

Comparative study of quality of life after aortic valve replacement through partial upper ministernotomy versus full median sternotomy

Michał Bociański^{1,A–D,F}, Mateusz Puślecki^{1,2,C,E}, Martyna Ratajczak^{3,B},
Sebastian Stefaniak^{1,C}, Piotr Buczkowski^{1,C}, Bartłomiej Perek^{1,E}, Marek Jemielity^{1,E,F}

¹ First Department of Cardiac Surgery and Transplantology, Chair of Cardiac and Thoracic Surgery, Poznan University of Medical Sciences, Poland

² Department of Medical Rescue, Chair of Emergency Medicine, Poznan University of Medical Sciences, Poland

³ Department of Emergency Medicine, Chair of Emergency Medicine, Poznan University of Medical Sciences, Poland

A – research concept and design; B – collection and/or assembly of data; C – data analysis and interpretation;

D – writing the article; E – critical revision of the article; F – final approval of the article

Advances in Clinical and Experimental Medicine, ISSN 1899–5276 (print), ISSN 2451–2680 (online)

Adv Clin Exp Med. 2025;34(6):895–900

Address for correspondence

Michał Bociański

E-mail: michalbocianski@gmail.com

Funding sources

None declared

Conflict of interest

None declared

Received on March 27, 2024

Reviewed on June 4, 2024

Accepted on June 25, 2024

Published online on October 2, 2024

Abstract

Background. Upper ministernotomy for sutureless aortic prosthesis implantation provides an attractive opportunity compared to conventional access. Although in the last decade, the former has gained popularity, data comparing quality of life (QoL) following these procedures are scarce.

Objectives. The purpose of this study was to assess the patient's QoL after aortic valve replacement (AVR) using a ministernotomy approach compared to a full sternotomy.

Materials and methods. One hundred fifteen AVR patients were operated on using either minimally invasive access with sutureless valve implantation through an upper median ministernotomy (group I; n = 58) or through a full sternotomy (group II; n = 57) with either biological Edwards Perimount Magna™ (Edwards Lifescience, Irvine, USA) (n = 30) or mechanical On-X™ (Carbomedics, Austin, USA) (n = 27) aortic valve prostheses implantation by 1 experienced surgeon. At the end of the follow-up period, QoL was assessed using the EQ-5D-5L scale telephone survey.

Results. In group I, there were significantly fewer problems with mobility, pain and usual activities than in group II ($p < 0.05$). Moreover, the visual analogue scale (VAS) and Health Index (HI) scores were more favorable for patients treated with ministernotomy. Additionally, group II participants provided comments beyond the survey questions, such as tiredness, dyspnea or pain. These kinds of remarks were not reported in group I. Ultimately, the EQ-5D-5L Index Score (IS) was consistent with the variables and more beneficial for group I subjects. Each group was compatible with the benefits for patients in group I.

Conclusions. Cardiac surgical procedures for severe aortic stenosis through minimally invasive access are associated with improved QoL parameters.

Key words: quality of life, ministernotomy, EQ-5D-5L, aortic valve disease

Cite as

Bociański M, Puślecki M, Ratajczak M, et al. Comparative study of quality of life after aortic valve replacement through partial upper ministernotomy versus full median sternotomy.

Adv Clin Exp Med. 2025;34(6):895–900.

|doi:10.17219/acem/190454

DOI

10.17219/acem/190454

Copyright

Copyright by Author(s)

This is an article distributed under the terms of the Creative Commons Attribution 3.0 Unported (CC BY 3.0) (<https://creativecommons.org/licenses/by/3.0/>)

Background

Minimally invasive aortic valve replacement (miniAVR) was first described in 1993 and popularized between 1996 and 1997.¹ Less invasive access due to shorter skin incisions may be recommended for a group of young, particularly female, patients for whom cosmetic outcome is important. Additionally, such procedures are associated with a low bleeding rate, reduced ventilation time and shortened stay in the postoperative intensive care unit (PICU) as well as in the hospital,² which may also be an attractive solution for the elderly and those with comorbidities who are not qualified for transcatheter aortic valve implantation (TAVI) procedures.

The early outcomes of minimally invasive approaches for severely diseased aortic valves are unequivocal. On the one hand, they enable reduced blood loss and probability of wound infection, but on the other, they are linked to longer cross-clamping (also called ischemic) and cardiopulmonary bypass times.³

Despite the common application of miniAVR around the world, there are still confusing data comparing the mini- to full sternotomy approaches. Of note, there are even fewer studies estimating any differences between the impact of surgical access and quality of life (QoL).

Objectives

The purpose of this study was to assess the patient's QoL after AVR from a ministernotomy approach compared to a full sternotomy.

Materials and methods

This study involved 115 consecutive patients who underwent AVR procedures. Group I (n = 58) had a minimally invasive J-shape upper ministernotomy with implanted sutureless aortic valve prostheses, while group II (n = 57) had full sternotomy access. Group II was divided into 2 subgroups: group II A (n = 25) had implantation with biological Edwards Perimount Magna™ (Edwards Lifescience, Irvine, USA), and group II B (n = 32) had implantation with mechanical prosthesis On-X™ (Carbomedics, Austin, USA) aortic valve prostheses. All procedures were conducted in a single cardiac surgical department between 2018 and 2023. To avoid false answers in the survey, we assessed the study patients' after a min of 3 months after surgery. All individuals were operated on electively by 1 experienced consultant who is particularly interested in aortic valve surgery. The patients' demographics and basic baseline clinical characteristics, including comorbidities, were comparable between the studied groups (Table 1).

According to the rules of the Local Bioethical Committee of Poznan University of Medical Sciences, the Statement

Table 1. Patients' parameters: Age, body mass index (BMI), EuroScore II, and comorbidities

Patients	Group I (n = 58) (Q1; Q3)	Group II (n = 57) (Q1; Q3)	p-value
Age [years]	67 (31; 81)	67 (52; 79)	0.441
BMI [kg/m ²]	27 (20; 37)	28 (19; 41)	0.447
EuroScore II [%]	0.86 (0.50; 3.83)	1.20 (0.56; 4.51)	0.582
Comorbidities, n (%)			
Diabetes	11 (19%)	20 (35%)	0.065
Hypertension	32 (55%)	41 (72%)	0.500
Chronic lung disease	6 (10%)	0	0.347
Poor mobility	1 (1%)	1 (1,75%)	1.000
Smoking	10 (17%)	17 (29%)	0.136

Q1 – 1st quartile; Q3 – 3rd quartile.

of Ethics Approval is not required for retrospective data analysis of patients treated with the use of standard methods.

At the end of follow-up, we conducted the EQ-5D-5L scale telephone survey to assess QoL. We used the EQ-5D-5L questionnaire to collect the data. To obtain the most accurate and objective results, the interviewer was not informed of which subject group he was calling. Each EQ-5D instrument comprises a short descriptive system questionnaire and a visual analogue scale (EQ-VAS) that are cognitively undemanding and take only a few minutes to complete. Patients were asked to rate their general health on the day they complete the questionnaire using the EQ-VAS, a 0–100 scale. Data are presented as medians with ranges (min–max). Categorical data are expressed as numbers (n) with percentages (%). The EQ-5D-5L scale is used to evaluate QoL. It consists of 5 questions with 5 answer options for responding to each. It evaluates mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. The valuation research using the EQ-VT was undertaken with available data prepared for Poland.⁴ The Severity Index (SI) is obtained by adding the digits that correspond to the levels of the 5 dimensions in each state of health, subtracting 5 and multiplying by 5, which produces a new index (0–100), where 0 indicates a total absence of health problems and 100 is the highest degree of severity. Subtracting the SI from 100 provides the Health Index (HI).

Continuous variables are presented as medians with ranges (min–max), whereas categorical variables are expressed as numbers (n) with percentages (%).

Surgical details

Patients in group I (n = 58) underwent surgery through a partial (upper) J-shape ministernotomy from the jugular notch of the sternum up to the third intercostal space, whereas group II subjects underwent a complete

sternotomy (n = 57). The hearts were arrested after connecting the patients to standard cardiopulmonary bypass (right atrium and ascending aorta) by means of cold cardioplegic solutions administered directly into the coronary ostia. Following the removal of the original valve, sutureless or biological Edwards Perimount Magna™ (n = 25) or mechanical On-X™ (n = 32) valve prostheses were implanted. All knots in the conventional mechanical and biological valve implantations were tied manually in the normal fashion. The later steps of the procedures followed standard protocol, and the chest was always closed in the usual fashion, placing 4 sternal wires for ministernotomy closure or 8 sternal wires for full sternotomy closure. At the end of the AVR procedure through minimally invasive access (group I), our routine practice was to open the right pleural cavity and leave 2 drains (1 in the pleura and 1 in the pericardium).

Data management and analysis

The data analysis was performed anonymously. First, the quantitative variables were checked for normality using the Shapiro–Wilk test, and because they did not satisfy the criteria of normal distribution, they were presented as medians with ranges (min–max) and compared with the Mann–Whitney U test. Categorical data were expressed as numbers (n) with percentages (%). For the EQ-5D-5L, VAS and HI, the t-test was used, whereas, for the estimated regression coefficient, Pearson's correlation coefficient was used. A p-value of less than 0.05 was considered statistically significant. All statistical analyses were performed using the Statistica v. 13.3 software package (TIBCO Software Inc., Palo Alto, USA).

Results

EQ-5D-5L index

At the end of follow-up, group I patients reported fewer problems with mobility, usual activities and pain/discomfort than group II patients overall. Out of the 5 categories of possible inconveniences, self-care problems were at least reported in both groups (in less than 10%), with comparable rates (Table 2).

When comparing the mean EQ-5D-5L Index scores of the 2 groups, we found no statistically significant differences in the results; however, the mean index values in group I were marginally higher. Furthermore, there was no statistically significant difference in index scores between genders. The mean index was lower in group I for female patients, while it was lower for males in groups II A and II B. Overall, there were no statistically significant differences between group I and groups II A and II B or between group II A and group II B (Table 3).

EQ-5D-5L visual acuity scale

In group I, 72% of respondents rated their health as good or very good. The rest rated their health status as average or poor. Overall, of the 57 patients in group II, only 40% reported their health status as good or very good. In subgroup II A, 40% of patients rated their health status as good or very good, and in subgroup II B, 37% of patients rated their health as good or very good. The rest of the respondents reported their health status as average or poor. There was a statistically significant difference between reports from respondents in the subgroups (groups II A and II B)

Table 2. Reported problems after different surgery approaches

Reported problems after different surgery approaches	Group I (n = 58)	Group II (n = 57)		p-value		
		group II A (n = 25)	group II B (n = 32)	group I vs II A	group I vs II B	overall group I vs II
Mobility n (%)	7 (12)	7 (28)	13 (41)	0.217	0.217	0.012
Self-care n (%)	4 (7)	4 (16)	3 (9)	0.260	0.460	0.482
Usual activities n (%)	9 (15)	6 (24)	17 (30)	0.548	0.012	0.019
Pain/discomfort n (%)	11 (19)	11 (44)	13 (41)	0.127	0.106	0.004
Anxiety/depression n (%)	13 (22)	8 (32)	14 (44)	0.600	0.177	0.174

Values in bold are statistically significant.

Table 3. Comparing EQ-5D-5L index score in both groups

Patients	Group I (n = 58)	Group II (n = 57)		p-value		
		group II A (n = 25)	group II B (n = 32)	group I vs II A	group I vs II B	overall group I vs II
Mean						
Index score	1	0.939	0.939	0.771	0.928	0.833
Gender						
Female	0.982	0.965	0.943	0.781	0.936	0.872
Male	1	0.939	0.938	0.968	0.880	0.904

Table 4. Visual analogue scale (VAS)

VAS	Group I (n = 58)	Group II (n = 57)	
		group II A (n = 25)	group II B (n = 32)
Min	30	10	40
Mean	80	70	70
Max	100	100	100
p-value			
Overall group I vs II	<0.05	group I vs II A <0.05	group I vs II B <0.05

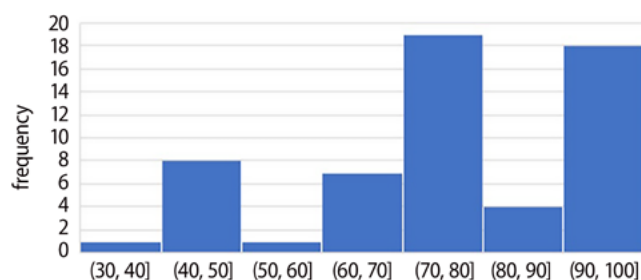


Fig. 1. Visual analogue scale (VAS) frequency distribution for ministernotomy

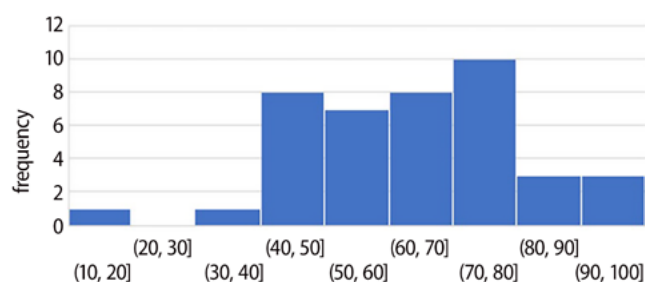


Fig. 2. Visual analogue scale (VAS) frequency distribution for full sternotomy

and those in group I that favored group I. We compiled the main VAS data in Table 4 and Fig. 1,2.

Patients' remarks

Although the results of the EQ-5D-5L index score and VAS are borderline, there was a significant difference when patients' remarks were compared. These comments were given spontaneously outside the survey.

According to the patients' remarks, it can be observed that patients who underwent full sternotomy reported

problems with tiredness, dyspnea and pain. Some patients rated their health status as worse than before surgery. Some of the comments concerned patients who had undergone surgery 2 years earlier. A summary of the reported remarks is included in Table 5.

Severity and health index

Using Pearson's correlation coefficient, we estimated the regression coefficient between the VAS and the HI. The regression coefficient was statistically significant in both groups.

Discussion

The increasing popularity of less invasive procedures and the increasing experience of surgeons allow them to perform complex cardiac surgical interventions with the same quality but through smaller skin incisions. According to data from the Polish National Registry of Cardiac Surgery Procedures (Krajowy Rejestr Operacji Kardiologicznych (KROK)), there has been a systematic increase in the rate of less invasive operations for isolated aortic valve disease. It has been reported that in Poland in 2022, almost the same number of isolated AVR procedures were performed via full sternotomy (n = 1,346) as through minimally invasive access (n = 1,344). The results are presented in Fig. 3.

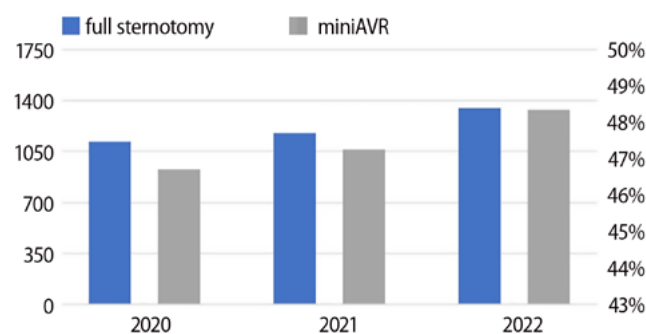


Fig. 3. Comparison of the number of operations depending on access in isolated aortic valve repair (AVR) surgery in Poland by years

Despite the obvious improvement in surgical techniques, technologies and anesthetic management, there is a debate about the clear benefits of less invasive AVR procedures.⁵ Some reports have failed to confirm significant differences

Table 5. Summary of reported remarks

Remarks	Tiredness	Dyspnea	Discomfort/pain	Inability to work	Health worse than before surgery
Full sternotomy	11	9	7	1	3
Ministernotomy	0	0	0	0	0
p-value	0.0003	0.001	0.01	0.495	0.118

Values in bold are statistically significant.

between the 2 approaches.² Currently, ministernotomy for AVR is not the gold standard of surgical management, and globally, most of these procedures are still performed using the full sternotomy approach.^{6,7} Although surgeries for aortic valve disease are commonly performed worldwide, information comparing the differences in patients' QoL between mini- and full sternotomy is very scarce.

EQ-5D-5L index score

In our assessment of both groups of patients, there was no statistically significant difference between the mean index scores in both groups ($p = 0.833$). However, in all of the analyzed parameters, the mean index score was lower in the full sternotomy approach group. A similar trend was presented by Rodriguez et al. in their study, where the ministernotomy group had a lower index than the full sternotomy approach group.⁷

Visual analogue scale

Group I patients reported a better state of health than group II individuals, which was confirmed by means of EQ-VAS analysis. Of interest, comparing the average value of health self-perspective to the entire Polish population (73.7 points), we showed that patients after ministernotomy reported better (median: 80 points) health, whereas those after standard full surgical access reported a worse (median: 70 points) state of health.⁴ The time after the operation had no effect on the results.

We believe the current assessment is reliable because the HI calculated from the EQ-5D-5L questionnaire correlates with the VAS and presents statistically significant favorable results for group I subjects. There were no statistically significant differences in the QoL results between the different types of implanted aortic prostheses.

Differences between patients' self-reported problems

Mobility, self-care and usual activities

It is well known that cardiac surgeries performed via complete median sternotomy elicit a clinical spectrum of systemic effects, including changes in patient body structure and function, activity level and participation in activities of daily life.⁸

This study found that patients' mobility and daily activities differed markedly between the groups in favor of group I. In our opinion, this may be due to relieved discomfort in the early postoperative period, which can lead to quicker recovery following ministernotomy. This fact can be of significance in respect to daily activities and self-care. According to Claessens et al., improvement in physical functioning was more prominent in minimally

invasive patients, and the pain scores of patients undergoing complete sternotomy improved significantly more slowly.

Overall, the general health and energy scores improved in both groups after surgery. However, the minimally invasive cardiac surgery patients had an earlier improvement in their general health and indicated that they had significantly more energy than the conventional surgery patients.⁹

Pain/discomfort

Fewer participants in the ministernotomy group experienced severe pain soon after their procedures, which was the opposite of patients who underwent the full sternotomy approach. This difference may result from limited stretching of the sternum during a partial sternotomy; in addition, the presence or absence of sternal fractures may be another important contributor to the early postoperative pain level.²

According to Huang et al., chronic pain after heart surgery may become a real problem. In a study of 244 patients after cardiac surgery by sternotomy, persistent pain (defined as pain persisting for more than 2 months after surgery) was seen in almost 30% of the patients. The cause of persistent pain after sternotomy is multifactorial and includes tissue destruction, intercostal nerve trauma, scar formation, rib fractures, sternal infection, stainless steel sutures, and/or costochondral avulsion.¹⁰

Anxiety/depression

According to Horne et al.,¹¹ up to 40% of patients are depressed after cardiac surgery. Preoperative depression and postoperative stressful events were the strongest independent associations postoperatively. Physical inactivity was associated with preoperative depression and new depression 6 months postoperatively. In the current study, there was no discernible difference between the 2 groups' levels of depression or anxiety.

Other remarks

Some of the study participants provided additional comments outside of the survey questions. From our perspective, these "off-topic" comments further demonstrate the difference in patient's QoL following AVR carried out through the 2 different approaches. Group II patients were much more eager to share inconveniences, and approx. 40% of them usually included negative remarks in their questionnaires. Most respondents complained of dyspnea, tiredness and chest pain. Unfortunately, some of them claimed that their health was even worse than it was before surgery. On the contrary, not only did group I subjects not mention any postoperative discomfort, but several of them even practiced sports or frequented the gym.

Limitations

We are aware of the numerous flaws in this study. First, the study's retrospective, non-randomized methodology and the observation of a small number of patients at a single institution diminish its statistical power. Second, even though we believe the EQ-5D-5L is an excellent tool for evaluating QoL, we are conscious that certain results cannot be completely objective due to the differences in years following surgery and the respondents' subjective emotions.

Conclusions

Cardiac surgical procedures for severe aortic stenosis through minimally invasive access are associated with improved QoL parameters.

Data availability

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Consent for publication

Not applicable.

ORCID iDs

Michał Bociński  <https://orcid.org/0000-0002-3880-4122>
 Mateusz Puślecki  <https://orcid.org/0000-0003-0015-2808>
 Sebastian Stefaniak  <https://orcid.org/0000-0002-4509-6494>
 Piotr Buczkowski  <https://orcid.org/0000-0002-5765-9506>
 Bartłomiej Perek  <https://orcid.org/0000-0003-2398-9571>
 Marek Jemielity  <https://orcid.org/0000-0003-2442-4644>

References

- Rodríguez-Caulo EA, Guijarro-Contreras A, Otero-Forero J, et al. Quality of life, satisfaction and outcomes after ministernotomy versus full sternotomy isolated aortic valve replacement (QUALITY-AVR): Study protocol for a randomised controlled trial. *Trials*. 2018;19(1):114. doi:10.1186/s13063-018-2486-x
- Brown ML, McKellar SH, Sundt TM, Schaff HV. Ministernotomy versus conventional sternotomy for aortic valve replacement: A systematic review and meta-analysis. *J Thorac Cardiovasc Surg*. 2009;137(3):670–679.e5. doi:10.1016/j.jtcvs.2008.08.010
- Aliahmed HMA, Karalius R, Valaika A, Grebelis A, Semėnienė P, Čypienė R. Efficacy of aortic valve replacement through full sternotomy and minimal invasion (ministernotomy). *Medicina (Kaunas)*. 2018;54(2):26. doi:10.3390/medicina54020026
- Golicki D, Jakubczyk M, Graczyk K, Niewada M. Valuation of EQ-5D-5L health states in Poland: The First EQ-VT-based study in Central and Eastern Europe. *Pharmacoeconomics*. 2019;37(9):1165–1176. doi:10.1007/s40273-019-00811-7
- Di Bacco L, Miceli A, Glauber M. Minimally invasive aortic valve surgery. *J Thorac Dis*. 2021;13(3):1945–1959. doi:10.21037/jtd-20-1968
- Dalén M, Biancari F, Rubino AS, et al. Ministernotomy versus full sternotomy aortic valve replacement with a sutureless bioprosthesis: A multicenter study. *Ann Thorac Surg*. 2015;99(2):524–530. doi:10.1016/j.athoracsurg.2014.08.028
- Rodríguez-Caulo EA, Guijarro-Contreras A, Guzmán A, et al. Quality of life after ministernotomy versus full sternotomy aortic valve replacement. *Semin Thorac Cardiovasc Surg*. 2021;33(2):328–334. doi:10.1053/j.semthor.2020.07.013
- El-Ansary D, LaPier TK, Adams J, et al. An evidence-based perspective on movement and activity following median sternotomy. *Phys Ther*. 2019;99(12):1587–1601. doi:10.1093/ptj/pzz126
- Claessens J, Rottiers R, Vandenbrande J, et al. Quality of life in patients undergoing minimally invasive cardiac surgery: A systematic review. *Indian J Thorac Cardiovasc Surg*. 2023;39(4):367–380. doi:10.1007/s12055-023-01501-y
- Huang APS, Sakata RK. Pain after sternotomy: Review. *Braz J Anesthesiol*. 2016;66(4):395–401. doi:10.1016/j.bjane.2014.09.013
- Horne D, Kehler DS, Kaouk G, et al. Impact of physical activity on depression after cardiac surgery. *Can J Cardiol*. 2013;29(12):1649–1656. doi:10.1016/j.cjca.2013.09.015