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The Practicality of TrueVue in Echocardiography: Literature Review

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Abstract

Objective: This study investigated the advantages and disadvantages of the emerging 3D rendering technique (TrueVue) in adult echocardiography compared to traditional 2D imaging aiming to improve diagnostic accuracy and clinical decision-making.

Methods: A systematic literature review was conducted through PubMed and Google Scholar to find current studies related to 3D echocardiography TrueVue. The review was conducted in December 2023 and included the search terms such as, “echocardiography”, “adult”, “TrueVue”, etc. Trials and studies were limited to adults, focusing on echocardiograms using 3D TrueVue.

Results: A total of 306 articles of original research or literature reviews were found and reviewed. Of those articles, 11 articles were analyzed in their entirety and provided relevant information for the review. While several articles omitted the disadvantages of utilizing TrueVue, the majority highlighted the advantages of how it can help define cardiac structures.

Conclusion: TrueVue in adult echocardiography can offer an improved visualization of the heart and aid in diagnosis.

Keywords: echocardiography, adult, three-dimensional

Introduction

In the field of echocardiography, ultrasound imaging technology has constantly advanced and improved to enhance the ability of sonographers to help diagnose cardiovascular diseases with greater accuracy and precision. Echocardiograms have become the gold standard for many cardiovascular heart diseases as they can accurately assess heart function and structure non-invasively. Today, a standard transthoracic echocardiogram (TTE) consists of a series of 2D real-time images of the heart at different angles along with the use of Doppler, which is used to assess the blood flow and hemodynamics of the heart.[7]

Three-dimensional (3D) ultrasound imaging has been used significantly more in addition to traditional two-dimensional (2D) imaging in recent years to aid in patient diagnosis. 3D ultrasound imagining first appeared in the 1970s and has been increasingly popularized.[7] 3D is now often used to help guide structural heart interventions (SHIs) by transesophageal echocardiograms (TEEs) because of its unique advantage of imaging cardiac soft tissue over fluoroscopy-guided SHIs and its ability to see multiple angles simultaneously over traditional 2D TEE imaging.[2]

Recent developments of a few new 3D rendering technologies invented by Philips[11] including, TrueVue, TrueVue Light, and GlassVue, have emerged within the last decade and are helping to improve the image resolution and diagnostic quality of echocardiography. TrueVue is a photorealistic imaging enhancing feature[6] that serves as a baseline for additional modalities such as TrueVue Glass/GlassVue and TrueVue Light which many sonographers and doctors have reported to help better understand their patient's heart structure and could more confidently diagnose based on the realistic detail of the structures seen because of TrueVue, especially during echo guided procedures and preoperative assessments.[4]

TrueVue is a photorealistic generated image of an acquired 3D image that enhances details and increases the spatial range of the image. Most 3D images are obtained via TEEs because they allow precise evaluation of the true origin and structure of heart components or devices used in SHIs. TEEs provide the clearest view of the heart without interference from other anatomical structures, which is a limitation in 2D TTEs. TrueVue Glass takes TrueVue further by incorporating AI-generated refinements to create images that make heart features look almost transparent, like glass.[9] TrueVue illuminates inside the heart cavity allowing for an enhanced look into the heart structures with shadow and texture rendering technology. TrueVue Light modality allows the user to move that virtual light to gain better depth perception.[4]

However, the sonographer may not always obtain a clear image when using 3D due to factors such as the patient's body habitus or artifacts, which can impede image quality. TrueVue can help get a clearer ultrasound picture because of these limitations by using new rendering technology and artificial intelligence (AI) based optimizations.[9] In the reviewed cases, the results consistently indicated that TrueVue helped visualize cardiac features.

Methods

A systematic literature review was conducted between December 2023 and May 2024 and consisted mainly of studies published by December 2023 to find, analyze, and compare current studies on 3D TrueVue in echocardiography and assess the practical use and relevance of TrueVue within adult echocardiography. A search was initially conducted through PubMed to determine the scope of the types and number of articles published on this topic. Another search was then performed on Google Scholar and focused on including peer-reviewed accepted articles and journals broadening the scope of journals included in the search. The searched terms included, but were not limited to "adult", "echocardiography", "TrueVue", "three-dimension",

"GlassVue", "rendering", and "ultrasound". Exclusion material were that of non-English Language, articles not connected to a medical journal, non-peer-reviewed articles, etc.

When examining the data and content of each article, all the trials and studies from articles used for the literature review included the adult population and echocardiography especially on TrueVue or 3D imaging, and how it benefits diagnosis or compared to other imaging modalities, especially 2D echocardiography.

Results

The search utilizing the aforementioned terms yielded a total of 306 articles relevant to adult echocardiography, with a emphasis on 3D imaging. Among these articles, a total of 11 peer-reviewed articles were read in their entirety and were included in the literature analysis review. While all articles had mostly positive reviews of TrueVue, TrueVue Glass, and/or TrueVue Light, some articles noted similar limitations within their use of TrueVue. The table below are the articles, authors, published year, and summary of articles used for the review.

Table 1: Literature review articles with authors, title, published year, and summary

Author(s), Article Title:	**Published Year:**	**Summary:**
Alhasan F, Arsanjani R, Alsidawi S.: The Use of New Emerging Technology in Echocardiography-Glass View.	2022	This article includes a few examples of how GlassVue can be used to see different pathologies.
Farina JM, Barry T, Arsanjani R, Ayoub C, Naqvi T: Three-Dimensional Transesophageal Echocardiography in Percutaneous Catheter-Based Cardiac Interventions	2023	How 3D TEE in SHIs is used for helpful guidance.
Fiore, G., Gaspardone, C., Ingallina, G., Rizza, V., Melillo, F., Stella, S., Ancona, F., Biondi, F., Margonato, D., Palmisano, A., Esposito, A., &	2023	Seeing the LAA with GlassVue vs. CT. in analyzing LAA.

Agricola, E: Accuracy and reliability of left atrial appendage morphology assessment by three-dimensional transesophageal echocardiographic glass rendering modality: A comparative study with computed tomography		
Gavazzoni M, Maisano F, Tagliari AP, Taramasso M, Pozzoli A, Zuber M: TrueVue transillumination volume rendering for three-dimensional transoesophageal echocardiography in interventional imaging	2021	A study of data collection and analysis on the benefit of transillumination/TrueVue in medical practice how much it was used, etc.
Davide Genovese, Karima Addetia, Kalie Kebed, Eric Kruse, Megan Yamat, Akhil Narang, Amit R. Patel, Luigi P. Badano, Denisa Muraru, Alexandra Gonçalves, Victor Mor-Avi, and Roberto M. Lang: First Clinical Experience With 3-Dimensional Echocardiographic Transillumination Rendering	2019	A survey study trying to determine if transillumination can improve heart structure visualization
L'Acqua C, Piazzoni N, Muratori M, Mazzanti V: Intraoperative 3D TrueVue transesophageal echo imaging in cardiac mass: Bridge between cardiac anesthesiologist and surgeon. Ann Card Anaesth	2022	How TrueVue modes better optimize structures like masses and pulmonary veins vs. without TrueVue.
Maleki M, Esmaeilzadeh M: The evolutionary development of echocardiography	2012	Explains the background and developments of echocardiography.
Sun A, Ren S, Xiao Y, Chen Y, Wang N, Li C, Tan X, Pan Y, Sun F, Ren W: Real-time 3D echocardiographic transilluminated imaging combined with artificially intelligent left atrial appendage measurement for atrial fibrillation interventional procedures	2022	A study showed how TrueVue Glass does a great job of helping outline the contour of the LAA.
Sun F, Sun A, Chen Y, et al. Novel TrueVue series of 3D echocardiography: Revealing the pathological morphology of congenital heart disease	2022	A comprehensive study and analysis of how TrueVue modes can help diagnose congenital heart diseases (CHDs).
T. R. Nelson and T. T. Elvins: "Visualization of 3D ultrasound data," in IEEE Computer Graphics and Applications	1993	A detailed introduction to echocardiagrphy and 3D imaging.
Vairo, Alessandro & Marro, Matteo & Ferrari,	2019	TrueVue guidance with

Gaetano & Rinaldi, Mauro & Salizzoni, Stefano: Use of a photo‐realism 3D rendering technique to enhance echocardiographic visualization of the anatomical details during beating‐heart mitral valve repair		Mitral Valve Repair (MVR).

Discussion

TrueVue offers valuable assistance to both seasoned and less experienced medical professionals in understanding patient heart anatomy and guiding echo-based procedures. IT can give the medical professional a better grasp on the origin of heart defects and properly asses and treat the area with better confidence and less error from anatomical limitations or other interfering factors compared to traditional 2D imaging. For example, TrueVue, TrueVue Light, and TrueVue Glass are beneficial modes to help better view the LAA which is not normally seen on standard 2D TTEs. While 3D TEEs can view the LAA more closely, TrueVue can visualize more accurate depiction of the LAA[1, 3, 8], especially in assistance to placing Watchman devices[1, 8].

Recent studies focusing on the benefits and advantages of TrueVue in the medical setting have been published with one survey grading TrueVue-obtained images with all scores greater than 3[4] and another with a median of 4[5] on the Likert scale. One study observed by 20 sonographers and cardiologists proficient in echocardiography showed the satisfaction ratio for 3D on TEEs to be 100% while 3D on TTEs was 87.8%.9 The overall satisfaction of TrueVue images was 88.7% and GlassVue images was 95.2%. Each study showing the satisfaction of the observers being more positive than negative with TrueVue acquired images.

TrueVue has helped health professionals assess many different heart structures and complications such as the left atrial appendage (LAA)3, ventricular septal defects (VSDs)9, atrial septal defects (ASDs)9, papillary fibroelastomas2, valve perforations2, valve prolapse1,

masses6, etc. TrueVue also helps during the evaluation for SHIs such as LAA occlusion devices (Watchmans)1, and various valve replacements/repairs.

True Vue is also useful at better assessing paravalvular leaks and the origin of the leaks, as well as assisting during valve procedures such as mitral valve repair (MVR) by improving the viewer's perception of the depth and structure of the mitral valve and from there discern highlight location of defects or abnormalities in need of repair[11]. A study that focused on an MVR, the MitraClip®, trans-septal punctures, and LAA with closure showed a positive 87% satisfaction amongst both knowledgeable echocardiograph observers that agreed with the advantage of TrueVue used to optimize the image of 32 different structure heart procedures.[5] Both observers, one more seasoned and experienced than the other, agreed with the criteria that TrueVue had enhanced the overall structure and cavity image for procedural intervention.

With accurate patient diagnosis being top priority, the use of TrueVue should carefully considered being more commonly used in the medical setting as each study has so far weighed the advantages over the disadvantages of using TrueVue for accurate assessment in procedures such as the Watchman and MitraClip.

Despite its promising capabilities, the application of TrueVue in adult echocardiography is relatively new, and many studies needed more extensive quantitative research and literature on the advantages of using TrueVue regularly. It must be considered that TrueVue is a relatively new development modality that was first released within the last 10 years and has been slowly making its way into more medical facilities. Another consideration is the cost and availability limitations[3, 7, 10] that would hinder many sites from considering a more cost-friendly option for assessing cardiac structures. TrueVue is an additional modality that requires a more advanced version of the common Philips ultrasound technology and thus requires additional cost,

maintenance, and training to use the additional settings. It is also important to remember that TrueVue is semi-constrained to the original 2D images acquired because they make up the 3D image and from AI-generated texture that may generate false strcutres.[9]

With these considerations in mind, TrueVue offers an advantage to echocardiographers and cardiologists, especially less trained professionals, by instilling confidence in diagnosis and reducing complications during procedures. It is important to keep in mind that for medical imaging professionals, eliminating artifacts and enhancing images is a matter of ethical and diagnostic responsibility.[11]

Conclusion

The application of TrueVue in adult echocardiography offers advancements in the diagnostic accuracy of many cardiovascular conditions by improving the depth, spatial range, structure, and texture visualization in the clinical and procedural setting. TrueVue offers a photorealistic image of the heart structure and can aid in structural heart interventions by improving the accuracy of the intervention location and minimizing error. The considered studies agree on the effects of TrueVue in that it has added additional enhancement of image quality for most cases reviewed using it. Although TrueVue is an additional modality not required by the American Society of Echocardiography (ASE) guidelines and will require additional funding and training, incorporating TrueVue's advantages should be carefully considered because of its contribution to improving patient care.

Key Takeaways

1. TrueVue modes improves the depth, spatial range, and texture of cardiac anatomy.
2. TrueVue helps medical individuals to evaluate/perform structural heart procedures.
3. TrueVue enhances the visualiation of cardiac structures compared to 2D imaging.

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