A new hope for aortic valve surgery: the rise of minimally invasive aortic valve replacement – a retrospective cohort study

Nora Knez[1]*, Tomislav Tokić[2], Ante Lekić[2], Hrvoje Gašparović[2,3]

[1]Institute of Emergency Medicine of the City of Zagreb, Zagreb, Croatia
[2]University Hospital Centre Zagreb, Zagreb, Croatia
[3]University of Zagreb, School of Medicine, Zagreb, Croatia

KEYWORDS: minimally invasive aortic valve replacement, cardiac surgery outcomes, perioperative management, cardiopulmonary bypass.

CITATION: Cardiol Croat. 2025;20(5-6):114-5. | https://doi.org/10.15836/ccar2025.114

***ADDRESS FOR CORRESPONDENCE:** Nora Knez, Nastavni zavod za hitnu medicinu Grada Zagreba, Ulica Vjekoslava Heinzela 88, HR-10000 Zagreb, Croatia. / Phone: +385-99-7466-450 / E-mail: noraknez6@gmail.com

ORCID: Nora Knez, https://orcid.org/0000-0002-4933-4947 • Tomislav Tokić, https://orcid.org/0000-0001-6871-8746
Hrvoje Gašparović, https://orcid.org/0000-0002-2492-3702

Introduction: Minimally invasive aortic valve replacement (miniAVR) is increasingly adopted as an alternative to conventional AVR, offering reduced surgical trauma, improved cosmesis, accelerated recovery, and decreased transfusion requirements.[1] Despite these advantages driving its uptake, concerns regarding longer operative times, technical complexity, and limited operative exposure continue to hinder its wider dissemination.[2] This study aims to evaluate and directly compare perioperative outcomes of miniAVR versus conventional AVR in a contemporary cardiac surgical setting.

TABLE 1. Demographic and clinical profiles of subjects undergoing isolated aortic valve replacement surgery.

	All subjects (n=1649)	Full Sternotomy AVR (n=1096)	Minimally Invasive AVR (n=553)	*p*-value
Age (years), median (IQR)	69 (62-75)	70 (64-75)	67 (60-73)	<0.001
Female, n (%)	675 (40.9)	447 (40.8)	228 (41.2)	0.862
BMI (kg/m2), median (IQR)	29 (25-32)	29 (26-32)	29 (26-32)	0.858
EF (%), median (IQR)	60 (52-65)	60 (50-65)	60 (55-65)	0.005
BAV, n (%)	510 (30.93)	259 (23.63)	251 (45.39)	<0.001
Preoperative AF, n (%)	290 (17.6)	217 (17.8)	73 (13.2)	<0.001
Endocarditis, n (%)	45 (2.7)	37 (3.38)	8 (1.45)	0.023
CAD, n (%)	430 (26.1)	323 (29.6)	106 (19.2)	<0.001
Hypertension, n (%)	1200 (72.8)	792 (72.3)	408 (73.8)	0.537
Diabetes mellitus, n (%)	491(29.78)	351 (32.03)	140 (25.32)	0.006
Dyslipidemia, n (%)	814 (49.36)	527 (48.08)	287 (51.9)	0.126
Smoking, n (%)	399 (24.2)	242 (22.08)	137 (24.77)	0.598
COPD, n (%)	166 (10.07)	119 (10.85)	47 (8.5)	0.144
Preoperative creatinine (mg/dL), median (IQR)	83 (70-100)	85 (69-105)	81 (71-97)	0.305
CKD, n (%)	850 (51.55)	578 (52.74)	272 (49.19)	0.088
Previous solid organ transplantation, n (%)	20 (1.21)	12 (1.1)	8 (1.45)	0.461
PVD, n (%)	117 (7.1)	89 (7.4)	36 (6.5)	0.570
Previous MI, n (%)	91 (5.52)	72 (6.57)	19 (3.44)	<0.001
Stroke, n (%)	189 (11.49)	138 (12.59)	52 (9.4)	0.009
EuroSCORE II (%), median (IQR)	2.46 (1.6-3.7)	2.54 (1.75-3.96)	2.20 (1.49-3.15)	<0.001

AVR: aortic valve replacement; miniAVR: minimally invasive aortic valve replacement; IQR: interquartile range; BMI: body mass index; EF: ejection fraction; BAV: bicuspid aortic valve; AF: atrial fibrillation; CAD: coronary artery disease; COPD: chronic obstructive pulmonary disease; CKD: chronic kindey disease; PVD: peripheral vascular disease; MI: myocardial infarction

RECEIVED:
March 14, 2025
ACCEPTED:
April 2, 2025

Patients and Methods: This retrospective cohort study was conducted at University Hospital Center Zagreb and included 1,649 patients who underwent full sternotomy AVR (n=1,096) or miniAVR (n=553) between 2010 and 2024. Group comparisons were performed using the chi-square test for categorical variables and the Mann-Whitney U test for continuous variables, with a significance threshold of p<0.05. Multivariable logistic regression was applied to categorical outcomes, while linear regression was used for continuous variables. Statistical analyses were conducted using SPSS.

Results: The median age was 69 years, with 59.1% male patients (**Table 1**). MiniAVR was associated with longer CPB (101 vs. 95 min, p<0.001) and ACC times (71 vs. 65 min, p<0.001) but shorter ventilation duration (7 vs. 8 hours, p<0.001). Stroke incidence was lower in miniAVR (0.6% vs. 1.2%, p=0.009), while pacemaker implantation was more frequent (2.35% vs. 1.92%, p<0.001). A summary of intraoperative and postoperative outcomes is provided in **Tables 2 and 3**. Regression analysis confirmed that miniAVR independently predicted longer CPB (B=4.75, p=0.040) and ACC times (B=1.97, p<0.001), lower stroke risk (B=-0.018, p<0.001) and reduced sternal wound infections (B=-0.031, p<0.001). Differences between univariate and multivariate analyses suggest confounding by other perioperative factors, highlighting the importance of adjusted analyses in assessing outcomes in minimally invasive surgery. A full regression analysis is presented in **Table 4**.

Conclusion: The increasing adoption of miniAVR reflects both patient preference and surgical advancements, underscoring its advantages over conventional AVR. By minimizing surgical trauma, accelerating recovery, and reducing stroke risk, miniAVR emerges as an optimal alternative in appropriately selected patients. Its clinical benefits position it as the preferred approach in high-volume centers, supporting enhanced perioperative outcomes and patient satisfaction.

TABLE 2. Intraoperative characteristics of the study subjects.

	All subjects (n=1649)	Full Sternotomy AVR (n=1096)	Minimally Invasive AVR (n=553)	*p*-value
ACC (min), median (IQR)	67 (55-85)	65 (56-88)	71 (53-83)	<0.001
CPB (min), median (IQR)	97 (80-120)	95 (77-117)	101 (86-122)	<0.001

AVR: aortic valve replacement; ACC: aortic cross-clamp; IQR: interquartile range; CPB: cardiopulmonary bypass

TABLE 3. Comparison of in-hospital outcomes between the study groups.

	All subjects (n=1649)	Full Sternotomy AVR (n=1096)	Minimally Invasive AVR (n=553)	*p*-value
MCS, n (%)	36 (2.18)	27 (2.46)	9 (1.63)	0.185
Revision due to bleeding, n (%)	49 (3.0)	32 (2.92)	17 (3.07)	0.366
Ventilation (hours), median (IQR)	7 (5-11)	8 (6-11)	7 (5-10)	<0.001
ICU stay (days), median (IQR)	2 (1-2)	2 (1-2)	2 (1-2)	0.771
Need for pacemaker, n (%)	34 (2.1)	21 (1.92)	13 (2.35)	<0.001
POAF, n (%)	545 (33.05)	355 (32.39)	190 (34.36)	0.343
Sternal wound infection, n (%)	73 (4.43)	44 (4.01)	29 (5.24)	0.090
Stroke, n (%)	20 (1.21)	12 (0.8)	8 (0.6)	0.221

AVR: aortic valve replacement; MCS: mechanical circulatory support; IQR: interquartile range; ICU: intensive care unit; POAF: postoperative atrial fibrillation

TABLE 4. Multivariable regression analysis of factors associated with perioperative outcomes in full sternotomy aortic valve replacement and minimally invasive aortic valve replacement patients.

	B Coefficient	95% Confidence Interval	*p*-value
Aortic cross clamp	1.968	0.915-3.563	<0.001
Cardiopulmonary bypass	4.750	0.226-9.138	0.040
Ventilation	-0.770	-1.660-0.120	0.090
Intensive care unit	-0.072	0.278-0.133	0.491
Postoperative atrial fibrillation	-0.015	-0.069-0.038	0.577
Need for pacemaker	-0.036	-0.057- -0.016	<0.001
Mechanical circulatory support	3.671		0.999
Sternal wound infection	0.031	-0.043--0.019	<0.001
Stroke	0.018	0.027--0.009	<0.001

LITERATURE

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