

## Minimally invasive mitral valve repair in Barlow's disease: Early and long-term results

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**Objective:** Barlow's disease remains a challenging surgical pathology in patients presenting with mitral regurgitation. We reviewed our early and long-term results for patients with Barlow's disease who underwent minimally invasive mitral valve surgery.

**Methods:** Between 1999 and 2010, 145 patients with Barlow's disease underwent minimally invasive mitral valve repair at Leipzig Heart Center. Preoperative echocardiography and intraoperative valve analysis confirmed annular dilatation, bileaflet prolapse, and excessive leaflet tissue in all cases. We retrospectively reviewed mitral valve repair techniques, early and late postoperative clinical outcomes, and follow-up echocardiographic data.

**Results:** Successful mitral valve repair was performed in 94.5% of patients (n = 137), initial mitral valve replacement was performed in 2.8% of patients (n = 4), and mitral valve replacement after unsuccessful mitral valve repair was performed in 2.8% of patients (n = 4). Mean aortic crossclamp time was  $99 \pm 33$  minutes, cardiopulmonary bypass time was  $153 \pm 47$  minutes, and total duration of surgery was  $200 \pm 44$  minutes. Mitral valve repair techniques consisted of ring annuloplasty and a variety of other methods (not mutually exclusive): "loop" neochordae (72% of patients), posterior mitral leaflet resection (28%), Alfieri stitch (17%), commissural plication (9%), chordal transfer (9%), and anterior mitral leaflet resection (7%). Concomitant procedures consisted of cryoablation for atrial fibrillation (28%), tricuspid valve repair (6%), and closure of an atrial septal defect/patent foramen ovale (12%). Thirty-day mortality was 1.4% (n = 2), rethoracotomy for bleeding was required in 4.1% of patients (n = 6), and conversion to sternotomy was required in 1 patient (0.7%). Long-term clinical follow-up was obtained in 100% of patients, and long-term echocardiographic data were obtained in 93.3% of surviving patients. Long-term survival was  $94.7\% \pm 2.2\%$  at 5 years and  $88.3\% \pm 4.9\%$  at 10 years. Freedom from mitral valve reoperation was  $96.8\% \pm 1.6\%$  at 5 years and  $93.8\% \pm 2.6\%$  at 10 years. Freedom from greater than 2+ grade mitral regurgitation was  $90.2\% \pm 3.4\%$  at 5 years and  $88.4\% \pm 3.9\%$  at 10 years.

**Conclusions:** A wide variety of repair techniques can be used to perform successful minimally invasive mitral valve repair in the majority of patients with Barlow's disease, with good early and long-term results. (*J Thorac Cardiovasc Surg* 2014;148:1379-85)

As the second most common valve-related indication for cardiac surgery in the western world, mitral regurgitation (MR) is common among the general population and its prevalence increases with age.<sup>1</sup> Approximately two thirds of patients with MR who are referred for surgery in developed countries have degenerative mitral valve (MV) disease. In the spectrum of degenerative MV disease,

Barlow's syndrome is characterized by excessive myxomatous leaflet tissue, bileaflet prolapse or billowing, annular dilatation, and calcification of the leaflets or annulus.<sup>2,3</sup> Barlow's pathology constitutes a clinical challenge for surgeons performing MV repair. Achieving a durable surgical result may be a formidable task in these frequently young and otherwise healthy patients.

Minimally invasive surgery (MIS) of the MV has proven to be feasible and technically acceptable for a wide range of mitral pathologies. Mounting data in the literature support the hypothesis that MIS can provide at least equivalent results for surgical correction of MR with several associated clinical benefits.<sup>4-6</sup> Some have demonstrated that MIS techniques can be safely used for complex mitral pathologies, such as bileaflet prolapse and Barlow's valve.<sup>5-11</sup> The objective of our study was to describe the early and long-term results for MIS of the MV in a relatively large series of consecutive patients with Barlow's disease.

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**Abbreviations and Acronyms**

AML	= anterior mitral leaflet
CPB	= cardiopulmonary bypass
MIS	= minimally invasive surgery
MR	= mitral regurgitation
MV	= mitral valve
NYHA	= New York Heart Association
PML	= posterior mitral leaflet
SAM	= systolic anterior motion
TEE	= transesophageal echocardiography

**PATIENTS AND METHODS****Study Population**

A total of 3502 patients underwent MIS of the MV at Leipzig Heart Center between 1999 and 2010. Of this cohort, 145 patients (4.1%) were identified as having Barlow's disease. The diagnosis was made during the intraoperative transesophageal echocardiography (TEE) examination and confirmed by the surgeon's direct assessment of the valve. All patients with Barlow's disease had excessive leaflet tissue, annular dilatation, and bileaflet prolapse or billowing. In more advanced stages, leaflet and annular calcification was present. Patients with isolated bileaflet prolapse without excessive leaflet tissue and patients with forme fruste Barlow's disease were not included. In addition, patients who required concomitant procedures that could not be performed through a MIS approach (eg, coronary bypass, ascending aorta, or aortic valve surgery) were excluded. All consecutive patients with documented Barlow's disease who underwent MIS at Leipzig Heart Center during this time period were included in the current study.

**Operative Technique of Minimally Invasive Mitral Valve Repair**

The standardized surgical approach for MV repair at Leipzig Heart Center is via a small (5-7 cm in length) anterolateral mini-thoracotomy and has been described in detail.<sup>4,5,12</sup> Briefly, cardiopulmonary bypass (CPB) was instituted via femoral arterial and venous cannulation. An additional venous cannula was inserted in the right internal jugular vein in patients who required concomitant tricuspid valve repair or in patients weighing more than 75 kg. The aorta was crossclamped with a Chitwood clamp,<sup>13</sup> and myocardial protection was achieved with mild hypothermia (34°C) and antegrade delivery of crystalloid Bretschneider cardioplegia (2 L). The left atrium was then opened posterior to the interatrial groove, and a left atrial retractor was used to expose the MV.

Our stepwise approach to Barlow's valve repair has been described.<sup>14</sup> With the use of a combination of recently developed reparative methods and more established principles of MV repair,<sup>15</sup> the following techniques were used: ring annuloplasty, the "loop technique" with premeasured polytetrafluoroethylene (Gore-Tex; WL Gore & Associates Inc, Flagstaff, Ariz) neochordae,<sup>7,12,16</sup> leaflet resection with or without sliding annuloplasty, commissural plication, chordal transfer, and the edge-to-edge ("Alfieri") technique.<sup>17</sup> MV replacement was performed in patients in whom satisfactory MV repair was not achieved or was evaluated as not technically possible during the initial assessment.

TEE was repeated post-CPB in all patients to assess the quality of the MV repair, and more than mild residual MR resulted in a repeat MV repair procedure or MV replacement. TEE examination also was used to confirm flow in the circumflex artery as it courses along the mitral annulus. Examination of the circumflex artery is routinely performed on all the MV cases at Leipzig Heart Center to rule out iatrogenic injury.<sup>18</sup>

**Follow-up**

Clinical long-term follow-up was 100% complete and consisted of New York Heart Association (NYHA) classification, reoperation on the MV or any other cardiac reoperation, and patient survival. It was ascertained by a mailed paper questionnaire or a phone call to the patient or family members, or by contact with the family physician. The follow-up was supplemented with late echocardiographic findings predominantly supplied by referring or institutional cardiologists. Late echocardiography follow-up was obtained in 93.3% of patients (n = 125), after excluding those who died perioperatively (n = 2) and those who underwent repeat MV surgery (n = 9). The degree of MR was classified as grade 0 (absent or trivial), 1+ (mild), 2+ (moderate), 3+ (moderate-to-severe), and 4+ (severe MR), according to published guidelines.<sup>19-21</sup> In those cases in which NYHA class or MR grade was reported to be between 2 categories, it was rounded up (ie, to the worse grade). The mean length of time between surgery and clinical follow-up was 5.4 ± 3.0 years, whereas the mean echocardiography follow-up time was 5.0 ± 2.9 years.

**Statistical Analysis**

Continuous variables are reported as mean ± standard deviation, and categoric variables are reported as percentages of group totals throughout the article. The Kaplan-Meier method was used to estimate survival rate, freedom from MV reoperation, and freedom from recurrent MR greater than 2+. Excel program (Microsoft Corp, Redmond, Wash) and Stata version XI (StataCorp, College Station, Tex) were used for statistical and survival analyses.

**RESULTS**

Baseline demographics and preoperative characteristics of the 145 patients are summarized in Table 1. Approximately two thirds of patients were male, and the mean age was 51.2 ± 12.6 years. Mean preoperative left ventricular ejection fraction was 63.2% ± 7.8%, and more than one quarter of the patients (26.9%) had preoperative atrial fibrillation. No symptoms were present in 22.1% of patients. One patient had undergone MV repair at another institution approximately 10 years previously.

Intraoperative data and selected MV repair techniques (not mutually exclusive) are listed in Table 2. Anterolateral mini-thoracotomy with femoral cannulation for CPB was the surgical approach in all 145 patients. Repair techniques consisted of neochordae formation with the loop technique in 71.7% of patients, which was applied approximately equally for the posterior mitral leaflet (PML) and anterior mitral leaflet (AML) (n = 87 and 90, respectively). Resection of the PML was performed in 28.3% of patients and the AML in 6.9% of patients. Chordal transfer and commissural plication were used in 9.0% of patients each. The Alfieri technique was applied in 25 patients (17.2%). A total of 77 patients (53.1%) received loop neochordae to both leaflets, 23 patients (15.9%) underwent resection of the PML in combination with loops to the AML, and 8 patients (5.5%) underwent resection of both leaflets. After excluding patients who underwent MV replacement (discussed later), all remaining patients but 1 received a complete (n = 123) or partial (n = 13) ring annuloplasty with a mean ring size of 35.7 ± 2.8 mm.

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