Systematic Transesophageal Echocardiographic Examination in Mitral Valve Repair: The Evolution of a Discipline into the Twenty-First Century

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Mitral valve repair was first suggested in 1902 by Sir Thomas Brunton (1) as a surgical approach to patients with rheumatic mitral valve disease. However, it was not until after the introduction of the heart-lung machine in 1953 by Gibbons (2) that techniques for the repair of pure mitral valve regurgitation were first introduced by Lillehei et al. (3) in 1957. Because of the development of prosthetic valves, further investigation into these techniques was not continued until the limitations of mechanical and bioprosthetic valves became apparent and mitral valve repair became a more viable alternative. In the 1970s, the field was revolutionized when Carpentier et al. (4) presented data detailing the anatomic changes in patients with mitral insufficiency and introduced a physiologic classification of the causes of mitral insufficiency. This provided the foundation of our current understanding of the echocardiographic patterns and anatomic mechanisms of mitral valve regurgitation. Both Carpentier et al. (4), in France, and Duran et al. (5), in Spain, developed mitral valve repair techniques primarily for the management of patients with rheumatic mitral disease. These procedures were attractive to surgeons in the United States who foresaw potential benefits for an older patient population with mitral regurgitation as a result of myxomatous degeneration and ischemia (6,7). From the beginning of the 20th century to the turn of the 21st century, mitral valve repair procedures have developed from a surgical suggestion to a therapeutic intervention used in >2000 patients annually in the United States (8).

Valve repair for the management of mitral regurgitation offers the advantages of less perioperative morbidity and mortality, preservation of the mitral tensor apparatus with better maintenance of ventricular function, freedom from anticoagulation, long-term durability, and freedom from reoperation (9). However, the surgical valve repair technique is more technically demanding for the surgeon. The development of improved myocardial protection during cardiopulmonary bypass and the technological advancements of intraoperative echocardiography have enhanced the development of innovative surgical techniques for reparative surgery. Both transesophageal and epicardial echocardiography provide an intraoperative safety net that helps to optimize surgical results with transference of real-time information to the surgical team regarding the underlying valve structure, physiologic abnormality, mechanism, and pathologic process. Intraoperative echocardiography has the added advantage of shortening the learning curve for those surgeons who are incorporating the valve repair techniques into their practice, which translates to benefits for patients.

The article by Lambert et al. (10) serves as a reminder of the importance of a comprehensive and systematic transesophageal echocardiographic (TEE) evaluation of the mitral valve apparatus in patients undergoing reparative procedures for mitral regurgitation. Their evaluation included a multiplane segment by segment characterization of leaflet structure and mobility, anatomy of the commissure and subvalvular apparatus, annular and ventricular size, and severity and direction of the regurgitant jet. Successful valve repair requires an understanding of the etiology and mechanism of valve regurgitation. This knowledge is a major determinant of the probability of successful repair, which may vary from 98% in patients with a flail middle scallop of the posterior leaflet to 20% in patients with severe rheumatic valvular disease and restricted bileaflet motion.

In their prospective study, Lambert et al. (10) report a small population of 13 patients who underwent surgery for significant mitral regurgitation. The mechanism of regurgitation and location of pathology was identified by using this systematic echocardiographic examination in 12 patients (92%) compared with a...
detailed surgical inspection of the valve. In a segment by segment analysis, the systematic multiplane TEE examination allowed visualization and diagnosis for 96% of mitral valve segments. In a retrospective group of 10 patients, TEE assessment established the diagnosis in 6 patients (60%). Segmental analysis in this retrospective group correctly identified and visualized 70% of segments as being either normal or abnormal (10). In a similar study by Stewart et al. (11), 286 patients were prospectively studied with either multiplane TEE (n = 141) or epicardial echocardiography (n = 51), with an overall 85% accuracy of diagnosis of the mechanism and pathology of mitral regurgitation. This accuracy varied according to the mechanism and etiology from 94% for anterior or posterior leaflet flail or prolapse to 38% for patients with two or more mechanisms of regurgitation (rheumatic regurgitation secondary to restricted leaflet motion and a flail segment with or without a leaflet perforation from endocarditis). The study by Lambert et al. (10) did not include patients with bileaflet prolapse, ischemic mitral insufficiency, more than one surgically identifiable regurgitant mechanism, solitary leaflet perforation, or cleft mitral leaflets. Their results are consistent with the previously reported high diagnostic accuracy in patients with single leaflet prolapse or leaflet restriction (11).

Although the patient population in the study by Lambert et al. (10) is modest in size, it is illustrative of three very important concepts. These are: 1) the importance of understanding the anatomy of the mitral valve apparatus and the mitral valve nomenclatures used in reparative surgery; 2) the absolute necessity for a comprehensive and systematic approach in evaluating mitral valve anatomy during repair procedures; and 3) the role that intraoperative echocardiography has assumed in defining the current practice of cardiovascular anesthesiology. Lambert et al. (10) have considerably included the three most commonly used nomenclatures used by surgical teams involved in repair of the mitral valve: the anatomic classification, the Carpentier nomenclature, and the Duran terminology (12–14). The designation P-2 refers to different posterior leaflet scallops in the Carpentier and Duran classification systems, and it can be confusing to those who are not familiar with these different terminologies. The anatomic classification refers to the Carpentier P-2 as the middle scallop of the posterior mitral valve leaflet, yet the Duran P-2 terminology refers to the postero medial scallop of the posterior mitral valve leaflet. Confusion that may affect patient outcomes occurs only when fluctuating between shorthand nomenclatures. If members of a perioperative team are using one common nomenclature, this should not be problematic. Nonetheless, it is important to understand the similarities and differences of these shorthand terminologies when reviewing results of clinical studies from different centers involving different mitral valve nomenclatures.

Lambert et al. use a systematic and comprehensive approach to the intraoperative multiplane TEE assessment of the mitral valve and offer encouraging results. They challenge us to prospectively apply these techniques to larger and more diverse patient populations to critically evaluate its effectiveness in affecting surgical management strategies and clinical outcomes.

Intraoperative echocardiography has become an integral, if not defining, aspect of the discipline and practice of cardiovascular anesthesia. This is reflected by the increasing number of cardiac surgery programs that provides this diagnostic and monitoring capability as part of the anesthetic management of patients undergoing surgery. In addition, echocardiography training and education is demanded by residents and fellows and is viewed as an important component of their postgraduate training in cardiac anesthesia. The Society of Cardiovascular Anesthesiologists has demonstrated the importance of echocardiography by developing the Perioperative Echocardiography Certification Examination, which was recently placed under the auspices of the National Board of Echocardiography. The study by Lambert et al. (10) further emphasizes the importance of intraoperative echocardiography to the discipline of cardiovascular anesthesia and its potential impact on the clinical management of our patients.

Intraoperative echocardiography provides a definitive mechanism to improve quality of care for our patients and offers the cardiovascular anesthesiologist greater involvement in perioperative decision-making, as well as increased interdisciplinary interaction in patient care and research. It challenges the anesthesiologist to combine the skills of the critical care specialist and diagnostic echocardiographer in the most crucial of circumstances. Regardless of practice setting, it is important that cardiovascular anesthesiologists function together with members of the care team. In the setting of hemodynamic instability or respiratory insufficiency, it is difficult for many to simultaneously manage a patient and competently perform the required diagnostic TEE assessment. Having immediate support from a colleague for the performance of the intraoperative TEE examination or assistance in managing a critical patient is essential if echocardiography is to enhance the development of our profession and patient care. Applying techniques such as those described by Lambert et al. (10) and working together with the other disciplines involved in the care of cardiac surgical patients, we all have much to gain.

References

3. Lillehei CW, Gott VL, DeWall RA, Varco RL. Surgical correction of pure mitral insufficiency by annuloplasty under direct vision. 1957;2:446.