Visualization Learning Technologies

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Three-dimensional (3D) imaging in echocardiography has been around since the early 1990s when researchers at Duke University invented the 3D ultrasound prototype (Wu & Takeuchi, 2017). 3D imaging in echocardiography has certainly come a long since the early ‘90s, however, it still has its pitfalls, such as its usage and quality.

3D in echocardiography is used more prominently in transesophageal echocardiography (TEE). The procedure is not as common as transthoracic echocardiogram (TTE) and is more invasive and uncomfortable for the patient. However, when 3D is used in TTE, it is used only for a small portion of the exam. The TTE exam still relies heavily on the two-dimensional (2D) images to complete a comprehensive examination. Moreover, if the 2D image of the TTE is suboptimal consequently the 3D images will also be suboptimal. This paper will explore the possibility of using 3D echocardiography more effectively in the application of TTE 5-10 years from now where it can potentially be more useful for sonographers, physicians, and patients.

3D echocardiography in the future could potentially decrease scan time that would significantly benefit sonographers that suffer from work-related musculoskeletal disorders (WRMDs) and patients that must lie in positions they find uncomfortable for long periods of time. A sonographer could acquire a 3D full volume acquisition of the heart that obtained a cycle of at least 10 heartbeats within a matter of minutes. This full volume would contain the same data as a full comprehensive 2D TTE such as spectral Doppler and color Doppler. After acquiring the data, the sonographer could use a computer workstation to analyze the data to create a report of findings to the physician. Using a full volume acquisition to analyze echocardiograms, physicians could manipulate the model to help them see areas of the heart that may be more difficult to view with 2D images alone, helping decrease cases of missed pathology.

For 3D TTE to be utilized in a more consistent manner, the ability of the phased-array transducer will have to be improved significantly while still complying with FDA to maintain output power that does not damage the soft tissue. The biggest detractor in image quality is artifacts created from bone and/or air. Engineers potentially would have to develop or invent new styles of transducers or equipment that has more capabilities to manipulate the soundwave transmitting through the body.

In reflection, I believe that the standard of echocardiography practice could be improved to exam times that last single digit minutes. However, the ability to provide adequate image quality among patient populations that are obese, have lung disease, and other pathologies may prove to be too difficult regardless of how good the equipment is. However, the images that could be acquired in a single full volume capture would be extremely beneficial in educational practices. Teaching ultrasound students views on the heart in 2D plane can be difficult since it is a 3D object. Manipulating and viewing 3D information of a heart could make explaining and instructing anatomy of the heart much easier for students to comprehend.

References

Wu, V. C., & Takeuchi, M. (2017). Three-Dimensional Echocardiography: current status and Real-Life Applications. *PubMed*, *33*(2), 107–118. https://doi.org/10.6515/acs20160818a