Mitral valve repair for severe mitral regurgitation secondary to lone atrial fibrillation


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Received 8 October 2011; received in revised form 20 December 2011; accepted 30 December 2011

Abstract

OBJECTIVES: Significant mitral regurgitation (MR) may arise from isolated annular dilatation secondary to lone atrial fibrillation (AF) and associated atrial remodelling. The aim of the present study is to assess the outcome of surgery for this condition.

METHODS: Between November 2007 and July 2011, 20 patients underwent mitral valve (MV) repair for severe MR secondary to AF. The median age of patients was 77.5 years (45–82 years) and the mean pre-operative duration of AF was 84.6 ± 92 months. The left ventricle was moderately (ejection fraction 30–50%; n = 6) or severely (<30%; n = 1) impaired in seven patients pre-operatively. Mean logistic EuroSCORE was 8.1 ± 5.9 and mean follow-up was 18.0 ± 12.5 months.

RESULTS: All operations were elective. Concomitant anti-arrhythmic procedures (maze procedure, pulmonary vein isolation) or left atrial (LA) appendage amputation were performed in all patients; tricuspid valve repair was undertaken in 12 patients and coronary artery bypass grafting in 2 patients. Ring annuloplasty was performed in all patients. The median ring size was 30 mm (range 24–36 mm). On-table transoesophageal echocardiography post-repair showed mild residual MR in two patients and no MR in the remainder. There were no cases of systolic anterior motion. There was one re-exploration for bleeding. No patients required haemofiltration or suffered from stroke and deep sternal wound infections. There was no in-hospital mortality. At discharge mean left ventricular (LV) end-diastolic diameter was 4.8 ± 0.7 cm compared with 5.6 ± 0.7 cm pre-operatively (P < 0.005), while mean LV end-systolic diameter was 3.2 ± 0.8 cm when compared with 4.0 ± 0.7 cm pre-operatively (P < 0.005). The mean LA size was 5.2 ± 1.0 cm when compared with 6.1 ± 1.6 cm pre-operatively (P = 0.03). There was mild MR in two patients, but none in the rest. The mean MV area was 3.0 ± 0.7 cm². The mean systolic pulmonary artery pressure was 40.4 ± 15.5 mmHg when compared with 54.1 ± 12.2 mmHg pre-operatively (P = 0.02). Seventeen patients (85%) were in NYHA class I/II at latest follow-up (P < 0.0001 vs pre-operatively). During follow-up, there were no thrombo-embolic complications, re-operation, endocarditis or deaths.

CONCLUSIONS: MV annuloplasty for annular dilatation secondary to AF has a good mid-term outcome.

Keywords: Atrial annuloplasty for annular dilatation secondary to AF has a good mid-term outcome.

INTRODUCTION

Atrial fibrillation (AF) is the most prevalent life-threatening cardiac arrhythmia, especially in the elderly. It is caused by disruption of the sino-atrial conduction system, often from intrinsic cardiac pathology but may also complicate systemic diseases. Serial echocardiography is used to assess patients with AF. This demonstrates a temporary rise in left atrial (LA) wall tension and pressure. Progressive atrial enlargement and annular dilatation then manifest in a compensatory mechanism aimed at restoring normal intra-cardiac pressure [1, 2]. The net result is further damage to the atrial conduction pathway and a cycle of arrhythmia propagation. Despite greater understanding of the pathogenesis of AF, its aetiology remains idiopathic in up to one-third of patients. Functional mitral regurgitation (MR) occurs when a structurally normal mitral valve (MV) regurgitates due to alterations in cardiac dimensions. AF and MR frequently occur concomitantly, although there is debate surrounding their association. MR is a recognized cause of AF: the underlying mechanism is believed to involve volume overload of the LA and subsequent atrial enlargement [3]. In contrast, functional MR is caused by a combination of mitral annular dilatation [4] and/or left ventricular (LV) dysfunction [5] both of which occur in patients with lone AF. The contribution of annular dilatation to functional MR has been disputed in patients with normal LV function [2, 6]. However, several authors have reported that lone AF can lead to isolated annular dilatation and functional MR [7].

Treatment of coexistent AF and functional MR is dependent on the severity of symptoms and echocardiographic findings as well as patient choice and co-morbidities. The asymptomatic patient may be controlled medically in the first instance, but there is an argument for early surgical intervention because of the likelihood of progressive annular dilatation and poor response to anti-arrhythmic surgery. Mitral annuloplasty may be
combined with techniques aimed at restoring sinus rhythm, such as the Cox-maze procedure [8] or pulmonary vein isolation (PVI). Annular dilatation also leads to tricuspid regurgitation (TR), and concomitant repair of the tricuspid valve may be warranted [2]. Evaluation of interventions for AF-induced functional MR is necessary because the condition is uncommon and poorly described. This study reports the medium-term outcomes of surgery for the condition.

MATERIALS AND METHODS

Eligibility criteria

This is a retrospective study and included all patients (n = 20) who underwent MV repair for severe functional MR secondary to lone AF between November 2007 and July 2011. Clinically, the patients were first identified with AF (confirmed by Electrocardiogram) by the cardiologist, with no murmur of MR. Echocardiography at that time did not reveal any MR. Annual echocardiographic follow-up showed progressive annular dilatation and increase in the degree of central MR with no underlying structural MV disease. During surgery, transoesophageal echocardiography (TOE) confirmed the pre-operative echocardiographic results and the operative findings included gross annular dilatation with a normal MV and sub-valvular apparatus. In all cases, AF preceded MR. Patients were excluded if the cause of MR was found to be organic (rheumatic heart disease, degenerative MV disease, MV leaflet perforation, ischaemic heart disease or cardiomyopathy). Computerized operation notes (which includes history, background and diagnosis) of all MV repairs performed by the senior surgeon were studied manually from this date until July 2011 to identify the patients correctly. To guarantee accuracy, this was cross-checked with the case-notes of the patients and the electronic database.

Patient population

Twenty patients underwent MV repair for severe MR secondary to lone AF (female n = 14, 70%) and the median age of patients was 77.5 years (range 45–82 years) at the time of surgery (Table 1). Indications for surgery were symptoms and preservation of LV function. Dyspnoea was the primary presenting complaint in most patients (n = 18, 90%). Seventeen patients (85%) were NYHA class III/IV. Palpitations and syncope were the predominant features in only one case (5%). There was a history of congestive cardiac failure in half of those included in the study (n = 10). Other co-morbidities included hypertension (n = 13, 65%), cerebrovascular disease (n = 4, 20%), ischaemic heart disease (n = 3, 15%) and diabetes (n = 2, 10%). AF was present pre-operatively in all patients for a mean duration of 84.6 ± 92.0 months. Electrical cardioversions had been unsuccessfully performed in all patients and no patient underwent percutaneous AF ablation.

Pre-operative investigations

Annual trans-thoracic echocardiography was performed in all patients. At surgery, mean pre-operative LA diameter was 6.1 ± 1.6 cm, while the LV end-systolic diameter (LVESD) and LV end-diastolic diameter (LVEDD) were 4.0 ± 0.7 and 5.6 ± 0.7 cm, respectively. The LV was moderately [ejection fraction (EF) 30–50%; n = 6] or severely (EF <30%; n = 1) impaired in seven patients pre-operatively, while the rest exhibited good LV function (EF >50%; n = 13). TR was graded as moderate to severe in 12 (60%) patients. Pre-operative coronary angiography was performed in all patients to identify lesions requiring concomitant revascularization. Two patients had evidence of left anterior descending artery stenosis and were treated with coronary artery bypass grafting (CABG) at the time of MV repair.

Surgical technique

Intra-operative TOE was performed in all cases. Surgery was undertaken through a median sternotomy and cardiopulmonary bypass was established via either aorto-bicaval cannulation. Cardiac arrest and cardio-protection were achieved through moderate hypothermia and antegrade cold blood cardioplegia. The MV was exposed through a longitudinal incision developing the inter-atrial groove. MV assessment was performed with the P1 scallop as the reference point to detect any localized pathology. After sizing of the anterior leaflet, an annuloplasty ring (Physio or Physio-II, Edwards Lifesciences, Irvine, CA, USA) of the same size was implanted with interrupted 2-0 Ethibond sutures (Ethicon, Inc., Somerville, NJ, USA). Valve competency was tested subsequently by injecting cold saline into the LV across the

<table>
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<th>Table 1: Pre-operative characteristics of included patients</th>
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<tr>
<td>Gender</td>
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<td>Median age in years (range)</td>
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<td>Presenting symptoms</td>
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<td>Shortness of breath</td>
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<td>Syncope and palpitations</td>
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<td>Co-morbidities</td>
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<td>History of congestive cardiac failure</td>
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<td>Severe tricuspid regurgitation</td>
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<td>Mean systolic pulmonary artery pressure</td>
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<td>Mean EuroSCORE</td>
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LV: left ventricle; LVEDD: left ventricular end-diastolic diameter; LVESD: left ventricular end-systolic diameter.
Cardiopulmonary bypass time 90.6 ± 23.4 min
Cross-clamp time 62.6 ± 18.3 min
Procedures performed
- MV repair + TV repair + LAAA: 6 (30.0)
- MV repair + TV repair + Cox-maze procedure: 4 (20.0)
- MV repair + LAAA: 3 (15.0)
- MV repair + TV repair + LAAA + PVI: 2 (10.0)
- MV repair + PVI: 1 (5.0)
- MV repair + Cox-maze procedure: 2 (10.0)
- MV repair + LAAA + CABG: 1 (5.0)
- MV repair + Cox-maze procedure + CABG: 1 (5.0)
Median annuloplasty ring size (range) 30 (24–36) mm
Annuloplasty ring
- Physio: 6 (30.0)
- Physio II: 14 (70.0)
Post-operative characteristic
- Mortality: 0 (0.0)
Complications
- Re-exploration for bleeding: 1 (5.0)
- Median duration of ventilation in hours (range): 12 (5–48)
- Median post-operative stay in days (range): 10.5 (6–37)
Mitral regurgitation
- None/trivial: 18 (90.0)
- Mild/moderate: 2 (10.0)
Tricuspid regurgitation
- None/trivial: 14 (70.0)
- Mild/moderate: 6 (30.0)
Pre-operative echocardiography
- Good LV function: 16 (80.0)
- Mean LVEDD: 4.8 ± 0.7 cm
- Mean LVESD: 3.2 ± 0.8 cm
- LA diameter: 5.2 ± 1.0 cm
- Mean MV gradient: 3.3 ± 1.0 mmHg
- MV area: 3.0 ± 0.7 cm²
- Mean systolic pulmonary artery pressure: 40.4 ± 15.5 mmHg

MV: mitral valve; TV: tricuspid valve; LAAA: left atrial appendage amputation; PVI: pulmonary vein isolation; CABG: coronary artery bypass grafting; LV: left ventricle; LVEDD: left ventricular end-diastolic diameter; LVESD: left ventricular end-systolic diameter.

valve. Before the LA was closed the MV leaflets were observed to be bulging with appropriate areas of coaptation and no residual regurgitation or prolapse. The median ring size implanted was 30 mm (range 24–36 mm). Concomitant procedures (Table 2) were performed in all patients (maze procedure: \( n = 7 \), PVI: \( n = 3 \), LV appendage amputation: \( n = 12 \), tricuspid annuloplasty: \( n = 12 \), CABG: \( n = 2 \)). Currently, we use a combination of radio-frequency ablation and cryo-ablation for maze and only radio-frequency ablation (epicardial) for PVI. Mean cardiopulmonary bypass time and aortic cross-clamp time were 90.6 ± 23.4 and 62.6 ± 18.3 min, respectively.

**Anti-coagulation**

All patients received aspirin 75 mg, unless contra-indications existed. Warfarin was given indefinitely to all patients who stayed in AF but was stopped 6 months later if they reverted to sinus rhythm.

**Statistical analyses**

Statistical analysis was performed using Statistical Package for the Social Science Programme, SPSS Version 16.0 (SPSS Inc., Chicago, IL, USA) and Microsoft Excel. Data were expressed as frequency with percentage, mean with standard deviation or as median with range, as appropriate. Continuous variables were compared using the two-tailed Student’s t-test. A \( P < 0.05 \) was considered statistically significant.

**RESULTS**

**Morbidity and mortality**

There were no cases of in-hospital mortality. Complications were minimal and included one re-exploration for bleeding. There were no cases of systolic anterior motion, cerebrovascular event, deep sternal wound infection or acute renal impairment necessitating haemofiltration. Peak post-operative creatinine levels were 93.7 ± 31.3 μmol/l (mean), while the median duration of ventilation was 12 h (range 5–48 h). Median hospital stay was 10 days (range 6–37 days). Follow-up was complete for a mean period of 18.0 ± 12.5 months. During this time, there were no deaths. In addition, there were no instances of thrombo-embolic complications, endocarditis or re-operation for valvular dysfunction. Seventeen patients (85%) were in NYHA class I/II at latest follow-up (\( P < 0.0001 \) vs pre-operatively). In the 10 patients who underwent Cox-maze or PVI, 9 were in sinus rhythm.

**Echocardiographic outcomes**

Trans-thoracic echocardiography was performed prior to discharge in all patients. This demonstrated mild MR in two patients (10%) and no MR in the remaining 18 cases (90%). The post-operative MV area was 3.0 ± 0.7 cm² and the mean MV gradient was 3.3 ± 1.0 mmHg. At discharge mean LVEDD was reduced at 4.8 ± 0.7 cm compared with 5.6 ± 0.7 cm pre-operatively (\( P < 0.005 \)). Furthermore, the LVESD decreased from 4.0 ± 0.7 to 3.2 ± 0.8 cm (\( P < 0.005 \)) following surgery. LV function was good in 16 patients, moderate in 3 and poor in 1 patient. Mean LA diameter was lower at discharge (5.2 ± 1.0 cm) compared with that pre-operatively (6.1 ± 1.6 cm; \( P = 0.03 \)). There was mild TR in six patients post-operatively and none in the remainder. The mean systolic pulmonary artery pressure decreased from 54.1 ± 12.2 mmHg pre-operatively to 40.4 ± 15.5 mmHg (\( P = 0.02 \)) at discharge.

**DISCUSSION**

Dilatation of the mitral and tricuspid annuli may lead to valvular regurgitation [3, 9]. AF leads to bi-atrial dilatation with resultant dilatation of the mitral and tricuspid annuli located at the inferior edge of the atrium [2]. It has been shown that lone AF is associated with both mitral and tricuspid annular dilatation, but the dilatation and valvular regurgitation are significantly greater in the tricuspid valve, as the fibrous skeleton is less well developed [2]. AF is a known cause of MR and vice versa, although different mechanisms are involved. Functional MR, in particular,
can be triggered by the annular dilatation and impairment of LV function often observed in patients with long-standing AF. Early diagnosis of new-onset functional MR in association with AF is important because treatment may offer potential return to sinus rhythm and alleviation of symptoms [10]. This helps to negate life-long anti-coagulation and complications of thrombo-embolism in a selective cohort of patients. However, if surgery is undertaken, this should be associated with minimal risk and appropriate patient selection is a pre-requisite for satisfactory outcome. Maze was not employed in long-standing AF (>7 years) and in those patients where it could have prolonged the CPB and the cross-clamp time in some very high-risk patients. Here, the increased LA wall tension [11] and the advanced LA fibrosis [12] may be associated with unsuccessful surgical ablation while increasing the risk to the patients. Hence, either no ablation was used or PVI was employed with the hope that it may revert the patient to sinus rhythm, despite the fact that it has lesser efficacy than the maze. Currently, we continue to follow the above algorithm.

This study has demonstrated that surgical intervention in patients with functional MR secondary to lone AF is both safe and effective in the medium-term. Safety of concomitant AF surgery and MV repair has been demonstrated with minimal operative mortality and good medium-term survival [10, 13]. Echocardiographic outcomes such as LV function, LVEDD, LVESD and LA diameter improved dramatically in patients in this series, often within days of surgery. In the majority of patients, there was significant improvement in symptoms, AF was abolished and there were no thrombo-embolic events observed during the follow-up period. However, early optimal medical management and referral for percutaneous ablation are recommended before severe symptoms, irreversible myocardial damage and advanced heart failure ensues. In a recent paper [14], patients who achieved continuous sinus rhythm after percutaneous ablation had greater reductions in LA size and annular dimension and lower rates of significant MR compared with those in whom sinus rhythm was not restored. In patients with preserved LV function unresponsive or unsuitable for ablation therapy, surgery may prevent deterioration of LV function.

The present study is retrospective and is limited by the possibility of recall bias. Furthermore, the number of patients included in the series is small but nevertheless, it is important to realize that this is the largest study reported which includes patients undergoing surgery for severe functional MR secondary to annular dilatation and LV dysfunction due to lone AF. This is a rare disease condition and is poorly described, with most large series pooling results for both organic and functional causes of MR. In summary, the study has demonstrated satisfactory mid-term clinical and echocardiographic outcomes for patients treated for severe.

MR secondary to AF-induced mitral annular dilatation and LV dysfunction. Continued follow-up in a larger group of patients is, however, required to determine the long-term advantage of this approach.

Conflict of interest: Steve A. Livesey is a Consultant for Edwards Lifesciences Inc.

REFERENCES


