

Superior Left Atrial Approach to the Mitral Valve: Incidence of Postoperative Arrhythmia

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Background and aim of the study: The superior left atrial approach to mitral surgery involves exposure of the mitral valve through a longitudinal, craniocaudally orientated incision in the roof of the left atrium. The study aim was to evaluate the incidence of postoperative arrhythmias following this procedure.

Methods: Fifty-nine patients underwent either mitral valve repair (n = 20), mitral valve replacement (n = 26) or an associated procedure (n = 13), including aortic valve replacement, coronary artery bypass grafting and atrial septal defect closure. Eight patients had undergone previous surgery on the mitral valve. Patients were classified according to their preoperative rhythm: sinus rhythm (SR), paroxysmal or chronic atrial fibrillation (AF), or permanent pacing. Changes in cardiac rhythm were evaluated postoperatively, after four weeks, and at late follow up (mean 23.8 months).

Results: Preoperatively, 24 patients had shown SR, 10

had paroxysmal AF, 24 had chronic AF, and one patient had permanent pacing. At the time of discharge, SR was recorded in 18 patients who had SR preoperatively, in seven who had paroxysmal AF preoperatively, and in one patient who had chronic AF preoperatively. At follow up, SR was seen in 19 patients with preoperative SR, in seven with paroxysmal AF preoperatively, and in two with chronic AF preoperatively. Four patients received permanent pacemakers postoperatively due to total heart block or bradycardia.

Conclusion: The superior left atrial approach to mitral valve surgery appears to be safe as it maintains the sinus rhythm in a high proportion of patients postoperatively. In addition, it is not normally prone to technical complications.

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Although a variety of surgical approaches has been developed to provide good exposure of the mitral valve (1-5), adequate exposure of the valve and its subvalvular apparatus is sometimes difficult. The traditional longitudinal left atrial incision via the interatrial groove may not provide optimal visualization, especially in patients with a deep chest or small left atrium, when it can be particularly difficult to visualize the subaortic area of the valvular annulus (6). Whilst the superior-septal approach is useful for mitral valve surgery because it provides excellent exposure, the higher rate of postoperative atrial dysrhythmias outweighs the visual advantages, and this represents a reason for caution (7-9). In 1965, Meyer et al. (10) first suggested a superior transverse approach through the dome of

the left atrium between the superior vena cava and the ascending aorta. Renewed interest in a modification of this technique has been created by Zacharias (11), Hirt et al. (12) and Molina (13), though some have objected that this technique may offer inadequate exposure and should not be used for repair procedures on the mitral valve; as such, it is used infrequently (14).

Herein, a modification of Meyer's method - the superior left atrial approach - is described for mitral valve surgery either alone or in combination with associated procedures. Modifications of the technique relate to only minor technical details, the main purpose of the study being to evaluate postoperative arrhythmias.

Clinical material and methods

Patient population

The patient characteristics are listed in Table I. A total of 59 patients underwent mitral valve surgery either alone or in combination with a concomitant cardiac intervention via a superior left atrial incision. One sur-

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geon (B.R.) in the authors' department primarily used the superior left atrial approach exclusively and consecutively from September 1999 to June 2003 for all such cases. Patients were assigned this surgeon according to routine scheduling procedure, without any particular selection of the study group.

Among the patient cohort, 20 underwent mitral valve repair, 26 had mitral valve replacement, and 13 had associated procedures which included aortic valve replacement (n = 5), coronary artery bypass grafting (CABG) (n = 6) and atrial septal defect (ASD) closure (n = 2).

Of these patients, 13 had a history of rheumatic mitral valve disease (MVD), 35 with degenerative, five with ischemic, three with infectious and three with congenital MVD. Eight patients in the degenerative MVD group underwent reoperation on the native valve after either closed commissurotomy (n = 4) or open commissurotomy (n = 4).

A diagnosis of active native valve endocarditis was established in three patients. In two of these, blood and valve cultures showed *Staphylococcus aureus* infection; one patient presented with culture-negative endocarditis. Preoperative transesophageal echocardiography (TEE) showed large vegetations (>25 mm) on the mitral valve and severe congestive heart failure in all three of the patients with endocarditis; embolic neurological problems were seen in one patient.

Table I: Patient characteristics (n = 59).

Parameter patients	No.
Age (years)*	66.7 ± 12.3
Gender ratio (M:F)	21:38
LVEF	
<40%	12
>40%	47
Left atrial dimension	
<5 cm	7
>5 cm	52
Single MVL	
Stenosis	13 ⁺
Regurgitation	24
Mixed	7
MVL + AVL	5
MVL + CAD	8
MVL + ASD	2
Preoperative NYHA class	
I-II	4
III-IV	55

*Mean ± SD.

⁺Eight of these patients had previous mitral valve surgery. ASD: Atrial septal defect; AVL: Aortic valve lesion; CAD: Coronary artery disease; LVEF: Left ventricular ejection fraction; MVL: Mitral valve lesion

One female patient had a high-grade mixed mitral valve lesion in combination with severe constrictive calcified pericarditis. The calcification enveloped most of the surface of the heart, and the posterior wall in particular showed calcification of the pericardium up to 4 mm thickness. This woman had significant shortness of breath on minimal exertion, hepatomegaly, and cachexia.

Indications for surgery were based on a weekly peer-review process, involving a cardiologist, a cardiac surgeon and the individual patients, all of whom were placed on a waiting list according to the urgency of the procedure.

Operative technique

Intraoperative TEE was performed routinely on all patients. The heart was exposed via a median sternotomy, and cardiopulmonary bypass (CPB) instituted after cannulation of the ascending aorta and the right atrium with a single right-angled, short-tip venous cannula. Moderate hypothermic CPB was utilized, and myocardial protection was accomplished with intermittent antegrade cold blood cardioplegia and topical cooling.

With the heart arrested, the aortic root was retracted medially, exposing the dome of the left atrium. The superior vena cava, the right atrium and the right pulmonary artery were identified, and the atriotomy was begun just to the left of the superior vena cava in the center of the dome of the left atrium (Fig. 1). The incision was extended caudally towards the right atrium and cranially to the right pulmonary artery. The distance between the incision and the aortic root should normally be more than 1 cm because of the friability of the atrial tissue of the atrial appendage near the aortic root. The incision should be approximately 4-5 cm in length, and care must be taken not to open the right atrium. Two right-angled retractors - one to pull the aortic root to the left side and the other to expose the mitral valve - were utilized (Fig. 2). In four cases, the view of the mitral valve was optimized by enlarging the incision towards the right pulmonary artery and to the posterior aspect of the left atrium. Concomitant procedures were performed as indicated. After completion of the mitral valve reconstruction or replacement, the atrium was closed with two continuous running 5-0 Prolene sutures, starting at the cranial corner. Careful de-airing of the heart was performed in a normal manner under TEE control from the uppermost portion of the incision before tying the sutures. Pacemaker wires (atrial and/or ventricular) were fixed in all patients.

Cardiac rhythm and follow up

Holter electrocardiograms (ECG) and echocardi-



Figure 1: Opening the dome of the left atrium with a vertical incision between the aorta and the superior vena cava: AO: Aorta; LA: Left atrium; RA: Right atrium; VCS: Superior vena cava.

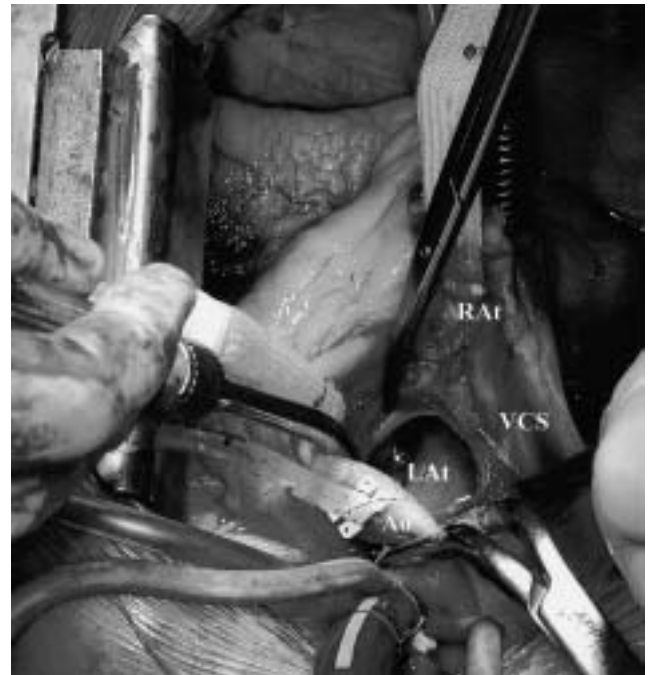


Figure 2: Exposure of the mitral valve (MV) (Barlow's syndrome). RA: Right atrium; Ao: Aorta; S: Suction inside the left atrium.

grams were obtained within three months before the operation, and repeated postoperatively upon discharge, at four weeks postoperatively, and at late follow up in all patients. Preoperatively, 24 patients showed sinus rhythm, 10 had paroxysmal AF, 24 chronic AF, and one patient had preoperative permanent pacing (Figure 3).

The early postoperative cardiac rhythm in the intensive- and intermediate-care units was monitored continuously with five-lead electrocardiography for four days. Early postoperative arrhythmia was defined as continuous arrhythmias lasting for at least 2 h. Additionally, a standard 12-lead surface ECG (MC-1700A cardiograph; Hewlett Packard, McMinnville, USA) was recorded daily.

Follow up was completed in all 57 survivors.

Data analysis

Continuous variables were expressed as mean \pm SD. Perioperative and postoperative changes in cardiac rhythm are referred to descriptively in the text.

Results

Valve exposure

Among the 59 patients in whom the superior left atrial approach was used, quality of exposure of the valve was recorded by the surgeon. Exposure was considered poor in one patient, moderately good in three

patients, adequate in 10, and excellent in 45. In all four patients with poor or moderately good exposure, there was a combination of small atrium and marked right ventricular hypertrophy. None of the patients required a conversion to conventional atriotomy.

The intraoperative data are listed in Table II. Four patients required postoperative implantation of a permanent pacemaker; the indications included persistent second- and third-degree heart block (>5 days), intermittent heart block, symptomatic bradycardia, or heart rates less than 40 beats per minute (persisting for >5 days postoperatively) (15). Those patients with no R-waves when briefly paced VVI at 40 beats per min were considered pacemaker-dependent. There were no intraoperative complications related to the superior left atrial approach, such as bleeding from the atrial incision. Two patients required re-exploration for

Table II: Intraoperative data.

Parameter	Value
Cross-clamp time (min)*	55.7 \pm 16.4 (20-114)
CPB time (min)*	3.0 \pm 23.2 (33-162)
Skin-to-skin time (min)*	164.2 \pm 41.8 (92-310)

*Values are mean \pm SD (range).

ASD: Atrial septal defect; CABG: Coronary artery bypass grafting; CPB: Cardiopulmonary bypass; MVR: Mitral valve replacement; MVR: Mitral valve repair.

bleeding from the sternal wall, and one patient for bleeding from an intercostal vessel. There were two in-hospital deaths (mortality 3%). One patient died on the first postoperative day from uncontrollable bleeding related to right ventricular posterior wall rupture. This 76-year-old woman had undergone surgery for mixed mitral valve lesion in combination with severe constrictive calcified pericarditis, as mentioned above. The second patient died on the eighth postoperative day from septicemia and multi-organ failure after mitral valve replacement. On admission, this 74-year-old female patient showed active native mitral valve endocarditis with high-grade mitral valve regurgitation, multiple preoperative cerebral infarctions and left hemiparesis. At discharge after mitral valve repair, all surviving patients had normal mitral valve function with no - or only trivial - regurgitation. All implanted valves functioned normally, and echocardiography before discharge did not identify any interatrial shunts.

Follow up was completed for all 57 survivors. The mean follow up was 23.8 months (range: 3 to 49 months). There was no late death, and no periprosthetic leakage or prosthetic malfunction.

Patients with preoperative sinus rhythm (n = 24)

The course of the cardiac rhythm is shown in Figure 3. On the first postoperative day, sinus rhythm persisted in 16 patients (66%), while six patients (25%) developed AF and two (8%) experienced early total atrioventricular block (AVB III). AVB III was managed with temporary atrial and ventricular pacing. Due to persistent AVB III, the two patients underwent permanent pacemaker implantation (DDDR-Mode) on the fifth and eighth postoperative days, respectively. The first patient, a 71-year-old woman, had undergone aortic valve replacement with mitral valve reconstruction. The second patient, a 63-year-old woman, had reoperation (after closed commissurotomy) with mitral valve repair.

At four weeks postoperatively, 20 patients (83%) maintained sinus rhythm, and two patients (8%) showed chronic AF. After 24 months, sinus rhythm was recorded in 19 patients (79%) and chronic AF in three patients (13%), while two patients (8%) required permanent pacing (see above).

Patients with preoperative paroxysmal AF (n = 10)

Postoperatively, sinus rhythm persisted in six patients (60%), while three patients (30%) developed AF and one patient required temporary pacing (DDD-Mode) because of an AVB III. At discharge, seven patients (70%) had sinus rhythm and three (30%) had AF. At four weeks postoperatively, there again were seven patients (70%) with sinus rhythm, two (20%)

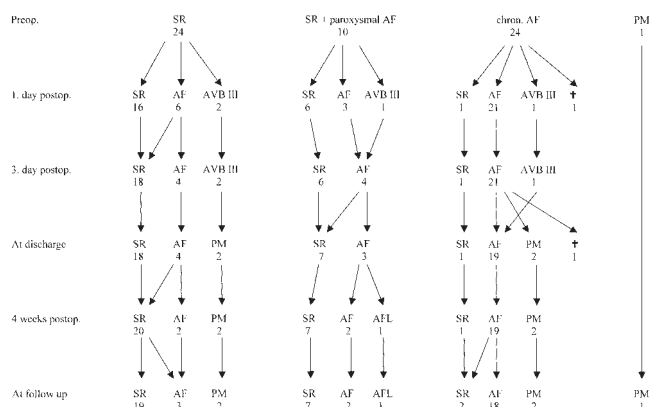


Figure 3: Changes in cardiac rhythms. SR: Sinus rhythm; AF: Atrial fibrillation; AFL: Atrial flutter; AVBIII: Total atrioventricular block; PM: Pacemaker.

with chronic AF, and one patient with atrial flutter. The situation was the same after 24 months.

Patients with preoperative chronic AF (n = 24)

Atrial fibrillation continued in 21 patients (88%) on the first postoperative day; one patient showed sinus rhythm, one had an AVB III, and one died on the first postoperative day, as mentioned above. Upon discharge, 19 patients (79%) were in AF, as well as the patient with postoperative AVB III; one patient was in sinus rhythm, one died on the eighth postoperative day (for details, see above), and two patients (8%) showed a pacemaker-ECG after implantation of a permanent pacemaker (VVI-Mode) on the sixth postoperative day. Both of these patients underwent surgery for degenerative mitral valve stenosis, and mitral valve replacement was performed. Permanent pacemaker implantation was indicated due to bradycardic AF with vertigo and cardiac breaks lasting for about 3.5 s. After 24 months, chronic AF was seen in 18 patients (75%), while two patients showed sinus rhythm, and two required a permanent pacemaker.

One patient required preoperative and postoperative permanent pacing for bradycardic AF.

Discussion

The surgical approach to the mitral valve is sometimes difficult because of its posterior anatomic position. Most surgeons approach the mitral valve via the inter-atrial groove by retracting the right side of the heart to the left and making the atriotomy lateral to the interatrial sulcus. Particularly in patients in whom the left atrium is not enlarged and is associated with ventricular hypertrophy, valve exposure with visualization of the subaortic area of the valve annulus can be problematic with this approach. Several alternative

surgical approaches have been described over the years to overcome this problem. In 1965, Meyer et al. first suggested a superior approach through the roof of the left atrium between the superior vena cava and the ascending aorta within the transverse sinus (10). Surgeons who have attempted to use this approach have often abandoned it because of technical complications during surgery - for example, tears in the left atrium at the base of the left atrial appendage or in the root of the aorta, with fatal outcome for the patient (13). Combined incisions in the interatrial groove and the dome of the left atrium with or without division of the superior vena cava have been described (16-18). However, extended atrial and transatrial septal incisions are often associated with a high incidence of postoperative arrhythmias, and the need to reconstruct the wall of both the atrium and the interatrial septum has prompted some concern that this leads to excessive postoperative bleeding (9,19,20). In contrast, Alfieri et al. found no rhythm disturbances or postoperative complications in patients who underwent mitral valve operations using the superior septal approach (2). Similarly, Gaudino et al. showed no significantly higher incidence of postoperative rhythm disturbances when the superior septal approach was used, as compared with the incidence associated with the traditional left atrial approach (6). However, especially in reoperations, in combined mitral valve operations or in high-risk patients, a quick, simple and practicable method is desirable.

Based on the present authors' experience, the superior left atrial approach to mitral valve surgery and combined interventions appears to be very suitable in these patients, as well as for those with a deep chest, a small left atrium or with associated high-grade ventricular hypertrophy. Eight patients underwent mitral valve reoperations after previous open or closed mitral valve commissurotomy. In these patients, the superior left atrial approach seemed especially suitable as damage to various cardiac structures due to extensive dissection and excessive traction was avoided.

In four of the present patients, only poor to moderately good exposure of the mitral valve was achieved, but all of these patients had a small left atrium as well as an extremely hypertrophic right ventricular wall.

Using the technique described, the left atriotomy is made in the most superior aspect of the atrium, which is why extensive atrial dissection in reoperations and rotation of the heart toward the left side are unnecessary; air reaches the highest point and is evacuated very efficiently with this approach. In contrast to the conventional superior approach described extensively by Molina (13), the present authors use a craniocaudally orientated incision through the roof of the left atrium. The advantage of this technique is that the thin

and friable atrial tissue at the root of the aorta and the base of the left atrial appendage is avoided. The distance from the incision to the aorta is about 1 cm, though clearly excessive retraction of the aorta must be avoided. This leads to one contraindication for the approach, namely high-grade sclerosis of the ascending aorta, wherein a conventional longitudinal left atriotomy was used for mitral valve surgery. Another limitation of the present approach was the need for associated tricuspid annuloplasty. In such a case, an alternative approach such as biatrial or combined left and right atrial incisions would be appropriate. Tricuspid repair was not indicated in any of the present patients.

This retrospective analysis of a series of consecutive patients who underwent surgery for mitral valve disease either alone or in combination with CABG, aortic valve replacement or ASD closure, showed that after a mean follow up of 23.8 months, sinus rhythm was preserved in the majority of patients (79%) with preoperative sinus rhythm. Chronic AF persisted in 75% of those patients with preoperative chronic AF. Postoperative arrhythmia problems involve two different complications: (i) atrial fibrillation, which reduces survival due to heart failure and thromboembolism and impairs quality of life (21); and (ii) the need for pacemaker implantation after heart block or bradycardic AF.

In the present study, after 24 months, the same number of patients had chronic atrial fibrillation or flutter as before surgery ($n = 24$) (Fig. 3). The reported incidence of postoperative dysrhythmias with different atrial approaches has been found to vary. For example, Utley et al. (7) found that in mitral valve operations, only 46% of patients who showed sinus rhythm preoperatively and underwent surgery with the superior-septal approach remained in sinus rhythm, compared with 80% of patients who underwent the conventional right lateral approach and 69% with the transeptal approach. Gaudino et al. (6) reported that, at late follow-up, sinus rhythm was maintained in 78% of patients with mitral valve replacement following the superior septal approach compared with 56% after a conventional approach. Jessurun et al. (21) investigated rhythm disturbances after mitral valve replacement and mitral valve plasty alone or with tricuspid valve plasty via the conventional approach, and recorded permanent sinus rhythm in 70% of patients with preoperative sinus rhythm, but in only 4% of patients with preoperative chronic AF. These data were comparable to those obtained in the present study where, especially when the heterogeneous group of operations performed is taken into consideration, preoperative sinus rhythm was maintained in a very high proportion of the patients postoperatively. Although the sinus node

artery normally transverses the roof of the left atrium in 40% of the cases, and is most likely divided by the vertical superior approach - whether or not this is noted by the surgeon - the present approach had a similar effect on the maintenance of stable sinus rhythm, as did the other approaches for mitral valve surgery (22,23). Among reported studies, the prevalence of permanent cardiac pacing after valvular surgery ranges from 3 to 6% (15,24), and after repeat cardiac surgery may reach 10% (25). In a multivariable analysis, Lewis et al. (25) showed that the need for permanent pacemaker implantation was more common among those patients with combined aortic and mitral valve replacement, preoperative endocarditis, reoperations and advanced age; this situation also applied very much to the present patients, 7% of whom required postoperative permanent pacemaker implantation. Two of the present pacemaker patients also required associated procedures such as aortic valve replacement and ASD closure.

Although the musculature of the roof of the left atrium is sometimes thin, laceration of the atrial wall and massive bleeding never occurred among the present patients. This was probably because the extension of the incision into the left atrial roof ran towards the posterior aspect of the left atrium, so that the sensitive tissue of the left appendage and near the aortic wall remained untouched.

In conclusion, the superior left atrial approach offered an excellent view of the mitral valve in most patients. The incidence of postoperative cardiac arrhythmia was comparable to that described for the conventional right lateral approach, and no technical complications were observed either intraoperatively or postoperatively. Hence, the superior left atrial approach can be viewed as an effective technique for mitral valve surgery either alone or in combination with associated procedures. Moreover, it may also be indicated for reoperations where extensive dissection of the heart is to be avoided, or in patients with small left atrium or deep thorax in whom unsatisfactory exposure with conventional approaches may be assumed.

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