CASE 4—2000
A Systematic Approach to Intraoperative Transesophageal Echocardiographic Evaluation of the Mitral Valve Apparatus With Anatomic Correlation

Video may be viewed at www.jcardioanesthesia.com

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Case Presentation*

Mitral valve repair is the established and preferred surgical treatment of myxomatous mitral valve disease. Numerous reports have shown the superiority of repair versus replacement in terms of operative mortality, thromboembolism, and long-term survival. Repair places greater demands on the surgeon, who is no longer satisfied with the standard preoperative data but requires precise anatomic details to direct specific repair maneuvers. Transesophageal echocardiography (TEE) of the beating heart provides more precise and reliable functional information than the direct visual observation of the valve in the arrested cardioplegic heart. A systematic intraoperative TEE examination of the mitral valve apparatus is described with the aim of providing the surgeon with a road map of the mitral valve using landmark midesophageal and ventricular TEE views. The following discussion reviews anatomy of the mitral valve apparatus and relates it to these landmark TEE views.

The mitral valve nomenclature proposed by Kumar et al is used (Fig 1). This mitral valve nomenclature is based on the following:

The structures are divided into what is perceived by the surgeon, who observes the valve through a left atriotomy.

The structures of the mitral apparatus in this orientation are defined as being anterior (A) or posterior (P) and being left or right as viewed by this surgical view; left-sided structures are noted by the numeral 1 and right-sided by the numeral 2.

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The chordae tendineae are named by the area of the leaflet into which they are inserted, independent of whether inserted into the free edge or the ventricular surface.

The anterior papillary muscle viewed to the left of the surgeon is termed M1, and the posterior papillary muscle viewed to the right is termed M2.

Case 1: Prolapse of the Middle Scallop of the Posterior Leaflet of the Mitral Valve

A 75-year-old man was referred for surgical treatment of mitral regurgitation. Seventeen years previously, he had undergone coronary artery bypass graft surgery with saphenous vein grafts to the right coronary, left anterior descending, and diagonal coronary arteries. He did well until 5 months before surgery, when he presented to his local internist with new-onset paroxysmal nocturnal dyspnea, orthopnea, and dyspnea on exertion. Echocardiogram at that time revealed normal left ventricular function and severe mitral regurgitation. The patient was given furosemide, digoxin (Lanoxin), and moexipril hydrochloride (Univasc). After initial clinical improvement, he developed recurring symptoms of heart failure. TEE was performed, finding normal left ventricular function and severe mitral regurgitation. The patient was given furosemide, digoxin (Lanoxin), and moexipril hydrochloride (Univasc). After initial clinical improvement, he developed recurring symptoms of heart failure. TEE was performed, finding normal left ventricular function and severe mitral regurgitation.

There was severe mitral regurgitation by the jet area, and the color jet directed toward the interatrial septum suggested a posterior leaflet prolapse. The midesophageal four-chamber view revealed a normal posterior leaflet P1 scallop, normal
anterior leaflet, and prolapsing portion of the posterior leaflet moving into view during systole suggestive of a posterior leaflet middle scallop (PM) prolapse (Figs 2B, 3B). This view also revealed dilation of the mitral annulus to 40 mm. The midesophageal midcommissural view revealed increased mitral annulus diameter to 43 mm and intact P2 but suggested a prolapsing PM scallop (Figs 2C, 3C). Rotation to the midesophageal longitudinal view revealed a prolapsing, flail PM with torn chordae (Figs 2E, 3E). Examination of the midventricular short and long axis to define the papillary origin of ruptured chordae was suggestive of torn chordae originating from the anterior and the posterior papillary muscles (M1 and M2) consistent with a complete PM flail leaflet (Fig 4). The left atrium was dilated with no thrombus visualized in the left atrial appendage.

The findings were summarized as myxomatous mitral disease with (1) dilated annulus, (2) torn chordae to PM1 and PM2 resulting in flail PM scallop of the posterior leaflet, (3) anterior leaflet with no significant pathology, and (4) left ventricle dilated with normal ventricular function. Risk factors for postrepair mitral valve systolic anterior motion (SAM) of the anterior leaflet were not present. This TEE can be viewed at www.jcardioanesthesia.com.

At surgery, the anatomic findings were consistent with those described by echocardiography. The patient underwent a quadrangular resection of PM, mitral annuloplasty with No. 31 Duran ring, a tricuspid valve annuloplasty with No. 33 Duran ring, purse-string exclusion of the left atrial appendage, and a plication annuloplasty of the aortic valve with 5-0 prolene pledgeted sutures at all three commissures.

Postbypass, the left ventricular function was normal with no new wall motion abnormalities. The mitral ring was visualized, and there was no mitral regurgitation under volume and pressure loading. The tricuspid ring was visualized, and there was no tricuspid regurgitation. Mild aortic insufficiency remained.

Case II: Complex Mitral Pathology

A 62-year-old man with a known loud murmur of mitral regurgitation for many years developed worsening symptoms of dyspnea on exertion 2 months before surgery. Cardiac catheterization revealed essentially normal coronary arteries. Preoperative TEE found severe mitral regurgitation with regurgitant jet directed toward the atrial free wall and anterior and posterior leaflet prolapse. The patient was referred for mitral valve repair.

After induction of general anesthesia, a multiplane TEE probe (omniplane probe, Hewlett Packard Sonos 1000, Palo Alto, CA) was placed without complications. TEE examination revealed a complicated mechanism of mitral regurgitation. The left atrium was dilated. The midesophageal three-chamber view revealed a color jet of severe mitral regurgitation having a large component directed toward the left atrial free wall consistent with anterior leaflet prolapse and a smaller component toward the interatrial septum consistent with posterior leaflet prolapse (Figs 2A, 3A). The three-chamber view revealed the midanterior leaflet to have prolapse and possible flail leaflet. The midesophageal four-chamber view revealed the anterior leaflet portion (A1) and posterior leaflet portion (P1) to coapt 10 mm above the annular plane, with no flail leaflet. The mitral annulus was dilated to 43 mm in this view (Figs 2B, 3B). The midesophageal midcommissural and two-chamber view revealed a prolapsing P2 with a torn chorda and a torn chordal attachment to the A2 portion of the anterior leaflet. Additionally, this view suggested that the remaining intact chordae to A2 and P2 were greatly elongated, allowing significant prolapse of these two scallops. The midesophageal longitudinal view showed prolapsing PM and flail portion anterior leaflet A2 above PM (Figs 2E, 3E). All midesophageal views showed increased height of the posterior leaflet (base to free edge), raising the concern of risk for SAM after mitral valve repair. Examination of the ventricular views was not able to define the papillary origin of ruptured chordae (Fig 4). The ventricle was minimally dilated with a midventricular end-diastolic diameter of 54 mm. Left ventricular function was well maintained. The tricuspid valve annulus was markedly dilated to 46 mm. Tricuspid regurgitation was present but difficult to quantitate. The TEE examination was summarized as severe mitral regurgitation caused by (1) a posterior leaflet abnormality with torn chordae to P2 scallop with area of flail, and prolapsing PM and P1 scallops; (2) an increase in the posterior leaflet base to free edge length, raising concerns of the likelihood of postrepair SAM; (3) a marked prolapse of A2 with torn chordae and less but significant prolapse of A1; (4) a dilated mitral annulus; and (5) a
resection of P2 and the associated ruptured chordae, a resection of all of PM, followed by a sliding plasty of P1 and P2 to prevent SAM. A localized triangular resection of A2 containing the ruptured chordae followed by shortening of the chordal group to A2 was performed. An annuloplasty was performed using a No. 27 Duran ring. The tricuspid annulus was measured at 45 mm and reduced to 31 mm using a No. 31 Duran ring.

After repair, there was no evidence of mitral stenosis or regurgitation. The tricuspid leaflets had good coaptation and no evidence of regurgitation.

**DISCUSSION†**

These two case reports represent part of the spectrum of mitral valve pathology, one being a simple PM scallop lesion and the other being complex anterior and posterior leaflet pathology. Both cases illustrate the usefulness of intraoperative TEE to facilitate mitral valve repair. This discussion focuses on the mitral anatomy and TEE views used to define this anatomy.

**Mitral Valve Anatomy**

The mitral valve apparatus (MVA) is an anatomic term describing structures of the heart associated with mitral valve function.\(^7\)\(^9\) These structures consist of the fibrous skeleton of the heart, mitral annulus, leaflets, chordae, and papillary muscle–ventricular wall complex. The true fibrous skeleton of the heart is formed by three U-shaped cords of the aortic annulus and their extensions forming the right trigone, left trigone, and a smaller fibrous structure from the right aortic coronary cusp to the root of the pulmonary artery (Fig 5).\(^10\) Three U-shaped cords of the aortic annulus are joined to each other at the commissures of the aortic valve forming a scalloped fibrous crownlike skeleton of the aortic valve. The right fibrous trigone extends down from the base of the noncoronary cusp annular cord and is more substantial than the left fibrous trigone. The left fibrous trigone extends down from the base of the left coronary cusp cusp annular cord and is more substantial than the left fibrous trigone. A scalloped area is formed between the right and left trigone and the annular cords of left and noncoronary cusp. This fibrous intertrigonal space is common to the aortic and mitral valves and is called the aortic curtain. This membrane merges with the anterior third of the mitral annulus, becoming the middle portion of the anterior leaflet of the mitral valve.

From the left and right fibrous trigone, a fibrous tissue continuum extends around the left and right atrioventricular orifices forming the annuli fibrosi of the mitral and tricuspid annulus. The annulus fibrosus of the mitral annulus becomes thinner and poorly defined as it extends posteriorly from the left and right trigones. This portion of the annulus is poorly supported and is prone to dilation in pathologic states. The posterior leaflet of the mitral valve attaches to this portion of the annulus. Dilation of the annular attachment of the posterior leaflet creates increased tension on the PM scallop, explaining the 60% occurrence of chordal tears at the PM scallop.

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Fig 3. Representative TEE views from case 1 and case 2. Rows A through E refer to midesophageal views as in Figure 2.
Mitra1 Valve Leaflets

A curtain of fibroelastie tissue extends from the mitral
annulus forming the mitral valve leaflets.11 The combined
surface area of the mitral leaflets is twice that of the mitral
orifice, permitting large areas of coaptation. The free edge
of this curtain has multiple indentations. These indentations do not
extend to the annulus. The commissural area between the
anterior and posterior leaflet is a small leaflet and is delineated
by the attachment of the commissural fan chordae. These
chordal attachments define the commissural area attaching to
the commissural scallops, which have variable size but great
importance for the function of the mitral valve. The commis-
sural scallops are defined as left (C1) and right (C2) as seen by
the surgeon through an atriotomy (Fig 1).

The anterior leaflet is semicircular in shape. The base to
apical height of the anterior leaflet is almost twice as great as the
posterior leaflet. The annular attachment of the anterior leaflet
runs along approximately 30% of the annular circumference.
The anterior leaflet is defined as A and is divided into left (A1)
and right (A2) halves as seen by the surgeon through a left
atriotomy (Fig 1).

The posterior leaflet is attached to the mitral annulus along

Fig 5. Fibrous skeleton of the
heart consisting of three U-shaped
cords of the aortic annulus, the
right and left trigones, and fi-
brous structure from the right
coronary cusp to the root of the
pulmonary artery. Extensions
from the skeleton include the
aortic curtain, mitral and tricus-
pid annulus, anterior leaflet of
the mitral valve, and pulmonic
valve.
the free wall of the left ventricle. It extends from the anterior commissure (C1) attachment of the left ventricular free wall to the junction of the posterior left ventricle and the muscular ventricular septum (C2). The posterior leaflet attachments involve about 70% of the mitral annulus. Small indentations in the posterior leaflet most commonly give it a three-scallop appearance: a larger middle scallop (PM), with lateral (P1) and smaller medial (P2) scallops on either side. PM is further divided into a left half (PM1) and right half (PM2) as viewed by the surgeon through an atriotomy (Fig 1).

Chordae Tendineae

The chordae tendineae are fibrous strings radiating from the left ventricular papillary muscles or the ventricular free wall (posterior leaflet only) and attaching to the mitral leaflets in an organized manner.12 Chordae arising from M1 (anterior papillary muscle) attach to A1, C1, P1, and PM1. Chordae arising from M2 (posterior papillary muscle) attach to A2, C2, P2, and PM2 (Fig 1). This relationship aids in defining the portion of the mitral valve visualized echocardiographically.

Two chordae attaching to the ventricular surface of the anterior leaflet are the thickest and largest of the chordae to the mitral valve. They have been called strut or stay chordae. One arises from M1 and attaches to A1 of the anterior leaflet; one arises from M2 and attaches to the A2 portion of the anterior leaflet.

Most chordae branch soon after leaving the papillary muscle or before insertion into the leaflet. Tandler13 defined three orders of chordae: First-order chordae attach on the free margin of the leaflet, second-order chordae insert into the ventricular aspect of the leaflet, and third-order chordae travel from the ventricular wall and insert into the undersurface of the leaflet (posterior leaflet only).

Lam et al12 noted that among chordae different morphologic characteristics are identified, depending on their site of insertion. Lam et al12 classified chordae on this basis into rough zone, cleft, basal, and commissural chordae. For purposes of echocardiography, the authors name the chordae by the area of the leaflet into which they are inserted, independent of whether they insert on the free edge or ventricular surface of the leaflet.4

Papillary Muscles

The papillary muscles are large trabeculae carneae originating from the junction of the middle and apical third of the left ventricular wall in a plane posterior to the intercommissural plane in diastole. Rusted et al14 suggested the nomenclature anterior (anterolateral) and posterior (posterolateral) based on the consistent relationship that each papillary muscle bears with its respective commissural area (C1, C2). According to the surgical classification used here, the anterior papillary muscle is termed M1 and the posterior termed M2 (Fig 1).

The anterior papillary muscle (M1) is located on the anterolateral free wall of the left ventricle. The posterior papillary muscle (M2) originates at the junction of the posterior left ventricular free wall and the muscular ventricular septum. They extend into the upper third of the ventricular cavity below the commissural tissue (C1, C2) of the left ventricle. The papillary muscles most commonly have one head but may have double, triple, or multiple heads.

The M1 papillary muscle is more commonly supplied by two separate arteries: the first obtuse marginal arising from the left circumflex and the first diagonal arising from the left anterior descending artery.15 A single artery, usually from the right coronary artery or the third obtuse marginal of the left circumflex, most commonly perfuses the M2 papillary muscle. The greater incidence of M2 papillary muscle dysfunction or rupture in myocardial ischemia has been associated with the single artery supply to it versus the common dual supply to the M1 papillary muscle.

The papillary muscles do not function in isolation from the left ventricular wall and chordae and leaflets to which they attach. The whole mitral valve apparatus interaction is important to proper ventricular function. Studies have shed new insight into pathologic mechanisms affecting this complex structure.16,17

Transesophageal Echocardiography Examination

Attempts should be made to find the following landmark TEE views to define the anatomy of the mitral valve apparatus: midesophageal three-chamber view, midesophageal four-chamber view, midesophageal midcommissural view, midesophageal two-chamber view, midesophageal longitudinal view, basal ventricular (fishmouth) short-axis and long-axis views, and midesophageal short-axis and long-axis views. The left column of Figure 2 shows how the landmark midesophageal views transect the mitral leaflets as viewed from the left atrium. The right column of Figure 2 shows schematic drawings of TEE views as seen on the screen. By convention, the TEE images on the screen are presented with the patients' right-sided structures seen on the left side of the screen and left-sided structures seen on the right side of the screen. TEE views with rotation of the imaging plane in the midesophageal views maintain this convention.

As the two-dimensional TEE examination of the mitral valve apparatus is performed, the relationship of chordal attachments between the papillary muscle and leaflet should be remembered and used to define the anatomic location of leaflets visualized. Chords from M2 attach to P2, C2, A2, and PM2. The chordae from M1 attach to P1, C1, A1, and PM1. The mitral leaflet free edge can be defined by visualizing a papillary or chordal attachment to the leaflet. Using multiple views, the leaflet surface anatomy is defined.

The midesophageal three-chamber view at 0° gives a section of the anterior leaflet passing through the midbase of the anterior leaflet to the tip of A1 (Figs 2A, 3A). The section of the posterior leaflet that is seen is in the area of PM1 or P1. The anterior leaflet is on the left of the screen and posterior to the right. When visualized, the papillary muscle seen is M1. The upper pulmonary veins are also visualized. This cut provides imaging for measuring left atrial dimension, annular diameter measurement, level of leaflet coaptation, and assessment of SAM and pulmonary vein flow velocities.

The midesophageal four-chamber view at 0° gives a section of the anterior leaflet passing through the medial base of A2 to the A1 edge cutting across more laterally to P1. The left
ventricular wall to the right of the screen is lateral and to the left is septal (Figs 2B, 3B). The anterior leaflet is on the left of the screen and the posterior leaflet on the right. When visualized, the papillary muscle seen is M1, often seen with primary and secondary chordal connecting to A1 and P1. This cut provides imaging for measuring left atrial dimension, annular diameter measurement to evaluate for dilation, and level of leaflet coaptation.

The mitral regurgitant jet direction in the midesophageal three-chamber and four-chamber views indicates leaflet pathology. The regurgitant jet toward the interatrial septum suggests posterior leaflet prolapse, and a jet toward the left atrial free wall suggests anterior leaflet prolapse. 18

The midesophageal commissural view (40° to 80°) shows three sections of the mitral leaflet (Figs 2C, 3C), with P2 on the left and P1 on the right. Most commonly, the middle leaflet seen is the anterior leaflet, the left half being A2 and right half being A1. With appropriate rotation of the probe, the papillary muscles M1 and M2 with their chordal attachments are seen—chordal from M2 going to P2 and A2 chordal from M1 going to A1 and P1. Consideration must be given to the possibility that the middle leaflet seen is PM of the posterior leaflet. 3 This possibility is determined by correlating the other midesophageal views. In Figure 3, case 1, line C, the commissural view is shown with the anterior leaflet in the middle and PM prolapsing into the plane of the examination above the anterior leaflet. The commissural view is excellent for evaluating regurgitation at these more peripheral areas of leaflet coaptation and evaluating ventricular and papillary wall motion abnormalities contributing to mitral regurgitation.

With the two-chamber midesophageal view (80° to 100°), the anterior leaflet is now seen on the right of the screen and posterior leaflet on the left (Fig 2D). The section goes through the base of A1 and the tip of A2, extending across toward P2. The papillary muscle seen is M2 with chordal attachments to P2 and A2. Often the left atrial appendage is visualized in this view, allowing the assessment of presence of atrial appendage thrombus.

The midesophageal longitudinal view (110° to 140°) is optimized when no papillary muscles are seen (Figs 2E, 3E). This view then gives a cut through the middle of the anterior leaflet and PM. This view is excellent for evaluating SAM and midposterior and anterior leaflet pathology.

The basal ventricular short-axis view is obtained by advancing the probe toward the stomach. It provides a basal cross-section between the annulus and midpapillary region of the left ventricle. When obtained, the basal ventricular short-axis view provides a fishmouth view of the mitral orifice showing a cross-section through the entire anterior and posterior leaflet (Fig 4). The anterior leaflet is seen on the left of the screen and the posterior leaflet toward the right. The posterior-medial commissure (C2) is seen at the upper right of the screen, and the anterior-lateral commissure (C1) is seen at the lower left. The midventricular long-axis view often provides a view of the left ventricular outflow tract for Doppler measurements.

The midventricular short axis at 0° provides a midpapillary view of the left ventricle (Fig 4). The location of the papillary muscles and determination of the number of heads is important here. This view is helpful in defining where torn papillary muscle chordae originate from and for assessing left ventricular papillary muscle contractile function. The view is excellent for measuring left ventricular systolic and diastolic dimensions. Rotation of the plane of the probe toward 90° obtains the midesophageal long-axis view, visualizing M1 and M2 and their chordal attachments to the mitral valve leaflets. If both papillary muscles are not visualized, they may be brought into view by rightward or leftward rotation. This view is helpful in defining where torn papillary muscle chordae originate and for assessing left ventricular papillary muscle contractile function.

During the TEE examination, the mitral valve apparatus should be examined for the anatomic basis determining mitral disease (Table 1). All midesophageal views should be examined for localization of regurgitant jets using color Doppler, then appropriate methods for quantification of mitral regurgitation should be used (Table 2).

In conclusion, a thorough evaluation of the mitral valve apparatus by TEE is optimal to precisely define anatomy before

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Table 1. Pathologic Anatomic Changes to Assess During Transesophageal Echocardiographic Examination of the Mitral Valve

<table>
<thead>
<tr>
<th>Mitral Annulus</th>
<th>Calcification, Dilatation, Perivalvular Leak of Prosthetic Valve</th>
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</thead>
<tbody>
<tr>
<td>Mitral leaflet</td>
<td>Billowing leaflet (Barlow)</td>
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<tr>
<td></td>
<td>Coaptation level of anterior and posterior leaflet relative to annulus</td>
</tr>
<tr>
<td></td>
<td>Systolic anterior motion of anterior leaflet</td>
</tr>
<tr>
<td></td>
<td>Leaflet thickening</td>
</tr>
<tr>
<td></td>
<td>Leaflet fusion (rheumatic); doming of fused leaflets in diastole (mitral stenosis)</td>
</tr>
<tr>
<td></td>
<td>Calcification of leaflets</td>
</tr>
<tr>
<td></td>
<td>Prolapse</td>
</tr>
<tr>
<td></td>
<td>Deformation of leaflet free margin:</td>
</tr>
<tr>
<td></td>
<td>Thickening, retraction of free margin into ventricle (curling under)</td>
</tr>
<tr>
<td></td>
<td>Endocarditis</td>
</tr>
<tr>
<td></td>
<td>Vegetation, leaflet aneurysm, perforation, associated regurgitant jet of aortic insufficiency hugging ventricular side of anterior leaflet (possible source of infectious seeding)</td>
</tr>
</tbody>
</table>

Chordae

| Chordal systolic anterior motion, thickening, fusion, calcification, elongation, rupture |
| Papillary muscle | Ruptured papillary muscle |
| Risk factors for systolic anterior motion post mitral valve repair | Narrow LVOT, small LV diameter, increased anterior and posterior leaflet area |
| Related findings | Left atrial enlargement, atrial appendage thrombus, LV dilation, LV aneurysm, TV annulus dilatation, tricuspid regurgitation, right ventricular enlargement |

Abbreviations: LV, left ventricular; LVOT, left ventricular outflow tract; TV, tricuspid valve.
apparatus and its analysis by standard TEE views have been echocardiographically, and communicate the findings to the reviewed. The ability to understand mitral anatomy, define it and after repair. The surgical anatomy of the mitral valve apparatus and its analysis by standard TEE views have been reviewed. The ability to understand mitral anatomy, define it echocardiographically, and communicate the findings to the surgeon effectively are essential components of mitral valve repair surgery.

**COMMENTARY**

The concept of valvular repair was revolutionized when a physiologic classification detailing the anatomic changes in patients with mitral insufficiency was introduced by Carpentier et al. This research provided the foundation of current understanding of the mechanisms of mitral valve regurgitation. In Europe, Duran et al and Carpentier et al developed mitral valve repair techniques to manage patients with rheumatic mitral disease. Surgeons in the United States saw potential benefits for an older patient population with mitral regurgitation as a result of mostly myxomatous degeneration and ischemia. This progress has continued to a point at which more than 2,000 mitral valve repair procedures are performed annually in the United States alone. Repair for mitral regurgitation offers the advantages of less perioperative morbidity and mortality, preservation of the mitral tensor apparatus with maintenance of ventricular function, freedom from need for anticoagulation, long-term durability, and freedom from reoperation. The surgical valve repair technique is more technically demanding, however. TEE provides real-time information to the surgical team regarding the underlying valve structure, mechanisms of the physiologic abnormality, and pathologic process. It serves as an intraoperative safety net, ensuring the adequacy of repair, and has the added advantage of facilitating immediate feedback to the surgeon, who can develop his or her individual valve repair technique.

The case presentation and discussion serve as a reminder of the importance of systematic TEE evaluation of the mitral valve apparatus in patients undergoing reparative procedures for mitral regurgitation. The evaluation of the mitral apparatus included a segment-by-segment evaluation of leaflet structure, anatomy of the commissure and subvalvular apparatus as well as the severity and direction of the regurgitant jet. The novel and ingenious anatomic nomenclature of the mitral apparatus that is proposed reflects the functional mitral valve anatomy and advanced concepts for mitral valve repair.

These case reports make three important points: (1) the importance of understanding the functional anatomy of the mitral valve apparatus and the mitral valve nomenclature used in reparative surgery, (2) the necessity for a comprehensive and systematic approach in evaluating mitral valve anatomy during repair procedures, and (3) the role that intraoperative echocardiography has acquired in defining the current practice of cardiovascular anesthesia. Although the nomenclature described by Bollen et al reflects the functional organization of the mitral apparatus, it differs from the other commonly employed nomenclatures used by surgical teams involved in repair of the mitral valve: the anatomic classification and the Carpentier nomenclature and the Duran terminology. The designation P2 refers to different posterior leaflet scallops in the Carpentier and Duran classification systems but can be confusing to those who are not familiar with these different terminologies. The anatomic classification refers to the Carpentier P2 as the middle scallop of the posterior mitral valve leaflet, whereas the Duran P2 terminology refers to the posterior-medial scallop of the posterior mitral valve leaflet. Although confusion may result in comparing shorthand nomenclatures, these multiple systems should not present a problem clinically if all members of the surgical team understand the nomenclature used at their institution. It is, however, important to recognize the similarities and distinctions of these shorthand terminologies when reviewing results of clinical studies from centers using these different mitral valve nomenclatures.

Intraoperative echocardiography has become an integral, if not defining, aspect of cardiovascular anesthesia. This importance is reflected in the United States by the increasing numbers of cardiac surgery programs providing this diagnostic and monitoring capability as part of the anesthetic management of cardiac surgery patients. Echocardiography training and education is demanded by residents and fellows and viewed as an important component of postgraduate training in cardiac anesthesia. The Society of Cardiovascular Anesthesiologists has confirmed the importance of echocardiography by developing the Perioperative Echocardiography Certification Examination placed under the auspices of the National Board of Echocardiography. This report serves to emphasize further the importance of intraoperative echocardiography to cardiovascular anesthesia and its potential impact on the clinical management of patients.

**REFERENCES**
