
An Atlas of Mitral Valve Imaging

Milind Desai • Christine Jellis
Teerapat Yingchoncharoen
Editors

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 Springer

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Milind Desai
Department of Cardiovascular Medicine
Cleveland Clinic
Cleveland, OH
USA

Teerapat Yingchoncharoen
Cleveland Clinic
Cleveland, OH
USA

Christine Jellis
Cleveland Clinic
Cleveland, OH
USA

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I would like to acknowledge my wife, Rajul, and my kids, Ria and Rohan, for their tremendous support in life.

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To my husband and son, Dan and Hamish Waters, for their unwavering love and support. Their ongoing encouragement, understanding, and sacrifice allow me to pursue my academic dreams.

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TY

Preface

Imaging and assessment of the mitral valve provides ongoing challenges due to its complicated structure and physiology. For decades, echocardiologists have been seeking new methods to evaluate the mitral valve and quantitate valve dysfunction. From the era of M-mode through development of two-dimensional Doppler and now three-dimensional techniques, echocardiography has remained the imaging modality of choice. The fact that there are still so many measures employed to assess the mitral valve illustrates that it remains a complicated process, which is not well performed with any single parameter.

The purpose of this Atlas is to provide readers with a case-based overview of mitral valve structure and echocardiographic evaluation. The clinical scenarios illustrate how the various echocardiographic parameters provide incremental value in the accurate assessment of mitral valve dysfunction. Detailed, noninvasive assessment of the mitral valve remains integral for planning and performance of mitral valve surgery. Increasingly, echocardiographic assessment and real-time guidance are also required to facilitate percutaneous treatment options. We highlight important imaging aspects of these cases, along with salient teaching points and further recommended reading.

We have aimed to make this contemporary style of Atlas interactive and useful for individual learning as well as group teaching purposes, with the inclusion of numerous video files. Real-world examples of both common and rarer conditions are included to illustrate the breadth of mitral valve pathology and the challenges faced in acquiring optimal images. We hope that readers will enjoy exploring the mitral valve with us in this format.

Cleveland, OH, USA

Milind Desai
Christine Jellis
Teerapat Yingchoncharoen

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- Video 8.9** Two-dimensional transthoracic echocardiogram in the same apical 2-chamber view demonstrating severe SAM with septal contact, following inhalation of amyl nitrite
- Video 8.10** Two-dimensional transthoracic echo with color Doppler in the parasternal long-axis view, demonstrating flow turbulence across LVOT suggestive of significant LVOT obstruction. Additionally, there is an anteriorly directed jet of MR, which is atypical for being SAM-related. In HOCM patients, presence of an anteriorly directed jet of MR should always raise a suspicion of intrinsic mitral valve (especially posterior leaflet) pathology
- Video 8.11** Two-dimensional transthoracic echocardiogram in the apical 3-chamber view demonstrating a very hypertrophied anterolateral papillary muscle. Notice that the mitral leaflet lengths are normal and the basal interventricular septum is normal in thickness
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- Video 11.21** 3D left atrial view of the mitral valve, atypically orientated with the aortic valve at 3 o'clock and the anterior paravalvular defect at the 9 o'clock position
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- Video 11.23** TEE imaging of the bioprosthetic mitral valve replacement at 38°, demonstrating the large pseudoaneurysm adjacent to the valve annulus and left atrium laterally
- Video 11.24** The addition of color Doppler imaging demonstrates regurgitant flow directly from the left ventricle into the pseudoaneurysm via a communication located just below the level of the valve annulus laterally
- Video 11.25** Transesophageal biplane view of the bioprosthetic mitral valve replacement at 0 and 90°, demonstrating the large lateral pseudoaneurysm, which expands during systole, when there is retrograde flow into the cavity
- Video 11.26** 3D reconstruction of the mitral valve viewed from the left atrium. The large pseudoaneurysm can be seen adjacent to the lateral aspect of the valve and left atrium
- Video 11.27** TEE imaging of the bileaflet mechanical mitral valve prosthesis at 58°. The valve appears well seated, with normal leaflet opening. A large left atrial appendage can be seen laterally to the right of the image. Between the appendage and the valve is a small cavity demonstrating expansion during systole. This dynamic appearance is suggestive of a pseudoaneurysm
- Video 11.28** Color Doppler imaging, in the same 58° TEE plane, demonstrates three separate jets of systole flow. There is a moderate (2+) valvular regurgitant jet, a moderate (2+) paravalvular jet originating laterally with flow directed into the left atrial appendage, and a small amount of systolic flow going directly from the left ventricle into the pseudoaneurysm
- Video 11.29** A 3D reconstruction of the mitral valve prosthesis from the left atrial aspect. The valve appears well seated, with normal motion of both leaflets. The large left atrial appendage can be seen adjacent to the valve laterally to the left of the image. Between the appendage and the valve ring is a small slit-like annular defect (9 o'clock position), which represents the cause of the paravalvular leak

- Video 11.30** Parasternal long-axis view on transthoracic echocardiography (TTE), demonstrating dehiscence of the mitral annuloplasty ring, which can be seen partially hanging below the native valve within the left atrium
- Video 11.31** The same parasternal long-axis view with color Doppler imaging shows a severe paravalvular regurgitant jet
- Video 11.32** An apical four-chamber transthoracic view also shows the partially dehisced annuloplasty ring hanging below the native valve annulus in the left atrium
- Video 11.33** Color Doppler imaging of the same four-chamber view confirms a severe paravalvular jet laterally
- Video 11.34** Biplane imaging of the mitral valve at 40° and 130° on TEE also demonstrates a moderate central jet of valvular regurgitation
- Video 11.35** 3D transesophageal imaging of the mitral valve demonstrates severe dehiscence of the annuloplasty ring, involving nearly 50 % of its circumference
- Video 11.36** 3D transesophageal imaging with color Doppler demonstrates the severe paravalvular regurgitation associated with the annuloplasty ring dehiscence
- Video 11.37** Transesophageal view (at 91°) of the repaired mitral valve with an annuloplasty ring in situ, taken immediately after the original valve surgery. There is good leaflet coaptation without restriction of leaflet movement
- Video 11.38** Another transesophageal view (at 139°) taken immediately after the original valve surgery, showing good leaflet coaptation without restriction of leaflet movement
- Video 11.39** Color Doppler imaging at the same transesophageal 139° view immediately after the original valve repair confirms that there was no residual regurgitation
- Video 11.40** A TEE image (0°) obtained 2 years later showed that the mitral annulus was severely thickened circumferentially, with laminated echogenic material extending from the annulus onto both leaflet bodies. This thickening restricted leaflet opening and resulted in a small, stenotic valve orifice
- Video 11.41** TEE view at 60°, also obtained 2 years later, showing thickening of the mitral annulus
- Video 11.42** TEE view at 90°, also obtained 2 years later, showing thickening of the mitral annulus
- Video 11.43** TEE view at 120°, also obtained 2 years later, showing thickening of the mitral annulus
- Video 11.44** 3D imaging of the mitral valve demonstrated a significant reduction in valve orifice area related to the smooth, laminated echogenic material overlying the annuloplasty ring and extending onto the leaflet bases. Severe associated valve leaflet thickening was also evident
- Video 11.45** Normal TEE (119° long-axis view) of the first bioprosthetic valve immediately after replacement
- Video 11.46** Standard TEE (0° view) demonstrating extensive multiple mobile echodensities attached to the left atrial aspect of the valve leaflets and annulus
- Video 11.47** Standard TEE (61° view) demonstrating extensive multiple mobile echodensities attached to the left atrial aspect of the valve leaflets and annulus
- Video 11.48** Standard TEE (94° view) demonstrating extensive multiple mobile echodensities attached to the left atrial aspect of the valve leaflets and annulus.
- Video 11.49** Biplane 0/90° view demonstrating orthogonal views of the mitral valve prosthesis with multiple mobile echodensities attached
- Video 11.50** 3D reconstruction of the mitral valve prosthesis with multiple mobile echodensities attached to the valve annulus and leaflets
- Video 11.51** Repeat TEE after the redo bioprosthetic mitral valve replacement also demonstrated small, mobile echodensities adherent to the left atrial aspect of the prosthetic valve annulus

- Video 11.52** Repeat TEE after the redo bioprosthetic mitral valve replacement also demonstrated small, mobile echodensities adherent to the left atrial aspect of the prosthetic valve annulus
- Video 11.53** 3D reconstruction of the mitral valve immediately after initial implantation, demonstrating a normal, functioning valve
- Video 11.54** Two days after surgery, while the patient was on arteriovenous extracorporeal membrane oxygenation support, TEE (0° view) demonstrated severe biventricular dysfunction and severe mitral valve dysfunction. Both leaflets demonstrated very poor mobility and were severely restricted by overlying thrombus, which extended into the left atrium. Swirling sludge could be seen throughout the left atrium. The left atrial appendage had been ligated at the time of the original surgery
- Video 11.55** TEE (138° view) performed at the same time as Video 11.54 also demonstrated severe biventricular dysfunction and severe mitral valve dysfunction. Both leaflets demonstrated very poor mobility and were severely restricted by overlying thrombus, which extended into the left atrium. Swirling sludge could be seen throughout the left atrium
- Video 11.56** Color Doppler imaging demonstrated only a small jet of turbulent forwards flow across the severely stenotic mitral valve
- Video 11.57** 3D reconstruction of the mitral valve showed a severely stenotic valve with only a slit-like valve orifice remaining
- Video 11.58** After the thrombectomy, leaflet mobility improved, but a degree of restricted leaflet excursion persisted because of residual thrombus on the valve leaflets and annulus. Biventricular function remained severely impaired. Video 11.59. Zoomed view of Video 11.58
- Video 11.60** (a) TEE (0° view) showing that the lateral prosthetic valve leaflet is relatively fixed because of overlying thrombus, which also extends onto the annulus
- Video 11.60** (b) Zoomed view of Video 11.60a
- Video 11.61** Color Doppler imaging demonstrated significant turbulence in the flow across the valve, suggestive of valvular stenosis. Trivial regurgitation was noted
- Video 11.62** 3D imaging of the trileaflet, bioprosthetic mitral valve prosthesis viewed from the left atrium. Significant restriction of lateral leaflet is noted, with relatively preserved excursion of the other two leaflets.
- Video 12.1** Parasternal long-axis end-systolic image at rest, demonstrating posterior mitral valve leaflet prolapse.
- Video 12.2** Parasternal long-axis end-systolic image at peak exercise. Note the decreased left ventricular cavity size.
- Video 12.3** Parasternal short-axis end-systolic image at rest.
- Video 12.4** Parasternal short-axis end-systolic image at peak exercise. Note the decreased left ventricular cavity size.
- Video 12.5** Apical two-chamber end-systolic image at rest.
- Video 12.6** Apical two-chamber end-systolic image at peak exercise. Note the decreased left ventricular cavity size.
- Video 12.7** Apical four-chamber view with color Doppler demonstrating moderate (2+) mitral regurgitation at baseline (heart rate 62 bpm).
- Video 12.8** Parasternal stress echocardiographic images before exercise (*left images*) and after exercise (*right images*). The images at the top show the long-axis view and the bottom images show the short-axis view at the level of the mid left ventricle. The left ventricular cavity increases with exercise stress, consistent with impaired contractile reserve.
- Video 12.9** Apical four-chamber (*top*) and two-chamber (*bottom*) stress echocardiographic images before exercise (*left images*) and after exercise (*right images*). The left ventricular cavity size increases with exercise stress, consistent with impaired contractile reserve.

- Video 12.10** Apical four-chamber view with color Doppler demonstrating severe (4+) mitral regurgitation in the early recovery phase even though the heart rate had nearly returned to the baseline of 68 bpm.
- Video 12.11** Parasternal long-axis view at rest, with color Doppler imaging demonstrating a repaired mitral valve with an annuloplasty ring and trivial valvular mitral regurgitation.
- Video 12.12** (a) Parasternal long-axis view before exercise
- Video 12.12** (b) The same view after exercise, demonstrating a decrease in left ventricular size with stress, indicative of preserved contractile reserve. No regional wall motion abnormalities are seen that would suggest underlying myocardial ischemia, although this exercise was at a submaximal predicted heart rate
- Video 12.13** (a) Apical four-chamber view before exercise
- Video 12.13** (b) The same view after exercise, demonstrating a decrease in left ventricular size with stress, indicative of preserved contractile reserve. No regional wall motion abnormalities are seen that suggest underlying myocardial ischemia, although this exercise was at a submaximal predicted heart rate
- Video 12.14** (a) Color Doppler imaging of the tricuspid valve at rest demonstrates mild to moderate (1–2+) tricuspid regurgitation
- Video 12.14** (b) This regurgitation increases to moderately severe (3+) after exercise stress
- Video 13.1** Transthoracic echocardiography (TTE) parasternal long-axis view showed a 3.7×3.6-cm, highly mobile echodensity with frond-like projections in the left ventricle, attached to the posterior mitral valve leaflet and subvalvular apparatus.
- Video 13.2** TTE apical four-chamber view showed the mass (*arrows*) of the mitral valve.
- Video 13.3** TTE parasternal long-axis view showed a thin-walled, well-circumscribed mass with an echolucent core in the posteroinferior wall area.
- Video 13.4** TTE parasternal long-axis view zoomed at the mass (*arrow*) confirmed the same findings.
- Video 13.5** TTE short-axis view zoomed at the mass attached to the anterolateral papillary muscle.
- Video 13.6** TTE apical four-chamber view confirmed the thin-walled, well-circumscribed mass with an echolucent core attached to the anterolateral papillary muscle, findings consistent with a blood cyst.
- Video 13.7** A TTE apical four-chamber view with color Doppler flow imaging showed typical systolic mitral regurgitation but also a short regurgitation jet from the left ventricle to the left atrium during diastole, consistent with diastolic mitral regurgitation.
- Video 13.8** A TTE apical four-chamber view with color Doppler flow imaging showed typical systolic tricuspid regurgitation but also a short regurgitation jet from the right ventricle to the right atrium during diastole, consistent with diastolic tricuspid regurgitation.