Three-dimensional printing for device selection: Several key points should not be neglected

Short title: Important points for 3D printing

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Key words: three-dimensional printing, device selection, preoperative evaluation

Conflicts of interest: none declared

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Sources of funding: This work has been supported by the Henan Provincial Key Medical Program (Henan Provincial Department of Science and Technology) and the Henan Provincial New Medical Technology Program (Health and Family Planning Commission of Henan Province).
We read with great interest the article by Liu P et al. (1) describing the utility of three-dimensional (3D) printing in left atrial appendage (LAA) occlusion. They showed us the great potential of 3D printing model in optimizing the preoperative device selection. Recently, our group has also studied on the applications of 3D printing to cardiology, and based on our own experience, some important points seemed to have been underappreciated in their study.

Since many clinicians may not have the basic knowledge of 3D printing, it’s very important to provide enough details on the reasons and the steps to make a 3D printing model to allow more similar studies to validate or extend their study. This kind of insufficient description of 3D printing in the study seemed to originate from the insufficient understandings of 3D printing by the authors, which is likely to undermine the reliability of their results and conclusions. The following points may not be neglected.

Firstly, they did not provide any specific inclusion criterion for patient selection. Not all patients planning to undergo LAA occlusion should be preoperatively evaluated by 3D printing model. Although currently there are no exact indications for the use of 3D printing in clinical medicine, it’s conceivable that the patients with poorer conditions are more likely to benefit from a comprehensive preoperative evaluation as compared with those with mild or moderate conditions. So it’s very crucial to clarify the inclusion and exclusion criteria adopted by them.

Secondly, how were the 3D transesophageal echocardiographic (TEE) images acquired? It’s not enough to simply state that the data were “high-quality”, but a detailed description should be provided. The quality of echocardiography is largely dependent on the experience of the operator, and an experienced operator gets much more reliable images than the inexperienced one. The source data acquired through real-time 3D TEE affects the quality of consequent steps including 3D model extraction, smoothing and the final 3D product. Besides, at which phase (systolic or diastolic phase) was the images captured? The shape of LAA is possible to change with different cardiac phases. How many images were acquired? The 3D reconstruction by the Mimics software generally requires a series of images obtained through sagittal, coronal and transverse views, so it’s interesting to know how they had dealt with this...
technical problem. Had any secondary digital imaging and communications in medicine technique been used?

Thirdly, they did not state the thresholding procedures for the extraction of the chosen region from the 3D TEE data. The thresholding is a key step to determine which parts should be printed. In fact, the automatic thresholding by the Mimics software is generally insufficient to obtain an ideal virtual 3D model. Many noncardiac tissues (e.g., extracardiac adipose tissues) may be retained when the grey value is too low while many cardiac tissues (e.g., heart valves) may be eliminated when the grey value is too high. Besides, how and how many times had they smoothed the virtual 3D model? The smoothing process generally refers to the reduction of the number of holes in the virtual 3D model and as a result, every smoothing process will be accompanied by the loss of original information and steer us away from the real model. In fact, it’s very challenging to extract an ideal virtual 3D model without the compromise of any cardiac structures. Thus a description of the data extraction would be very helpful.

Fourthly, they did not state which method was used for 3D printing. Did they use fused deposition manufacturing, steroligograph apparatus, or selective laser sintering? Different printing methods vary in their manufacturing mechanisms and affect the quality of final 3D printing models. Although fused deposition manufacturing is more commonly used and cheaper than other methods, the final 3D product is not precise enough. Steroligograph apparatus and selective laser sintering produce more precise models but they are more expensive. How had they achieved the balance between the precision and price of the 3D model?

Since there are currently no standards or consensuses for 3D printing in clinical medicine and the technology is at its infancy in cardiology, it’s very important to detail the procedures to allow more similar studies to further our understandings of this novel technology. Most studies have employed computed tomography to obtain source data for 3D printing, the use of real-time 3D transesophageal echocardiography for data acquisition remains rare, so it would be very valuable and inspiring to detail the image postprocessing steps, or the reliability of the study results will be doubtful.
References:
