The dome of the left atrium: an alternative approach for mitral valve repair

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Abstract

Objective: Surgical repair of mitral insufficiency is most commonly performed through a left atriotomy via the inter-atrial groove or trans-atrial (septal) approach. While the dome of the left atrium approach has been described for mitral replacement concerns have been raised about its adequacy for complex repairs. We report our experience with mitral valve repair carried out through the dome of the left atrium, in comparison with more standard approaches. Methods: One hundred and thirty-one consecutive patients undergoing mitral valve repair for regurgitation were reviewed retrospectively between 1995 and 2001. Three groups were created based on their surgical approach: inter-atrial groove group (n = 43), trans-atrial group (n = 18), and dome of the left atrium group (between the superior vena cava and the ascending aorta; n = 70). Results: The three groups were similar in terms of pre-operative variables except for significantly older patients in the inter-atrial groove group (P < 0.001). The etiology of MR was 24% ischemic (P = ns between groups) and 52% of patients had a concomitant procedure, most commonly coronary artery bypass grafting (P = ns). Valve repairs were achieved using Carpentier techniques including: ring annuloplasty (n = 130), isolated posterior leaflet resection (n = 69), isolated anterior leaflet (n = 11), or bi-leaflet repair (n = 19). The overall mortality was 4% with a median length of hospitalization of 7 days and these did not differ significantly between groups. However, longer CPB times (P < 0.01) and requirement for prolonged mechanical ventilation (P = 0.002) were more frequent in the inter-atrial groove group. Conclusion: We report a simple, alternative approach for mitral valve repair via the dome of the left atrium that provides similar outcome to other commonly used approaches.

Keywords: Mitral valve repair; Left atrial dome; Surgical approach; Outcomes

1. Introduction

Mitral valve repair is often preferred allowing preservation of chordal attachments with preservation of ventricular function and geometry when compared to mitral valve replacement with currently available prostheses [1,2]. Techniques of mitral valve repair popularized by Carpentier and others have been demonstrated to be feasible, durable and reproducible [2–4].

The surgical approach used to expose the mitral valve is largely dependent on surgeon preferences. The most commonly described approach is a left atriotomy via development of the inter-atrial groove (Sondergaard’s groove), either through a median sternotomy or right thoracotomy [5]. Limitations in visualization of the entire mitral valve and subvalvular apparatus are sometimes experienced with this approach in patients with a deep chest, small left atrium or extensive pericardial adhesions. This can often be remedied by further incision superiorly or incision into the right atrium and inter-atrial septum [6]. The trans-atrial (trans-septal) technique involves a right atrial incision that is carried through the inter-atrial septum and dome of the left atrium to widely expose the mitral valve [7]. This approach offers excellent mitral exposure, but has been associated with higher rates of post-operative atrial dysrhythmias, potentially impacting on patient morbidity and length of hospitalization [8].

A third, infrequently reported approach to the mitral valve is via the dome of the left atrium located between the ascending aorta and superior vena cava. This approach originally described by Meyer in 1965, is a recognized alternative when performing mitral valve replacement [9,10]. However, some have suggested that this technique may offer inadequate exposure and should not be used for repair procedures on the mitral valve and as such is infrequently utilized by many surgeons [5].

We report our experience with three different surgical approaches to the mitral valve at our institution for all...
consecutive mitral valve repair procedures performed over the last 6 years with particular emphasis on the dome of the left atrium as an alternative approach.

2. Methods

2.1. Patient population

All consecutive patients from 1995 to 2001 who underwent mitral valve repair were reviewed retrospectively \((n = 131)\). Groups were divided according to the surgical approach to the left atrium and included: inter-atrial groove \((n = 43)\), trans-atrial \((n = 18)\), and dome of the left atrium \((n = 70)\). A total of seven surgeons performed the procedures with certain approaches being favored by individual surgeons. Indications for surgery were based on a weekly peer review process, involving cardiologist, cardiac surgeons and cardiac radiologists with individual patients placed on a wait list according to urgency of procedure.

2.2. Surgical approach

All patients starting in 1997 had trans-esophageal echocardiography (TEE) routinely intra-operatively to assist in planning the repair and to confirm a good technical result. A full, median sternotomy was performed in the majority of patients and partial sternotomy from the sternal notch to the fourth intercostal space in nine patients. Cardiopulmonary bypass was instituted with cannulation of the ascending aorta or transverse arch and right atrial cannulation with a single two stage venous drain or a bi-caval cannulation technique depending on the surgical approach utilized. Body temperature during the procedure was allowed to drift to approximately 28–32°C. Cardioplegic arrest was obtained with intermittent antegrade and/or retrograde cold blood cardioplegia.

2.2.1. Inter-atrial groove

With the heart arrested the inter-atrial groove was developed and the left atrium entered with an incision parallel to the inter-atrial septum. Standard hand-held, or fixed (Carpentier) retractors were utilized to visualize the mitral valve.

2.2.2. Trans-atrial approach

With the heart arrested and complete inflow occlusion with the use of caval tapes, the right atrium was opened obliquely and the inter-atrial septum incised at the inferior rim of the fossa ovalis. This incision was carried superiorly to meet the right atriotomy and then carried out onto the dome of the left atrium providing wide exposure to the mitral valve.

2.2.3. Dome of the left atrium approach (Dome group)

With the heart arrested a 3–4 cm incision was made in the dome of the left atrium beginning at the junction of the left atrial roof with the superior vena cava and extended towards the left superior pulmonary vein. This directed the incision away from the aorta to avoid injury to the SA nodal artery [9,11]. Standard hand-held mitral valve retractors were then utilized to expose the mitral valve.

Concomitant procedures were performed as indicated. Post-operatively all patients were taken to a dedicated cardiac surgical intensive care unit typically for 24 h, then transferred to an intermediate care unit with continuous electrocardiogram (ECG) monitoring for an additional 24 h prior to transfer to regular ward. Patients were not routinely anti-coagulated with warfarin unless otherwise indicated (as for atrial fibrillation). A majority of patients received routine \(\beta\)-blockers for a minimum of 6 weeks post-operatively unless contra-indicated to limit post-operative atrial dysrhythmias.

2.3. Data collection and analysis

Perioperative patient variables were collected in the surgical database maintained by the Division of Cardiac Surgery. This has been a standard practice at this institution for all cardiac surgical cases since 1995 with regular data auditing. Statistical analysis was performed using the SAS software package (SAS, Cary, NC, USA). Continuous data, presented as mean ± standard deviation, were analyzed by analysis of variance (ANOVA) with post hoc means comparisons by the Tukey’s method. Post-operative length of stay, presented as median and inter-quartile range, was examined using the Kruskal–Wallis test. For categorical variables, the chi square test or Fisher’s exact test were applied, as appropriate. Statistical significance was defined as a \(P\) value of <0.05.

3. Results

One hundred and thirty-one consecutive patients underwent mitral valve repair for severe MR between 1995 and 2001. The patients were predominantly male, of New York Heart association class functional class (NYHA) III or IV and one-third of patients had urgent procedures defined as patients requiring surgery within 24 h or admitted to hospital on maximal medical therapy prior to surgery (Table 1). All three groups were similar in terms of pre-operative variables except for the average age of patients. Younger patients were found to undergo a trans-atrial or dome of the left atrium approach as opposed to the inter-atrial groove \((P < 0.001)\). An upper hemi-sternotomy was used in nine patients and all of these were approached via the dome of the left atrium. Adequate visualization to complete a reparative procedure was achieved in all cases and did not require conversion to another surgical approach (Fig. 1).

The overall etiology for MR was predominantly myxomatous (67%) and ischemic (24%) (Fig. 2). Ischemic MR was distributed evenly amongst the groups ranging from 22 to 26%. A ring annuloplasty was performed in most patients...
and performed as a solitary procedure in 31 patients (24%) with annular dilatation and/or leaflet restriction (Carpentier type I and III). All remaining patients had evidence of myxomatous degenerative disease. The reparative procedures consisted of isolated posterior leaflet resection \( (n = 69) \), isolated anterior leaflet repair \( (n = 11) \) or bi-leaflet repair \( (n = 19) \) utilizing a combination of chordal transfer \( (n = 13) \), Gore–Tex cords \( (n = 9) \), chordal shortening \( (n = 4) \) and/or papillary muscle shortening \( (n = 3) \). Routine TEE was performed in all patients starting in 1997 and used sporadically from 1995 to 1997. As such, the use of TEE confirmed adequate repair in 120 patients or 92% of patients. Of the TEE patients, nil MR was found in 89 patients, trivial to mild residual MR \( (1 +) \) in 22 patients and mild to moderate \( (+2) \) in 11 patients with no significant trends between groups.

Patient outcomes are illustrated in Table 2. The overall mortality rate was 4% and not significantly different between groups. However, significantly longer pump time \( (P = 0.005) \), longer clamp time \( (P = 0.002) \) and more frequent requirement for prolonged mechanical ventilation \( >24 \text{ h} \) \( (P = 0.002) \) were observed in patients approached via the inter-atrial groove. Four patients in the groove group required an intra- or post-operative intra-aortic balloon pump (IABP) for a low output state as compared to no patients in the other two groups. Concomitant procedures were performed in 44–61% of patients and consisted of coronary artery bypass grafting (CABG) in the majority of cases. The overall median length of hospitalization was 7 days and not different between groups.

There was marked variability in the pre-operative incidence of atrial dysrhythmias ranging from no patients in the trans-atrial group to 23% in the dome of the left atrium group (Fig. 2). New onset of atrial fibrillation seen post-operatively was not significantly different between groups.

![Fig. 1](image1.png)  
**Fig. 1.** Intra-operative photograph illustrating excellent visualization of the entire MV annulus available to the surgeon via a hemi-sternotomy and dome of left atrium approach. The black and white diagram illustrates the approach to the dome of the left atrium located between the ascending aorta and the superior vena cava. A, aorta; AL, anterior leaflet of mitral valve; RA, right atrium; SVC, superior vena cava.

![Fig. 2](image2.png)  
**Fig. 2.** Bar graph illustrating the incidence of pre-operative and new post-operative atrial fibrillation in each of the three surgical groups. Results are expressed in percent of patients in each group.
Two patients (5%) in the groove group as compared to three (4%) in the dome group and none in the trans-atrial group required permanent pacemakers for sinus node dysfunction or heart block.

Two patients required re-operation for worsening symptoms and increasing MR, 56 and 78 months after his initial procedure. The mean follow up was 26 ± 20 months.

4. Comments

We report a series of 131 consecutive patients undergoing MV repair performed via three distinct surgical approaches. In all cases adequate visualization was achieved and resulted in adequate repair. Despite apparent similarities between the three groups of patients pre-operatively these differed significantly in terms of age, concomitant procedures, and CPB times making it difficult to draw meaningful conclusions. Patients approached via the inter-atrial groove were generally older, and had a trend to more concomitant procedures (60%). These differences may account for the prolonged cardiopulmonary bypass times, increased incidence of prolonged mechanical ventilation and utilization of IABP. Age alone has been shown to be an independent predictor of prolonged mechanical ventilation after cardiac surgery [12]. The inter-group differences in this non-randomized, retrospective study and, lack of standard criteria used to assign which approach was used by individual surgeon may limit comparison between groups.

A unique feature of this analysis is the large proportion of patients (n = 70) who underwent a mitral valve repair, including complex bi-leaflet repairs, performed via the dome of the left atrium. This technique, first introduced by Meyer et al. in 1965 [9,10], has not been previously reported for mitral valve repair. In fact, Larbalestier et al. [5] had previously suggested that the dome of the left atrium would not allow exposure necessary for repair. We have, however, demonstrated the feasibility of this approach for achieving excellent exposure with good short-term and medium-term results in a wide variety of patients requiring mitral valve repair procedure.

There are several potential advantages of using the dome of the left atrium as compared to the commonly utilized inter-atrial groove technique. Firstly, this approach is simple, rapid, and negates the need for extensive dissection of the heart. This is particularly important with redo-operations which are becoming more common (9/70 in the dome group). Secondly, this approach is anatomically appropriate for de-airing and allows easy visualization of the suture line at the end of the case [13]. Thirdly, the more direct visualization of the mitral valve allows for excellent visualization for both the assistant and operator, an important teaching consideration for cardiothoracic trainees. Finally, we have demonstrated a novel approach that is safe via hemi-sternotomy or a limited access procedure that may limit the morbidity associated with full median sternotomy [14,15].

Atrial fibrillation is a common finding in patients with long standing mitral valve disease and was found in up to 23% of our patients pre-operatively [16,17]. These patients are also at significant risk of post-operative atrial fibrillation which can range from 10 to 65% depending on risk factors such as age and mitral valve disease [17]. No systematic efforts were made to limit atrial dysrhythmias other than the use of β-adrenergic receptor blockade in the post-operative period. Additional anti-aryrhythmics drugs such as amiodarone or concomitant maze procedures were not utilized [16–18]. None of the surgical approaches were associated with an increased incidence of new atrial dysrythmia.

While exposure of the mitral valve apparatus is certainly adequate, there are limitations unique to the dome of the left atrium. Occasionally, the left atrial tissue may prove to be quite thin and fragile, particularly in proximity of the aortic root; we emphasize the importance of keeping the incision away from the aortic root. Similarly, avoidance of carrying the incision into the left atrial appendage is important in these circumstances. Our practice is to extend the atriotomy towards the left superior pulmonary vein (as described in Section 2).

The present study was limited by its retrospective nature, variability in patient characteristics between groups, and variability in surgeon distribution between groups owing to preference for one technique over another. We have shown that the dome of the left atrium is a safe approach for mitral valve repair. We suggest that this approach is a useful alternative, particularly for re-operative cases, where the inter-atrial groove approach has been previously utilized [13].

References


