THE CASE FOR SURGICAL MYECTOMY IN

HYPERTROPHIC CARDIOMYOPATHY: IS STRATEGIC PLANNING THE KEY TO SUCCESS?

To the Editor:

We want to congratulate Hermesen and colleagues¹ for their precise use of 3-dimensional (3D) printing as a guide for myectomy in hypertrophic cardiomyopathy (HCM) with left ventricular (LV) outflow tract obstruction. HCM has differing phenotypes characterized by hypertrophy of the area of the ventricle. Myectomy, although advocated as the gold standard of definitive treatment, has a very low incidence.² This is due to a variety of factors, the chief being a steep learning curve with a paucity of experienced surgeons. Resection is based heavily on the surgeon's subjective assessment and therefore carries significant intraobserver and interobserver variability. Inadequate resection leads to recurrence in approximately 20% of cases, whereas excessive resection can lead to damage to the mitral and aortic valves, complete heart block, or ventricular septal defects.

The Editor welcomes submissions for possible publication in the Letters to the Editor section that consist of commentary on an article published in the Journal or other relevant issues. Authors should: • Include no more than 500 words of text, three authors, and five references. • Type with double-spacing. • See <http://jtcvs.ctsnetjournals.org/misc/fora.shtml> for detailed submission instructions. • Submit the letter electronically via jtcvs.editorialmanager.com. Letters commenting on an article published in the JTCVS will be considered if they are received within 6 weeks of the time the article was published. Authors of the article being commented on will be given an opportunity of offer a timely response (2 weeks) to the letter. Authors of letters will be notified that the letter has been received. Unpublished letters cannot be returned.

Although myectomy for the apical and midventricular variants necessitates a ventriculotomy, adequate resection of the hypertrophied septum may require bimanual palpation.³ Specifically, the myectomy trough should be wider in the midventricle and should be opposite the anterior mitral leaflet, chordal apparatus, and papillary muscles to avoid damage to the mitral valve apparatus. Apical extent of the myectomy in the septum is more important than basal septal thinning.

This study goes a long way in precise delineation of the areas of hypertrophy and fibrosis to facilitate myectomy. Its major drawback is the time-consuming methodology, which may limit its use in larger populations.

We have used an image-based 3D software tool for preoperative planning for HCM with midventricular obstruction and apical hypertrophy in 5 patients.⁴ Our tool was based on cardiac magnetic resonance images because it has demonstrated more specificity than other imaging modalities.

The methodology is briefly illustrated. Patient-specific LV endocardium and epicardium surfaces were reconstructed in 3D from short-axis cine steady-state free precession. Once the preoperative LV shape was reconstructed, hypertrophic regions were identified interactively in 3D to visualize the extents and location of midventricular obstruction. Virtual myectomy was performed using in-house interactive presurgical planning software tools that facilitated surgeon-guided virtual myectomy at precise 3D sites on the LV endocardium. Then, regional endocardial shape-difference mapping was conducted between patient-specific preoperative and virtual postoperative LV endocardium surfaces to serve as a visual rendering of the locations and extents of virtual myectomy performed for review of the final surgical strategy. After virtual myectomy, there was a trend toward increased mean LV end-diastolic volume

FIGURE 1. End-diastolic 3D renderings of the virtual postoperative LV endocardial surfaces of 3 patients (A to C). Regionally thicker myocardial walls are seen as the space between grey epicardial and green endocardial surfaces. Sites of virtual myectomy in the midventricular or apical regions are color mapped from blue to red indicative of the extent of myectomy performed, in millimeter units.

Authors have nothing to disclose with regard to commercial support.

and an increase in stroke volume. Postoperative studies were performed after 3 months, which were consonant with the virtual myectomy plan (Figure 1). The clinical outcomes were optimal with no 30-day mortality or recurrence of symptoms. There was no incidence of ventricular septal defects or complete heart blocks. There was no recurrence of symptoms at 6 months postsurgery with no recurrence of hypertrophy.

Our preoperative imaging tool provides a guide to the location and extent of hypertrophy and helps the surgeon perform a virtual myectomy preoperatively. This software tool is less time-consuming and provides a template for myectomy. It has been validated in a pilot study reflecting its clinical applicability and reproducibility.

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<http://dx.doi.org/10.1016/j.jtcvs.2017.02.032>

**IN THESE “GOOD TIMES,”
IT CAN STILL BE
“DIFF’RENT STROKES”
FOR DIFFERENT FOLKS**

Reply to the Editor:

We appreciate the interest of Menon and colleagues in the use of 3-dimensional imaging in planning surgical treatment for patients with hypertrophic cardiomyopathy.^{1,2} Their work is an excellent example of the application,

N.A.M. is an investigator for HeartWare, St. Jude and SynCardia, and is a consultant for HeartWare and St. Jude. J.L.H.'s wife has performed paid work as consultant for Medtronic. The other author has nothing to disclose with regard to commercial support.

integration, and manipulation of advanced imaging technologies into the effort to improve surgical care.

Virtual and physical simulation systems have similar strengths and weaknesses. Both types of model allow targeted inspection in multiple planes and visualization of a proposed resection. Both types of model give the surgeon additional sensory input, allowing enhanced preoperative preparation. Both types of model are constructed in diastole, but both still reflect the state of a blood-filled or “inflated” heart that differs from the bloodless, “deflated” heart encountered during a myectomy. There are also differences. Virtual models are less expensive, and once constructed they provide a supply limited only by the cost of powering a computer. Physical models will likely always involve some increased cost, but they will also always possess one key advantage: surgery is performed in the physical world, and physical models allow the rehearsal of an operation by the same hands and with the same tools that will be used to operate on the patient.

A next logical step could be to combine and harness the powers inherent in each type of simulation. Imagine using 4-dimensional magnetic resonance imaging blood flow modeling to custom design an optimal resection and then using 3-dimensional printing to produce a patient-specific model that allows the physical simulation of the operation in the days, hours, or minutes before making an incision in the operating room!^{3,4}

Although individual innate talents and learning styles may drive preferences for virtual or physical simulation, the human brain begs for the use and integration of as many inputs as possible. In our collective quest to maximize our surgical opportunities, we should continue to collaborate and strive for progressive improvement!

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