0 ETHICON sutures. Initially, gingival margins were positioned coronally and anchored toteeth by placing composite stops.

After 10 days of follow-up.

After 3 months of follow-up, complete root coverage was observed at all six treated teeth, along with sustained gains in keratinized gingiva, linear root coverage, and clinical attachment levels.

Discussion

Gingival recession, particularly in the anterior esthetic zone, presents complex challenges for clinicians, including restoring the protective architecture of the periodontium, achieving esthetic harmony, and ideally regenerating lost periodontal structures i.e gingiva, cementum, periodontal ligament, and supporting alveolar bone.[10] These challenges are amplified when multiple contiguous recession defects are present, as limited donor tissue and increased morbidity complicate treatment. In addition, the need for optimizing esthetic results through simultaneous treatment of contiguous defects tends to further challenge therapeutic success.[11] The Vestibular Incision Subperiosteal Tunnel Access (VISTA) technique offers a minimally invasive solution by allowing broad access through a single vestibular incision, typically placed within the maxillary frenum. This technique avoids trauma to the gingiva adjacent to the recession sites and preserves interdental papilla, enabling tension free coronal advancement of the gingival margin.[6]

When combined with Platelet-Rich Fibrin (PRF) membrane a second generation autologous biomaterial rich in growth factors the regenerative potential of the procedure is significantly enhanced.[8] PRF's 3D fibrin matrix supports angiogenesis, boosts immunity, promotes osteoblastic differentiation, and guides wound healing, affords a number of unique advantages to the successful treatment of multiple recession defects.[11] In the VISTA technique, access is broader and is made in the vestibule, where a single vestibular incision can provide access to an entire region, including visual access to the underlying alveolar bone and root dehiscences.[6] The remote incision reduces the possibility of traumatizing the gingiva of the teeth being treated.[8] Critical to the success of VISTA is a careful subperiosteal dissection that reduces the tension of the gingival margin during coronal advancement while at the same time maintaining the anatomical integrity of the interdental papillae by avoiding papillary resection.[9] The VISTA approach overcomes some of the shortcomings of intrasulcular tunneling techniques used for periodontal root coverage.[11] Considerations of optimizing both blood supply and esthetics determine a vertically placed vestibular incision as superior alveolar arteries, branches of the internal maxillary artery, run in a superior inferior orientation. Therefore, a vertically oriented initial incision will less likely disrupt the blood supply than horizontally positioned incisions. Placement of the initial vertical incision and a tunnel entrance within the maxillary frenum results in little to no visible scarring, assisting in maximization of the esthetic outcome.[6]

Ethicon silk sutures are then secured to the facial aspect of each tooth, effectively preventing apical relapse of the gingival margin during the initial stages of healing but compensating for some degree of apical migration during the healing period.[14] One of the major obstacles to regenerative healing is micromotion, which promotes formation of scar tissue.[8] The rigid fixation of gingival margins introduced with the present coronally anchored suturing technique minimizes micromotion of the regenerative site. Reduction of micromotion has proven to be a major advantage of the present technique over conventional methods, where the gingival margin may be subject to displacement during facial movements.[8] The combination of VISTA and PRF consigning both biological and esthetic demands, offering predictable root coverage, improved gingival biotype, and minimal postoperative morbidity. It shows a significant advancement in periodontal plastic surgery, particularly in the maxillary anterior region where esthetic outcomes are critical.

Conclusion

Based on the result, we can conclude that PRF membrane combined with the VISTA technique in multiple gingival recession defects, enhances gingival biotype and successfully promotes the healing. VISTA has shown excellent outcomes in the anterior esthetic region, delivering reliable root coverage with improved esthetics and patient satisfaction. Its minimally invasive approach and low postoperative morbidity make it a significant advancement in periodontal surgical procedures.

However, more clinical studies with longer period of follow-up with larger no. of patients are needed for better assessment of the VISTA technique with PRF membrane for the treatment of gingival recession.

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Immediate Implant Placement In Esthetic Zone - A Case Report

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Abstract

Immediate implant placement in the lower anterior region involves inserting a dental implant directly into the extraction socket immediately after tooth removal. This approach aims to preserve alveolar bone, reduce treatment time, and enhance esthetic outcomes. A 26 year old female patient presented with the primary concern of poor facial appearance while smiling due to the mobility of the lower central incisor. After evaluating the CBCT results, implant was planned for the patient. Immediate implantation helps prevent vertical tissue collapse around the implant, promotes the formation of keratinized tissue on all sides, and allows for easier apical anchorage. Early implant placement does have limitations, such as increased surgical time and complexity compared to immediate placement.

Keywords - Dental Implants, Cementoenamel junction, Immediate implant placement, Cone beam Computed Tomography, Esthetic Zone.

Introduction

Initially, it was recommended that dental implants be surgically placed at the planned site only after several months of healing following tooth extraction. This delay allowed for sufficient remodelling and healing of the alveolar bone, which was believed to enhance osseointegration of the implant [1]. However, not long afterward, an alternative approach immediate implant placement (IIP) was introduced, involving the insertion of the implant directly into the alveolar socket immediately after tooth extraction [2]. Compared to the traditional delayed protocol, IIP offers several benefits, including reduced overall treatment time, fewer surgical procedures, minimized post-extraction alveolar bone resorption, a positive psychological impact on the patient, and the potential to position the implant in an optimal axial alignment with the extracted tooth [3].

The placement of implants into the alveolar socket right after tooth extraction is called immediate implant placement (IIP) [4]. This approach has its particularities depending on which region of the jaws is involved. The anterior mandible region is peculiar due to the presence of mandibular incisors, which have the shortest roots among all permanent teeth. Immediate implant placement in the lower anterior region involves inserting a dental implant directly into the extraction socket immediately after tooth removal. This approach aims to preserve alveolar bone, reduce treatment time, and enhance esthetic outcomes.

The Immediate implant placement approach has its particularities depending on which region of the jaws is involved. The anterior mandible region is peculiar due to the presence of mandibular incisors, which have the shortest roots among all permanent teeth [5]. Having that in mind, it is important that an adequate pre-treatment evaluation is conducted in the cases which Immediate implant placement is planned [6].

Proper positioning of the implant is essential to ensure long-term success. It is recommended to place the implant at least 1.5 mm from the buccal plate and 2 mm below the cemento-enamel junction (CEJ) of adjacent teeth. This positioning helps prevent implant thread exposure due to buccal plate resorption and allows space for bone grafting material if needed.

A study utilizing cone-beam computed tomography (CBCT) found that bone driven implant placement aligning the implant according to available bone and anatomical structures resulted in a higher rate of safe placements (22.2%) compared to prosthetically driven placement (3.3%). This suggests that prioritizing existing bone structure may

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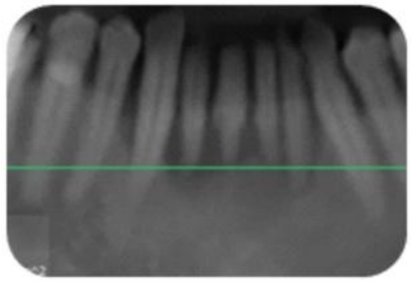
reduce the risk of cortical bone perforation and proximity to vital anatomical features. When compared with the delayed implant placement protocol, early dental implant placement offers advantages in the preservation of soft and hard tissues [7]. In certain cases, immediate loading of the implant (attaching a prosthetic tooth shortly after placement) can be considered. Immediate implant placement in the mandibular esthetic zone is a viable treatment option that can lead to favourable outcomes when executed with meticulous planning and technique.

This case report presents a technique involving early implant placement with immediate loading in the mandibular anterior region. This method offers a prompt and effective solution, minimizing the potential for tissue loss while optimizing esthetics and functionality though careful case selection and precise surgical technique are imperative to ensure success.

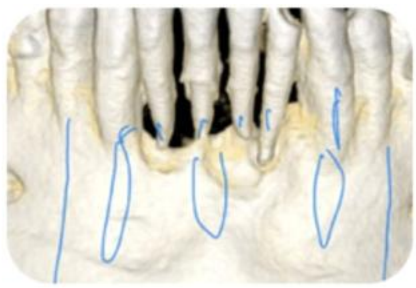
Clinical Case Report

A 26 year old female patient presented to the Department of Periodontics, DJ College of Dental Sciences and Research, Modinagar with the primary concern of poor facial appearance while smiling due to the Mobility of the lower central incisor. The patient reported a history of trauma to the area few months back, which resulted in this. There was no other significant medical, family or dental history. Considering the patient's esthetic concerns in the anterior region and their preference, an implant based fixed prosthetic rehabilitation was planned. Oral prophylaxis was performed, and the patient was given detailed oral hygiene instructions. During follow-up visits, the patient's oral hygiene was found to be satisfactory. A diagnostic impression was made with irreversible hydrocolloid and poured in dental stone. The obtained cast was used for mock-up using acrylic tooth. After evaluating the CBCT results, implant was planned for the patient.

We followed the standard surgical protocol for early implant placement by Buser et al. [8, 9] in which their various publications were taken into consideration for better clinical outcomes. Informed as well as written consent was taken from the patient prior to the treatment. Anesthesia was achieved through the local infiltration of 2% Lignocaine HCl with 1:200,000 epinephrine. A midcrestal incision was performed using a suitable BP blade, and a full thickness mucoperiosteal flap was gently raised to visualize the available alveolar bone in both the mesiodistal and buccolingual directions. The soft tissue remnants from the implant surgical site were cleared and irrigated with normal saline. Subsequently, the osteotomy site preparation was performed with respect to tooth. Initial pilot drill of 2.0 mm from the implant surgical kit was used as the first drill. Next, a guide pin was placed into the osteotomy site to ensure its alignment parallel to the adjacent tooth which was confirmed with intraoral periapical radiograph. Final implant placement was then done, and again, intraoral periapical radiograph was taken. With temporary abutment in place, closed tray impression was made using putty and light body and sent to the lab for provisional crown fabrication. Healing cap was screwed into the implant. Jumping distance was filled with Xeno-grafts, and two interrupted 3-0 silk sutures were placed. The patient was well informed about the possible risks associated with implant surgery. Mouthwash with 0.2% chlorhexidine gluconate (100 ml mouthwash) 10ml twice daily for 21 days was advised. Nonsteroidal anti-inflammatory drugs (NSAIDs) (ibuprofen 400mg and paracetamol 375mg, as per need and antibiotics (Amoxicillin 500mg+clavulanic acid 125mg, three times a day for five days were prescribed to the patient. After provisional crown fabrication, occlusal adjustments were done so that no contact is established with opposing teeth, and immediate loading was done. After one week following surgery, the patient was recalled for suture removal and evaluation of the surgical site. Regular follow-up visits at 2 and 3 months were scheduled for the patient. On re-evaluation during follow-up visits, soft tissue healing was found to be satisfactory. The patient was then recalled after five months for the final prosthesis. At 5 months, the temporary crown was removed, impression coping was connected to the implant fixture, and the final impression was made using putty and light body using a closed tray technique. The implant analogue was then attached to the impression coping. Shade selection was done, and the impression was sent to the lab for the final zirconia prosthesis. After occlusal adjustments, the final prosthesis was cemented using type II GIC as a luting agent. The patient was kept on regular follow-up visits.



Preoperative CBT



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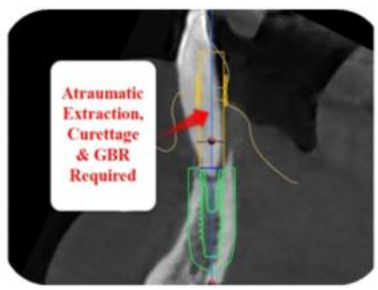
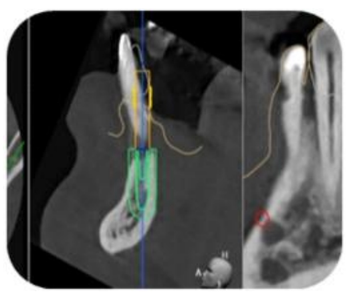


Digital Planning



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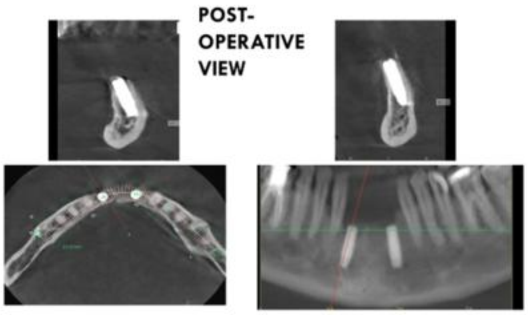

Discussion

Implant placement and loading protocols are pivotal components in dental implant treatment planning. Traditionally, implants were placed in fully healed edentulous sites, typically after six months of healing [10]. However, this delayed protocol often led to extended treatment times and esthetic challenges due to alveolar bone resorption following extraction [10].

Studies comparing immediate and early placement in anterior sites have shown comparable outcomes in ridge preservation, esthetics, and patient satisfaction [11]. However, immediate implants have been associated with a higher incidence of mid-facial mucosal recession affecting up to 26% of cases [12] with an average recession of 0.85 mm versus only 0.06 mm for early implants [13].Early implant placement allows for soft tissue healing, often resulting in a significantly thicker mucosal flap up to sevenfold in cases with thin or damaged facial walls thereby improving vascularity and reducing the need for grafting procedures [14]. Additionally, this approach facilitates the formation of 2–3 mm of keratinized mucosa due to spontaneous healing and apical bone regeneration [10]. Clinical studies have reported stable peri-implant soft tissue conditions for over three years with this technique [8].

Immediate loading, defined as placing a prosthesis in occlusion within 48–72 hours post-surgery [15,16], has shown comparable implant survival rates and marginal bone levels when compared with early loading protocols over 1–3 years. Given patient preference for shorter treatment times, immediate or early loading should be considered when clinical conditions are favorable [17]. In the case presented, early implant placement with immediate loading was performed in the mandibular anterior region. A xenograft (Bio-Oss®) was used to fill the jumping gap, but no barrier membrane was applied. This simplified the procedure, reduced surgical time and cost, and maintained the regenerative capacity of the periosteum an essential source of mesenchymal stem cells, vascular supply, and growth factors crucial for bone healing [18].The clinical outcome showed excellent esthetic and functional results: no soft tissue recession, no vertical bone loss at six months, and well maintained peri-implant tissue in all directions. Both intraoral and extraoral soft tissues are vital in achieving optimal esthetics, and early implant placement plays a crucial role in preserving these tissues.

Despite its advantages, early implant placement does have limitations, such as increased surgical time and complexity compared to immediate placement. Still, it offers a slightly higher first year survival rate 98.3% versus 94.6% for immediate placement with immediate loading.

Conclusion

Early implant placement following soft tissue healing involves a healing period of 4–8 weeks after tooth extraction before implant insertion. This approach is particularly suitable when the facial bone wall is thin or compromised, and the local bone morphology permits accurate three-dimensional implant positioning with adequate primary stability. It helps prevent vertical tissue collapse around the implant, promotes the formation of keratinized tissue on all sides, and allows for easier apical anchorage. The use of a surgical guide can further enhance the digital workflow in guided implant placement, improving precision and efficiency. Nonetheless, additional research is necessary to validate the potential benefits and clinical effectiveness of this emerging technique.

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Curcumin In Endodontics : A Comprehensive Review of its Applications, Efficacy, and Future Prospects

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Abstract

Curcumin, a naturally occurring polyphenolic compound derived from the rhizome of Curcuma longa (turmeric), has attracted considerable attention in dentistry due to its anti-microbial, anti-inflammatory, antioxidant, and wound healing properties. In endodontics, the quest for biocompatible and effective agents has prompted research into curcumin as an intracanal medicament, irrigant, and adjunct for regenerative therapies. This review explores the pharmacological profile of curcumin, its mechanisms of action, current applications in endodontics, and future directions for clinical translation.

Keywords

Curcumin; Endodontics; Intracanal Medicament; Irrigant; Photodynamic therapy; Regenerative Endodontics; Herbal Medicine.

1. Introduction

Endodontics focuses on the prevention, diagnosis, and treatment of diseases of the dental pulp and periapical tissues. Successful root canal therapy requires thorough microbial elimination, which remains a challenge due to the complexity of root canal anatomy and the persistence of biofilm-forming organisms such as Enterococcus faecalis. Conventional disinfectants including sodium hypochlorite (NaOCl), chlorhexidine (CHX), and calcium hydroxide ($Ca(OH)_2$) have demonstrated efficacy but also exhibit limitations such as cytotoxicity, unpleasant taste, and potential for dentin discoloration. This has stimulated the exploration of herbal alternatives that offer antimicrobial action with fewer side effects.

Curcumin, the principal bioactive compound of turmeric (Curcuma longa), has been used for centuries in Ayurvedic and Chinese medicine. Modern biomedical research highlights its broad pharmacological activities, including antimicrobial, anti-inflammatory, antioxidant, and anticancer effects. In dentistry, curcumin has been investigated for applications in periodontics, oral mucosal lesions, and more recently, endodontics. This review provides a comprehensive evaluation of curcumin's applications in endodontics, its advantages, limitations, and future prospects.

2. Pharmacological Profile of Curcumin

Curcumin is a yellow-orange hydrophobic polyphenol derived from turmeric rhizomes. Chemically, it is a diferuloylmethane with the molecular formula C21H20O6. The pharmacological properties of curcumin relevant to endodontics include:

Antimicrobial Activity: Curcumin exhibits inhibitory effects against Gram positive and Gram-negative bacteria, fungi, and viruses. Its mechanisms include disruption of bacterial membranes, inhibition of cell division, suppression of quorum sensing, and interference with nucleic acid synthesis.

Anti-inflammatory Action: Curcumin down regulates pro-inflammatory cytokines such as tumor necrosis factor-alpha (TNF-α), interleukin-1β, and interleukin-6. It also inhibits cyclooxygenase-2 (COX-2) and nuclear factor kappa B (NF-κB), thereby reducing periapical inflammation.

Antioxidant Properties: Curcumin acts as a free radical scavenger and upregulates endogenous antioxidant enzymes such as superoxide dismutase and catalase.

Wound Healing: Curcumin accelerates tissue repair by promoting fibroblast proliferation, collagen synthesis, and angiogenesis.

Biocompatibility: Compared with conventional irrigants like NaOCl, curcumin demonstrates superior safety with minimal cytotoxicity to periapical stem cells.

Nanotechnology Potential: Encapsulation of curcumin into nanoparticles, liposomes, or hydrogels enhances its solubility, bioavail-

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ability, and stability, making it a more viable candidate for clinical dentistry.

3. Applications in Endodontics

3.1 Curcumin as an Intracanal Medicament

Intracanal medicaments are crucial for eliminating residual microbes after instrumentation. Calcium hydroxide has been the gold standard but is less effective against resistant species such as E. faecalis. Curcumin pastes have demonstrated superior antimicrobial efficacy against E. faecalis and Candida albicans biofilms. Studies have shown that curcumin mixed with vehicles such as propylene glycol, polyethylene glycol, or chitosan provides controlled release and deep penetration into dentinal tubules. Comparisons with $Ca(OH)^2$ suggest that curcumin is equally or more effective in inhibiting biofilms.

3.2 Curcumin as an Irrigant

Root canal irrigants serve to flush debris, dissolve tissues, and disinfect. Although sodium hypochlorite remains the most commonly used irrigant, its toxicity to periapical tissues is a concern. Curcumin based irrigants have demonstrated antimicrobial efficacy in vitro, though their tissue dissolving ability is inferior to NaOCl. However, when combined with photodynamic activation, curcumin irrigants can achieve enhanced disinfection by generating reactive oxygen species.

3.3 Curcumin in Photodynamic Therapy (PDT)

Photodynamic therapy involves a photosensitizer, a light source, and oxygen to produce reactive oxygen species that kill microbes. Curcumin acts as a natural photosensitizer, activated by blue light (400–500 nm). Curcumin mediated PDT has shown effective disruption of endodontic biofilms, including multidrug-resistant E. faecalis. This approach holds promise as an adjunct to conventional irrigation protocols.

3.4 Curcumin in Regenerative Endodontics

Regenerative endodontic procedures (REPs) rely on stem cell survival, scaffold support, and a favorable micro-environment. Curcumin promotes mesenchymal stem cell proliferation and differentiation while exerting anti-inflammatory effects. In regenerative contexts, curcumin can be incorporated into scaffolds or hydrogels, facilitating pulp-dentin complex regeneration. Its role in modulating inflammation makes it a suitable adjunct in pulp revascularization therapies.

4. Advantages of Curcumin in Endodontics

- Natural, safe, and biocompatible agent
- Broad-spectrum antimicrobial activity
- Anti-inflammatory and antioxidant support for periapical healing
- Potential use in photodynamic therapy
- Cost-effective and easily available
- Can be combined with nanotechnology for improved clinical performance

5. Limitations and Challenges

Despite promising properties, curcumin's clinical use in endodontics faces limitations:

- Poor aqueous solubility and stability
- Limited tissue-dissolving ability compared with NaOCl
- Lack of standardized protocols and concentrations
- Scarcity of long-term randomized clinical trials
- Possible staining of dentin with prolonged use

6. Future Directions

- Future research should focus on:
- Developing nano-curcumin formulations with enhanced solubility
- Combining curcumin with established irrigants for synergistic effects
- Incorporating curcumin into scaffolds for regenerative endodontics
- Conducting randomized controlled trials to validate laboratory findings
- Standardizing clinical protocols for curcumin use in endodontics

7. Conclusion

Curcumin is a promising natural compound with diverse applications in endodontics. Its antimicrobial, anti-inflammatory, and regenerative properties make it an attractive alternative or adjunct to conventional agents. While its limitations in solubility and stability remain challenges, advancements in nanotechnology and photodynamic therapy may enhance its clinical utility. Well-designed randomized clinical trials are required to establish curcumin as a mainstream endodontic agent in the future.

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Heal Talk

Understanding Anxiety In The Geriatric Population: A Narrative Review of Prevalence, Presentation and Management

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Abstract

Background : Anxiety disorders rank among the most prevalent yet frequently under diagnosed mental illnesses within the older demographic. Anxiety in older persons sometimes goes unrecognised due to unusual symptomatology, concurrent physical ailments, and cognitive deterioration, resulting in diminished functional capacity and quality of life.

Objective : This narrative review seeks to thoroughly investigate the existing knowledge of anxiety in the elderly, emphasising its prevalence, etiological variables, clinical symptoms, neuro-biological foundations, diagnostic difficulties, and treatment strategies.

Materials and Methods: A comprehensive literature review was performed utilising electronic sources such as PubMed, Scopus, ScienceDirect, PsycINFO, Google Scholar, and the Cochrane Library. The review encompassed peer reviewed publications, observational studies, randomised controlled trials, systematic reviews, and policy documents published from 1980 to 2022. Keywords pertaining to geriatric anxiety, its risk factors, diagnosis, and treatment were utilised. Studies were selected based on their relevance, quality, and emphasis on those aged 65 and older.

Results: Elderly population were affected by anxiety, with Generalised Anxiety Disorder being the most common kind. Risk factors encompass neurobiological changes, including compromised GABAergic transmission and dysregulation of the HPA axis, and psychosocial stresses such as loneliness, grief, and loss of autonomy. The clinical presentation is frequently somatic and intersects with other medical diseases, hence confounding diagnosis. Cognitive Behavioural Therapy and SSRIs are established therapies, although non-pharmacological approaches such as mindfulness and social interventions demonstrate increasing effectiveness.

Conclusion: Anxiety in the elderly is a multifaceted health issue necessitating comprehensive screening and therapeutic strategies. Enhanced knowledge, age appropriate diagnostic instruments, and accessible mental health care are crucial for alleviating the burden of untreated anxiety in elderly people.

Keywords: Geriatric anxiety, Generalized Anxiety Disorder, elderly mental health, neuro-biology of anxiety, quality of life, cognitive behavioral therapy, SSRIs, late life psychiatry.

Introduction

Ageing is a multifaceted biological and psychological phenomenon characterised by various physiological alterations, functional constraints, and a heightened incidence of chronic illnesses. Alongside medical comorbidities, mental health issues like anxiety are increasingly acknowledged as substantial factors diminishing the quality of life in the aged. Anxiety in older persons frequently remains unrecognised or misdiagnosed due to unusual manifestations, overlapping somatic symptoms, or the erroneous belief that psychological suffering is a normal aspect of ageing.[1]

Anxiety disorders rank among the most common mental diseases in older persons, with community based research indicating prevalence rates between 10% and 20%, contingent upon population, environment, and diagnostic criteria employed.[2] Generalised Anxiety Disorder (GAD), specific phobias, panic disorder, and social anxiety disorder are the most frequently diagnosed anxiety disorders in late life. Nevertheless, these diseases frequently go under diagnosed owing to stigma, inadequate mental health literacy, and the absence of specialised screening instruments in geriatric clinical practice.[3]

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The causes of anxiety in the elderly are multifaceted. Biological modifications, including changes in the hypothalamic pituitary adrenal (HPA) axis, diminished GABAergic activity, and neurodegeneration in critical brain regions such as the amygdala and prefrontal cortex, enhance susceptibility to anxiety.[4] Psycho-social stressors, such as spousal bereavement, retirement, financial instability, and social isolation, exacerbate the emotional anguish encountered in later life.[5]

If not addressed, anxiety in older persons may result in considerable functional impairment, diminished treatment adherence, cognitive deterioration, and a heightened risk of disability. Furthermore, it has been associated with the aggravation of medical conditions such as cardiovascular disease and diabetes. Nonetheless, a significant deficiency persists in geriatric mental health services and research, especially in low and middle income nations like India, where the ageing population is swiftly increasing.[1,5,6]

In light of these issues, it is essential to investigate the burden, manifestation, neurobiology, and treatment of anxiety disorders in the aged population. This narrative review seeks to consolidate existing material to offer a thorough understanding of anxiety in senior populations and to identify areas necessitating additional clinical and research focus.

Methodology

Study Design

This narrative review aimed to thoroughly analyse and integrate the current literature on anxiety in the elderly population. This study aims to examine the prevalence, risk factors, clinical characteristics, neurobiological foundations, quality of life effects, and treatment strategies concerning anxiety in adults aged 65 and older. A narrative review was deemed appropriate for its capacity to integrate many sources and study methods, so enhancing comprehension of this multifaceted issue that spans fields like psychiatry, psychology, geriatric medicine, and dentistry sciences.

Sources of Data and Search Strategy

A comprehensive review of the current literature was conducted utilising computerised databases and manual reference verification. The principal databases utilised were PubMed, Scopus, Google Scholar, Science Direct, the Cochrane Library, and PsycINFO. The investigation encompassed articles from 1980 to 2022, guaranteeing the incorporation of both historical and present research pertinent to the subject. Grey literature, including WHO publications, government policy documents, and consensus statements on geriatric mental health particularly in the Indian context was evaluated to offer policy level insights.

Keywords and Medical Subject Headings (MeSH) were employed to develop the search strategy. The terms encompassed "anxiety disorders in the elderly," "geriatric anxiety," "late-life anxiety," "generalized anxiety disorder in older adults," "dental anxiety in the geriatric population," "anxiety and cognitive decline," "neurobiology of geriatric anxiety," "quality of life and anxiety in the elderly," and "non-pharmacological therapy for late life anxiety." Boolean operators like AND and OR were utilised to refine search results and improve relevancy.

Inclusion Criteria

This review covered studies based on certain criteria to ensure topic relevance. Only papers published in the English language were included. Eligible studies comprised human participants aged 65 years and older or those from which data pertinent to this age group could be collected. Research publications addressing anxiety, either as a principal diagnosis or as a secondary symptom, were incorporated. Both qualitative and quantitative research methodologies were evaluated, encompassing observational studies, cohort studies, randomised controlled trials, case control studies, systematic reviews, and meta-analyses. Furthermore, research focussing on the influence of anxiety on quality of life, neurobiological associations, diagnostic difficulties, and therapeutic approaches was emphasised.

Exclusion Criteria

To maintain focus and relevance, certain studies were excluded from this review. Articles that were not available in full text or those written in languages other than English were excluded. Case reports, editorial letters, commentaries, and conference abstracts without empirical data were also omitted. Studies focusing exclusively on younger populations (below 65 years) or those involving animal models were excluded unless they provided relevant comparative data for elderly individuals. Furthermore, studies in which anxiety was not a primary or distinctly addressed secondary outcome, particularly in the presence of other severe psychiatric conditions like schizophrenia or bipolar disorder, were not considered for inclusion.

Data Extraction and Analysis

Data extraction was performed manually by reviewing the full texts of selected articles to identify key findings relevant to the objectives of this review. Information was gathered on prevalence rates of anxiety disorders in elderly populations, demographic and clinical risk factors, diagnostic tools and challenges, neurobiological mechanisms, quality of life impairments, and treatment modalities including pharmacological and non-pharmacological approaches.

Results

Prevalence of Anxiety in the Elderly Population

Anxiety disorders rank among the most common mental problems in older persons, with prevalence estimates varying from 10.2% to 52.3% when accounting for subclinical symptoms. Himmelfarb et al. identified clinically significant anxiety symptoms in 17.1% of males and 21.5% of females aged 55 and older, highlighting the necessity for early identification and intervention.[1] Beekman et al. observed a 10.2% prevalence of anxiety disorders among elderly adults in the Longitudinal Ageing Study Amsterdam, with Generalised Anxiety Disorder (GAD) being the most prevalent. Despite a minor decrease in the frequency of anxiety with advancing age, the clinical burden remains substantial due to comorbidities and functional deterioration.[1]

Anxiety disorders in older persons are often underdiagnosed despite their high prevalence, primarily due to overlapping physical symptoms and cultural stigma, resulting in delayed or missed therapies.[7]

Risk Factors Contributing to Geriatric Anxiety

Risk factors for elderly anxiety encompass biological, psychological, and social dimensions. Isaacs et al. identified social risk factors, including widowhood, childlessness, and solitary living, that predispose the elderly to anxiety and depressive disorders.[8] Physical diseases, cognitive deterioration, and polypharmacy contribute to the psychological stress encountered by the aged.[9]

From a neurological perspective, modifications in neurotransmitter pathways particularly those involving serotonin, norepinephrine, and gamma-aminobutyric acid (GABA) play a role in the pathophysiology of anxiety. Age associated deterioration in cerebral areas, including the amygdala and hippocampus, as noted by Charney, further intensifies susceptibility.[4] Moreover, research has identified female gender, low socioeconomic position, urban isolation, and exposure to early life trauma as major predictors of anxiety in later life.[10,3]

Clinical Presentation and Diagnostic Challenges

The clinical presentation of anxiety in the elderly is frequently unusual and obscured by physical symptoms, including sleeplessness, palpitations, and gastrointestinal issues.[11] As a result, anxiety is sometimes erroneously ascribed to physical disorders or the process of ageing. The presence of cognitive impairment complicates diagnosis, since symptoms may overlap with dementia, thereby obscuring anxiety related distress.[12]

Conventional diagnostic tools such as the DSM-IV may not consistently identify nuanced anxiety manifestations in elderly individuals. Instruments like the Geriatric Anxiety Inventory (GAI) and the Hospital Anxiety and Depression Scale (HADS) are more appropriate for this demographic.[13]

Impact on Quality of Life and Daily Functioning

Anxiety significantly impairs the quality of life (QOL) in the elderly by reducing physical functionality, social participation, and emotional well being. Anxiety contributes to functional dependence by limiting activities of daily living (ADLs) and instrumental activities of daily living (IADLs), as well as increasing fall risk and frailty.[14] Maddux et al. found that anxiety, especially when comorbid with depression, leads to disability and loss of autonomy in aging individuals.[15]

The WHO defines QOL as the individual's perception of their position in life in the context of their goals, expectations, and cultural environment.[16] Anxiety interferes with this perception, causing decreased satisfaction, impaired cognition, and strained interpersonal relationships.[17]

Neurobiological Correlates of Anxiety in the Elderly

Recent studies highlight the significance of modified brain circuitry and neuroendocrine modulation in anxiety among the elderly. Paulus et al. established that the anterior insula has increased activity in anxious individuals, associated with heightened interoceptive awareness and anxiety feelings.[18] Gold et al. demonstrated via fMRI investigations that older adults with anxiety disorders show modified connection between the amygdala and ventromedial prefrontal cortex, hindering fear control.[19] Moreover, chronic stress and dysregulation of the hypothalamic pituitary adrenal (HPA) axis are prevalent among elderly individuals with anxiety disorders. Genetic determinants, including polymorphisms in the CRHR1 and FKBP5 genes, have been associated with enduring susceptibility to anxiety disorders.[20]

Treatment Modalities and their Effectiveness

The management of elderly anxiety encompasses both pharmaceutical and non-pharmacological approaches. Cognitive Behavioural Therapy (CBT) is a fundamental therapeutic modality, as evidenced by Gloster et al., who reported substantial enhancements in panic and agoraphobic symptoms among older patients receiving therapist guided CBT.[21]

Pharmacological therapies, including selective serotonin reuptake inhibitors (SSRIs) and serotonin-norepinephrine reuptake inhibitors (SNRIs), are primary agents. Nevertheless, vigilance is required due to polypharmacy and the modified pharmacodynamics in elderly individuals. Bandelow et al. concluded in a meta-analysis that both CBT and SSRIs are helpful, but their combination produces greater outcomes.[22]

Alternative therapies, including mindfulness, yoga, and relaxation training, have demonstrated efficacy with little adverse effects. These adjuvant therapy improve self regulation and diminish physiological arousal, rendering them appropriate for the geriatric population.[23]

Systemic and Policy Level Challenges

Despite progress in diagnoses and therapies, systemic obstacles impede appropriate care for worried older patients. Bruce et al. indicated that homebound elderly individuals exhibited markedly elevated levels of anxiety and depression symptoms; yet, few obtained psychiatric therapies due to inadequate access and insufficient recognition. Tripathy highlighted the deficiency of geriatric-oriented healthcare infrastructure and mental health services in India, particularly in rural and semi-urban regions.

National programs such as the NPHCE have been established to enhance geriatric care; nevertheless, they encounter challenges stemming from inadequate finance, personnel deficiencies, and limited public awareness. A multi-disciplinary strategy that incorporates mental health treatments within primary care is essential to address this disparity.[5]

Discussion

This review's findings highlight that anxiety among the elderly is a common but often overlooked mental health issue that considerably affects quality of life, functional capacity, and overall health outcomes. Although data suggests that as many as 20% of senior persons exhibit clinically severe anxiety symptoms[1,2], diagnosis and management are inadequate due to age related diagnostic intricacies, stigma, and systemic deficiencies in geriatric mental healthcare.

A significant problem resides in the unconventional manifestation of anxiety in elderly persons. Anxiety in this population frequently manifests as somatic complaints, including gastrointestinal pain, cardiovascular symptoms, or sleep difficulties, rather than overt fear or worry, increasing the likelihood of misattribution to physical conditions.[3] Cognitive loss in circumstances like moderate cognitive impairment or early Alzheimer's disease can obscure or complicate the emotional symptoms of anxiety, so confounding diagnosis.[4,15]

The neurobiological foundations of late life anxiety demonstrate age associated structural and functional alterations in the brain that hinder emotional regulation. Charney et al. emphasised that modifications in amygdala prefrontal brain circuitry and neurotransmitter imbalances, particularly diminished GABAergic and serotonergic transmission, significantly contribute to increased anxiety susceptibility in older adults.[4] Likewise, research employing functional neuroimaging has revealed aberrant anterior insular activity and impaired hypothalamic-pituitary-adrenal (HPA) axis function as associated factors of prolonged anxiety in older persons.[5] These findings underscore the significance of neurobiologically informed diagnosis and therapeutic approaches.

In addition to biological factors, psychosocial influences significantly influence outcomes. Social isolation, bereavement, loss of autonomy, and financial need are substantial stresses that exacerbate anxiety in the elderly.[1,2] In low and middle income contexts such as India, these issues are exacerbated by restricted access to geriatric mental health treatments, a shortage of qualified clinicians, and inadequate mental health literacy among patients and carers.

Pharmacological interventions, including selective serotonin reuptake inhibitors (SSRIs) and serotonin-norepinephrine reuptake inhibitors (SNRIs), exhibit efficacy; however, they require cautious application due to altered pharmacokinetics in the elderly and the potential for adverse effects or drug interactions. Cognitive

Behavioural Therapy (CBT) has proven to be a safe and effective option, with research indicating that adapted CBT methods, customised for cognitive and physical constraints, can alleviate anxiety symptoms and enhance coping strategies in the elderly.[1] Moreover, complementary therapies such as mindfulness, yoga, and social support initiatives demonstrate potential as non-invasive, culturally attuned supplements to conventional treatment, especially in community-oriented and resource-limited environments.

Conclusion

Managing elderly anxiety necessitates a comprehensive approach that incorporates biological, psychological, and social elements. Healthcare personnel must be alert for unusual presentations, utilise age appropriate screening instruments, and implement tailored, interdisciplinary treatment approaches. Public health systems must prioritise the enhancement of geriatric mental health infrastructure, especially in rapidly ageing populations. Additional research, particularly extensive longitudinal studies, is essential to create customised interventions and formulate evidence based guidelines.

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Heal Talk

Sealing the End : Root End Surgery for a Persistent Periapical Pathosis : A Case Report

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Abstract

Surgical root canal therapy, or apicoectomy, is indicated when non surgical re-treatment is unsuccessful or impractical. The procedure involves resection of approximately 3 mm of the root apex, removal of periapical pathology, preparation of a root end cavity, and placement of a retrograde filling to establish a hermetic apical seal. Various root end filling materials, including amalgam, gutta-percha, zinc oxide-eugenol cements, glass ionomers, and bioceramics, have been employed; however, mineral trioxide aggregate (MTA) has emerged as the material of choice due to its superior sealing ability, biocompatibility, and capacity to promote regenerative healing. This case report presents a case of a 22-year-old male with a persistent periapical lesion associated with tooth 21. Following unsuccessful non surgical management, apicoectomy was performed with root end filling using MTA. Postoperative evaluation revealed uneventful healing, histopathological confirmation of periapical granuloma, and radiographic evidence of bone regeneration at 5 months. This case highlights the effectiveness of apicoectomy as a predictable treatment modality in managing refractory periapical pathology, with success rates exceeding 85–90% when combined with modern microsurgical techniques and biocompatible materials.

Introduction

Surgical root canal therapy is often indicated when non surgical retreatment has failed or cannot be performed. Surgical root canal therapy usually involves resecting a portion of the root apex and preparing and filling a cavity in the root end. The term apicoectomy defined as the surgical removal of the apical portion of a tooth root, along with any associated periapical pathologic tissue, followed by the praparation and placement of a retrograde filling to seal the root canal system from the periapical aspect. The principal objective is to seal the canal system at the apical foramen from the periradicular tissues. To do this, it is necessary to resect the apical part of the root to gain access to the root canal. The aim of resection is to present the surface of the root so that the apical limit of the canal can be visually examined and to provide access for retrograde cavity preparation. Approximately 3 mm of root is removed which includes almost all lateral canals. Root end resection must be an adjunct measure to orthograde root treatment for two reasons. Firstly, there is very little chance of being able to seal all the lateral communications between the canal and the periodontal ligament with a retrograde root filling technique. Secondly, the area of root filling material exposed will be greater and the long-term success affected, because all root filling materials are, to some extent, irritant to the tissues.[1,2]

Retrograde filling materials such as amalgam, gutta percha, zinc-oxide eugenol cements (IRM, SuperEBA),Glass ionomer cements, composite resins, compomers, diaket, Ceramicrete, Bio-aggregate, Bioceramics etc. are commonly used in endodontic surgical procedures. All of these materials have been shown to be compatible with tissue cicatrisation and the reconstitution of periradicular alveolar bone, but none of them is able to induce cementum formation and full periodontal ligament repair. Mineral trioxide aggregate (MTA), a calcium silicate based material developed by the modification of Portland cement, has been introduced to address this problem and has shown good biocompatibility and sealing properties. This material permits a full regenerative healing and can be considered as the material of choice in endodontic surgery. In addition, the

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sealing properties of MTA are not affected by moisture during treatment.[3]

Surgical Technique Overview

Although the details vary depending on the tooth location, root morphology, and surgeon preference, the general sequence of an apicoectomy includes:

Preoperative assessment : Detailed clinical and radiographic examination, evaluation of the lesion, root anatomy, and proximity to anatomical landmarks.

Local anesthesia and flap design : Incision planning to ensure optimal access, minimal trauma, and primary closure potential. Common flap designs include triangular, rectangular, or sub-marginal incisions.

Osteotomy : Removal of overlying cortical bone to expose the root apex and periapical lesion.

Periapical Curettage : Complete removal of pathological tissue for histopathological examination.

Root end resection : Resection of 3 mm of the apical root portion to eliminate most apical ramifications and lateral canals.

Root end preparation : Ultrasonic tips are often used to prepare a class I cavity, centered along the long axis of the canal.

Retrograde filling : Placement of a biocompatible material such as MTA or Biodentine to create a hermetic apical seal.

Flap repositioning and suturing: Ensuring tension free closure and optimal healing.

Postoperative care : Analgesia, antimicrobial measures if indicated, and follow-up assessments.

Case Report

Patient History and Examination

A 22 year old male presented to the Department of Conservative Dentistry and Endodontics in Shree Bankey Bihari Dental College and research Centre, Ghaziabad with a chief complaint of occasional swelling and mild tenderness in the upper front region for the past six months.

Extraoral examination was unremarkable. Intraoral examination revealed the crown on tooth 21 to be intact, with no mobility or periodontal pockets. Palpation elicited mild tenderness over the labial mucosa apical to the tooth. Percussion produced slight discomfort. Thermal and electric pulp tests were negative for the tooth, as expected.

Periapical radiograph revealed tooth 21 with a large periapical lesion approximately 6 mm in diameter. No sinus tract was observed clinically. (Fig 1)

Fig 1: Pre-operative Radiograph

Treatment Plan

Access opening was done using high speed airotor and working length was determined using a 10k file. Biomechanical preparation was performed and calcium hydroxide dressing was placed for 1 week. No change in periapical lesion was noticed even after intracanal medicament placement. Obturation was done using lateral condensation technique and surgical endodontic treatment was considered. (Fig 2)

Fig 2 : Obturation of 21

Surgical Procedure

After obtaining written informed consent, the procedure was performed under local anesthesia (2% lignocaine with 1:80,000 adrenaline). A full-thickness mucoperiosteal flap was raised using a sulcular incision with vertical releasing incisions adjacent to tooth 21 (Fig 3). The labial cortical bone overlying the lesion was removed using a round bur under copious irrigation to create an osteotomy window. (Fig 4)

Fig 3 : Flap Reflected

Fig 4 : Bony Window

Granulation tissue surrounding the root apex was curetted (Fig 6) and stored in 10% formalin for histopathological examination. Approximately 3 mm of the root apex was resected perpendicular to the long axis of the tooth using a tapered fissure bur(Fig 5). Ultrasonic tips were used to prepare a 3 mm deep root end cavity centered along the canal (Fig 7). The cavity was irrigated with sterile saline and dried with paper points.

Mineral Trioxide Aggregate (ProRoot MTA, Dentsply) was placed incrementally into the cavity and compacted to achieve a dense, flush fill (Fig 8). The surgical site was irrigated with saline, the flap repositioned, and sutured with 4-0 silk sutures (Fig 11). A sterile pressure pack was applied.

Fig 5 : Root End Resection

Fig 6 : Curettage of the Granulation Tissue

Fig 7: Retrograde Cavity Preparation using Ultrasonic

Fig 8 : Retrograde Cavity filled with MTA

Fig 9 : Retrograde Cavity Prepared

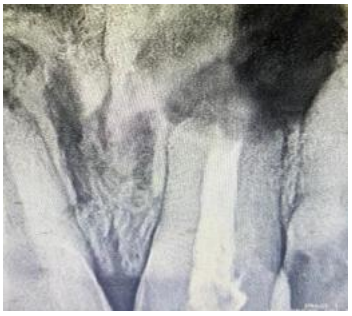

Fig 10 : Retrograde Cavity filled by MTA

Fig 11: Suturing Done

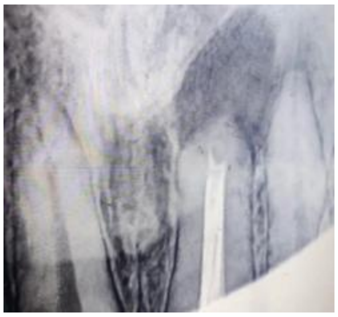

Fig 12 : 1 Months follow up

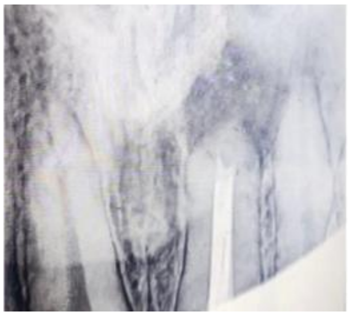

Fig 13 : 3 Months follow up up

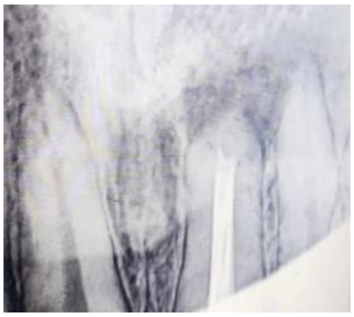

Fig 14 : 5 Months follow up

Postoperative Care

The patient was prescribed antibiotics and analgesic every 6 hourly for 7 days and chlorhexidine mouth rinse twice daily for one week. He was instructed to avoid mechanical trauma to the surgical site. Sutures were removed after 7 days, with uneventful soft tissue healing.

Follow Up and Outcome

Histopathological examination of the excised tissue confirmed a periapical granuloma. At the 5-month review (Fig 14), the patient reported no symptoms, and radiographs showed partial bone fill, with restoration of normal periodontal ligament space and lamina dura.

Discussion

This case illustrates the role of apicoectomy in managing persistent periapical pathology in situations where non surgical retreatment is not feasible. The maxillary anterior region offers favorable access, and the use of microsurgical techniques with MTA as a root-end filling material contributed to the predictable outcome observed.

MTA is composed of a hydrophilic powder mainly composed of calcium oxide. The high level of the apical seal of MTA, compared to that of other materials has been confirmed by several studies. The main advantages of the material are: biocompatibility, osteo-induction and regenerative potential, MTA did not induce cytotoxicity or inflammatory response of the body. Some of its disadvantages are: difficult manipulative and slow hardening, which may be the reason for the penetration and also surface disintegration and loss of marginal adaptation. Some authors have reported that the success in retrograde filling with MTA is higher in comparison with dental amalgam while others come to the conclusion that both materials used in the retrograde filling have similar clinical outcomes. [4,5]

MTA is known for its superior sealing ability, biocompatibility, and promotion of periapical healing. Resection of at least 3 mm of the root apex is recommended to remove most apical ramifications and lateral canals that may harbor bacteria. Success rates for modern apicoectomy exceed 85–90% when performed under magnification with appropriate materials.[5]

Conclusion

Apicoectomy provides an effective means of preserving teeth affected by persistent periapical lesions when orthograde re-treatment is not practical. The present case demonstrates favorable clinical and radiographic outcomes following surgical apicoectomy in a maxillary anterior tooth, underscoring the importance of meticulous surgical technique, appropriate case selection, and use of biocompatible materials.

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Heal Talk

Efficacy of Duloxetine and Amitriptyline along with Arthrocentesis In The Management of Temporomandibular Joint Disorders

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Abstract

Temporomandibular Joint Disorders (TMDs) are musculoskeletal conditions affecting the temporomandibular joint (TMJ), commonly resulting in pain, limited mouth opening, joint sounds, and psychological distress. This study aimed to evaluate and compare the efficacy of Duloxetine and Amitriptyline as adjuncts to arthrocentesis in the management of TMD. A total of 10 patients diagnosed with early-stage internal derangement of the TMJ (Wilkes Stage II and III) were randomly divided into two groups. Group I underwent arthrocentesis followed by Duloxetine 20 mg twice daily for 15 days, while Group II received arthrocentesis followed by Amitriptyline 25 mg twice daily for the same duration. Clinical parameters such as pain (VAS score), maximum mouth opening, TMJ clicking, lateral mandibular movement, and psychological status (Hospital Anxiety and Depression Scale) were evaluated preoperatively, and at the 7th day and 4th week postoperatively. Both groups showed improvement in symptoms, but Group I demonstrated significantly better outcomes in pain reduction ($p = 0.021$), increased mouth opening ($p = 0.016$), and decreased anxiety levels ($p = 0.021$) at the 4th week. No significant difference was noted between the groups in terms of TMJ clicking and lateral movement. The results suggest that arthrocentesis combined with Duloxetine is more effective than when combined with Amitriptyline in managing TMD symptoms. However, larger studies with extended follow up are needed to further substantiate these findings.

Introduction

The temporomandibular joint (TMJ), also known as the mandibular joint, is a synovial joint that uniquely functions as a bilateral articulation composed of two ellipsoid joints. It is encased in a fibrous capsule and includes essential synovial components such as the synovial membrane and fluid, along with several ligaments that contribute to joint stability. Anatomically, the mandible and the cranium join together to create a unified structural unit, which justifies the accurate anatomical term craniomandibular articulation[1]. This articulation shares several classic features with other synovial joints, including the presence of an articular disk, synovial fluid, capsule, and supporting ligaments. Move-ment within the joint is precisely regulated by the interplay of the joint's osseous morphology, masticatory muscles, supporting ligaments, and the occlusal relationship of the dentition. Owing to the bilateral connection of the mandible, the joints operate in unison and cannot function independently[2].

The TMJ comprises two distinct anatomical components: the mandibular element, which includes the condylar process and the mandibular neck, and the cranial element, which encompasses the articular surface of the temporal bone. Other important anatomical landmarks of the joint include the articular eminence, articular tubercle, preglenoid plane, mandibular fossa's lateral boundary, and the glenoid process. Central to the joint is the articular disk - a biconcave fibrocartilaginous structure that facilitates smooth gliding and hinge movements. The entire joint is enclosed within a fibrous capsule and is supported by multiple ligaments including the collateral, sphenomandibular, and stylomandibular ligaments. Lubrication is maintained by synovial fluid, secreted by synoviocytes, which is critical for reducing friction and ensuring smooth movement.

Temporomandibular disorders (TMD) encompass a range of musculoskeletal and functional disorders affecting the TMJ and its associated structures. Common clinical manifestations include joint pain, restricted

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mouth opening, and joint locking[2]. The etiology of TMD is multifactorial and includes systemic, hormonal, mechanical, and parafunctional factors. Advancing age, autoimmune diseases, endocrine imbalances, nutritional deficiencies, metabolic dysfunctions, and infectious diseases can all affect the metabolism of fibrocartilage, compromising the joint's adaptive capabilities. Hormonal influences are particularly noted for their role in remodeling of the condylar region. Mechanical stress, whether due to trauma or malocclusion, can lead to internal derangements and degeneration of the articular cartilage. Microtrauma or macrotrauma to the joint may initiate inflammatory cascades, resulting in chronic pain. Parafunctional habits such as bruxism exert abnormal forces on the joint and can precipitate disc displacements and degenerative alterations. Additionally, emotional and psychological factors such as stress and depression often co-occur with chronic TMJ pain, indicating a biopsychosocial model of TMD pathogenesis[3].

Accurate diagnosis of TMD requires a multidisciplinary assessment strategy, incorporating the patient's medical and dental history, clinical evaluation, and radiographic imaging. Clinical examination involves palpation of the joint and muscles, evaluation of mandibular range of motion, and occlusal analysis. Radiographic modalities such as X-rays, MRI, and CT scans provide detailed visualization of both soft and hard tissues within the joint and help in identifying structural anomalies or degenerative changes[4].

The management of TMD focuses on symptom alleviation, restoration of function, and prevention of progression. Initial treatment options include conservative therapies such as pharmacological management (e.g., NSAIDs, acetaminophen, muscle relaxants, and tricyclic antidepressants), physical therapy, and patient education. Behavioural interventions such as cognitive behavioural therapy, habit reversal, biofeedback, and relaxation techniques are shown to be beneficial, especially in chronic cases. Occlusal splints are widely used due to their reversibility and non-invasive nature; they help in muscle relaxation, TMJ unloading, and protection against dental wear caused by parafunction[5].

Pharmacologic agents like TCAs and serotonin nore-pinephrine reuptake inhibitors (SNRIs) have shown promise in managing chronic TMD pain. Duloxetine, a centrally acting SNRI, is effective in treating chronic musculoskeletal pain, including that arising from osteoarthritis and TMD. It works by inhibiting the reuptake of serotonin and norepinephrine, key neurotransmitters involved in central sensitization and chronic pain. Similarly, amitriptyline, a tricyclic antidepressant, has demonstrated efficacy at low doses (e.g., 25 mg/day) in managing chronic TMD pain without significant adverse effects. These agents modulate central pain processing and can significantly reduce pain intensity and improve quality of life when used as part of a multidisciplinary treatment plan[3].

In patients who do not respond adequately to conservative therapies, arthrocentesis has gained popularity as a minimally invasive surgical intervention. This procedure involves lavage of the upper joint compartment with the aim of breaking intra-articular adhesions and flushing out inflammatory mediators such as interleukins and cytokines. Arthrocentesis improves joint mobility, reduces pain, and restores mandibular function. It is considered a valuable first-line surgical approach before more invasive surgical options are explored[7].

Objective of the Study

This study aims to evaluate the comparative efficacy of arthrocentesis combined with duloxetine (20 mg) and arthrocentesis combined with a tricyclic antidepressant (amitriptyline) in the management of chronic pain associated with temporomandibular disorders. By comparing these combinations, the study seeks to determine which pharmacological adjunct, when used alongside arthrocentesis, offers superior relief from chronic TMJ pain and improves overall joint function.

Materials and Methods

This prospective randomized clinical study was conducted in the Department of Oral and Maxillofacial Surgery at Shree Bankey Bihari Dental College & Research Centre, Ghaziabad, Uttar Pradesh. A total of 10 temporomandibular joints (TMJ) were included and randomly divided into two groups of five joints each, irrespective of the patients' race, sex, caste, or socio-economic status. Group I received arthrocentesis followed by duloxetine 20 mg administered twice daily for 15 days, while Group II received arthrocentesis followed by amitriptyline 25 mg administered twice daily for 15 days. Inclusion criteria comprised patients aged 18 to 70 years with TMJ pain located in the face, jaw, temple, or around the ear during chewing or mouth opening, and diagnosed with Wilke's stage II or III internal derangement. All patients provided informed consent before participation. Patients were excluded if they had a history of TMJ surgery, responded to prior conservative therapy, had joint pathologies, or presented with coagulation disorders.

Hospital Anxiety and Depression Scale (HADS)

Tick the box beside the reply that is closest to how you have been feeling in the past week.
Don't take too long over you replies: your immediate is best.

D	A		D	A	
		I feel tense or 'wound up':			**I feel as if I am slowed down:**
	3	Most of the time	3		Nearly all the time
	2	A lot of the time	2		Very often
	1	From time to time, occasionally	1		Sometimes
	0	Not at all	0		Not at all
		I still enjoy the things I used to enjoy:			**I get a sort of frightened feeling like 'butterflies' in the stomach:**
0		Definitely as much		0	Not at all
1		Not quite so much		1	Occasionally
2		Only a little		2	Quite Often
3		Hardly at all		3	Very Often
		I get a sort of frightened feeling as if something awful is about to happen:			**I have lost interest in my appearance:**
	3	Very definitely and quite badly	3		Definitely
	2	Yes, but not too badly	2		I don't take as much care as I should
	1	A little, but it doesn't worry me	1		I may not take quite as much care
	0	Not at all	0		I take just as much care as ever
		I can laugh and see the funny side of things:			**I feel restless as I have to be on the move:**
0		As much as I always could		3	Very much indeed
1		Not quite so much now		2	Quite a lot
2		Definitely not so much now		1	Not very much
3		Not at all		0	Not at all
		Worrying thoughts go through my mind:			**I look forward with enjoyment to things:**
	3	A great deal of the time	0		As much as I ever did
	2	A lot of the time	1		Rather less than I used to
	1	From time to time, but not too often	2		Definitely less than I used to
	0	Only occasionally	3		Hardly at all
		I feel cheerful:			**I get sudden feelings of panic:**
3		Not at all		3	Very often indeed
2		Not often		2	Quite often
1		Sometimes		1	Not very often
0		Most of the time		0	Not at all
		I can sit at ease and feel relaxed:			**I can enjoy a good book or radio or TV program:**
	0	Definitely	0		Often
	1	Usually	1		Sometimes
	2	Not Often	2		Not often
	3	Not at all	3		Very seldom

Please check you have answered all the questions

Scoring:
Total score: Depression (D) ___________ Anxiety (A) ___________
0-7 = Normal
8-10 = Borderline abnormal (borderline case)
11-21 = Abnormal (case)

Figure 1- Hospital Anxiety and Depression Scale

All patients were educated about their condition and instructed to avoid excessive jaw movements, including hard biting and gum chewing. Clinical evaluation involved obtaining a complete medical history, informed consent, and performing extra-oral and intra-oral examinations using diagnostic instruments. Radiographic evaluation using orthopantomogram (OPG) and TMJ open and closed views was carried out to exclude bony pathologies. Each patient was assessed preoperatively and at postoperative intervals (1st and 4th weeks) based on several parameters. Pain was measured using a 10 cm visual analogue scale (VAS), with scores ranging from 0 (no pain) to 10 (severe pain), as described by Singh et al. in 2021. Maximum mouth opening (MMO) was assessed in millimeters between the incisal edges of the upper and lower central incisors using a calibrated ruler, following Nitzan et al. (1991). Lateral and anterior excursive jaw movements were evaluated by measuring the deviation of the lower jaw from the midline of the upper central incisors, as per Yura and Totsuka (2005). TMJ clicking sounds were assessed through clinical palpation during mouth opening and closing and noted as either present or absent, according to the method described by Carvajal and Laskin (2000). Psychological assessment was done using the Hospital Anxiety and Depression Scale FIGURE 1- HOSPITAL ANXIETY AND DEPRESSION SCALE (HADS), as per Singh et al. (2017), where scores of 0–7 were considered normal, 8–10 borderline, and 11–21 indicative of clinical anxiety or depression.

Arthrocentesis was performed under local anesthesia in a sterile setting. The patient was draped, and the TMJ area was disinfected with povidone-iodine. An auriculotemporal nerve block was given using 2% lignocaine hydrochloride. The Holmlund Hellsing line was drawn from the midpoint of the tragus to the outer canthus of the eye. Two entry points were marked: the first point was 10 mm anterior and 2 mm inferior to the tragus-canthus line, and the second was 20 mm anterior and 10 mm inferior to the same line. Using a 26-gauge needle and 10 ml syringe, lavage was performed using 0.9% normal saline to irrigate the joint and eliminate inflammatory mediators. After irrigation, the needles were removed, and entry points were covered with sterile dressings. Group I patients were then prescribed duloxetine 20 mg twice daily, and Group II patients were prescribed amitriptyline 25 mg twice daily, both for 15 days. Postoperative care included instructions for a soft diet, application of hot and cold fomentation, maintenance of proper sleep, and adherence to physiotherapy exercises. Follow-up assessments were conducted on the 7th and 28th days post-treatment using the same clinical and psychological parameters to evaluate treatment outcomes.

Figure 2- Holmlund Hellsing Line

Statistical Analysis

Data collected during the study were entered in Microsoft Excel 2007 and analyzed using SPSS version 23.0. Descriptive statistics, including mean, standard deviation, frequency, and percentage, were used to summarize the data. The level of statistical significance was set at 5% ($p < 0.05$).

To assess data distribution, the Shapiro–Wilk test was applied, while Levene's test was used to evaluate the homogeneity of variance. For intergroup comparisons, the independent t-test was employed to determine statistical significance between the two treatment groups. Chi-square tests were used for the comparison of ordinal and nominal variables, particularly to assess associations in categorical data.

The following statistical formulas were applied:

Mean: calculated as the sum of all scores divided by the number of observations.

Range: computed as the difference between the highest and lowest scores.

Variance and Standard Deviation : used to measure data dispersion around the mean.

Independent t-test : used to compare the means between two independent groups and determine if the difference is statistically significant.

Chi-square test: used to test the goodness of fit and evaluate the association between categorical variables by comparing observed and expected frequencies.

This statistical approach ensured reliable and valid interpretation of the data, allowing objective comparison between the two treatment modalities for temporomandibular joint disorder management.

Radiograph

Figure 3 - Orthopantomogram

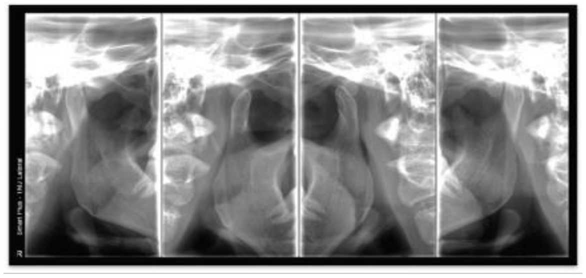

Figure 4 - TMJ Open and Close View

Intraoperative Picture

Figure 5 - Landmark (holmlund-hellsing Line)

Figure 6 - TMJ Lavage

Figure 7 - Mouth

Group II

Pre-operative Picture

Figure 8 - Mouth

Radiograph

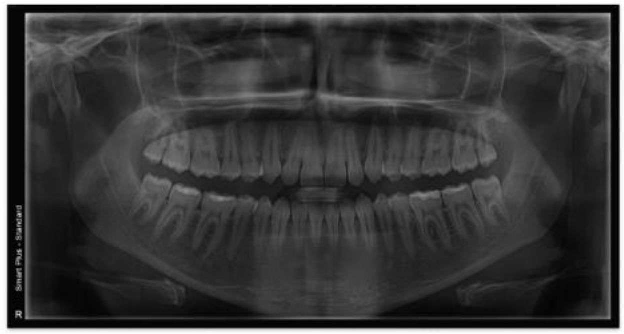

Figure 9 - Orthopantomogram

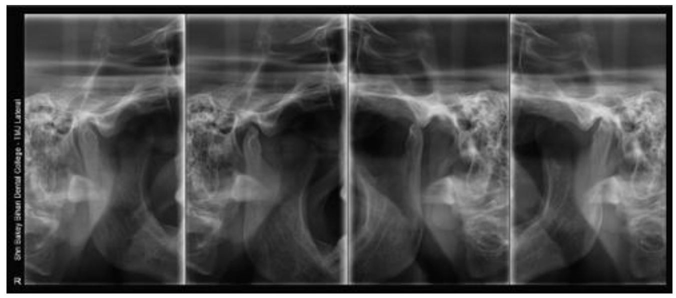

Figure 10 - TMJ Open and Close

Intra-operative Picture

Post-operative 1 Month Picture

Figure 11 - Landmark (holmlund-hellsing

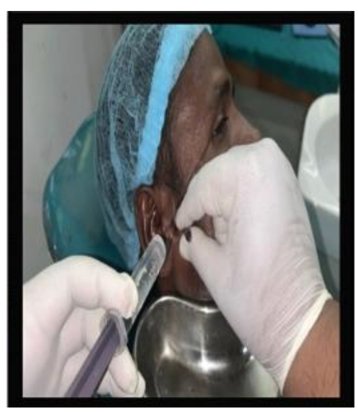

Figure 12 - TMJ Lavage

Figure 13 - Mouth Opening

Results

In terms of gender distribution, Group 1 consisted of 20% females and 80% males, while Group 2 included 60% females and 40% males.

Regarding pain scores, both groups showed improvement over time. The pre-treatment mean pain score was 6.60 in Group 1 and 7.00 in Group 2. On the 7th postoperative day, the mean scores reduced to 3.80 and 4.40, respectively. Although Group 1 showed a slightly greater reduction in pain, the difference between the two groups was statistically non-significant ($p = 0.759$). By the 4th week, the mean pain score further decreased to 1.40 in Group 1 and 3.00 in Group 2, showing a statistically significant difference in favour of Group 1 ($p = 0.021$).

In the comparison of mouth opening, Group 1 showed a mean pre-treatment value of 27.60 mm, which increased to 33.20 mm at day 7 and 39.00 mm at the 4th week. Group 2 started with a higher baseline of 31.20 mm, which improved to 35.40 mm at day 7 and 37.60 mm at week 4. Although the difference was not significant at day 7 ($p = 0.443$), it became statistically significant at the 4th week ($p = 0.016$), indicating better mouth opening in Group 1.

In terms of pain on lateral movement, 100% of patients in Group 1 and 60% in Group 2 reported pain at baseline. By the 7th day, only 20% in Group 1 and 40% in Group 2 reported pain. At the 4th week, none of the patients in either group experienced pain during lateral movement. The intergroup differences at all time points were statistically non-significant.

TMJ clicking was present in 40% of Group 1 and 80% of Group 2 at baseline. By day 7, it was reduced to 20% in Group 1 and 40% in Group 2. At the 4th week, no clicking was reported in either group. The reduction was clinically noticeable but statistically non-significant throughout the evaluation period.

Anxiety scores also decreased in both groups. Group 1 showed a pre-treatment mean anxiety score of 8.20, reducing to 4.40 at day 7 and 2.00 at week 4. Group 2 started at 7.60, reduced to 5.60 at day 7 and 3.00 at week 4. The intergroup comparison showed a non-significant difference at day 7 ($p = 0.133$), but a statistically significant difference at week 4 ($p = 0.021$), with greater improvement observed in Group 1.

Overall, both treatment modalities showed improvement in TMJ pain and function, but Group 1 (arthrocentesis with duloxetine) demonstrated more significant and sustained reductions in pain, better mouth opening, and greater reduction in anxiety over the 4 week period.

Discussion

Temporomandibular joint disorder (TMD) was initially described by Hey et al.[1] as a localized mechanical fault disrupting the smooth function of the temporomandibular joint (TMJ). TMD is now widely recognized as a group of musculoskeletal and neuromuscular conditions involving the TMJ, masticatory muscles, and surrounding tissues[2]. These disorders often lead to significant clinical symptoms including pain, restricted mandibular movement, joint noises (clicking or crepitus), and in many cases, psychological distress.

The current study was undertaken to assess and compare the clinical efficacy of duloxetine and amitriptyline, both centrally acting medications, when used as adjuncts to arthrocentesis in managing patients with internal derangement of the TMJ. Arthrocentesis is a minimally invasive procedure that helps in flushing inflammatory mediators, releasing adhesions, and restoring normal joint mobility. The focus was particularly on patients diagnosed with Wilkes Stage II and III disorders, which typically involve anterior disc displacement with and without reduction[3].

Wilkes' classification system[3] provides a crucial framework for understanding disease progression from early stages involving mild disc displacement and occasional pain (Stage I & II) to advanced stages marked by severe disc deformation and degenerative bony changes (Stage IV & V). These progressive stages highlight the importance of early intervention. In our study, arthrocentesis combined with centrally acting agents was performed on patients primarily in early stages to arrest progression and alleviate symptoms.

Pain, the cardinal symptom of TMD, results from both peripheral and central mechanisms. Peripheral sources include inflammation of the retrodiscal tissues and muscles, while centrally, altered neurotransmitter activity plays a role. Singh et al.[2] conducted a study comparing arthrocentesis, duloxetine therapy alone, and their combination. They concluded that the combination therapy offered superior pain relief. Similarly, Kumar et al.[4] observed that duloxetine, a serotonin norepine-phrine reuptake inhibitor (SNRI), significantly enhanced pain control when used adjunctively with arthrocentesis. Supporting evidence from Nitzan et al.[5] and Yura & Totsuka[6] emphasized that arthrocentesis itself plays a vital role in reducing intra-articular pressure and washing out inflammatory mediators, thus directly relieving joint pain. In our findings, both groups showed pain reduction postoperatively, but the Group I (Duloxetine + Arthrocentesis) exhibited significantly better outcomes at the fourth week ($p = 0.021$), suggesting the potential central action of duloxetine in reducing chronic pain.

Maximum mouth opening (MMO) is a key clinical measure to assess the improvement in joint function. Nitzan et al.[5] first demonstrated the utility of arthrocentesis in treating patients with restricted mouth opening. Malik and Shah also supported these findings and highlighted the long-term improvement in jaw mobility after joint lavage. Furthermore, Singh et al.[2] and Kumar et al.[4] reported that duloxetine significantly contributes to improved MMO, likely due to pain modulation and reduction in muscle tension. In our study, the Group I patients showed greater improvement in MMO compared to Group II at the fourth week, with a statistically significant difference ($p = 0.016$), reinforcing the idea that duloxetine may be more effective than amitriptyline in enhancing functional mobility post arthrocentesis.

Lateral jaw movement, though less emphasized in many studies, is vital for normal masticatory function. Yura and Totsuka[6] found that arthrocentesis improved all components of mandibular motion, including lateral excursions. List and Jensen[8] proposed that pharmacological interventions aimed at central pain mechanisms may improve jaw dynamics indirectly by reducing associated myofascial pain and muscular tension. Our results indicated a trend toward improvement in lateral movement across both groups, but the difference was not statistically significant, suggesting that while joint lavage contributes to improved mobility, neither drug had a marked differential effect on this parameter.

Joint clicking, a common clinical sign of disc displacement with reduction, was present in several patients at baseline. Moses et al.[9] in their arthroscopic study observed improved disc mobility and joint function in the majority of patients following surgical lavage, though they did not directly measure sound. Yura and Totsuka[6] demonstrated that sufficient hydraulic pressure during arthrocentesis could eliminate clicking by restoring disc-condyle coordination. In our study, TMJ clicking decreased in both groups by the fourth week, but no statistically significant difference was observed between groups, suggesting that improvement was primarily due to the mechanical effect of arthrocentesis.

The psychological impact of TMD is increasingly recognized. Chronic orofacial pain is often associated with anxiety, depression, and impaired quality of life. Zigmond and Snaith[10] developed the HADS scale, which has become a standard tool to assess psychological distress in medical settings. Santos et al.[11] evaluated amitriptyline's efficacy in TMD patients and found improvements in both pain and psychological parameters, particularly when combined with cognitive behavioral therapy (CBT). However, duloxetine has a more robust dual action on serotonin and norepinephrine pathways, which has shown efficacy in chronic pain conditions such as fibromyalgia and diabetic neuropathy, as seen in the study by Thor et al.[12]. In our analysis, Group I (duloxetine) patients exhibited a greater reduction in anxiety scores, with statistical significance at the fourth week ($p = 0.021$), highlighting duloxetine's superior central action in relieving psychological comorbidities associated with TMD.

Conclusion

The treatment of internal derangement temporomandibular joint has sparked widespread debates because no consensus has been reached. When conservative therapy fails, minimally invasive procedures such as arthrocentesis were recommended. There were various medications available to reduce temporomandibular joint pain, Duloxetine had been used in various fields of modern medicine for its invaluable useful properties and only a very few studies had been conducted to assess its role in Internal derangement of TMJ. Our study had concluded that use of combination of duloxetine with arthrocentesis gave an outcome much better than Amitriptyline with arthrocentesis of TMJ in controlling the pain. The maximum incisal mouth opening was better with Duloxetine group with arthrocentesis than Amitriptyline group with arthrocentesis of TMJ. Clicking sounds were reduced in Duloxetine group than Amitriptyline group. Anxiety and depression were reduced in Duloxetine group than Amitriptyline group. Further studies with large sample size must evaluate the effect of arthrocentesis combined with duloxetine in providing permanent relief to the patient.

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Heal Talk

Minimally Invasive Management of Oral Submucous Fibrosis : A Clinical Guide

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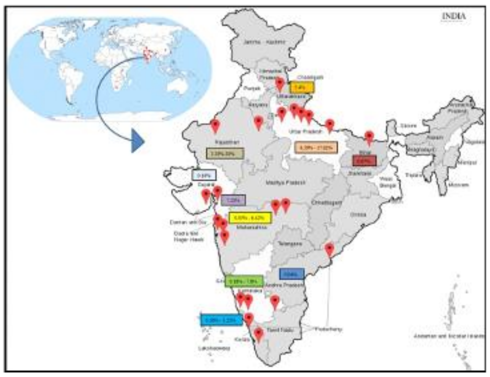
Abstract

Oral Submucous Fibrosis (OSMF) is a chronic, progressive, scarring disease of the oral mucosa with a malignant transformation risk ranging from 7–13%. The condition, strongly linked to areca nut chewing, has a high prevalence in South and Southeast Asia. Its progressive fibrosis leads to restricted mouth opening, impaired function, and precancerous potential. This comprehensive review elaborates on history, etiopathogenesis, clinical features, histopathology, and classification of OSMF, with an extensive focus on management strategies divided into conservative, minimally invasive, and surgical modalities. Evidence from clinical studies, systematic reviews, and meta-analyses is integrated to provide a detailed, publication ready reference.

Keywords - Oral Submucous Fibrosis; Areca nut; Antifibrotic therapy; Corticosteroids; Hyaluronidase; Antioxidants; Immunomodulators; Minimally invasive management; Laser fibrotomy; Cryotherapy; Surgical Management; Oral Potentially Malignant Disorder.

Introduction

Oral Submucous Fibrosis (OSMF) is a chronic, insidious disorder characterized by inflammation and progressive fibrosis of the oral mucosa. First described by Schwartz in 1952 among Indian women in East Africa, it has since emerged as a major public health concern in the Indian subcontinent. OSMF is classified as an Oral Potentially Malignant Disorder (OPMD) by the WHO. OSMF is defined as "A debilitating, progressive, irreversible collagen metabolic disorder induced by chronic chewing of areca nut and its commercial preparations; affecting the oral mucosa and occasionally the pharynx and esophagus; leading to mucosal stiffness and functional morbidity; and having a potential risk of malignant transformation" by WHO. The disease impairs nutrition, speech, and oral hygiene due to trismus, and malignant transformation into oral squamous cell carcinoma has been reported in up to 13% of cases. Over decades, management has evolved from simple dietary supplements to advanced surgical reconstruction and minimally invasive innovations.



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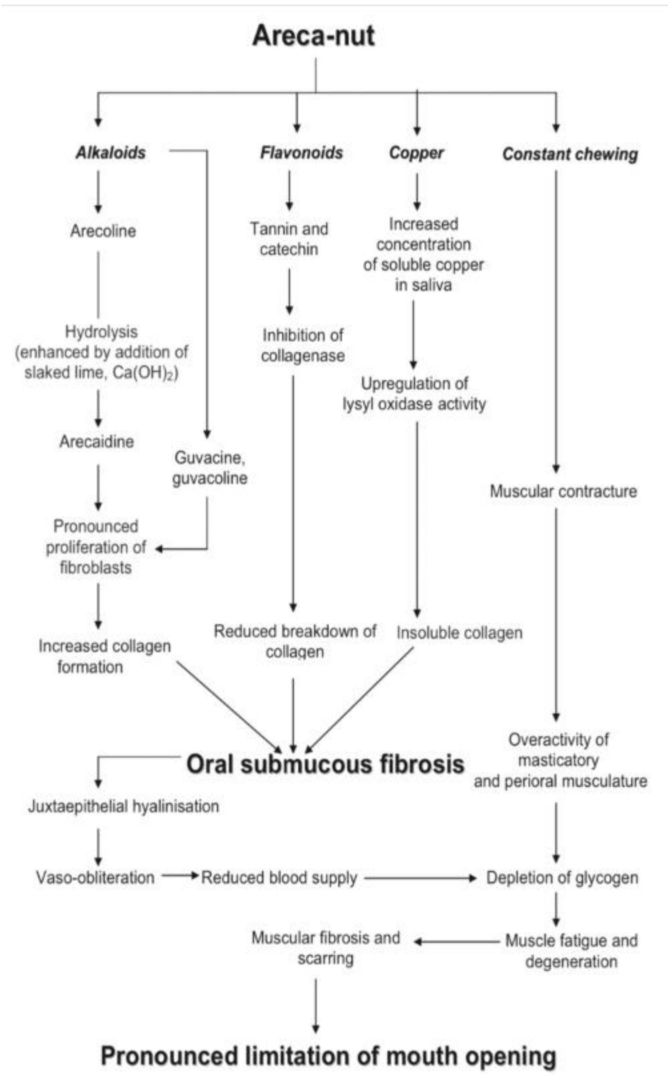
History

The earliest references to a condition resembling OSMF date back to Shushrutha in 600 B.C. ('Vidari'). Modern recognition came with Schwartz (1952), who described OSMF in Indian women in Kenya. Pindborg and Sirsat (1966) provided histopathological definitions and established the fibrotic and premalignant nature of the disease. Since then, several researchers including Murti (1995), Khanna & Andrade (1995), and Borle & Borle (1991) have contributed to understanding its patho-genesis and management.

Etiopathogenesis

Areca nut alkaloids, particularly arecoline and arecaidine, stimulate fibroblast prolifera-tion and excessive collagen synthesis. Copper enhances lysyl oxidase activity, stabilizing collagen fibers and reducing breakdown. Tannins and catechins inhibit collagenase, leading to further accumulation. Pathological features include juxta-epithelial hyalinization, reduced vascularity, and progressive fibrosis with muscular degeneration. Nutritional defici-encies (iron, zinc, vitamins), genetic predispo-sition, immune dysregulation, and oxidative stress also contribute. Cytokines such as TGF-β, TNF-α, and NF-κB play pivotal roles in perpetuating fibrosis.



Epidemiology

OSMF is prevalent in South and Southeast Asia, especially India, Pakistan, Sri Lanka, and Taiwan. The prevalence in India ranges from 0.2% to 6.4%, most common among males aged 20–40 years. Immigrant populations in Western countries also exhibit cases due to continued areca nut use. The disease's malignant potential makes it a pressing health burden.

Clinical Features

Initial symptoms include burning sensation, intolerance to spicy foods, and mucosal blanching. Progressive features involve fibrous band formation, trismus, reduced cheek flexibility, restricted tongue mobility, xerostomia, and dysphagia. Severe cases show mouth opening <15 mm with compromised function. Pre-malignant epithelial changes are often observed in advanced OSMF.

Intraoral view showing: (A) Marble-like appearance of soft palate. faucial pilars and upper pharvngeal mucosa(B)Shrunken uvula, blanching or left buccal mucosa and retromolar region, (C) fibrosis and depapillation or tongue, (D) Blanching or right buccal mucosa and (E) fibrosis and pigme-ntation of lower lip.[65]

Extraoral view showing: (A) Sunken cheeks and prominent malar bone. (B) reduced mouth opening[65]

Classification and Staging

Khanna & Andrade's functional staging is widely used:

Stage I : >35 mm mouth opening

Stage II : 26–35 mm

Stage III : 15–25 mm

Stage IV : <15 mm or OSMF with carcinoma

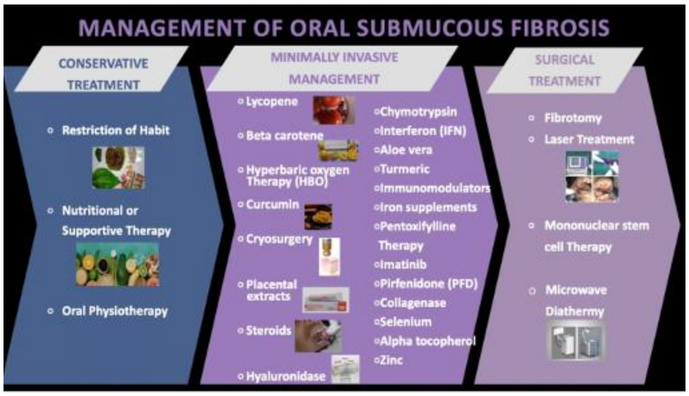
Histological staging includes early fibroelastic changes, hyalinization, and epithelial atrophy with dysplasia in advanced stages.

Histopathology

Microscopically, OSMF demonstrates juxta-epithelial inflam-mation, thickened collagen bundles, fibroelastic changes, and epithelial atrophy. With progression, hyalinization dominates, muscle fibers are replaced by dense collagen, and dysplastic changes may occur, explaining malignant potential.

Management of OSMF

Management of OSMF is stage specific and multifaceted, focusing on symptom relief, functional improvement, prevention of progression, and reduction in malignant potential. Broadly, inter-ventions fall under conservative, minimally invasive, and surgical modalities.



Conservative (Pharmacological) Management

Conservative management is the first line, especially in early disease. Modalities include:

1. Corticosteroids : Triamcinolone and dexamethasone reduce inflammation and fibroblast activity.
2. Hyaluronidase : Breaks down hyaluronic acid in ECM, improving elasticity and mouth opening.
3. Antioxidants : Lycopene (inhibits TGF-β and NF-κB), curcumin (anti-inflammatory, antioxidant), vitamins C & E (collagen synthesis and ROS neutralization).
4. Immunomodulators : Pentoxifylline enhances microcirculation, inhibits fibroblast proliferation, improves oxygenation.
5. Novel Antifibrotics : Imatinib (tyrosine kinase inhibitor), pirfenidone (anti-TGF-β), collagenase injections.
6. Other Agents : Chymotrypsin, interferons, aloe vera, turmeric, spirulina, zinc, selenium, alpha-tocopherol, iron supplements.
7. NSAIDs : Combined with antioxidants, provide dual anti-inflammatory and anti-oxidative effect.
8. Physiotherapy : Mouth-opening devices and exercises to prevent relapse and maintain mobility.

Clinical trials (Borle & Borle 1991, Khanna & Karjodkar 2006, Arakeri 2018) demonstrate improvements in burning sensation and modest increases in mouth opening, though fibrosis reversal remains limited.

Minimally Invasive Management

These bridge the gap between pharmacological and surgical therapy:

1. Laser therapy : CO_2, diode, and ErCr : YSGG lasers excise fibrotic bands with hemostasis, minimal scarring, and faster healing.
2. Endoscopic release : Precise visualization and targeted cutting of bands, sparing normal mucosa, reducing morbidity
3. Cryotherapy : Freezing of fibrotic tissue induces necrosis followed by regeneration.
4. Biologics : Platelet concentrates, stem cell conditioned media, growth factor gels explored for regeneration.
5. Combination protocols : Laser release with concurrent pharmacological therapy improves outcomes.

Studies (Kashyap 2023, Gondivkar 2020, Shao 2024) suggest improved functional outcomes, reduced complications, and faster recovery compared to traditional surgery.

Surgical Management

Surgical treatment is indicated in advanced cases with severe trismus (<15 mm):

1. Fibrotomy/Excision : Scalpel excision or anterior fibrotomy directly releases fibrous bands.
2. Mucosal Grafts : Split-thickness skin grafts, palatal mucosa grafts restore elasticity.
3. Flaps : Nasolabial flap, tongue pedicle flap, buccal fat pad, temporalis myofascial flap.
4. Coronoidectomy : Removes coronoid process when temporalis fibrosis contributes to trismus.
5. Free Tissue Transfer: For extensive, recurrent disease (e.g., radial forearm free flap).

Studies (Kamath 2015, Mudgal 2022) report significant improvement in mouth opening (average gain 20–25 mm), but highlight relapse without physiotherapy and abstinence from habits.

Discussion

Conservative therapy is effective in early stages but rarely curative. Minimally invasive modalities offer durable results with less morbidity, while surgery remains indispensable in advanced cases. An integrated approach habit cessation, pharmacotherapy, minimally invasive techniques, surgery when indicated, and sustained physiotherapy is essential. Future directions include regenerative medicine, stem cell therapies, and molecular agents targeting fibrotic pathways (e.g., anti-TGF-β, anti-fibroblast activation molecules).

Conclusion

OSMF continues to pose diagnostic and therapeutic challenges. Conservative strategies remain essential in early disease, minimally invasive modalities bridge the gap by offering effective, patient friendly solutions, and surgical interventions are reserved for advanced cases. A multimodal, evidence based approach offers the best long-term outcomes.

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Heal Talk

PAX 9 Gene - Its Role in Dentistry

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Abstract

Background: PAX 9 gene (Paired box 9 gene) is an important member of the homeobox genes. They are important transcription factors which help in conversion of DNA into RNA and are key regulators of developmental processes such as regional specification, patterning and differentiation of a developing individuals. PAX9 proteins are expressed in the pharyngeal pouches, developing vertebral column and neural crest derived mesenchyme of maxillary and mandibular arches, contributing to palate and tooth formation.

Aim: This narrative review was conducted to understand the role of PAX9 gene in various orodental diseases and its future scope.

Methods: Research publications were searched on search engines such as Scopus, Pub-Med, and Google Scholar, and articles with terms such as "PAX9 gene, oligodontia/ hypodontia, class II div 2 or class III malocclusion, tooth impactions, cleft lip and palate" were collected.

Results: A total of 35 articles were collected and they were further used to formulate this review.

Discussion: PAX9 gene was found to have a role in development of orodental diseases, especially in: (i) Dental agenesis, (ii) Class II div 2 Malocclusions, (iii) Class III malocclusion, (iv) Cleft lip and palate, and (v) Impaction of teeth.

Key words: PAX9 gene, Dental agenesis, class II and III malocclusions, cleft lip and palate.

Introduction

Humans possess approximately 30,000 genes, and recent advancements in genetics have significantly broadened our understanding of this field. The causes of various oro-dental diseases have long been debated, particularly regarding whether their origins are primarily environmental or genetic.[1] With the progress in genetics and molecular biology, new techniques have emerged that provide deeper insights into the etiology and pathogenesis of numerous human diseases, including those affecting the oral and dental regions. Conditions such as periodontitis, tooth agenesis, cleft lip and palate, dental caries, and various malocclusions have all been shown to have genetic associations.[2] Genes such as MSX (Muscle Segment Homeobox), PAX (Paired Box Gene), Cathepsin C, AMELX (Amelo-genin X-linked Gene), ENAM (Enamelin), and RUNX2 (Runt Related Protein) have been implicated in dental disorders.[2]

Among these, the PAX9 gene stands out for its critical role in dental development. PAX9 gene belongs to transcription factors family (homeobox genes) which is characterized by DNA binding domain known as paired domain, which is a conserved amino acid motif and has DNA binding activity.[3] This gene plays a crucial role in organogenesis by triggering cellular differentiation. PAX9 is expressed in mesenchyme derived from neural crest cells and plays a crucial role during development of the craniofacial structures and teeth.[4] The gene is located on the long arm of chromosome 14 (14q13.3)[5], and it has been reported that mutations in this gene tends to cause various oro-dental diseases.

The PAX9 gene is one of the most extensively studied genes involved in dentition development. Its proteins act as signaling factors during the initiation, bud, and cap stages of tooth development, any mutations in this gene likely to result in dental agenesis (congenital absence of teeth).[6] Beyond its traditional role in tooth development, recent research has revealed that mutations of PAX9 gene has caused a wide range of other dental issues, such as maxillary canine impactions, cleft palate, Class II Division 2 malocclusions, and Class III malocclusions. Understanding the implications of PAX9 gene mutations is invaluable for clinicians in patient diagnosis,

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treatment planning, and prognostic assess-ments. By integrating this knowledge into clinical practice, clinicians can create personalized treatment plans, predict possible complications, and enhance overall care of the patient.

Methods

Research publications were searched for 6 months on various search engines such as Scopus, PubMed, and Google Scholar, and articles with terms such as "PAX9 gene, oligodontia / hypodontia, class II div 2 or class III malocclusion, tooth impactions, cleft lip and palate" were collected. Further, all those articles were analyzed to find out the various mutations of PAX 9 gene which can lead to orodental diseases.

Results

32 articles were collected and they were used to formulate this review.

Discussion

PAX9 (Paired box gene) is a member of paired box transcription factor family and includes an octapeptide, two paired box domains (N-terminal subdomain [NSD], linking peptide, C-terminal subdomain [CSD]), and a 128-amino acid paired type homeodomain. It is essential for the formation of dental mesenchyme throughout all stages of odontogenesis. Consequently, mutations in PAX9 gene can lead to abnormal or diminished regulation of proteins, which is crucial for normal development. The PAX9 gene is composed of five exons (1 to 5), with Exon 2 accounting for 61.11% of the coding sequence.[7]This exon encodes the paired box domain, which is an evolutionary conserved area of DNA binding domain.

Mutations in paired domain can impact binding activities of DNA, stabilization of protein, and activation of other related genes. The PAX9 gene is crucial for the formation of the medial nasal process, palatal shelf, and maxilla. Loss of PAX9 gene function can lead tohypodontia, oligodontia, clefts of the palate, and some skeletal abnormalities. Mutations in the PAX9 gene can range from single nucleotide substitutions which results in amino acid changes, premature termination of translation, and loss of function of the protein and lead to haploinsufficiency.[8]

Additionally, the PAX9 gene is also associated with various orodental issues, including dental agenesis, various mal-occlusions, canine impactions, and cleft lip and palate.

Role of PAX9 Gene In Dental Agenesis

Most common outcome of PAX9 mutation is non syndromic dental agenesis. Tooth agenesis, also known as congenitally missing teeth, is one of the most common congenital abnormalities in man, and it can affect mastication, speech , aesthetics, and can also cause malocclusion.[9] Tooth agenesis is classified as hypodontia (lack of one to five permanent teeth, excluding the third molars), oligodontia (lack of six or more permanent teeth, excluding the third molars), or anodontia (complete lack of teeth) on the basis of the number of missing teeth.[10]

Molecular studies across different populations have identified several gene mutations linked to the congenital absence of permanent teeth, including AXIN2, EDAR, FGFR1, GREM2, IRF6, LRP6, MSX1, PAX9, and WNT10B.[11] To date, highest number of etiological mutations has been found in PAX9 gene, which encodes a transcription factor crucial for the development of various organs and skeletal elements, including teeth. PAX9 is expressed in dental mesenchyme at initiation, bud, cap, and bell stages of odontogenesis.[12] Proteins function as transcription factors that facilitate communication between epithelial and mesenchymal tissues, playing a vital role in establishing the odontogenic potential of the mesenchyme.[13] Therefore, any mutation in this gene can lead to orodental anomaly. PAX9-deficient mice have shown lack teeth and also pharyngeal pouches derivates structures were affected. Mutant mice have severe craniofacial anomalies, and were unable to survive due to malformation of secondary palate. Permanent molars are most frequently affected by defects in PAX9 gene also the size of teeth was found to be reduced. Stockton DW et al [14] was the first one to describe mutation in human PAX9 gene as insertion of an additional G allele within the paired box sequence at nucleotide 219 of exon 2 in a family with oligodontia which causes pre-mature termination of translation. Over the years, more than 50 mutations have been found in PAX9 gene in connection with dental agenesis[15] It was also observed that due to PAX9 mutations more missing teeth were seen in maxillary arch when compared to the mandibular arch.[16]

Role of PAX 9 Gene In Malocclusions

Development of craniofacial structures is widely believed to be influenced by both genetic and environmental factors. Changes in genes crucial for craniofacial development has affected the development of craniofacial abnormalities. After detecting the association of PAX9 gene in dental agenesis researchers start to investigate its association with class II div 2 malocclusion as dental agenesis is common in this malocclusion. Mathew D Wall[17] found the association between SNP (Single Nucleotide Polymorphism) Marker rs8004560 with individuals suffering from class II div 2 malocclusion and hypodontia. Later similar results were seen by Morford et al[18] in 2010 and it was found that rs8004560 may have a role in class II/D2 mal-occlusions.

In contrast Ghergie, et al [19] when conducted a study on various malocclusion and their association with PAX9 gene it was found that SNP (rs8004560) polymorphism was associated with Class I malocclusion patients rather than class II div 2 malocclusion. Later a study was conducted on Malaysian population by Saad et al [20] in which they found no association between PAX9SNP (rs8004560) and Class II skeletal base malocclusion contributed by mandibular retrognathism but they concluded that there is a gray area which need to be researched. PAX9SNP (rs8004560) could be detected and the distribution of genotype and allele could be determined in study with bigger sample size.

Along with association of class II div 2, class III malocclusion association with PAX9 gene have also been studied. Baker et al [21] conducted a study on individuals with class III malocclusions and found over representation of PAX9 (rs8004560) in the individuals with mandibular prognathism (MP) indicating the genetic association of PAX9 (rs8004560) SNP in the incidence of Mandibular prognathism. Another study was conducted by Rodrigues et al [22] to assess if there is any association between polymorphisms in genes causing tooth agenesis and craniofacial patterns. It has also been said that the chance of presenting skeletal class III malocclusion increased by two folds due to the presence of at least one g allele. However, no association was found between PAX9 gene and skeletal craniofacial pattern.

Role of PAX9 Gene In Canine Impaction

The etiology of impacted canine is multifaceted and encompass various factors, such as environmental input (e.g., trauma), local factors (e.g., lack of space, retention of primary teeth, trauma to permanent tooth buds and the presence of pathological lesions, such as dentigerous cysts or odontoma), genetic factors, and systemic disease.[23] Impacted teeth are frequently found in the maxilla, particularly the canines and incisors, as well as in the mandible, including the third molars and second pre-molars.

Among these, second most commonly impacted teeth are maxillary canines with approximately two thirds being impacted on the palatal side.

Peck et al [24] first contributed the biologic evidence pointing towards genetic factors as the primary origin of most palatally displaced canines. Decades later in 2019 Devi and Padmanabhan [25] found the rs2073247 polymorphism of the PAX9 gene, hetero-zygous genotype CT was positively associated with palatal impaction of maxillary canines. It has also been suggested that individual's with genotype CC located on SNP 3 (rs12881240) and SNP 4(rs4904210) of PAX 9 gene carried a greater risk for maxillary canine impaction.[26]

Role of PAX9 Gene In Cleft Lip and Palate

Orofacial clefts are widely acknowledged as prevalent congenital maxillofacial abnormalities globally, affecting approximately 1 in 700 live births (Dixon et al., 2011). Initially, when cleft lip and palate were first documented a century ago, they were attributed to supernatural malevolent forces. However, with advancements in genetic and genomic analysis, there has been significant progress in comprehending the underlying causes of these conditions. Similar to the embryonic development of other organs, palatogenesis from its inception to completion is meticulously regulated, overseen by a complex interplay of genes, tissue interactions, and environmental factors.

Peters in 1998[27], was the first to display that PAX9 mutant mice was associated with cleft palate also the development of teeth was arrested at bud stage and mice was not able to survive after birth. The PAX9 gene, which encodes a transcription factor found in both mesenchymal and epithelial cells, exhibits a dynamic expre-ssion pattern during palatogenesis. Initially, PAX9 was observed in the epithelium of the murine foregut at embryonic day 8.5 (E8.5).[28] By E14.5, there is a decrease in mesenchymal PAX9 expression, while it remains present in the medial edge epithelium (MEE). Between E14.5 and E15.5, epithelial PAX9 gradually diminishes as the midline epithelial seam (MES) disappears and the shelves fuse.[29] The distribution pattern of PAX9 varies in accordance with the progression of developmental events.

Palatal shelves in mutant cases exhibit an unusually widened shape on the nasal side, accompanied by reduced mesenchymal proliferation particularly in the middle and posterior regions which result in deficient elongation of shelves.[30]At E14.5, delayed elevation is observed on one or both sides of the PAX9 mutant shelves. Subsequently, in PAX9 mutants, the palatal shelves fail to fuse and exhibit irregular and poorly developed palatal rugae. Years later, it was discovered that in cleft embryos, PAX9 expre-ssion persists in the medial edge region without down regulation by E15.5, whereas PAX9 expression is down regulated in paired palatal shelves.[31] Consequently, altered PAX9 expression in spontaneous cleft lip and palate disrupts the fusion of palatal shelves during embryonic development

When compounded effect of mutations in the PAX9 and MSX1 was researched in double homozygous mutants by Nakatomi et al [32]is was suggested combined reduction of PAX9 and MSX1 gene dosage in humans may increase the risk for oro-facial clefting and oligodontia. Till date various SNPs of PAX9 gene have been detected which has shown a positive exhibited significant association with non-syndromic cleft lip.

Conclusion

PAX9 gene plays an intricate role within the realm of dentistry, shedding light on its significance in odontogenesis and craniofacial development. The PAX9 gene's pivotal role in dental development has been elucidated, highlighting its involvement in the formation of teeth and associated structures. Its regulatory functions in odontogenesis, including tooth morphogenesis and differentiation, underscore its indispensable contribution to dental patterning and growth. Furthermore, the implications of PAX9 gene mutations and variations in dental anomalies has been explored, emphasizing its clinical relevance in understanding the etiology of various orodental diseases. Different mutations in different exons of PAX9 gene has been detected which leads to various consequences. Conditions such as dental agenesis (hypo-dontia and oligodontia), malocclusions, cleft lip and palate, impacted teeth etc. are associated with the mutations in PAX9 gene. Identification of various mutations of PAX9 gene can empowers the clinicians to deliver more precise, personalized, and effective care, ultimately improving the oral health outcomes and quality of life for individuals worldwide.

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Heal Talk

Effectiveness of Implant Design on Implant Stability

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Abstract

With the advent of implants, other options of rehabilitation such as removable dentures and crowns have taken a backseat. Implants are placed after meticulous planning and after placement there are specific criteria that can predict and determine their success. At present the implant survival rate ranges from 90 – 95 percent over a 10 year observation period. Implant survival depends upon implant stability both at the time of placement and as the treatment progresses. Implant stability is of two types, primary and secondary and there are various factors that influence implant stability. Recently, a wide array of researches has been conducted on factors improving implant stability. The factors influencing implant stability include implant design, implant surface topography, bone quality, and patient-related factors. Implant design has gained particular relevance especially because the intricacies in implant design are increasing over the years. The role of implant design on implant stability has been explored. Various aspects of implant design which includes its macro and micro geometry play their respective parts in optimizing implant stability. With the available information, the present review aims to discuss the implant design factors associated with implant stability.

Keywords: Implant stability, implant design, thread design, macrogeometry, microgeometry .

Introduction

Implants in dentistry are becoming the more sought after treatment option. In an edentulous space, an implant can be placed without using the support of abutment teeth. This makes implant therapy a conservative treatment option unlike fixed partial dentures wherein adjacent teeth need to be prepared. It is also better to use an implant compared to other removable treatment options because removable prosthesis require constant attention and lack the natural simulation created by an implant. Prior to the placement of the implant various factors are evaluated. A thorough understanding of all the factors involved in the treatment planning of implants is of utmost importance. According to Misch1, there are eight factors to be considered in the treatment panning of an implant. They include, prosthesis design, patient force factors, bone density in the edentulous sites, key implant positions, implant number, implant size, available bone in the edentulous sites and implant design.[1] All these factors influence one another and vary from case to case. Historically, the implant number and position took precedence over the prosthesis design. However, our main goal is to provide rehabilitation of missing teeth; in other words the patient is missing teeth and not implants. The treatment planning should take place in retrograde where the rehabilitating prosthesis dictates the implant position and number.[2] The ideal treatment plan is established while considering the number and position of missing teeth and then modified based on patient force factors.[3] The forces exerted onto the prosthesis depend upon parafunctional habits, masticatory dynamics, opposing dentition, crown height space and arch position.[4] The next most important criteria is bone density; bone density varies according to the edentulous site. Bone density can provide valuable input to the treatment plan; for example weaker bone density requires wider implants. Overall, the poorer the bone density the greater the implant support required.

The last of the factors mentioned include implant design which will be the highlight of this article. Implants can be broadly divided into three parts; the crest module, the body and the apex. The crest module receives the abutment in the latter stages of treatment. Earlier, the crest module formed the trans-

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ossteal portion of the implant; however with the introduction of subcrestal implants the whole of the implant, including the crest module lies primarily within bone. The crest module may be optimized to increase bone implant contact, however that function is mainly taken care of by the body of the implant.[5] The body of the implant lies in direct contact with the bone. This bone implant contact (BIC) is essential for the stability of the implant. By virtue of this contact the implant derives stability. The crest module plays a minor role in stabilizing the implant within the bone. It houses the anti rotation components required to attach the abutment onto the implant. The body of the implant, referred to as 'root form endosteal implants', is of three types; cylindrical type, screw type and a combination of both. Cylinder implants can be parallel walled or tapered; they are generally pushed or tapped into the prepared bone site. Due to the lack of threads within this design they depend upon the surface condition for retention. Screw root form implants on the other hand derive their retention from threads mainly; additionally they may also have surface treatments to enhance retention. Thread shape, thread pitch, helix angle of the thread and other features associated with the threads make the screw root form implants more complex and better for implant stability.[6] Several important design factors can affect implant stability including implant diameter, implant length, implant thread design, implant surface roughness, and implant shape.7 All of these features of an implant should be optimized in order to provide maximum bone implant contact which will lead to good implant stability. A thorough understanding of implant design including its macro and microgeometry is important to understand their effect on primary and secondary stability. Good implant stability is a fixed determinant for the success of an implant. The two types of stability that can be achieved are primary and secondary stability. Primary stability refers to the mechanical seating of the implant. The engagement of the implant with the bone provides stability to the implant. The aim is to provide maximum stability with minimum movement at the bone implant interface.8 Secondary stability, on the other hand, comes after primary stability and primarily refers to the stability achieved between bone and implant after the process of osseointegration has taken place. This is also referred to as biological stability because the new bone is now integrated to the implant surface.9 Primary and secondary stability are positively correlated with each other. According to literature, if the micro motion is above the range of 50 – 150 microns during the measurement of primary stability, the secondary stability does not properly take place. This is because micro motion between bone and implant above this range will result in fibrous encapsulation as opposed to osseo-integration.[10]

With the introduction of immediate placement and immediate loading of implants the stability of implants has become an even more crucial factor. The implant design has to be optimized in such scenarios as well to give a better stability. Implant placement can be divided into immediate, early and delayed. Immediate implant placement as the name suggests, is the immediate placement of an implant into the extraction socket after the extraction of the tooth. Early placement is 2–4 week delayed implantation after extraction and allowing soft tissue healing. Delayed approach is the conventional method which describes implantation after 4–6 months of waiting for complete healing time.[11] Right after the placement of an implant the bone implant contact creates primary stability in all three cases. However, immediate implant placement poses the maximum challenge owing to the compromised condition of the hard and soft tissues. Just like implant placement, implant loading can also be classified into immediate, early and delayed (or conventional).[12] Loading refers to the prosthetic rehabilitation of the implant by virtue of which the implant is brought into function. Since occlusal forces come into play after loading, loading creates stresses at the bone implant interface. This makes implant stability even more important. The stability of the implant dictates loading protocols. If immediate loading is being considered then primary stability plays and even greater role; this is because the load distribution will be immediate and during the period when primary stability dominates (upto 4weeks). Immediate implant loading will depend upon primary stability of the implant where as delayed loading will depend upon the secondary stability as it will occur after the new bone formation has already taken place.

The present review aims to discuss implant design features involved in stability. It also gives us idea of proper selection of implant design in scenarios such as immediate placement and immediate loading where implant stability plays an even more important role.

Implant Design Considerations

Implant Macrogeometry

The Crest Module

The crest module serves as the transition zone between the implant body and the prosthesis. The crest module might extend into the soft tissue zone in which case it is referred to as transosteal. In case the total implant including the crest module is submerged into the bone it may be referred to as sub crestal. The crest module can further be reviewed under shape, size and surface.[13]

Shape of the Crest Module

The shape of the crest module determines the stresses created between the bone and the implant at the crest of the bone. The stresses come into play when the implant is loaded. Regardless of the loading protocol used these stresses may affect the primary and/or secondary stability of the implant. [13] As a general rule shear stresses are minimized while compressive stresses are preferred because bone is strongest when loaded in compression, 30% weaker to tensile loads, and 65% weaker to shear loads. Misch and Bidez[14] claimed that when compared to parallel walled implants, crest modules designed at 20 degree angulations provide the benefit of compressive and tensile components; a surface texture may also be added.[14] Wan-Ling Shen et al.[15] compared the three most common shapes of crest module: straight, divergent and convergent. According to his findings the divergent collar design produced least stress and strain followed by the straight type and the convergent one.[15] The reason for this is that the divergent collar design provides the maximum surface area of bone implant contact.

Size of the Crest Module

As demonstrated by a finite element analysis by Cynthia et al[16], increasing the crestal diameter led to a decrease in strain at the crestal region by 3.5.[16] The crest module diameter is kept larger than the outer diameter of the body of the implant to provide good initial stability and also to provide a better seal to the initial osteotomy site.

Surface of the Crest Module

Machined and smooth collars were introduced for maintaining proper hygiene. The biological width of the implant including the sulcus depth is 3.08 mm while the bristles of a brush reach 0.5 to 1mm of depth. This is the primary reason why a smooth surface is necessary to reduce plaque accumulation.[17] However, the placement of smooth surface of crest module at the crestal bone region leads to more marginal bone loss. This is because smooth collared implants placed in contact with crestal bone produces shear stresses leading to crestal bone loss. Furthermore, smooth collars may induce fibroblast growth which interrupts the contact between the bone and the implant creating a fibrous capsule instead.[18] Herman et al conducted a study in 2001 to determine the suitable length and location of smooth collar to avoid crestal bone loss. In his study he placed transgingival implants in dogs. The implants were divided mainly into two study groups ; one group had roughened surface at the crestal bone region and the other group had a smooth collar of 1.5mm below the crestal bone region after which the roughened surface began. The two groups were observed for a period of 6 months in unloaded condition. In this study it was observed that within 1 month itself the group with a 1.5 mm smooth collar underwent marginal bone loss while no such bone loss was seen in the other group.[19] Hanggi et al.[20] conducted similar experiments and the conclusion that can be raised from these experiments is that the smooth collar within the bone should be of minimum length possible.[20]

The Body of the Implant

In the given literature it has been seen that implant body has influence on implant survival after loading of implants. Inappropriate body designs can cause early implant failure after loading. Early loading (within 1 week to 2 months after implant placement) cases, combined with softer bone types or shorter implants fall under the category most likely to fail.21Good acre et al conducted a review of literature between 1981 and 2003 according to which in soft bone type, loading causes a 16% increase in chances of failure.[22] Weng et al,[23] conducted a study of 6 years and observed that 98% implants survived in the initial healing period. However, within 18 months of loading, implants of 7mm length failed 25% of the time.[23] The rate of failure was highest in short implants, specifically in the soft bone of the posterior maxilla, in early loading conditions.

The Size of the Implant

The implant body receives the biomechanical load from the prosthesis; this load is transferred to the surrounding hard tissue bone. This biomechanical load depends on two factors: the force being applied and the surface are throughout which that force is dissipated. The Surface Area over which the occlusal forces are dissipated play a major role in reducing the stresses between implant bone interface. Stress = Force/

Surface area thus it is evident that to reduce stress, the force must decrease or the surface area must increase. The size of an implant may be modified in either length or diameter.

The length of the Implant

The greater the length of the implant the more surface area it possesses to interact with the surrounding bone, thus an increased amount of stability can also be predicted. Under conditions such as lateral loading implant lengths greater than 15 mm in length have shown greater stability. Theoretically, increasing the implant length reduces the stresses of force transfer; however this only happens till a limit. Misch and Bidez[14] placed cylindrical implants of different lengths in a computer bone model with ideal bone density and volume. According to the results of the analysis, implant lengths ranging from 10 – 15mm length have comparable force dissipation capability with implants of length 20 – 30mm. The highest stress region is the crestal bone region and regardless of the length of the implant the crestal region receives maximum stress. However the stress contours differ in softer bone types where the stresses are directed more apically. Thus in softer bone types such as D3 and D4 bones, longer implants are beneficial.

The Width of the Implant

The width of the implant also increases the surface area of contact; this is a three dimensional volumetric increase in contact area. Brånemark et al. introduced a constant implant body diameter of 3.75 mm. Any implant body greater than 4 mm may be considered a "wide-diameter implant."

The wide-diameter implant may present surgical, loading, and prosthetic advantages. Osteotomy sites are made for a particular implant size during surgery, subsequently a proper drilling sequence is followed and an implant is placed with an initial torque known as insertion torque. The value of the insertion torque is an indicator of primary stability; a 30 – 40 Ncm value is mandatory for successful implant stability. However, even with proper protocol, at times the implant may not osseointegrate after the conventional healing period of 3 months. In this situation the surgical advantage of wide diameter implants can be seen. When regular body implant fails to integrate into the bone in the osteotomy site, the regular implant may be removed and replaced with the wide-body implant.

When it comes to primary stability, the increase in contact area of wide diameter does help the stability , however more important factors such as available bone dimensions should be kept in mind. For instance, a distance of 1.5 mm or greater should be kept between implant and tooth and a distance of 3mm or greater should be present between implant and another implant. Increasing the implant body might pose other problems such as unaesthetic appearance and stress shielding. Stress shielding phenomenon is seen when the force dissipation happens within the body of the implant without transference to the adjoining bone. This leads to disuse atrophy of the bone. Depending on the region of rehabilitation an ideal range of implant diameter has been considered. Mandibular incisors and maxillary lateral incisors: 3–3.5 mm diameter, Maxillary centrals, maxillary and mandibular canines and premolars: 4 mm diameter, Molars: 5–6 mm diameter.

Thread Shape

The thread primarily aids in mechanical retention as a result of increased surface area for osseointegration. Based on the cross-section of the thread, thread shape can be of five types : Square, V shaped, buttress, and reverse buttress types.24 Changing the thread design in an implant can help change the angle of the load on the bone. Threaded implants convert occlusal loads into compressive, tension and shear stresses. In the square thread maximum load is converted to compressive stresses. In the V shaped, stresses are mostly converted into shear and tension stresses. The bone can withstand compressive forces better than shear and tensile forces and has more potential to resorb under the latter.[25]

Kim et al [26] conducted a finite element analysis where he simulated implants with different thread shapes; the thread depth and number remaining constant. The square thread shape had least value of shear stresses as well as compressive stresses.[26] Chun et al conducted a similar study and came to the same conclusion.[27]

The bone implant contact is also more in square thread shape. **Steigenga et al.**[28,29] conducted a animal study where it was observed that when other parameters are kept the same, the thread shape with maximum bone implant contact and least reverse torque values. This makes the thread shape important in primary stability as well.[28,29]

Thread Pitch

Defined as the distance from the centre of one thread to the centre of the adjacent thread measured parallel to the axis of a screw calculated by dividing unit length by the number of threads. The smaller or finer the pitch, the more threads on the implant body for a given unit length. This increases the surface area and decreases stress distribution per unit length of the implant body. It is considered as the most important design variable that affects the surface area of the implant. Roberts et al.[30] observed in an animal model that the thread number may affect the BIC percentage. When two different implant thread pitch designs were placed in the same animal, a higher BIC was observed with the implants with the greater thread number.[30]

Thread Depth

The thread depth is defined as the distance from the tip of the thread to the body of the implant. It can also be defined as the distance between the major and minor diameter of the implant. Shallow threads tend to fracture more during insertion of the implant when compared to deeper threads.

Measurement of Implant Stability

Implant stability is the absence of clinical mobility immediately after insertion and after the integration of implant with bone. There are two types of stability primary implant stability and secondary stability. Primary stability refers to the mechanical seating of the implant; This type of stability signifies the engagement of the implant with the bone.

The latter refers to the biological stability achieved between bone and implant after the process of osseointegration has taken place.

- Torque levels can be evaluated during the insertion process with the help of a drilling unit especially designed for torque documentation or by use of manual torque wrenches. Both systems can measure torque levels during implant insertion. The higher the torque value the more firm the attachment of bone to implant. A minimum value of 40 Ncm, is required for immediate or early loading protocols. A value of 30 – 40 Ncm requires the conventional 4 – 6 months healing period before loading. However a value of greater than 50Ncm induces compressive stresses within the bone, which leads to vessel obstruction which can limit periimplant bone perfusion and induce bone necrosis.
- Insertion torque is a good way of measuring the stability of the implant during the placement of the implant, however the measurement of implant stability maybe required during the process of healing. This helps in assessing the loading protocol that can be followed and in judging the success of the implant integration process.
- Periotest and RFA methods are helpful in this; these versatile measuring techniques have made implant survival a much more predictable process. The Periotest device is electromagnetically controlled and essentially measures the micromotion created by the device. Given its mechanism it is clear that a lower value, indicating a lower level of micromotion, indicates better stability of implant.
- The newer magnetic RFA method - A special probe and sensor are used to assess a dental implant's resonance frequency. The probe is a transducer producing electromagnetic pulses and the sensor is a rod with magnet on top. The sensor is attached to the implant and the probe emits impulses; pulse duration is 1ms. The sensor will vibrate in response and the probe reads the frequency at which the sensor vibrates.
- The measurement unit for frequency is hertz, but when assessing implants, hertz are often converted into an implant stability quotient (ISQ). This value is mathematically derived from the frequency measurements, and ISQ was developed to create a scale of values, ranging from 1 to 100, that can be tracked and translated into micromobility and implant stability. High stability means >70 ISQ, between 60-69 is medium stability and < 60 ISQ is considered as low stability. If the initial ISQ value is high, a small drop in stability normally levels out with time.

Implant Stability In Grafted Site

Bone graft procedure is beneficial for increasing the stability of immediately placed implants, especially when the ISQ of implants is below [65]. A few factors need to be considered while placing bone grafts in immediate implant cases.

- Grafting is done in the buccal void between the implant and the socket wall, this partially preserves the dimensions of alveolar ridge after immediate implant placement.
- This procedure is more beneficial in the maxillary region where there is thin buccal bone.
- It is important to note that the initial primary stability will be given by the available bone itself. It is only after the healing process has taken place that the graft contributes to the stability of the implant.
- Also, if primary stability is achieved, a provisional restoration can be placed, since it may lead to midfacial soft tissue stability at immediate implants.
- Implant design features such as square threads and SLA surfaces should be considered for implant stability enhancement.

Implant Stability In Maxillary Sinus Lift Cases

The maxillary substantial augmentation procedure is a well established technique for increasing bone volume in the deficient posterior maxilla. Survival rates of single tooth replacements were found to be reduced if supported by implants < 10 mm in length. Survival rates of rough surfaced short implants for single-tooth replacement have been reported to approach those of implants ≥ 10 mm. However, this finding was predominantly obtained in the posterior mandible. For 10mm implant the minimum requirement is 12 mm of bone. This leaves 2mm of bone between the implant apex and the floor of the maxillary sinus. Less than 6mm of bone requires the lateral window approach for sinus floor elevation whereas more than 6mm of bone can be augmented by the transcrestal approach of the sinus floor elevation. Less than 5mm bone will not provide the necessary primary stability for simultaneous implant placement. Loading protocol is also dictated by primay implant stability and is usually done within 8 – 12 months. Another consideration for implants to be placed in conjunction with SFE is the fact that bone density is often suboptimal in the posterior maxilla. It is therefore highly recommended to select an implant design whose geometry and surface characteristics can maximize primary stability. Although evidence is lacking to determine which geometric features are essential for maximum primary stability, a number of geometric designs have been proposed. These include threads with a modified shape, self-tapping threads, tapered profiles, and flared necks. On the other hand, there is strong evidence that the survival rate of implants with a roughened surface (96.9%) is significantly higher than the survival rate of implants with a machined surface (88%). However, since all implants with plasma sprayed, HA-coated, and sand-blasted/acid-etched surface types fall into the category of "rough surface" implants, it is not clear how different surface treatments may affect implant survival and success. It has been suggested that healing periods before prosthetic loading can be reduced with micro-rough implants compared to implants with more traditional surface characteristics. Recently, implants offering a chemically modified and hydrophilic microrough surface have been developed (SLActive surface). In conjunction with SFE, there is no evidence of superiority to conventional surfaces at this time, although preclinical and clinical studies have yielded promising results for this newly developed surface type.

Implant Microgeometry

Implant surface condition or micro geometry has a more important role in initial bone healing as compared to macro geometry which has a role after loading of implant.[31] The functional surface of the implant refers to that part of the implant that takes part in active force transmission of force. For example plasma spray coating increases the total surface area through bone implant contact by 600%. However the particles of plasma spray are as small as 8 microns and are too microscopic to transfer loads.[32,33]

The enhancement of bone healing through the increase in surface roughness is because the roughened surface enhances adhesion of platelets, monocytes and osteoblasts. Hansson et al. 1999, proposed that the ideal surface of an implant should be covered with hemispherical pits approximately 1.5 micrometer in depth and 4 micrometer in diameter.[34] Histologic and Histomorphometric analysis was conducted by Watzek et al.35 on machined and rough surface screw shaped and rough-surface cylinder implants after 18 months of occlusal loading in baboons. There BIC was significantly different, with screw-type implants having higher values in both the maxilla and mandible. The rough-surface screw had slightly more BIC than the machined surface screw. In addition, the trabecular bone pattern was irregular around the cylinder implants, but the bone was organized and perpendicular to the threads around the screw implants. Therefore, the bone trabeculae pattern and the higher BIC resulted in a superior support system for threaded implants.[35]

Thus it can be inferred that, after occlusal loading the macro design takes precedence over the microdesign or surface condition. However, since surface characterization aids in healing of bone and thus it has role in secondary stability as well as primary stability.

Hydroxy Apatite Coated Implants

The inorganic material in human teeth is primarily composed of a calcium phosphate related to hydroxyapatite (HAP). The chemical composition and properties of HAP are comparable to those of the natural components of teeth. Because of its high biocompatibility, HAP has the potential to be used for many dental applications.

Further, due to its highly brittle nature, HAP alone cannot be used as an implant in load bearing uses. Uncoated metallic implants are also unsuitable due to a lack of biocompatibility with the local tissue environment. Thus, a coating of biocompatible materials such as HAP on metallic surfaces has become a promising field of dentistry. The coating of the surface of titanium dental implants with hydroxyapatite can improve the osseointegration of these devices because of the bioactivity of the molecule, which reduces the healing period and improves the bone fixation of the implant.

UV Light Activated Implants

One of the most crucial aspects of successful dental implant surgery is osseointegration of the jaw with the dental implant post. To achieve adequate osseointegration, the surface of the implant must be properly treated and sterilized before surgery. This is most commonly done via sandblasting and acid etching, which help clean the surface of the implant and prepare it for placement.

However, surface preparation treatments often make the surface material of the implant hydrophobic; thereby inhibiting successful osseointegration. This issue is resolved with a unique new UV activation technology, which studies show helps achieve 98% osseointegration within three months of dental implant surgery.

Conclusion

Implant design has been established as a crucial factor in implant survival. Implant design has been optimized and has evolved to include various features which increase their contact with the bone. This bone implant contact is essential for the stability of the implant, specifically primary stability. The implant design not only caters to the implant stability before loading but also has features to enhance stability after loading. After loading of the implant, the implant design is optimized to give favourable load transfer. This will prevent other complications such as screw loosening and marginal bone loss. These complications may lead to decrease in stability after loading. The product used by the implant team may increase or decrease the risk of screw loosening, crestal bone loss, marginal bone loss, peri-implantitis, esthetics of the soft tissue drape, implant failure, and implant body fracture. The decision of choosing the implant should be based on patient force factors. The bone density should be evaluated which will be a guiding factor in assessing the length and width of the implant to some extent. It is essential to measure the implant stability at various stages of the implant rehabilitation procedure. Methods to measure the same include many of which resonance frequency analysis is the most versatile. Implant stability quotient (ISQ) values obtained from RFA provides valuable information regarding the stability and the loading protocol. Grafting procedures done prior to implant placement increase the primary stability. Sometimes when immediate implant placement is done after extraction, grafting procedures become more complex, however these cases have to be thouroughly understood. A thorough knowledge of how implant design impacts the stability of the implant and its success is crucial. The decision is even more important when force factors are greater than usual, bone density is poorer than usual, or implant body size is reduced. This article provides a review which enhances the knowledge needed to select appropriate implant design, macro and micro geometry for optimum stability and success of implant.

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CLINICAL GRANDEUR

SANTOSH DENTAL COLLEGE, GHAZIABAD

(12TH&13TH SEPTEMBER)

Santosh Dental College hosted Clinical Grandeur on the 12th and 13th of September, an event that truly lived up to its name. The scientific sessions brought together delegates from across India, who showcased some of the finest and most meticulously executed clinical cases.

The highlights included impactful lectures delivered by stalwarts of Orthodontics, who distilled their vast knowledge into insightful presentations. The academic exposure and clinical demonstrations offered during the event set a high benchmark for professional excellence.

The organizing committee, led by Dr. Rajiv Ahluwalia (Organising Chairman), along with Dr. Mayank Gupta, Dr. Nishant Gupta, Dr. Tina Chugh, and Dr. Dhruv Yadav, ensured flawless execution and warm hospitality throughout the program.

Clinical Grandeur was more than just an academic event-it was a true celebration of knowledge, clinical skill, and professional camaraderie.

SGT UNIVERSITY

SGT DENTAL COLLEGE, GURUGRAM

(11TH SEPTEMBER)

Academic Session on Skeletal Malocclusion Correction at SGT University

On 11th September, SGT University, Gurgaon, hosted a distinguished academic session on "Skeletal Malocclusion Correction: Harnessing Orthodontic Bone Screws." The lecture was well received and provided valuable insights into the evolving role of skeletal anchorage in contemporary orthodontic practice.The program was marked by active participation from faculty members and students, whose thoughtful discussions enriched the academic exchange. The initiative was made possible under the guidance and support of Dr. Omkar Shetty (Principal) and Dr. Tarun Rana (Head of the Department, Orthodontics), whose leadership and hospitality ensured the success of the session.

The event stood out as a platform for knowledge sharing and interactive learning, contributing meaningfully to the academic growth of participants.

Save The Girl Child

"Girls are Diamonds. Shape them for the Betterment of the Generation" - Afzal A. Zaidi

"Inequality gets learnt, equality needs teaching"

The Durga Puja competition in my society was filled with cheers as a girl secured first place, and a boy came second. Parents clapped proudly for their children, but amidst the celebration, one voice stood out. The boy's father patted his son on the back and said, "Well done, beta! But… you lost to a girl?" The boy, too young to understand, simply ran off to play. Yet, the message had already been planted losing to a girl was different.

Watching this unfold, one thought crossed my mind: Thank God my father was not like that.

When I wanted to play cricket instead of dolls, he never stopped me. When I chose swimming over Kathak, he took me to the pool himself. When I struggled to ride a bicycle, he didn't tell me, "You're a girl, this isn't for you." Instead, he said, "If you never fall, you'll never learn to ride."

My father never raised me as a daughter he raised me as his child. Had he imposed society's gender biases on me, I might not be pursuing my Master's in Dentistry today, or even writing this piece.

But my journey wasn't shaped by my father alone. My mother, a teacher and a working woman, showered me and my sister with love and guidance. She taught us the value of education and financial independence not to prove anything to society, but for our own fulfillment. My grandparents, too, played a vital role my nani imparting life lessons, and my dadaji encouraging me to step into the world of dentistry.

Growing up, I never truly understood the statement, "Life is harder when you're a girl." But as I matured, I saw the reality: a woman carries the responsibility of illuminating two homes her parental home and her in-laws'. She plays multiple roles **daughter, sister, wife, mother**and balances them all with grace.

Now, as I step into a new phase of life married and pursuing my MDS, I realize how crucial it is to have a support system that believes in you. I am deeply grateful for the love and encouragement my in-laws have given me. They have never made me feel as though my ambitions must take a backseat to my responsibilities as a wife or daughter-in-law.

And then, there is my husband my biggest cheerleader, my strongest pillar. He has never let me feel bound by traditional expectations. Instead, he reminds me, "You are Aastha first. Prioritize yourself, your dreams, and your happiness." His unwavering support, respect, and belief in me make all the difference. A loving and supportive husband is more than a partner he is a pillar of strength in his wife's journey. For a woman like me pursuing higher education, his encouragement makes all the difference. He stands by me through late-night studies, exams, and self-doubts, ensuring I have the time and space to chase my dreams. More than helping, he shares my responsibilities, adjusting and supporting to build a balanced life together. From a cup of coffee during an all nighter to a simple reminder to rest, his small gestures have become the foundation of my success. In a world that often tries to clip a woman's wings, my truly supportive husband has become the wind beneath my wings.

While talking about everyone, who has hepled me get where I am today, I can never forget my little sister who I love to the moon and back. She has never left my side in my good or bad times. While I used to study for the NEET MDS examination, she used to sit besides me bringing me food, encouraging me, teaching me tactics to remember, asking me questions, helping me in study so that I could crack the most important exam of my life. She is the person who has never judged me for shortcomings of life and always told me, " Didi, you can do it." My little sister I love you and no one can ever replace you.

Through this article, I deeply want to thank god for giving me such wonderful and amazing people that love me so much and who have stood besides me in my happiness and sorrows.

Moving Forward, I would like to add, that if we want a world where girls are not made to feel less than, it begins at home. Parents must teach boys and girls alike that capability is not defined by gender. Schools must nurture ambition in both, without bias. Society must celebrate achievements, not through the lens of gender, but for what they are achievements.

Equality is not automatic. It is something we must teach, reinforce, and fight for every single day.

Because, children are not born with bias; they learn it from the world around them. Inequality seeps in effortlessly, but equality must be taught with intention, every single day.

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