Case Report

Curved section modeling-based three-dimensional printing for guiding septal myectomy

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Introduction

The use of three-dimensional (3D) printing technology in cardiovascular medicine has attracted more and more interest. Congenital cardiovascular disease is often associated with complex and unique anatomic characteristics. It is difficult to be fully understood from two-dimensional (2D) CT, cardiac magnetic resonance (CMR), or echocardiographic imaging. To date, 3D printed models have been used in various congenital heart diseases such as double-outlet right ventricle (1), tetralogy of Fallot (2), and complex aorta surgery (3,4). Recently, one study applied the 3D printed models in pre-operative planning and simulation for septal myectomy in hypertrophic obstructive cardiomyopathy (HOCM) (5). Here, we investigated the curved section modeling technique from surgeon's view angle for 3D printing of HOCM model.

Case presentation

A 47-year-old male patient was diagnosed as HOCM with moderate mitral valve regurgitation. The patient underwent cardiac CT angiography (CTA) for comprehensive anatomical assessment to acquire 3D volumetric imaging data for prototyping. The DICOM datasets were imported into Medraw software platforms (Medraw, Image Medraw Technology Co., Ltd., Shanghai, China) for digital modeling and subsequently processed to reduce imaging noise. A spline surface reconstruction (SSR) algorithm was applied in modeling process. After image segmentation, region of coronary and left ventricle was extracted. A spline defined by three manually specified nodes was extruded alone a directional axis to construct a spline surface. Then, the coronary and left ventricle combined image could be segmented into two image parts. From the segmented image parts, model was reconstructed and 3D printed (*Figure 1*). Before operation, 3D printed model was analyzed and discussed by a team of cardiac surgeons, perfusionist and anesthesiologist. With the help of 3D printed model, surgeons operated successful septal myectomy. The weight of resected myocardium was 10.26 g. Transesophageal echocardiography showed that the mitral valve regurgitation turned to be mild and needed no further treatment. The patient was discharged at 6 days after operation. The follow-up echocardiography showed that mitral valve regurgitation was still mild at 6 months after operation.

Discussion

This is the first case on the successful use of a 3D printed HOCM model based on curved section modeling from surgeon's view angle. The traditional modeling strategy of HCOM is to obtain a flat section profile using existing multiple plane reconstruction technology. However, the modeling based on flat section cannot reflect the real status of resection area. Hence, both morphology and geometry of HOCM could be confused in 3D space. In the clinical scenario, surgeon's view angle is almost quartering to the myocardium to be cut. Therefore, the section profile should pass through coronary, mitral orifice, and apical, which

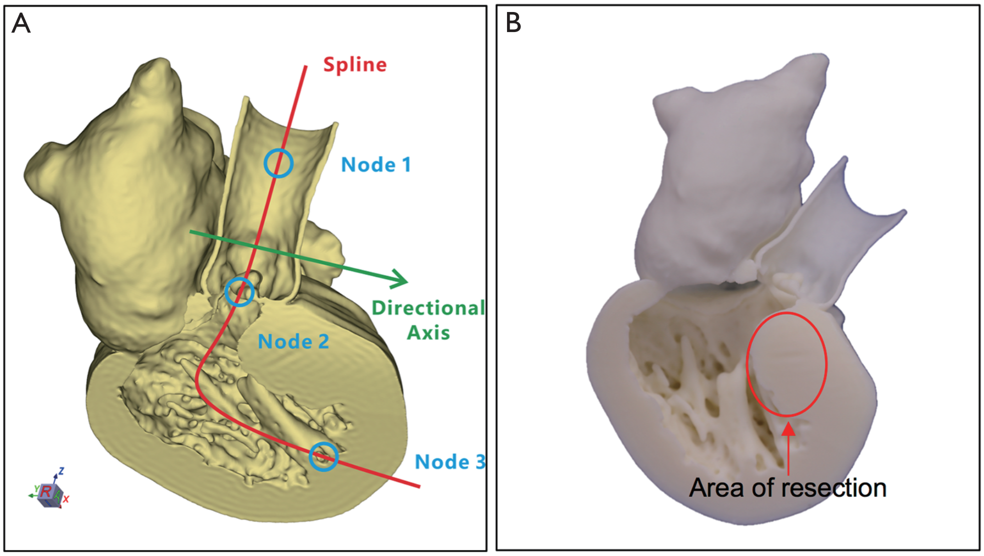

Figure 1 (A) The curved section modeling-based remodeling for HOCM; (B) the 3D printed model of HOCM. Red arrow indicated the area of resection. HOCM, hypertrophic obstructive cardiomyopathy.

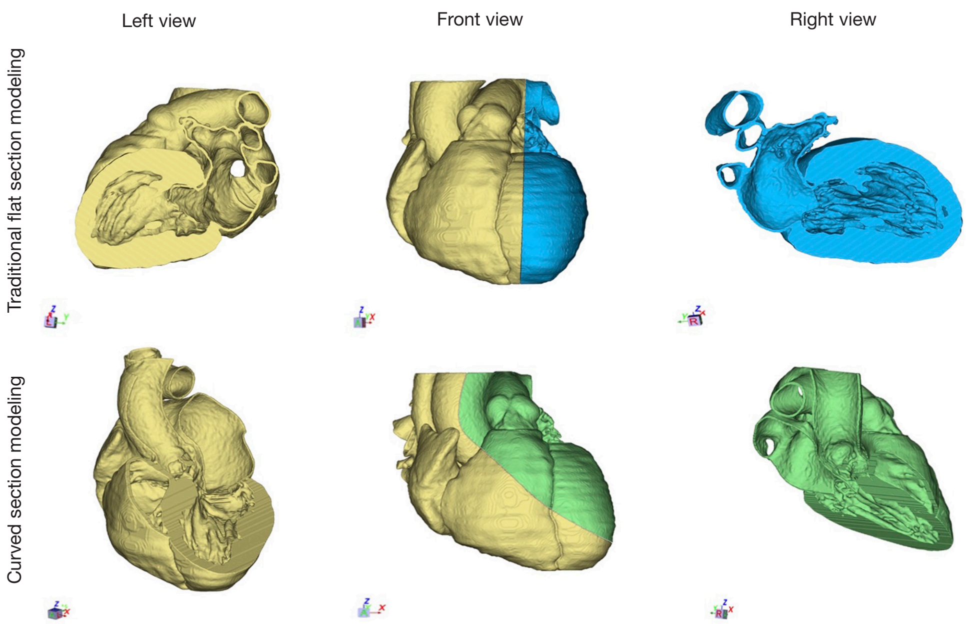

Figure 2 The traditional flat section modeling and the curved section modeling for HOCM. HOCM, hypertrophic obstructive cardiomyopathy.

was shown as a curved surface. In *Figure 2*, we compared the traditional flat section profile with the present curved section one. It was shown that curved section modeling based on the SSR technique had more excellent surgical view of the resection area than the traditional one (*Figures 3,4*). Surgeons can effectively make operation plan and predict the scope, depth, and orientation of septal myectomy. This technique could keep surgeons aware of the suitable extent of resection and prevent from the risk of injury. Also, the 3D HOCM model enables effective and

Figure 3 Flat section modeling of HOCM (6). HOCM, hypertrophic obstructive cardiomyopathy.
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Figure 4 Curved section modeling of HOCM (7). HOCM, hypertrophic obstructive cardiomyopathy.
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intuitional surgical training for fellows and communication with patients and their families for preoperative counseling.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

Informed Consent: Written informed consent was obtained from the patient for publication of this manuscript and any accompanying images.

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