# CONTENTS

## SECTION 1: INTRODUCTION


1. **Prelude** **3-6**
*Harikrishnan S*

2. **Rheumatic Heart Disease—An Epidemiological Mystery** **7–14**
*Biju Soman*

3. **Anatomy of the Mitral Valve** **15–24**
*Yoav Turgeman, Hosam Hasan-Ali, Syamkumar Menon, Raghuram A Krishnan*
- Mitral Subvalvular Apparatus 18
- Mitral Valve Orifice 22

4. **Pathological Aspects of Rheumatic Mitral Stenosis** **25–37**
*Ruma Ray, Prasenjit Das*
- Normal Mitral Valve 25
- Rheumatic Mitral Stenosis 26

5. **Pathophysiology, Natural History and Hemodynamics of Mitral Stenosis** **38-50**
*Krishnakumar M, Mahesh Kumar S, Arun SR*
- Natural History of Mitral Stenosis 38
- Pathophysiology of Mitral Stenosis 39
- Obstructive Physiology of Mitral Stenosis 41
- Chamber Dynamics in Mitral Stenosis: Left Atrium and Left Ventricle 42
- Pulmonary Circulation 44
- Hemodynamics of Mitral Valve Stenosis 44
- Hemodynamics of Percutaneous Balloon Mitral Valvotomy 47


## SECTION 2: EVALUATION PRIOR TO PERCUTANEOUS MITRAL VALVOTOMY


6. **Mitral Stenosis— Evaluation and Medical Management** **53-59**
*Harikrishnan S, Stigimon Joseph*
- Clinical History 53
- Medical Management 55
- Mixed Valve Lesions 58

7. **Percutaneous Mitral Valvotomy—Indications, Contraindications and Mechanism** **60–66**
*Harikrishnan S*
- Mechanism of Percutaneous Balloon Mitral Valvotomy 60
- Indications and Contraindications for PMV 61
- PMV—Special Considerations 62
- Practical Approach in the Developing World 64

**8. Stress Testing Prior to Percutaneous Mitral Valvotomy** **67–70**
*P Shanmuga Sundaram, Harikrishnan S*

- Treadmill Exercise Testing in Patients with Mitral Stenosis 68
- Dobutamine Stress Echocardiography 68

**9. Electrocardiogram in Mitral Stenosis** **71–78**
*Krishnakumar Nair, Diego Chemello, Raja Selvaraj*

- Terminology 71
- Left Atrial Abnormality 72
- Right Atrial Abnormality 73
- Combined Atrial Abnormality 74
- Right Ventricular Hypertrophy 74
- Atrial Arrhythmias 75
- Mitral Stenosis Severity and the ECG 76
- Effects of Mitral Valvotomy on Electrocardiographic Changes of Mitral Stenosis 76
- Clinical Significance 76

**10. Radiological Evaluation in Mitral Stenosis** **79–85**
*Bhavesh Harivadan, Harikrishnan S*

- Chest Roentgenography 79
- Left Ventricular Angiography in Mitral Stenosis 82

**11. Balloon Mitral Valvotomy—Role of Echocardiography** **86–124**
*Hosam Hasan-Ali, Harikrishnan S*

- Anatomical Background 86
- Pathophysiology of Mitral Stenosis 86
- Echocardiographic Assessment in MS Prior to Percutaneous Mitral Valvotomy 87
- Subvalvar Pathology 96
- Left Atrium 97
- Assessment of Lesions in Other Valves 100
- Transesophageal Echocardiography in PMV 101
- Doppler Assessment of Mitral Valve 105
- Pressure Half-Time 106
- Pulmonary Hypertension 108
- Periprocedural Monitoring 108
- Post-PMV Assessment 109
- Left Atrial Function 110
- Exercise Echocardiography 110
- Predictive Value of Echocardiographic Assessment of MV Morphology Before PMV 111

**12. Three-dimensional Echocardiography in PMV: The Latest Tool** **125–133**
*Gadage Siddharth, Sivasubramonian Sivasankaran*

**13. Subvalvular Apparatus in Rheumatic Mitral Stenosis—Methods of Assessment and Therapeutic Implications** **134-142**
*Yoav Turgeman*

- Anatomy and Function of Subvalvular Apparatus 135
- Methods of Assessment of the SVA 136

- Impact of SVA Deformity on the Results of PBMV 140
- Clinical Implications and Conclusion 140

**14. Atrial Function in Mitral Stenosis—Effect of Percutaneous Mitral Valvuloplasty** **143-150**
*Tomás F Cianciulli, María C Saccheri*

**SECTION 3: PMV—PROCEDURE, TECHNICAL CONSIDERATIONS AND PERIPROCEDURAL MONITORING**

**15. Transseptal Puncture** **153–168**
*Harikrishnan S, Krishnakumar Nair*

- Anatomy of the Atrial Septum 153
- How to Perform Transseptal Puncture 155
- Landmarks for Septal Puncture 161
- Septal Puncture Without Arterial Stick 167
- Probing the Septum 168

**16. Use of Safe-Sept Guidewire in Transseptal Access** **169–173**
*Carlo de Asmundis, Darragh Moran, Jayakeerthi Yoganarasimha Rao Gian-Battista Chierchia, Pedro Brugada*

- Indications 169
- Technical Aspects 169

**17. Percutaneous Mitral Valvotomy—Procedure** **174–183**
*Harikrishnan S, Sanjay G, Rajesh Muralidharan*

- Preparation of the Patient (SCTIMST Protocol) 174
- Obtaining the Vascular Access 174
- Preparation of the Septal Puncture System and the Balloon 175
- Steps of Percutaneous Mitral Valvotomy 176

**18. Periprocedural Monitoring during PMV** **184–190**
*S Venkiteshwaran, Suchith Majumdar*

- Other Formulas to Calculate Mitral Valve Area (MVA) 188

**19. Anesthetic Management during Percutaneous Mitral Valvuloplasty** **191–195**
*Thomas Koshy*

- Patient Evaluation Prior to PMV 191
- Precatheterization Preparation 192
- Premedication and Fasting Guidelines 192
- Patient Monitoring During PMV 193
- Patient Sedation 193
- General Anesthesia 194
- Management of Complications 194
- PMV and the Anesthesiologist 195

**20. Intracardiac Echocardiography Imaging in Percutaneous Balloon Mitral Valvuloplasty** **196–206**
*Santhosh KG Koshy, Antwon Robinson*

## SECTION 4: PMV—TECHNIQUES AND GADGETS

**21. Different Techniques and Devices for Percutaneous Mitral Valvuloplasty—Introduction** **209–211**
*Mohammad A Sherif*

- Historical Background 209
- Techniques Available for Percutaneous Mitral Valvotomy 210

**22. The Single Balloon Mitral Valvotomy Catheters** **212–224**
*Harikrishnan S, Krishnakumar M, Suji K*

- Comparison Between Inoue and Accura Balloons with Respect to Safety and Efficacy 222
- Blue Arrow PBMV Balloon 223

**23. Double Balloon Technique** **225–231**
*Mohammad A Sherif, Arun Gopalakrishnan*

- Double Balloon-Technique (DBT) 225
- Balloon Sizing 226
- Double Balloon Technique—Advantages and Disadvantages 228

**24. Mitral Valvotomy by Metallic Commissurotome** **232–238**
*Mohammad A Sherif, Harikrishnan S*

- Description of the Device 232
- Mechanism of Valvotomy with Metallic Commissurotome 234
- Technique 234
- Technical Considerations 235
- Complications 236
- Initial and Long-Term Results 237

**25. JOMIVA Balloon** **239–241**
*Sajy Kuruttukulam*

- Technique 239

**26. Other Gadgets for Percutaneous Mitral Valvotomy** **242–245**
*Mohammad A Sherif, Harikrishnan S*

- Multi-Track System 242
- Nucleus™ Balloon 244

**27. Percutaneous Mitral Valvuloplasty—Comparative Analysis of Different Gadgets** **246–252**
*Mohammad A Sherif*

- Inoue Versus Double Balloon 247
- Inoue Balloon Technique Versus Percutaneous Metallic Commissurotomy 249

**28. Reuse and Resterilization of PMV Hardware** **253–258**
*Suji K, Sethu Parvathy VK*

- Methods of Sterilization 254
- Resterilization Process of the PMV Hardware 255

- Sterilization Using Hydrogen Peroxide 255
- Resterilization of Inoue Balloon 256

**SECTION 5: COMPLICATIONS FOLLOWING PMV**

**29. Device-related Complications during Percutaneous Mitral Valvotomy** **261–267**
*Harikrishnan S*

- Breakage of Coiled Left Atrial (LA) Wire 261
- Entrapment of the Pigtail Guidewire 262
- Balloon Rupture During PMV 264
- Balloon Impasse 266

**30. Complications of Transseptal Puncture and Management** **268–274**
*Harikrishnan S, Meera R*

- Suspected Pericardial Tamponade 268
- Management 269
- Reversal of Heparin—Protamine 270
- Autotransfusion 271
- Thrombus Formation in the Septal Puncture Site 271

**31. Neurological Complications Related to Percutaneous Mitral Valvotomy** **275–281**
*Sajith Sukumaran*

- Systemic Embolism in Patients with Mitral Stenosis 275
- Factors Associated with Systemic Embolization 276
- Percutaneous Balloon Mitral Commissurotomy and Systemic Embolism 277
- Prevention of Cardioembolic Stroke in Rheumatic Mitral Stenosis During Percutaneous Mitral Interventions 277
- Periprocedural Stroke and Treatment Options 278

**32. Thromboembolic Complications during Balloon Mitral Valvotomy** **282–288**
*Dash PK*

**33. Arrhythmias and Its Management during Percutaneous Mitral Valvotomy** **289–296**
*Shomu R Bohora*

- Arrhythmias During PMV 289
- Preprocedure Management of Atrial Fibrillation 291
- Postprocedure Management of Atrial Fibrillation 293
- Atrial Flutter 294

**34. Deflation Failure of Mitral Valvuloplasty Balloon** **297–304**
*Pranav Bansal, Mamtesh Gupta, Jagdish Dureja*

**35. Emergency Surgery after Percutaneous Mitral Valvotomy** **305–310**
*Praveen Reddy Bayya, Praveen Kumar Neema, Praveen Kerala Varma*

- Acute Mitral Regurgitation 307

**36. Troubleshooting of Single Balloon Catheters—Inoue and Accura Balloons** **311–316**
*Harikrishnan S*

## SECTION 6: PMV IN SPECIAL SITUATIONS

**37. Percutaneous Mitral Valvotomy in Pregnancy** **319–329**
*Shyam Sundar Reddy*

- Mitral Stenosis and Pregnancy 319
- Medical Therapy 320
- Interventions in Mitral Stenosis in Pregnancy 321
- Percutaneous Mitral Valvotomy (PMV) in Pregnancy 321
- PMV in Pregnancy—Procedural Details 322
- Short- and Long-term Outcomes Following PMV in Pregnancy 324

**38. Percutaneous Mitral Valvotomy in Juvenile Mitral Stenosis** **330–334**
*Randeep Singla*

- Indication for PMV in Juvenile Mitral Stenosis 330
- Valve Morphology 330
- PMV Procedure in Juvenile Mitral Stenosis 330
- Vascular Access 331
- Balloon Selection and Dilatation 331
- Complications 331

**39. Transjugular Percutaneous Mitral Valvotomy** **335–340**
*Boonjong Saejueng, Sudaratana Tansuphaswadikul*

- Transjugular Interatrial Septal Puncture 336
- Procedure of Septal Puncture 336
- Mitral Valve Dilatation Procedure 337
- Complications 340

**40. Percutaneous Prosthetic Mitral Balloon Valvotomy** **341–346**
*Col. Subroto Kumar Datta*

- Case Selection/Indication 341
- Evaluation 342
- Echo 342
- Selection and Sizing of Balloon 343
- Procedure 343
- Follow-Up 344
- Discussion 344

**41. Tackling Subvalvular Disease during Balloon Mitral Valvotomy** **347–353**
*CN Manjunath, Prabhavathi, BC Srinivas*

**42. Over-the-Wire Techniques during PMV** **354–359**
*KS Ravindranath, Ravi S Math, CN Manjunath*

**43. PMV Performed with other Percutaneous Interventions** **360–370**
*Dinesh Choudhary, Harikrishnan S*

- PMV and Percutaneous Valvotomy of Other Valves 360
- Which Valve to Tackle First? 360
- PMV and Percutaneous Aortic Valvotomy 361
- BAV Along with PMV—Techniques 362
- PMV and Balloon Tricuspid Valvotomy 367
- Triple Valve Intervention 368
- Percutaneous Coronary Intervention and PMV 368

**44. Balloon Tricuspid Valvotomy along with PMV** **371–375**
*Harikrishnan S, Amit Kumar Chaurasia*

**45. PMV in Patients with Atrial Fibrillation** **376–384**
*Krishnakumar M*

- Mechanism of Atrial Fibrillation in Mitral Stenosis 376
- Restoration and Maintenance of Sinus Rhythm in Mitral Stenosis 380

**46. Percutaneous Mitral Valvotomy in Dextrocardia** **385–388**
*Harikrishnan S, Krishnakumar Nair*

**47. Balloon Mitral Valvotomy—Left Femoral Vein Approach and in Venous Anomalies** **389–393**
*Rajesh Muralidharan*

- BMV in Other Venous Anomalies 392

**48. Retrograde Nontransseptal Balloon Mitral Valvuloplasty** **394–398**
*Harikrishnan S, Arun Gopalakrishnan*

**49. Percutaneous Mitral Valvotomy in Technically Challenging Situations** **399–415**
*Harikrishnan S, Rohan Vijay Ainchwar*

- Calcification of the Valve 399
- Left Atrial Thrombi 400
- Difficulty at the Groin Puncture Site 400
- Difficulty in Septal Puncture, Dilatation and Balloon Entry 401
- Difficulty in Negotiating the Atrial Septum 403
- Balloon Catheter Stuck at Septum—Septal Catch 403
- Techniques Facilitating Entry of Balloon Across Mitral Valve 406
- Entry of Balloon Through the Secondary Orifices 410
- Failure to Dilate the Valve 411
- Popping of the Balloon Back to Left Atrium 411
- Small Left Atrium 412
- Percutaneous Mitral Valvotomy in Small Children 413

**50. Left Atrial Appendage Occlusion and Percutaneous Mitral Valvotomy** **416–426**
*Dale Murdoch, Darren Walters*

- Background and Rationale 416

**51. Percutaneous Treatment of Lutembacher's Syndrome: Balloon Mitral Valvotomy and Device Closure of Atrial Septal Defect** **427–439**
*Shiv Bagga, Saujatya Chakraborty, Ramalingam Vadivelu*

- Pathophysiology 427
- Treatment of Lutembacher's Syndrome 427
- Percutaneous Treatment of Lutembacher's Syndrome 428
- Step-by-Step Technique for Percutaneous Therapy of Lutembacher's Syndrome 435

**52. Percutaneous Mitral Valvotomy in Mitral Restenosis** **440–450**
*Krishnakumar Nair, Harikrishnan S*

- Definition 440

- Prevalence 441
- Predictors of Restenosis 441
- Pathology 442
- Management 443

**SECTION 7: LONG-TERM OUTCOME FOLLOWING PMV**

**53. Left Atrial Thrombosis in Rheumatic Mitral Stenosis** **453–461**
*Sonny P Jacob*

**54. Comparison of Percutaneous Mitral Valvotomy and Surgical Mitral Commissurotomy** **462–467**
*Sanjay G*

- PMV Vs Surgical Commissurotomy in Special Situations 464

**55. Mitral Regurgitation Following Percutaneous Mitral Valvotomy** **468–475**
*Rachel Daniel, Anees Thajudeen*

- Mechanism of Mitral Regurgitation Following PMV 468
- Incidence 471
- Clinical Course of MR 472
- Surgical Management of MR Following PMV 474

**56. Atrial Septal Defects Following Percutaneous Mitral Valvotomy** **476–479**
*Harikrishnan S, Kiron Sukulal*

**57. Pulmonary Hypertension in Rheumatic Mitral Stenosis— Influence of Percutaneous Mitral Valvotomy** **480–491**
*Harikrishnan S, Chandrasekharan C Kartha*

- PH in Rheumatic Mitral Valve Disease 484
- Effect of Balloon Mitral Valvotomy on PH 486

**58. Long-term Follow-up of Patients Undergoing Percutaneous Mitral Valvotomy** **492–499**
*Rachel Daniel*

- Mitral Restenosis and Long-Term Outcome 494
- Follow-up and Management of Patients After PMV 494
- Infective Endocarditis Prophylaxis 495

**59. Setting A New PMV Program** **500–503**
*Ajeet Arulkumar, Harikrishnan S*

*Index* *505*