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Key Words: hypertrophic cardiomyopathy, left ventricular outflow tract obstruction, septal myectomy, left ventricular myocardium remodeling, 3-dimensional computed tomography, systolic anterior motion, mitral regurgitation

Discussion

Presenter: Dr Tsuyoshi Yamabe

Dr Nicholas G. Smedira *(Cleveland, Ohio)*. I want to thank the Association for the opportunity to review this work and Dr Yamabe and Dr Takayama for a great presentation. It's really well written. It's very concise and to the point. I think there were 3 points they mentioned that are important and interesting. I think among the most important points for the readers and for those viewing this talk is their idea of a septal band. They had previously published this concept, but I had not seen that publication. I think it's a really critical observation postulating that there is an apparent band of muscle originating from the left trigone and then spiraling in a counterclockwise direction toward the posteromedial papillary muscle. The recognition of this pattern is critical when performing a standard myectomy to avoid the known complications associated with a myectomy such as a ventricular septal defect and the need for pacemakers. So, I congratulate the authors on this insight. I think it's a really important insight. I'm going to ask some questions related to that.

They tried to answer the question of whether a myectomy results in regression of septal muscle remote from the septum. It is a small series, only 19 patients. They showed on average about a 6% reduction in the volume of the muscle in remote segments. And, interestingly, almost all the regression occurred within 90 days. I thought for a bit that 90 days is really fast. And then I remembered what happens to me when I stop exercising. I regress probably to my baseline state in less than 90 days, so that might be how muscle remodels, and it does so very quickly. It's been shown in other treatments, including septal ablation that there is rapid regression of remote muscle hypertrophy.

I have a couple of questions to make sure I understand their methodologies. I'll let the presenter respond after his question—are the measurements of the muscle segment volumes by the computed tomography angiography done by a computer algorithm, or are they done manually? And if they're done manually, how do we know that they're reliable and accurate measurements?

Dr Tsuyoshi Yamabe *(New York, NY)*. Thank you everyone. Thank you for your question, Dr Smedira. As you pointed out, the reliability and reproducibility of the measurement are very important for this method to be generalized. At present, the measurement of muscle segment volume was done by a person manually. To assess the interobserver variability, the measurements were performed by 2 blinded physicians. The Bland-Altman plot showed the interclass correlation coefficient was 0.96, indicating high reproducibility. However, it's important to point out that these 2 physicians received special training for the measurement. They repeated it a couple of times to actually measure in front of one expert and have him teach them the tips. We believe that the reliability of these measures needs to be confirmed by conducting more measurements in more cases and comparing the results with clinical outcomes.

Dr Smedira. That's great. Well, that enhances the validity of your observations. I mentioned the septal band spiraling. Is it your sense that this is a real anatomical structure inside the heart? Or is it just something that you've observed and it's where the hypertrophy occurs? Is this a real structure?

Dr Yamabe. Yes. This is another excellent question. In the development of the virtual myectomy, our first few cases, we used a 3-dimensional printed model. It was after third or fourth case that we recognized the consistent

presence of the septal band and were surprised that this had not been previously described at autopsy. We did review multiple hearts in our pathology lab, and reached the conclusion that this structure cannot be seen postmortem because the heart is preserved in a contracted state, that is not at end diastole as is seen on computed tomography or when arrested in the operating room where the band is most obvious. Of course, its presence is difficult to appreciate in the operating room given the limited view through the aortic root. This structure is seen in all cases we have operated on with septal myectomy. Interestingly, it's also seen on 3-dimensional computed tomography in afterload lesions such as aortic stenosis, although is a much less prominent structure.

Dr Smedira. Yes. I agree. Well, like anything else, once you're aware of its existence, then you start to look for it. It is apparent more frequently than one would think. I know Dr Schaff has done a lot of apical myectomies. There's so much variation in the morphology. Some patients don't have basal hypertrophy rather it's midventricular and apical. Do you think this band as it spirals can be hypertrophied in different segments?

Dr Yamabe. Yes, as you expect, majority of our patients had hypertrophic obstructive cardiomyopathy with typical anatomy with basal septal hypertrophy and systolic anterior motion. Based on our observation of several cases with combined basal and midventricular obstruction, we think the midventricular obstruction occurs when the septal band is prominent more toward the apex. On the other hand, apical hypertrophic cardiomyopathy may have a different mechanism, although in some cases, the band continues to the apex where it fuses with circumferential apical hypertrophy. We only had a few apical hypertrophic cardiomyopathy cases and don't have enough data yet. What we do believe is the septal band likely represents hypertrophy of the most endocardial helical myofibers, and it forms an angle of roughly 45° with the centerline of the heart, essentially the same as the innermost layer of myocardium on pathological specimens. Further studies are needed to elucidate why this portion of the myocardium alone hypertrophies in hypertrophic cardiomyopathy.

Dr Smedira. Good. Thank you. This is a really important observation, and I want to thank you for that contribution.