Aortic valve replacement through full sternotomy with a stented bioprosthesis versus minimally invasive sternotomy with a sutureless bioprosthesis


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Abstract

OBJECTIVES: The aim of this study was to analyse early postoperative outcomes and 2-year survival after aortic valve replacement (AVR) through a ministernotomy with a sutureless bioprosthesis implantation compared with a full sternotomy with implantation of a stented bioprosthesis.

METHODS: Patients who underwent primary isolated non-emergent AVR at six European centres were included in the study. Of these, 182 (32%) underwent a ministernotomy with a sutureless bioprosthesis (ministernotomy sutureless group) and 383 (68%) a full sternotomy with a stented bioprosthesis (full sternotomy stented group). Propensity score matching was used to reduce selection bias.

RESULTS: In the overall cohort, 30-day mortality was 1.6 and 2.1%, and 2-year survival was 92 and 92% in the ministernotomy sutureless group and in the full sternotomy stented group, respectively. Propensity score matching resulted in 171 pairs with similar characteristics and operative risk. Aortic cross-clamp (40 vs 65 min, \( P < 0.001 \)) and cardiopulmonary bypass time (69 vs 87 min, \( P < 0.001 \)) were shorter in the ministernotomy sutureless group. Patients undergoing ministernotomy received less packed red blood cells but the risk for postoperative permanent pacemaker implantation was higher. There were no differences regarding 30-day mortality or 2-year survival between the two groups.

CONCLUSIONS: AVR through a ministernotomy with implantation of a sutureless bioprosthesis was associated with shorter aortic cross-clamp and cardiopulmonary bypass time and less transfusion of packed red blood cells, but a higher risk for postoperative permanent pacemaker implantation compared with a full sternotomy with a stented bioprosthesis.

Keywords: Aortic valve replacement • Minimally invasive surgery • Ministernotomy • Sutureless

INTRODUCTION

Minimally invasive aortic valve replacement (AVR) through a ministernotomy has been developed as an alternative approach to conventional full sternotomy AVR. The technique was developed to reduce surgical trauma and studies have demonstrated favourable postoperative outcomes compared with full sternotomy AVR [1–5].

However, minimally invasive AVR is associated with a reduction of surgical exposure and working space, resulting in a more technically challenging procedure compared with conventional AVR, which has led to questioning of the safety of the procedure. The more complex implantation is associated with prolonged aortic cross-clamp and cardiopulmonary bypass time [1, 2], which has been related to worse postoperative outcomes [6–9]. It has been hypothesized that the longer procedural times compared with full sternotomy AVR attenuate the benefits of
minimally invasive incisions [10] and ways to shorten procedural time may be of great importance for the success of minimally invasive AVR.

During recent years, sutureless aortic bioprostheses were introduced. These prosthetic valves were designed to facilitate implantation, and thus reduce operative and myocardial ischaemia time and previous studies have demonstrated excellent postoperative outcomes [11–15] and reduced aortic cross-clamp and cardiopulmonary bypass time compared with implantation of conventional stented bioprostheses [12, 14].

Sutureless bioprostheses may substantially facilitate minimally invasive AVR, and thereby reduce the risks associated with prolonged myocardial ischaemia. There are no previous studies comparing the risks and benefits of current era minimally invasive AVR using sutureless bioprostheses with conventional AVR through full sternotomy with sutureless valves. Combining the advantages of minimally invasive surgical techniques with implantation of sutureless bioprosthetic valves is theoretically appealing, and might improve AVR postoperative outcomes.

The aim of this study was to analyse early postoperative outcomes and 2-year survival after AVR performed through a ministernotomy with sutureless bioprosthesis implantation compared with a full sternotomy with implantation of a stented bioprosthesis.

MATERIALS AND METHODS

This study was approved by a human research ethical review board at each participating centre.

Study design and study population

This was an analysis of two consecutive series of patients who underwent primary isolated non-emergent AVR at six European centres. Patients who underwent AVR through ministernotomy with sutureless bioprosthesis were operated on from June 2007 to April 2014 at six European centres (Belgium, Finland, Germany, Catania and Trieste in Italy and Sweden). Sutureless bioprostheses in combination with full sternotomy were performed infrequently when compared with sutureless bioprostheses through a ministernotomy. Sutureless valve implantation through a full sternotomy was mostly performed in the beginning of each centre’s sutureless valve programme, so that the surgeons would be familiar with sutureless valve implantation before proceeding with minimally invasive approaches. Patients who underwent AVR through full sternotomy with stented bioprosthesis were operated at Karolinska University Hospital, Stockholm, Sweden between January 2005 and December 2010. The inclusion criterion was severe aortic stenosis with indication for primary isolated non-emergent AVR with the use of the Perceval sutureless bioprosthesis made of bovine pericardium mounted on a nitinol stent (Sorin Biomedica Cardio Srl, Salluggia, Italy) or the Carpentier-Edwards Perimount stented bioprosthesis made of bovine pericardium (Edwards LifeSciences, Irvine, CA, USA). Patients who had previous cardiac surgery, active endocarditis or a concomitant cardiac procedure in addition to AVR were excluded. Implantation with the Perceval prosthesis was considered feasible if the aortic annulus size was between 19 and 27 mm and the ratio between the diameter of the sinotubular junction and the diameter of the aortic annulus did not exceed 1.3. Data on patients’ characteristics and operative details were retrieved retrospectively from patients’ medical records. The follow-up data were retrieved from national registries, by reviewing hospital records or contacting the patient or his/her physician.

Outcome measures

The primary outcome measures of this study were all-cause 30-day mortality and 2-year survival. Secondary outcome measures were aortic cross-clamp time, cardiopulmonary bypass time, paravalvular regurgitation, transfusions of packed red blood cells, reoperation for paravalvular regurgitation, reoperation for bleeding, de novo dialysis, permanent pacemaker implantation and intensive care unit stay.

Ministernotomy with sutureless bioprosthesis

A 6- to 10-cm midline skin incision was made over the upper part of the sternum. A partial J-shaped ministernotomy in the third to fourth intercostal space or a V-shaped ministernotomy at the level of the second intercostal space was performed. Cardiopulmonary bypass was established with central arterial and central or peripheral venous cannulation. Antegrade crystalloid or cold blood cardioplegia was used. The ascending aorta was incised transversally 1.5 cm above the sinotubular junction. The aortic valve was excised and the aortic annulus completely decalcified. The manufacturer’s sizer was used for selecting the appropriate bioprosthetic valve size. Three guiding 4-0 polypropylene sutures were placed at the nadir point of each valve sinus. At back table, the Perceval prosthesis was collapsed using a specific device system. The prosthesis was attached to the guiding threads through the three loops at the proximal ring of the prosthesis and the deployment system was positioned into the aortic root and the valve released into the aortic annulus. A balloon was inserted into the prosthesis and diluted at a pressure of 4 atmospheres for 30 sec. The three guiding sutures were removed and the aortotomy was closed using running sutures. After weaning from cardiopulmonary bypass, transoesophageal echocardiography was performed to confirm correct positioning of the prosthesis and for the detection of any paravalvular regurgitation.

Full sternotomy with stented bioprosthesis

A full median sternotomy, cardiopulmonary bypass with central arterial and venous cannulation, and antegrade or retrograde, or both, cold blood cardioplegia were used. In all patients, the stented Carpentier-Edward Perimount bioprosthesis was used. The manufacturer’s sizer was used for selecting the appropriate bioprosthetic valve size.

Statistical analysis

Independent samples t-test and χ² test were used for univariate analyses in the overall cohort, and paired samples t-test and univariate conditional logistic regression was used in the propensity score matched cohort. The model included only the variable/characteristic/outcome of interest and an indicator variable for the ministernotomy sutureless group. The Kaplan–Meier method was used to calculate cumulative survival and to construct survival curves and the log-rank test was used to compare differences between the curves. To reduce selection bias, a propensity score was calculated for each patient by logistic regression. A propensity
score-matched cohort was constructed by nearest neighbour matching without replacement, one ministernotomy sutureless bioprosthesis patient to one full sternotomy stented bioprosthesis patient. We calculated standardized differences for variables to investigate post-match balance. Standardized differences <10% are generally considered a small and acceptable imbalance. Analyses were performed using SPSS version 22.0 (IBM SPSS Inc., Chicago, IL, USA) and Stata version 13.1 (StataCorp LP, College Station, TX, USA).

RESULTS

From the multicentre Perceval registry, we identified 189 patients with severe aortic stenosis who underwent non-emergent AVR through ministernotomy with implantation of a sutureless bioprosthesis between June 2007 and April 2014. Of these, we excluded 7 patients who had undergone previous cardiac surgery. No patient implanted with a sutureless bioprosthesis through a ministernotomy had active endocarditis or any concomitant cardiac procedure in addition to AVR. From the single centre Carpenter-Edwards Perimount registry, we identified 787 patients with severe aortic stenosis who underwent non-emergent AVR through sternotomy with implantation of the stented bioprosthesis between January 2005 and December 2010. Of these, we excluded 373 patients who had another cardiac procedure in addition to AVR, 4 patients with active endocarditis and 27 patients excluded 37 patients who had undergone previous cardiac surgery. The total study population consisted of 565 patients with severe aortic stenosis who had diabetes but fewer had coronary artery disease. More patients in the ministernotomy sutureless group underwent an elective procedure. Creatinine clearance was lower in the ministernotomy sutureless group. Logistic European system for cardiac operative risk evaluation (EuroSCORE) I was higher for patients in the ministernotomy sutureless group (10.6 ± 7.5 vs 7.7 ± 6.3%, P ≤ 0.001).

Baseline characteristics

The baseline characteristics of the two groups are listed in Table 1. Compared with the full sternotomy stented group, the patients in the ministernotomy sutureless group were older, and more likely to be females. More patients in the ministernotomy sutureless group had diabetes but fewer had coronary artery disease. More patients in the ministernotomy sutureless group underwent an elective procedure. Creatinine clearance was lower in the ministernotomy sutureless group. Logistic European system for cardiac operative risk evaluation (EuroSCORE) I was higher for patients in the ministernotomy sutureless group (10.6 ± 7.5 vs 7.7 ± 6.3%, P ≤ 0.001).

Overall cohort

The number of patients implanted with different sizes of bioprostheses is presented in Fig. 1. Data regarding procedural times are presented in Table 2. Ministernotomy with implantation of a

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<th>Table 1: Baseline characteristics for patients who underwent aortic valve replacement through a ministernotomy with implantation of a sutureless bioprosthesis or through a full sternotomy with a stented bioprosthesis</th>
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<td>Logistic EuroSCORE I (%)</td>
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Continuous variables are reported as mean ± standard deviation; dichotomous variables are reported as counts and percentages in parentheses.
Sutureless bioprosthesis was associated with shorter aortic cross-clamp and cardiopulmonary bypass time compared with full sternotomy with implantation of a stented valve.

Postoperative outcomes are presented in Table 3. Crystalloid cardioplegia was used in 16% of patients in the ministernotomy sutureless group and in no patient in the full sternotomy stented group.
group. Thirty-day mortality was 1.6% in the ministernotomy sutureless group and 2.1% in the full sternotomy stented group \((P = 1.0)\). During a total follow-up time of 1794 years (mean 3.2 ± 2.1 years), 81 patients died. In the ministernotomy sutureless group, 9 of 182 (4.9%) patients died and the mean follow-up time was 1.2 ± 1.1 years. In the full sternotomy stented group, 72 of 383 (19%) patients died and the mean follow-up time was 4.1 ± 1.7 years. Two-year survival was 92% [95% confidence interval (CI): 84–96%] in the ministernotomy sutureless group and 92% (95% CI: 89–95%; Fig. 2) in the full sternotomy stented group. In patients in the ministernotomy sutureless group, the mean follow-up time was 1.2 ± 1.1 years and in the full sternotomy stented group was 4.1 ± 1.7 years. The incidence of reoperation for major bleeding was 4.4% in the ministernotomy group and 7.8% in the full sternotomy group \((P = 0.152)\). Compared with the full sternotomy stented group, patients in the ministernotomy sutureless group had a longer intensive care unit stay (2.4 vs 1.6 days, \(P < 0.001)\) and were more likely to undergo postoperative implantation of a pacemaker (9.3 vs 1.8%, \(P < 0.001)\). No patient in the ministernotomy sutureless group and one patient (0.3%) in the full sternotomy stented group had severe postoperative paravalvular regurgitation, necessitating reoperation within the same hospital stay. No patient in the ministernotomy group and 4 patients (1.0%) in the full sternotomy stented group were discharged with moderate paravalvular regurgitation \((P = 0.381)\).

Because the full sternotomy stented group, in contrast to the ministernotomy sutureless group, was included at a single institution, we performed repeated analyses with focus on this single centre. We compared baseline characteristics in patients who underwent ministernotomy sutureless implantation at the same centre as the full sternotomy stented group with the ministernotomy sutureless from all other centres, and found that the baseline characteristics were similar between the two groups. Furthermore, we analysed survival, and found that the results were in line with the results from the main analyses.

**Propensity score matched cohort**

Propensity score based matching resulted in 171 pairs with similar baseline characteristics (Table 1; Fig. 3). In the propensity matched cohort, the 30-day mortality was 1.8% in the ministernotomy sutureless group and 2.3% in the full sternotomy stented group \((P = 0.706)\). During a total follow-up time of 910 years (mean 2.7 ± 2.1 years), 46 patients died. In the ministernotomy sutureless group, 9 of 171 (5.3%) patients died and the mean follow-up time was 1.1 ± 1.1 years. In the full sternotomy stented group, 37 of 171 (22%) patients died and the mean follow-up time was 4.2 ± 1.7 years. Two-year survival was 91% (95% CI: 82–96%) in patients who underwent ministernotomy with sutureless bioprosthesis, and 93% (95% CI: 88–96%) in patients who underwent full sternotomy with stented bioprosthesis (Fig. 4). Aortic cross-clamp (40 vs 65 min, \(P < 0.001\)) and cardiopulmonary bypass time (69 vs 87 min, \(P < 0.001)\) were shorter in the ministernotomy sutureless group.

Patients in the ministernotomy sutureless group received less transfusions of packed red blood cells than patients in the full sternotomy sutureless group \((1.4 \text{ vs } 2.4 \text{ units, } P < 0.001)\). The proportion of patients undergoing postoperative permanent pacemaker
improvement in minimally invasive AVR. Procedural times could therefore be of great value in order to reduce ischemia and cardiopulmonary bypass time and to decrease the risk of postoperative complications and death. Whether the higher risk for postoperative pacemaker implantation in the ministernotomy sutureless group could be attributed to the implantation technique with balloon dilatation of the sutureless bioprosthesis used in the present study or is simply a result of different policies regarding indications for pacemaker implantation in the different centers is not clear. Some studies have shown that patients undergoing minimally invasive AVR received less packed red blood cells, shorter intensive care unit and hospital stay and reduced hospital costs when the sutureless Perceval bioprosthesis was compared with conventional stented bioprostheses [14].

By facilitating implantation, use of a sutureless bioprosthesis in minimally invasive AVR might be associated with similar excellent postoperative outcomes as minimally invasive AVR but without the prolongation of myocardial ischemia time and cardiopulmonary bypass time. Still, there are only very few studies of minimally invasive AVR with implantation of a sutureless bioprosthesis [11–13, 16]. Recently, we showed that minimally invasive AVR with the sutureless Perceval bioprosthesis was associated with similar aortic cross-clamp or cardiopulmonary bypass time, early postoperative outcomes and 2-year survival compared with a Perceval implantation through a full sternotomy [16]. However, there are no previous studies comparing the risks and benefits between minimally invasive sutureless AVR and conventional AVR through a full sternotomy with implantation of a stented valve.

In the present study, we compared minimally invasive implantation of the sutureless Perceval bioprosthesis through ministernotomy with conventional implantation of the Carpentier-Edwards Perimount stented bioprosthesis through a full sternotomy. After propensity score matching, the minimally invasive sutureless approach was associated with shorter aortic cross-clamp and cardiopulmonary bypass time compared with full sternotomy stented AVR. Notably, a significantly higher proportion of patients in the ministernotomy sutureless group had aortic cross-clamp time <30 min or cardiopulmonary bypass time <60 min. The association between sutureless bioprostheses and short procedural times was reported previously [12, 14] but the novel finding in the present study is that minimally invasive implantation of these sutureless bioprostheses could in fact be associated with shorter procedural times compared with conventional AVR with full sternotomy and implantation of a stented bioprosthesis. Aortic cross-clamp and cardiopulmonary bypass time in the full sternotomy stented group was shorter than those reported for full sternotomy isolated AVR in the Society of Thoracic Surgeons National Database (mean aortic cross-clamp time 78 min, mean cardiopulmonary bypass time 106 min) [17]. This indicates that the difference in procedural time between the ministernotomy sutureless group and the full sternotomy stented group in this study was not due to exceptional long aortic cross-clamp and cardiopulmonary bypass time in the full sternotomy stented group.

After propensity score matching, there were also differences between the two groups regarding packed red blood cell transfusions and postoperative pacemaker implantation. Patients undergoing minimally invasive sutureless AVR received less packed red blood cell transfusions, which is in line with previous studies that showed that patients undergoing minimally invasive as well as sutureless AVR receive less transfusions [4, 12, 14].

Whether the higher risk for postoperative pacemaker implantation in the ministernotomy sutureless group could be attributed to the implantation technique with balloon dilatation of the sutureless bioprosthesis used in the present study or is simply a result of different policies regarding indications for pacemaker implantation in the different centers is not clear. Some studies have shown that patients undergoing minimally invasive AVR received less packed red blood cells, shorter intensive care unit and hospital stay and reduced hospital costs when the sutureless Perceval bioprosthesis was compared with conventional stented bioprostheses [14].

In 5 cases (2.7%), the sutureless bioprosthesis needed to be repositioned after release in the aortic annulus. One patient (0.5%) had intraoperative prosthesis dislodgement of the sutureless bioprosthesis, requiring conversion to implantation of a conventional stented bioprosthesis. There were no conversions from ministernotomy to full sternotomy.

**DISCUSSION**

This study showed that AVR through a ministernotomy with implantation of a sutureless bioprosthesis was associated with shorter aortic cross-clamp and cardiopulmonary bypass time and less transfusion of packed red blood cells, but a higher risk for postoperative permanent pacemaker implantation compared with a full sternotomy with implantation of a stented bioprosthesis. Thirty-day mortality and 2-year survival were comparable with a full sternotomy with a stented bioprosthesis.

Previous studies showed excellent results after minimally invasive AVR performed through a ministernotomy, with low perioperative mortality, low rates of postoperative complications and short hospital stay [1–5]. Meta-analyses demonstrated small benefits in terms of shorter intensive care unit and hospital stay, shorter ventilation time and less bleeding compared with conventional full sternotomy AVR [1–3]. However, minimally invasive AVR was associated with longer myocardial ischemia and cardiopulmonary bypass time [1, 2]. In patients undergoing AVR through full sternotomy, prolonged aortic cross-clamp and cardiopulmonary bypass time are associated with higher morbidity and mortality [6–9]. Hypothetically, the benefits associated with minimally invasive AVR could be offset by this prolongation of myocardial ischemia and cardiopulmonary bypass time and to decrease the procedural times could therefore be of great value in order to improve outcomes in minimally invasive AVR.

Sutureless aortic bioprostheses were designed to facilitate implantation and thereby reduce implantation time. The sutureless Perceval bioprosthesis is shown to shorten aortic cross-clamp and cardiopulmonary bypass time compared with implantation of a conventional stented bioprosthesis [12, 14] and early and midterm postoperative outcomes are proved to be excellent [11–15]. A recent study demonstrated lower rate of transfusion of packed red blood cells, shorter intensive care unit and hospital stay and reduced hospital costs when the sutureless Perceval bioprosthesis was compared with conventional stented bioprostheses [14].

In the present study, we compared minimally invasive implantation of the sutureless Perceval bioprosthesis through ministernotomy with conventional implantation of the Carpentier-Edwards Perimount stented bioprosthesis through a full sternotomy. After propensity score matching, the minimally invasive sutureless approach was associated with shorter aortic cross-clamp and cardiopulmonary bypass time compared with full sternotomy stented AVR. Notably, a significantly higher proportion of patients in the ministernotomy sutureless group had aortic cross-clamp time <30 min or cardiopulmonary bypass time <60 min. The association between sutureless bioprostheses and short procedural times was reported previously [12, 14] but the novel finding in the present study is that minimally invasive implantation of these sutureless bioprostheses could in fact be associated with shorter procedural times compared with conventional AVR with full sternotomy and implantation of a stented bioprosthesis. Aortic cross-clamp and cardiopulmonary bypass time in the full sternotomy stented group was shorter than those reported for full sternotomy isolated AVR in the Society of Thoracic Surgeons National Database (mean aortic cross-clamp time 78 min, mean cardiopulmonary bypass time 106 min) [17]. This indicates that the difference in procedural time between the ministernotomy sutureless group and the full sternotomy stented group in this study was not due to exceptional long aortic cross-clamp and cardiopulmonary bypass time in the full sternotomy stented group.

After propensity score matching, there were also differences between the two groups regarding packed red blood cell transfusions and postoperative pacemaker implantation. Patients undergoing minimally invasive sutureless AVR received less packed red blood cell transfusions, which is in line with previous studies that showed that patients undergoing minimally invasive as well as sutureless AVR receive less transfusions [4, 12, 14].

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showed a high incidence of postoperative development of atrioventricular block and subsequent need for permanent pacemaker implantation after balloon-dilated transcatheter aortic valve implantation (TAVI) [18], however, this risk varies between different types of transcatheter prosthetic valves. Although there were differences between the two groups regarding postoperative pacemaker implantation rate and transfusion of packed red blood cells, these differences did not translate into differences regarding morbidity or mortality.

The rapid increase in TAVI procedures performed increased the interest for minimally invasive AVR. However, TAVI is associated with a high risk of paravalvular regurgitation, which is associated with poor survival [19]. Minimally invasive sutureless AVR could prove to be beneficial over TAVI because the procedure permits removal of the diseased valve and decalcification of the aortic annulus before deployment of the prosthesis. In the present study, the rate of paravalvular regurgitation after AVR through ministernotomy with implantation of a sutureless bioprosthesis was very low, which could be a possible advantage of this procedure compared with TAVI.

Limitations

Because it was not possible to collect data regarding implantation of a stented bioprosthesis through full sternotomy from all centres, we instead chose to report a consecutive series of full sternotomy implantations of a specific type of stented bioprosthesis from one centre. Baseline characteristics as well as survival were comparable between patients undergoing minimally invasive sutureless AVR at the centre that included all patients undergoing full sternotomy stented AVR and the remaining centres. On the basis of these analyses, we believe that it was reasonable to compare the multicentre ministernotomy sutureless group with the single centre full sternotomy stented group. Because full sternotomy implantation of a stented bioprosthesis is the widely accepted and conventional implantation strategy for surgical AVR with very similar short- and long-term results between different European centres, we believe that the results of a single institution can be generalized to serve as a European standard comparison with which new surgical techniques, such as ministernotomy sutureless implantation, can be compared.

The multicentre design of this study composes benefits as well as limitations. An advantage of this design is the possibility to include a larger number of patients at different geographical locations that increases the generalizability of the study. However, postoperative monitoring and treatment strategies may differ between participating centres, making comparison of some postoperative variables difficult. For this reason, we were not able to compare differences in some specific clinical outcome measures. For example, at Karolinska University Hospital, patients undergoing AVR were discharged early to a rehabilitation facility, in contrast to some of the other participating centres where patients were discharged home after a predicted longer period of hospital stay. We were therefore unable to compare hospital stay between the two groups. Similarly, the results of some of the included outcome measures should be interpreted carefully, since clinical policies may have been different for patients undergoing different treatment strategies in the present study. Furthermore, the two treatment groups were not operated during the exactly same time period (2005–10 vs 2007–14). The full sternotomy stented group time period was chosen to obtain a large cohort of patients undergoing AVR with implantation of one single type of stented bioprosthesis. During the selected time period, the Carpentier-Edwards Perimount bioprosthesis was the standard bioprosthetic valve option at Karolinska University Hospital.

Due to the multicentre (multinational) study design, cost analyses would be difficult to interpret because of large differences in hospital reimbursement/health-care systems between countries. Therefore, we chose not to include a cost analysis.

The findings of our study might have been influenced by selection bias. In the overall cohort, the ministernotomy sutureless group and full sternotomy stented group were not balanced regarding several potentially confounding factors such as age, gender, diabetes mellitus, coronary artery disease, renal function, urgency of the operation and preoperative risk score evaluation (logistic EuroSCORE I). To reduce selection bias, we performed a propensity matching analysis, achieving a satisfactory balance regarding baseline characteristics. The propensity matching analysis reduced the risk that the findings were due to selection bias. However, although we attempted to adjust for differences between the two groups, a number of important risk factors might have been left unrecognized in this analysis, and still could have guided the clinicians through the decision-making process. Nevertheless, it is our opinion that the propensity matching analysis used, which included most recognized baseline characteristics associated with increased postoperative risk, was an adequate statistical methodology that accounted for the different considerations in the decision of surgical approach.

CONCLUSIONS

Ministernotomy sutureless AVR was associated with shorter aortic cross-clamp and cardiopulmonary bypass time and less transfusion of packed red blood cells, but a higher risk for postoperative permanent pacemaker implantation compared with a full sternotomy with a stented bioprosthesis. Thirty-day mortality and 2-year survival were comparable with a full sternotomy with a stented bioprosthesis.

Conflict of interest: Theodor Fischlein, Bart Meuris, Carmelo Mignosa and Peter Svenarud are consultants for Sorin Group. Antonino S Rubino received research grants from Sorin Group.

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