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INVITED COMMENTARY

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Ge and colleagues [1] should be commended for their initial work using finite element simulation to quantitatively model mitral valve repair for a flail posterior leaflet segment. As the authors point out, longer-term follow-up has demonstrated that mitral valve repair techniques for myxomatous disease are less durable than was previously thought [2]. A significant number of repair failures result from chordal, leaflet, and suture-line disruption, which suggests that mechanical leaflet stress plays a significant role in repair failure [3]. Considering that patients with even mild residual/recurrent mitral regurgitation after repair have decreased exercise tolerance and longevity compared with patients with competent repairs, there is a need to improve current repair techniques [4].

As the authors have demonstrated, we are entering an era when computational mitral valve modeling has the potential to have a realistic impact on the development of mitral valve repair procedures. This era has been ushered in by improvements in anatomically realistic and quantitatively accurate imaging [5], enhanced understanding of collagen fiber microstructure, more accurate constitutive material models of valve soft tissue, and a more precise understanding of valvular kinematics based on both in vivo and in vitro data [6].

We believe that as these modeling techniques continue to evolve and are applied to increasing numbers of patients, they will provide powerful tools that will allow the optimization of repair techniques based, for the first time, on quantitative analysis rather than the surgeon's intuition. Ultimately, preoperative imaging will be used in conjunction with such software to test various leaflet resection and annuloplasty options to more precisely tailor surgical strategies to individual patients [7].

References

1. Ge L, Morrel WG, Ward A, et al. Measurement of mitral leaflet and annular geometry and stress after repair of posterior leaflet prolapse: virtual repair using a patient-specific finite element simulation. *Ann Thorac Surg.* 2014; 97:1496–504. [PubMed: 24630767]
2. Mauri L, Foster E, Glower DD, et al. Four year results of a randomized controlled trial of percutaneous repair versus surgery for mitral regurgitation. *J Am Coll Cardiol.* 2013; 62:317–28. [PubMed: 23665364]
3. Gillinov AM, Cosgrove DM, Blackstone EH, et al. Durability of mitral valve repair for degenerative disease. *J Thorac Cardiovasc Surg.* 2004; 128:916–24. [PubMed: 15573077]
4. Kim HJ, Ahn SJ, Park SW, et al. Cardiopulmonary exercise testing before and one year after mitral valve repair for severe mitral regurgitation. *Am J Cardiol.* 2003; 93:1187–9.
5. Pouch AM, Wang H, Takabe M, et al. Fully automatic segmentation of the mitral leaflets in 3D transesophageal echocardiographic images using multi-atlas joint label fusion and deformable medial modeling. *Med Image Anal.* 2014; 18:118–29. [PubMed: 24184435]

6. Lee CH, Oomen PJA, Rabbah JP, et al. A high-fidelity and micro-anatomically accurate 3D finite element model for simulations of functional mitral valve. *Lect Notes Comput Sci.* 2013; 7945:416–24.
7. Pouch AM, Xu C, Yushkevich PA, et al. Semi-automated mitral valve morphometry and computational stress analysis using 3D ultrasound. *J Biomech.* 2012; 45:903–7. [PubMed: 22281408]

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