Interactive CardioVascular and Thoracic Surgery 22 (2016) 287–291
doi:10.1093/icvts/ivv323 Advance Access publication 29 November 2015



Cite this article as: Minol J-P, Akhyari P, Boeken U, Kamiya H, Weinreich T, Sixt S *et al*. Single-centre experience of mitral valve surgery via right lateral mini-thoracotomy in octogenarians. Interact CardioVasc Thorac Surg 2016;22:287–91.

# Single-centre experience of mitral valve surgery via right lateral mini-thoracotomy in octogenarians

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Received 30 August 2015; received in revised form 11 October 2015; accepted 19 October 2015



## Abstract

**OBJECTIVES**: According to demographic changes in the industrialized world, the average age of patients referred to cardiac surgery is increasing. These patients typically display numerous comorbidities, associated with increased perioperative risk. Therefore, the indication for a catheter-based therapy is progressively extended, including interventions on the mitral valve (MV). In this context, we evaluated a contemporary series of octogenarians undergoing minimally invasive MV surgery at our institution using right lateral minithoracotomy to elucidate the preoperative risk profile and the postoperative course in this particular cohort.

**METHODS**: Between October 2009 and October 2014, 34 patients aged 80 years and older (82.5 ± 2.0) undergoing minimally invasive MV surgery were identified with a subgroup of 15 patients (44.1%) receiving concomitant surgery on the tricuspid valve (TV). We analysed the preoperative profile, perioperative course and functional outcome.

**RESULTS**: Preoperative comorbidities included insulin-dependent diabetes mellitus (17.6%), COPD (17.6%), active endocarditis (2.9%) and previous neurological events (2.9%). The mean left ventricular ejection fraction was 59.7 ± 6.9%. Mean European System for Cardiac Outcome Risk Evaluation II was 5.2 ± 5.3%. The repair rate of all treated MVs and TVs in isolated and combined procedures was 81.6% (73.5% for MV and 100.0% for TV surgery). Postoperatively, 4 patients (11.8%) required new-onset intermittent haemodialysis. Prolonged ventilation (>12 h) was necessary in 9 patients (26.5%). The 30-day mortality rate was 5.9%.

**CONCLUSIONS**: Minimally invasive right lateral MV surgery in octogenarians results in favourable outcomes. Therefore, MV surgery represents a valid option in this cohort, providing established and durable concepts of valve reconstruction.

**Keywords:** Minimally invasive surgery • Mitral valve • Octogenarians

## INTRODUCTION

From 2004 to 2013, the proportion of octogenarians among all patients admitted to cardiac surgery in Germany increased from 7.4 to 13.8% [1]. Recent studies have demonstrated significant comorbidities and an elevated risk profile in this special cohort, which has been associated with a complicated postoperative course and a negative impact on the overall outcome [2, 3]. Moreover, an age of more than 80 years has been identified as a strong independent risk factor for long-term survival in cardiac surgical patients [3]. In this context, percutaneous mitral valve (MV) clipping has been established as an alternative to surgery [4, 5]. Moreover, catheter-guided valve procedures were described as a valid option not only to address aortic valve pathology, but also to provide MV therapy [6–8].

In this context, the consideration of minimally invasive surgery on MVs in octogenarians has achieved topicality. This approach has repeatedly proved to be feasible and to achieve results comparable with those achieved by full sternotomy [9–13]. However, real-world practice includes a steadily increasing utilization of percutaneous MV procedures, while the role and benefit of MV surgery in octogenarians is questioned, irrespective of the technical aspects of the actual surgical practice. Moreover, only a few reports have focused on contemporary results of modern, minimally invasive MV surgery in elderly patients [14], while the majority of the previous literature on MV surgery involves a mixture of minimally invasive and full-sternotomy procedures [15–18], which may not adequately display contemporary outcomes of minimally invasive MV surgery. A meta-analysis of these data recently concluded with an enlarged indication for transcatheter mitral valve repair (TMVR) and transcatheter mitral valve implantation (TMVI) [8].

To specify this discussion, we contribute here our experience in minimally invasive MV surgery in octogenarians.

## MATERIALS AND METHODS

Between September 2009 and April 2014, of all patients who underwent minimally invasive MV surgery at our department, a group of 34 patients of age 80 years or more was identified (10 males, 24 females; age 82.5 ± 2.0 years). Nineteen patients received isolated MV surgery, whereas 15 patients underwent a combined procedure on both the MV and the tricuspid valve (TV).

All patients had a minimally invasive surgical approach via right lateral thoracotomy as described in detail before [10, 11, 18]. Patients were positioned in a supine position with the right side of the chest slightly elevated. All patients were cannulated via right femoral vessels for establishment of extracorporeal circulation.

Preoperative characteristics are displayed in Table 1. Mean preoperative logistic European System for Cardiac Outcome Risk Evaluation (EuroSCORE) was 5.2 ± 5.3%. Mean New York Heart Association (NYHA) functional class was 2.6 ± 0.8%, with 58.8% having NYHA class III or IV. The preoperative mean left ventricular ejection fraction was 59.7 ± 6.9%. Pulmonary hypertension was diagnosed in 20 patients (58.8%).

Two patients (5.9%) presented a history of previous cardiac operations, including an aortic valve replacement in one case and a combined MV replacement and CABG surgery in the second case. Three patients received TMVR before and suffered now from a combination of MV regurgitation and stenosis. One of these also displayed an active endocarditis.

Eighteen patients (52.9%) showed a dilatation of the MV annulus; 13 patients (38.2%) exhibited a rupture of at least one chorda. Any kind of MV prolapse without association with a ruptured chorda was seen in 13 patients (38.2%). Extended valve-related calcification could be noted in 9 patients (26.5%), including the 1 patient with a previous implantation of a biological MV prosthesis.

This study was approved by the local ethics committee (approval no.: 3650). The authors had full access to the data and take full responsibility for their integrity.

### Statistical analysis

Categorical variables were expressed as proportions. Continuous variables are given as mean ± standard deviation. For statistical analyses, we employed the Mann–Whitney *U*-test for the duration of surgery, the duration of cardiopulmonary bypass, the duration of intensive care unit (ICU) stay and the duration of hospitalization. For the duration of cross-clamping, we used the unpaired *t*-test. Fisher's exact test was employed for the number of postoperative events, the incidence of new-onset renal insufficiency and prolonged ventilation, the number of revisions for bleeding and the 30-day mortality (InStat3, GraphPad Software, La Jolla, CA, USA). Differences were considered significant at $P < 0.05$.

## RESULTS

In this cohort, 25 patients received an MV repair (73.5%), while 9 patients (26.5%) received a bioprosthetic MV replacement (diameter: 25–33 mm; mean size 28.3 ± 2.5 mm). Indication for MV replacement was failed TMVR ($n = 2$), degenerated MV bioprosthesis ($n = 1$), active endocarditis after previous TMVR ($n = 1$), enlarged calcification ($n = 3$) or other reasons ($n = 2$). Techniques for MV repair included implantation of annuloplasty device ($n = 22$), partial resection of the posterior mitral leaflet (P2) ($n = 10$), implantation of neochordae ($n = 9$) and cleft closure ($n = 8$). All TV procedures followed repair strategies with implantation of an annuloplasty device in all except 1 patient, who received a De Vega annuloplasty. Operative details are displayed in Table 2. No major intraoperative complications were to be noted. No conversion to sternotomy was necessary. Details of the postoperative course are described in Table 3. Postoperative stay on the ICU was 3.1 ± 4.7 days. Overall

**Table 1:** Preoperative characteristics

| Preoperative characteristics | 34 (100%) |
|---|---|
| Female | 24 (64.9%) |
| Body mass index ≥30 kg/m$^2$ | 1 (2.9%) |
| NYHA | 2.6 ± 0.81 (I–IV) |
| I | 3 (8.8%) |
| II | 10 (29.4%) |
| III | 17 (50.0%) |
| IV | 3 (8.8%) |
| Age (years) | 82.5 ± 2.0 (80–87) |
| EuroSCORE (%) | 5.2 ± 5.3 (0.37–28.97) |
| Endocarditis | 1 (2.9%) |
| Atrial fibrillation | 21 (61.8%) |
| Hypertension | 32 (94.1%) |
| COPD | 6 (17.6%) |
| Pulmonary hypertension | 20 (58.8%) |
| IDDM | 6 (17.6%) |
| LVEF (%) | 59.7 ± 6.9 (45–70) |
| Mitral regurgitation >I° | 33 (97.1%) |
| Mitral stenosis >I° | 2 (5.9%) |
| Previous neurological events | 1 (2.9%) |
| Previous cardiac operation | 2 (5.9%) |

Preoperative patient characteristics are given as continuous variables with the relative percentage in brackets or as mean ± SD with the range of variables in brackets.
NYHA: New York Heart Association Index; EuroSCORE: European System for Cardiac Outcome Risk Evaluation; COPD: chronic obstructive pulmonary disease; IDDM: insulin-dependent diabetes mellitus; LVEF: left ventricular ejection fraction.

**Table 2:** Intraoperative course

| Intraoperative course | 34 (100%) |
|---|---|
| Duration of surgery (min) | 248 ± 84 (120–616) |
| Cross-clamp time (min) | 90 ± 23 (31–129) |
| Duration of CPB (min) | 164 ± 85 (95–423) |
| MV replacements | 9 (26.5%) |
| Size of MV prosthesis (mm) | 28.3 ± 2.5 (25–33) |
| MV repairs | 25 (73.5%) |
| Implanted MV annuloplasty devices | 22 |
| Size of MV annuloplasty devices (mm) | 30.6 ± 2.7 (26–33) |
| Resection of P2 | 10 |
| Implanted neochordae | 9 |
| Cleft closures | 8 |
| TV repairs | 15 (100%) |
| De Vega annuloplasty | 1 (6.7%) |
| Implanted TV annuloplasty devices | 14 (93.3%) |
| Size of TV annuloplasty devices (mm) | 30.3 ± 1.8 (28–34) |

Intraoperative course is given as continuous variables with the relative percentage in brackets or as mean ± SD with the range of variables in brackets.
CPB: cardiopulmonary bypass; MV: mitral valve; TV: tricuspid valve; SD: standard deviation.

duration of hospitalization was 19.0 ± 12.0 days. At 30 days, the mortality rate was 5.9% (2 patients), both owing to a low-cardiac-output syndrome. There were 2 cases of neurological incidents, one of whom also suffered from new-onset renal failure requiring haemodialysis in the postoperative course. Neither was there any revision for bleeding, nor were any wound infections to be noticed. Echocardiographic examination at discharge displayed no mitral regurgitation or stenosis exceeding Grade I. The orifice area after successful MV reconstruction was 2.43 ± 0.38 $cm^2$. All TV surgeries could be performed as reconstruction. At discharge, 3 patients displayed a TV regurgitation greater than Grade I. There was no valve-related reoperation or intervention. Upon subgroup analysis of patients undergoing isolated MV surgery or combined MV and TV surgery, no significant differences were noted (Table 4). Nevertheless, both events of 30-day mortality were to be found in the subgroup of patients with combined MV and TV surgery. Moreover, the group of combined procedures displayed a higher rate of patients demanding a prolonged ventilation (40.0 vs 15.8%; $P = 0.139$).

## DISCUSSION

Minimally invasive MV surgery is an established concept. It has been proved to be comparable with MV surgery via full sternotomy [9–13]. Moreover, its superiority regarding lower operative mortality has been reported [11]. Seeburger *et al*. found an in-hospital mortality rate at 30 days of 3.1% in a mixed cohort of patients aged 80 and older [14]. In the present study, we noted an overall 30-day mortality rate of 5.9%, which is to be attributed exclusively to 2 patients undergoing a combined MV and TV surgery. It is likely that the worse outcome in the subgroup of patients undergoing combined MV and TV surgery is not only due to the more complex surgical procedure; in this context, one has to consider the impairment of the right heart and further organs due to a relevant TV regurgitation. As we recently reported, our total cohort of isolated minimally invasive TV surgical patients displayed a 30-day mortality rate of 4% [19]. This is in line with the still existing challenge of the early postoperative period after TV surgery [20–22]. In contrast, in the cohort of octogenarians described here, there was no mortality in the subgroup of isolated MV surgery. Hence, the observed mortality in our overall series might be associated with an increased rate of combined procedures representing 44.1% (15 of 34) of all operations. In comparison, in the recent publication by Seeburger *et al*., the proportion of combined MV and TV procedures equalled 24% of all operations [14]. Nevertheless, not only our total group but also the subgroup of isolated MV surgery displayed lower rates of mortality at 30 days when compared with previously published studies irrespective of the chosen access route, be it minimally invasive approach or full sternotomy. Chikwe *et al*. reported a mortality rate of 13.3% (43 of 322) in a group of isolated and combined MV surgeries in octogenarians in contrast to the mortality rate of 5.9% in the present study [15]. Similarly, Badhwar *et al*. described a mortality rate of 4.3% in a group of 2198 octogenarians receiving isolated MV surgery with full sternotomy, whereas our corresponding subgroup showed no mortality within 30 days postoperatively [16]. Moreover, we observed considerably low rates of perioperative complications, as well as favourable results regarding repair rate and functional outcome of the MV. In this context one has to consider that our cohort displayed a moderate EuroSCORE of 5.2 ± 5.3%. This is mostly owing to an ejection fraction (EF) of 59.7 ± 6.9%. Moreover, no patient displayed an EF lower than 45%. This is in line with the current guidelines on the management of valvular heart disease [23]. According to those guidelines, mitral regurgitation in patients with an EF >30% and without conflicting comorbidities should primarily be considered for surgical therapy (Class I Level C) [23]. Despite this, recent reports suggest that age is often regarded as a

**Table 3:** Postoperative course

| Postoperative course | 34 (100%) |
|---|---|
| New-onset renal failure requiring dialysis | 4 (11.8%) |
| Wound infection | 0 (0%) |
| Revision for bleeding | 0 (0%) |
| Duration of ICU stay (days) | 3.1 ± 4.6 (1–18) |
| Duration of hospitalization (days) | 19.0 ± 12.0 (11–75) |
| Prolonged ventilation (>12 h) | 9 (26.5%) |
| Postoperative neurological events | 2 (5.9%) |
| 30-day mortality | 2 (5.9%) |

Postoperative course is displayed as a continuous variable with the relative percentage in brackets or as mean ± SD with the range of variables in brackets.
ICU: intensive care unit; SD: standard deviation.

**Table 4:** Subgroup comparison between isolated and combined MV surgery

| | Isolated MV 19 (100%) | MV + TV 15 (100%) | *P*-value |
|---|---|---|---|
| Duration of surgery (min) | 225 ± 55 (120–299) | 263 ± 100 (179–616) | 0.136* |
| Cross-clamp time (min) | 89 ± 27 (31–129) | 90 ± 18 (61–114) | 0.865** |
| Duration of CPB (min) | 151 ± 33 (95–201) | 180 ± 69 (114–423) | 0.218* |
| New-onset RF requiring dialysis | 4 (21.1%) | 0 (0%) | 0.113*** |
| Duration of ICU stay (days) | 2.7 ± 4.8 (1–17) | 4.2 ± 5.5 (1–18) | 0.463* |
| Duration of hospitalization (days) | 15.9 ± 4.3 (10–28) | 21.8 ± 16.8 (12–75) | 0.947* |
| Prolonged ventilation (>12 h) | 3 (15.8%) | 6 (40.0%) | 0.139*** |
| Postoperative neurological events | 1 (5.3%) | 1 (6.7%) | 1.000*** |
| 30-day mortality | 0 (0%) | 2 (13.3%) | 0.187*** |

Subgroup comparison is displayed as a continuous variable with the relative percentage in brackets or as mean ± SD with the range of variables in brackets.
CPB: cardiopulmonary bypass; RF: renal failure; ICU: intensive care unit; SD: standard deviation.
*Mann–Whitney *U*-test; **Unpaired *t*-test; ***Fisher's exact test.

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strong independent factor causing a denial of surgery to patients presenting with severe symptomatic mitral regurgitation [24]. Such a trend may be partially triggered by single reports on increased perioperative morbidity and mortality in octogenarians undergoing cardiac surgery [3]. TMVR as a non-surgical approach offers certain benefits especially for elderly patients. The avoidance of intubation and respiratory ventilation as well as reduced tissue trauma may limit potential complications and the overall duration of hospitalization. However, recent studies demonstrated certain limitations of the TMVR concept with respect to the correction of functional MV regurgitation. Taramasso *et al*. found in a cohort suffering from functional MV regurgitation a relapse of severe MV regurgitation of up to 20% [25] 1 year after TMVR. This was significantly more ($P = 0.01$) compared with a parallel group of patients receiving surgical MV repair. This finding emphasizes the value of MV reconstruction, especially for patients with functional MV regurgitation.

The favourable results of the current study further support the practice of assessing octogenarians for surgical suitability according to the overall individual profile and not just by their age. Minimally invasive MV surgery may be a valid option for patients with severe mitral regurgitation, also beyond the age of 80 years.

## Limitations

Our study is limited by its character of a single-centre experience and its small number of patients.

## CONCLUSION

Minimally invasive MV surgery is a suitable option even in octogenarians. Our results demonstrate the importance of a careful and differentiated discussion when comparing interventional and novel surgical therapy concepts. In this context, age should not be considered as the sole argument against a surgical procedure.

**Conflict of interest:** none declared.

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**eComment. What is the best perfusion strategy for minimally invasive mitral valve surgery in octogenarians?**


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doi: 10.1093/icvts/ivv405



We read the article by Minol *et al.* [1]. They evaluated the contemporary series of octogenarians undergoing minimally invasive mitral valve surgery using right lateral minithoracotomy to elucidate the preoperative risk profile and the postoperative

course. However, there are some contradictory points when compared with literature.

Minimally invasive valve surgery with antegrade perfusion has a low risk of neurological complications and has excellent outcomes. Retrograde perfusion in older patients with significant vascular comorbidities is associated with an increased risk of stroke. There are some studies about perfusion for minimally invasive valve surgery in elderly patients. Grossi and colleagues presented a focused report on a more homogeneous subset of 1282 isolated mitral valve operations performed through a right anterior minithoracotomy over a 12-year period [2]. This homogeneity allowed us greater discriminatory power to analyze the specific patient factors associated with an increased risk of stroke. The only significant risk factor interaction for neurological complication identified was the use of retrograde perfusion in patients with high-risk comorbidities: peripheral vascular disease, cerebrovascular disease, or atherosclerotic aortas. These data suggest that retrograde perfusion remains a viable option for younger patients without vascular comorbidities. In older patients, or those with the risk factors discussed previously, performing a computed tomography angiography of the descending aorta with distal runoff in addition to an intraoperative transoesophageal echocardiographic assessment of the thoracic aorta [2,3] is currently recommended. The incidence of peripheral arterial disease (PAD) is 12.2% in >70 years of age [4]. Regarding the advanced age of patients included in this study, were the participants evaluated for peripheral artery disease? Why did the authors prefer femoral vessel cannulation for all patients? Given the high (>80) average age of patients in this study, we would recommend a preoperative screening for PAD and, if there were no contraindications, it would be safer to use antegrade perfusion in order to prevent postoperative neurological complications.

**Conflict of interest:** none declared.

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