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ORIGINAL RESEARCH ARTICLE

One-year mortality in patients undergoing aortic valve replacement and its relationship with the extent of myocardial damage scale

Mortalidad a un año en pacientes sometidos a reemplazo de válvula aórtica y su relación con la escala de extensión del daño miocárdico

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Abstract

Objective: *To determine the 1-year mortality in patients undergoing aortic valve replacement and its relationship with the myocardial damage extension scale.* **Methods:** *An observational, retrospective, cross-sectional, and comparative study was conducted. Patients over 18 years of age, of both sexes, who underwent aortic valve replacement between March 1, 2019, and March 31, 2021, were included. Patients were classified into subgroups based on the myocardial damage extension classification to determine 12-month mortality. In addition, risk factors associated with mortality, as well as clinical and socio-demographic variables, were documented.* **Results:** *A total of 177 patients (104 men [59%] and 73 women [41%]) were included. Distribution among myocardial damage stages was: Stage 0 (5%), stage 1 (25%), stage 2 (56%), stage 3 (8%), and stage 4 (6%). One-year mortality was 6% (11/177), predominantly in stage 2 (72%) and stage 3 (18%). Hypertension (64%) and diabetes mellitus (55%) were the most frequent comorbidities among the deceased. Left ventricular ejection fraction (LVEF) < 30% and Society of Thoracic Surgeons (STS) score > 2% were risk factors associated with mortality.* **Conclusions:** *One-year mortality was 6%, predominantly in stage 2 of myocardial damage extension. The staging did not correlate with mortality after 1 year of follow-up. An STS score > 2% and LVEF < 30% are risk factors for mortality.*

Keywords: *Aortic stenosis. Extent of myocardial damage. Mortality.*

Resumen

Objetivo: *Determinar la mortalidad a 1 año en pacientes sometidos a reemplazo de válvula aórtica y su relación con la escala de extensión del daño miocárdico.* **Métodos:** *Se realizó un estudio observacional, retrospectivo, transversal y comparativo. Se incluyeron pacientes mayores de 18 años, de ambos sexos, sometidos a reemplazo de valvula aórtica entre el 1 de marzo de 2019 y el 31 de marzo de 2021. Los pacientes fueron asignados a subgrupos según la clasificación de la extensión del daño miocárdico, con el objetivo de determinar la mortalidad a 12 meses. Asimismo, se documentaron factores de riesgo*

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asociados a la mortalidad, así como variables clínicas y sociodemográficas. **Resultados:** *Se incluyeron 177 pacientes, de los cuales 104 eran hombres (59%) y 73 eran mujeres (41%). La distribución entre los estadios de daño miocárdico fue la siguiente: en estadio 0 el 5%, en estadio 1 el 25%, en estadio 2 el 56%, en estadio 3 el 8% y en estadio 4 el 6%. La mortalidad a 1 año fue del 6% (11/177), predominantemente en el estadio 2 (72%) y el estadio 3 (18%). La hipertensión (64%) y la diabetes mellitus (55%) constituyeron la comorbilidad más frecuente entre los fallecidos. La fracción de eyección del ventrículo izquierdo (FEVI) < 30% y una puntuación de la Society of Thoracic Surgeons (STS) > 2% fueron factores de riesgo asociados con la mortalidad.* **Conclusiones:** *La mortalidad a 1 año fue del 6%, predominantemente en el estadio 2 de extensión del daño miocárdico. La estadificación no se correlacionó con la mortalidad después de 1 año de seguimiento. Una puntuación STS > 2% y una FEVI < 30% son factores de riesgo para mortalidad.*

Palabras clave: *Estenosis aórtica. Extensión del daño miocárdico. Mortalidad.*

Introduction

Aortic stenosis is one of the most prevalent valvular diseases worldwide[1], and aortic valve replacement is the second most performed surgery in our unit. This condition shows increasing prevalence due to its association with degenerative processes linked to aging and the longer life expectancy of the population. Timely identification of at-risk populations enables earlier interventions, which can positively influence patients' long-term prognoses[2].

Although there is no ideal time for intervention, new assessment techniques suggest that earlier intervention could be beneficial[3]. Simplistic assessment based on individual parameters, such as left ventricular ejection fraction (LVEF), has evolved, as have risk scores, which are becoming increasingly specific to populations or pathologies[4].

The myocardial damage extent score proposed by P. Généreux allows for an objective evaluation using simple echocardiographic parameters, providing a valuable tool to address the complex interplay and progression of cardiovascular disease[5]. Its implementation on a smaller scale offers insight into its value in the Mexican population.

The STS score has been used to stratify patients undergoing aortic valve replacement. It includes clinical parameters that predict morbidity and mortality[6].

For this reason, this study aims to determine 1-year mortality in patients undergoing aortic valve replacement (AVR) and its relationship with the myocardial damage extension scale. A secondary objective is to assess the surgical risk in our population using the STS scale.

Materials and methods

This is an observational, retrospective, cross-sectional, and comparative study where we associated mortality and myocardial damage stages.

The selected population included patients undergoing aortic valve replacement through cardiac surgery. The inclusion criteria were patients over 18 years of age, of either sex, with a single aortic valve intervention between March 1, 2019, and March 31, 2021, or a medical record containing complete echocardiography studies and a complete surgical report. Patients with significant coronary disease, those undergoing valve replacement with coronary revascularization, and patients in a terminal state or not undergoing surgical treatment were excluded. The elimination criteria included patients who did not have complete information to classify the extent of myocardial damage.

Mortality was assessed based on hospital records, with the assumption that all patients' records were properly documented throughout the full year in the hospital system, without any omissions.

All patients undergoing aortic valve replacement in the period above were included. A non-probabilistic sampling technique on consecutive cases was used. The information of patients diagnosed with aortic stenosis was collected in our hospital unit, and each case was reviewed individually using the digital and physical clinical records; it was not necessary to obtain a letter of informed consent. This instrument included echocardiographic variables for staging based on the myocardial damage extent scale. The complete information from the transthoracic echocardiography study was incorporated into a database, and the most relevant variables were analyzed, such as the LVEF, the maximum velocity of tricuspid insufficiency, and the systolic pressure of the pulmonary artery. The pre-operative echocardiographic characteristics were determined, and each patient was classified into the different stages of the myocardial damage extent scale. Mortality rates at 1 year of follow-up were documented. For subsequent statistical analysis, patient data and variables were stored in a Microsoft Excel spreadsheet. The results were analyzed using descriptive statistics

(measures of central tendency, frequencies, and percentages). For quantitative variables, the characteristics of the distribution curve were considered.

The stages of myocardial damage extension were analyzed to make comparisons between them using the Kruskal-Wallis test, since the Kolmogorov-Smirnov test, reinforced by Lilliefors, showed a $p < 0.05$, which indicated that the quantitative variables did not follow a normal distribution (Fig. 1). Afterward, the Tukey test was used to compare *post hoc* between stages to determine the similarity between groups (Groups a and b).

To compare the stages of myocardial damage extension, the Kruskal-Wallis test was employed due to the non-normal distribution of the quantitative variables, as indicated by a Kolmogorov-Smirnov test with Lilliefors correction ($p < 0.05$; Fig. 1). Five groups were compared according to the myocardial damage extension classification. Subsequently, a *post hoc* Tukey test was applied to identify significant differences between specific groups and assess their degree of similarity (e.g., Group "a" vs. Group "b"). Groups sharing the same letter (e.g., "a") are not significantly different from each other in terms of LVEF. Groups labeled with different letters (e.g., "a" vs. "b") show statistically significant differences ($p < 0.05$).

A binary logistic regression was performed, where the dependent variable was mortality after aortic valve replacement, represented in the database as 1 for the presence and 0 for the absence of mortality. The independent variables are the observations described in table 1, where 1 refers to the presence of the risk factor and 0 to its absence. An $\alpha < 0.05$ was assigned, so variables with $p < 0.05$ are included at the beginning of table 1, which also describes the odds ratio (OR), 95% confidence intervals (CI), β, and Wald χ^2 of the statistical model, considering a value of $p < 0.05$ as statistically significant. R-studio version 2024.04.2 + 764 was used for statistical analysis and data visualization.

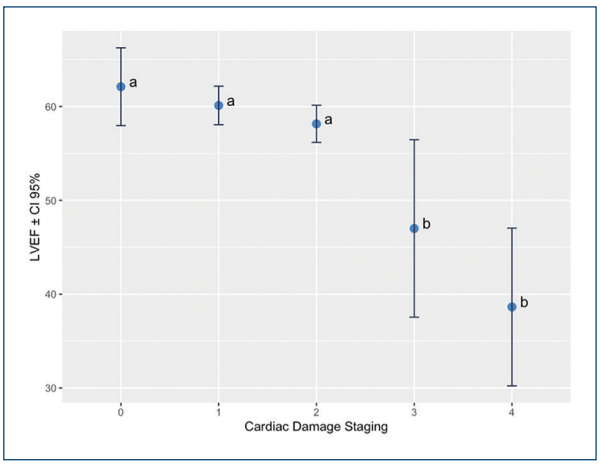

Figure 1. Relationship between the myocardial damage scale and left ventricular ejection fraction, $p < 0.05$.

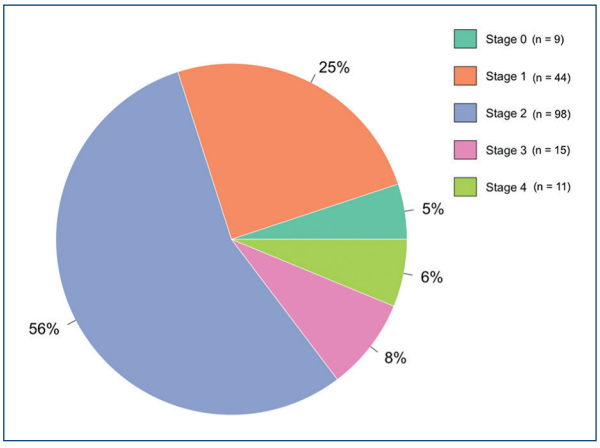

Figure 2. Frequency distribution of the stages of the myocardial damage extension scale.

Results

During the study period, from March 1, 2019, to March 31, 2021, clinical and echocardiographic data were collected from patients undergoing aortic valve replacement in our unit. The total population consisted of 177 patients, of whom 104 (59%) were men and 73 (41%) were women, with an average age of 62 years.

Among the most prevalent comorbidities, hypertension was present in 106/177 (60%) patients, whereas type 2 diabetes mellitus affected 64/177 (36%) patients. Most valve replacements were performed using a mechanical valve, with 108/177 (61%) cases, whereas 69/177 (39%) patients received a biological valve. The mean age of patients with mechanical prostheses was 54 years, and that of those with biological valves was 74 years. The rest of the general characteristics of the population are presented in table 2. Regarding the classification of the extent of myocardial damage, 98/177 (55%) patients were in stage 2, being the most prevalent group, followed by stage 1 with 44/177 (25%). The least prevalent stage was 0, with 9/177 (5%) patients. The detailed frequencies of each stage are shown in figure 2. The average LVEF in the different stages of the extent of myocardial damage is presented in figure 1, with an average value of 57%.

The mortality at 1 year of follow-up after aortic valve replacement, based on the myocardial damage score,

Table 1. Risk factors for death in severe aortic stenosis (n = 177)

Risk factor	β	χ^2	p	OR	95% CI	
LVEF < 30%	2.390	5.283	0.022	10.909	1.422	83.696
STS > 2%	1.772	5.266	0.022	5.881	1.295	26.712
Gender (M/F)	6699	0.000	0.998	0.550	0.159	1.926
Hypertension	5865	0.000	0.994	1.215	0.342	4.333
DM2	5273	0.000	0.997	2.249	0.657	7.686
Obesity	5808	0.000	0.993	0.976	0.234	4.123
Dyslipidemia	4348	0.000	0.995	1.766	0.354	8.615
Smoking	6280	0.000	0.996	1.295	0.378	4.448
AVA < 1 cm^2	4453	0.000	0.994	0.190	0.005	0.988
PASP	0.010	0.336	0.556	1.016	0.986	1.047
Age > 65 years	0.928	1.825	0.177	1.032	0.973	1.094

OR: odds ratio; CI: confidence intervals; χ^2: Chi-squared; β: beta, STS: Society of Thoracic Surgeons score; PASP: pulmonary arterial systolic pressure; M: male; F: female; AVA: aortic valve area; LVEF: left ventricular ejection fraction.

Table 2. General characteristics of the population with severe aortic stenosis based on the classification of the extent of myocardial damage (n = 177)

Myocardial damage stage (Généroux)	0 (n = 9)	1 (n = 44)	2 (n = 98)	3 (n = 15)	4 (n = 11)	Total (n = 177)
Men, n (%)	5 (55)	26 (59)	56 (57)	9 (60)	8 (73)	104 (59)
Women, n (%)	4 (45)	18 (41)	42 (43)	6 (40)	3 (27)	73 (41)
Average age (years)	57	61	63	65	59	62
Average PASP[1]	32	30	35	47	47	36
Average LVEF[2] (%)	62	60	58	57	39	57
Comorbidities, n (%)						
Hypertension	5 (55)	26 (59)	62 (63)	11 (73)	2 (18)	106 (60)
DM[3]	2 (22)	11 (25)	44 (45)	6 (40)	1 (9)	64 (36)
Dyslipidemia	1 (11)	5 (11)	12 (12)	1 (7)	1 (9)	20 (11)
Smoking	2 (22)	16 (36)	38 (39)	9 (60)	3 (27)	69 (39)
Valve type, n (%)						
Mechanic	8 (89)	28 (64)	56 (57)	7 (47)	8 (73)	108 (61)
Biological	1 (11)	16 (36)	42 (43)	8 (53)	3 (27)	69 (39)
Average pump (min)	98	88	91	97	94	91
Average STS[4] (%)	0.79	1.06	1.19	1.48	0.95	1.15
Days of Hospitalization	8	7	9	12	10	9

[1]PASP: pulmonary artery systolic pressure.
[2]LVEF: left ventricular ejection fraction.
[3]DM: diabetes mellitus.
[4]STS: Society of Thoracic Surgeons score.

was 6% (11/177). One-year mortality was the highest in group 2, with 8/98 (8.16%) deaths (72% of all defunctions), followed by group 3 with 2/15 (13.3%) deaths (18% of all defunctions). The remaining variables are presented in table 3. Of the cases of mortality, 5 (45%) were men and 6 (55%) were women. The age group with the highest prevalence of death was 70-79 years, with 4 patients (36%).

Hypertension was the most frequent comorbidity in the cases of death, present in 7 (64%) patients, followed by diabetes mellitus in 6 (55%) patients (Tables 1 and 4).

Table 3. Analysis of the relationship between the extent of myocardial damage and mortality (n = 177)

Myocardial damage stage	0 (n = 9)	1 (n = 44)	2 (n = 98)	3 (n = 15)	4 (n = 11)	Total
Mortality, n (%)	0 (0)	1 (9)	8 (72)	2 (18)	0 (0)	11
Mortality rate (per stage) (%)	0	2	8	13	0	6
Average age	0	76	63	68	0	65
Average LVEF	0	62	57	52	0	57
Comorbidities, n (%)						
Hypertension	0 (0)	1 (9)	5 (45)	1 (9)	0 (0)	7 (63.6)
Diabetes mellitus	0 (0)	0 (0)	4 (36)	2 (18)	0 (0)	6 (54.5)
Dyslipidemia	0 (0)	0 (0)	2 (18)	0 (0)	0 (0)	2 (18.1)
Smoking	0 (0)	0 (0)	4 (36.3)	1 (9)	0 (0)	5 (45.4)
Valve type, n (%)						
Mechanic	0 (0)	0 (0)	4 (36.3)	1 (9)	0 (0)	5 (45.4)
Biological	0 (0)	1 (9)	4 (36.3)	1 (9)	0 (0)	6 (54.5)
Hospitalization days	0	2	9.6	23	0	11

*Mortality rate: number of deaths/total population × 100.

Table 4. One-year mortality in patients undergoing aortic valve replacement (n = 177)

Mortality	Count	%	Total
General mortality	11/177	6	177
Mortality by sex			
Male	5/11	45	105
Female	6/11	55	72
Mortality by age group			
30-39	1/11	9	4
40-49	1/11	9	17
50-59	1/11	9	50
60-69	3/11	27	59
70-79	4/11	36	39
80-90	1/11	9	8
Mortality and comorbidity			
Hypertension	7/11	64	116
Diabetes mellitus	6/11	55	64
Dyslipidemia	2/11	18	20
Smoking	5/11	45	69
Overweight (25-29.9)	3/11	27	68
Obesity (30-34.9)	1/11	9	42
Grade II obesity (35-39.9)	3/11	27	28
Mortality and valve replacement			
Mechanic	4/11	36	107
Biological	7/11	64	70

Among the causes of mortality, the main ones were cardiovascular complications in 7/11 (64%) patients, followed by hemorrhage in 2/11 (18%) and sepsis in 2/11 (18%) patients. Cardiovascular complications are arrhythmias, myocardial infarction, and cardiac tamponade.

Among the main causes of mortality, cardiovascular events stand out, followed by sepsis and hemorrhage. These results are similar to those described in the international literature, where the causes of cardiovascular death are the most determining variable[7].

The risk factors for death in severe aortic stenosis are LVEF < 30% (OR 10.9, 95% CI 1.42-83.69) and STS > 2% (OR 5.88, 95% CI 1.29-26.71). The rest of the variables were not statistically significant.

Table 5 presents a comparative analysis of clinical and echocardiographic characteristics by vital status. The deceased patients had an average age of 65 ± 13 years, whereas the alive patients had an average age of 62 ± 10 years. The mean LVEF was 57% ± 14 in both groups.

Of the deceased patients, 64% (7) had systemic arterial hypertension and 55% (6) had type 2 diabetes mellitus. On the other hand, 60% (99) of the alive patients had hypertension, and 36% (58) had type 2 diabetes mellitus. The mean pulmonary artery systolic pressure (PASP) was 41.91 ± 19.77 mmHg in deceased patients and 36.47 ± 16.23 mmHg in alive patients.

The mean maximum tricuspid insufficiency velocity was 2.74 ± 0.39 m/s in deceased patients and 2.69 ± 0.52 m/s in alive patients. Regarding surgical risk, the mean STS score in deceased patients was 1.56% ± 0.72 versus 1.12% 0.59 in alive patients.

As shown in figure 1, significant differences in LVEF were observed across the stages of myocardial damage. The average LVEF decreased progressively from stage 0 (62%) to stage 4 (39%). Specifically, the LVEF was highest in stage 0 (62%) and stage 1 (60%), and

Table 5. Basal, clinical, and echocardiographic characteristics by vital state (n = 177)

Variable	Deceased (n = 11) (%)	Live (n = 166) (%)
Average age	65 ± 13	62 ± 10
Hypertension	64 (7)	60 (99)
Diabetes mellitus	55 (6)	36 (60)
Dyslipidemia	18 (2)	11 (18)
Smoking	45 (5)	39 (64)
Mechanical valve	45 (5)	61 (101)
Biological valve	55 (6)	39 (65)
Mean pulmonary artery systolic pressure	41.91 ± 19.77 mmHg	36.37 ± 16.23 mmHg
Mean score STS	1.56 ± 0.72	1.12 ± 0.59
Mean maximum aortic valve velocity	4.57 ± 0.77 m/s	4.82 ± 0.7 m/s
Mean transvalvular gradient	55.82 ± 22.37 mmHg	58.5 ± 18.71 mmHg
Mean aortic valve area	0.6 ± 0.15 cm^2	0.65 ± 0.19 cm^2
Mean LVEF	57 ± 14	57 ± 11
Mean maximum velocity of tricuspid regurgitation	2.74 ± 0.39 m/s	2.69 ± 0.52 m/s

STS: Society of Thoracic Surgeons; LVEF: left ventricular ejection fraction.

significantly lower in stages 3 (52%) and 4 (39%). *Post hoc* Tukey analysis indicated that groups with the same letter (e.g., groups "a" vs. "a") did not differ significantly in terms of LVEF, whereas groups with different letters (e.g., groups "a" vs. "b") showed statistically significant differences ($p < 0.05$), highlighting a decline in LVEF as the severity of myocardial damage increased.

These differences are important as they correlate with the worsening of cardiac function across myocardial damage stages.

Discussion

The study's main findings can be summarized as follows: the overall mortality of the population undergoing aortic valve replacement in our research is higher than that reported in the international literature.

The mortality rate of our population was 6%, with an average age of 65 years. Cardiac surgery procedures consistently present lower mortality in developed countries compared to developing countries, a situation influenced by various factors, including the socioeconomic aspect, the type of hospital care, timely detection, management of the center, comorbidities, and the initial level of severity of the disease. Mejia et al. evaluated the usefulness of STS and EUROSCORE in Brazilian patients as tools to predict outcomes after cardiac surgery, concluding little correlation for predicting morbidity and mortality[8].

Various studies highlight that the increase in the volume of procedures is not necessarily associated with an increase in the center's quality[9].

The stratification of myocardial damage extent does not have a statistical correlation with the mortality of patients undergoing aortic valve replacement in our population.

The stage where the highest mortality occurred was stage 2, which in turn had the largest number of patients, followed by stage 3. Highlighting the absence of deaths in stages 0 and 4, this finding could be explained by the small number of patients in these groups. The damage derived from aortic stenosis does not necessarily occur sequentially and could be associated with the patient's susceptibility and genetic predisposition.

Among the most relevant factors found in patients who died after aortic valve replacement were advanced age, hypertension, type 2 diabetes mellitus, smoking, and being overweight.

After performing the logistic regression analysis, none of the previously mentioned factors was directly associated with mortality. On the other hand, an STS > 2% and an LVEF < 30% were associated with risk factors in our population (Table 1).

The STS scale is multidimensional, with a good correlation with mortality in aortic valve replacement surgery. However, it is a scale validated in the North American population. None of the patients who underwent surgery exceeded STS > 4%, being generally considered a low-risk population. Given these findings, it is worth highlighting the importance of searching for specific scales for the Mexican population. Risk scales validated in specific populations or under certain conditions usually do not present a good correlation when applied to other populations over time.

The average LVEF of all patients shows a progressive decrease when comparing the various stages of myocardial damage extension (Fig. 1). Although aortic stenosis may not present a sequential clinical evolution, the fall in LVEF seems to be a constant within the natural evolution of the disease. LVEF < 30% is a significant risk

factor for mortality in the population operated on in our unit. Various clinical trials have highlighted the prognostic value of LVEF, recommending early interventions, even before its fall[10].

Mortality in our population occurred within the first 30 days after hospital admission. There were no new deaths during the 1 year of follow-up. This higher prevalence of mortality during hospitalization is well known. Malvindi et al. reported hospital mortality of 2.2% in isolated aortic valve replacement in the octogenarian population. This is the most vulnerable period. Emphasizing prolonged surgical times as a morbidity and mortality factor[11].

Mortality was similar regardless of the type of valve placed, with 5 (45%) patients in the mechanical valve group and 6 (55%) in the biological valve group. Du et al. evaluated mortality during the first 30 days after aortic valve replacement in a retrospective cohort, documenting higher mortality with the use of mechanical valves[12].

One of the most relevant subanalyses is the mortality associated with PASP and the type of valve. In patients who died and underwent mechanical valve replacement, PASP was higher, while patients undergoing biological valve replacement had lower PASP values. Weber et al. associate the presence of pulmonary hypertension as a variable that predicts an unfavorable hemodynamic profile after 1 year of follow-up[13].

Regarding myocardial damage and functional class after 1 year of follow-up, no statistically significant association was found. However, a key limitation is the data collection method, as this was a retrospective study. It would be worthwhile to standardize the evaluation of functional class within our unit.

Finally, one of the most notable limitations is the lack of echocardiographic follow-up in our sample, as a significant proportion of patients did not undergo follow-up imaging. This situation may be related to circumstances associated with the COVID-19 pandemic, which limit the evaluation of the reversibility of changes observed in the myocardial damage extension scale. Our study is limited by its retrospective design and single-center data collection. A survival analysis was not possible to perform due to the lack of complete data on the exact timing of patient deaths.

Another limitation of this study is the possibility of mortality events occurring outside our institution (e.g., at home or in another hospital). As a referral center in the northern region, patients may have died in their states of origin without these events being reported to us, potentially leading to underreporting of mortality data. Mortality was recorded as a binary outcome (yes/no) during the 1-year follow-up period. However, the exact date of death was not systematically captured in our database, as death was not recorded as a time-to-event variable.

However, the hypothesis and data obtained open the door for us to continue with this line of research, which is of great relevance in the future for the complementary evaluation of patients.

Conclusion

The mortality rate in our population was 6%. One-year mortality was the highest in stage 2 of myocardial damage extension. In our investigation, the stratification of myocardial damage extension did not correlate with the mortality of patients after 1 year of follow-up. Patients with a higher classification of myocardial damage extension had a lower LVEF. Among the risk factors most associated with mortality in our population are STS > 2% and LVEF < 30%. The STS is a scale that has not been validated in the Mexican population. The search for specific risk scales in populations different from Americans should be encouraged.

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Conflicts of interest

The authors declare no conflicts of interest.

Ethical considerations

Protection of humans and animals. The authors declare that the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation and with the World Medical Association and the Declaration of Helsinki. The procedures were authorized by the Institutional Ethics Committee.

Confidentiality, informed consent, and ethical approval. The authors have obtained approval from the Ethics Committee for the analysis of routinely collected and anonymized clinical data; therefore, individual

informed consent was not required. Relevant ethical recommendations have been followed.

Declaration on the use of artificial intelligence. The authors declare that no generative artificial intelligence was used in the writing or creation of the content of this manuscript.

References

1. Kanwar A, Thaden JJ, Nkomo VT. Management of patients with aortic valve stenosis. Mayo Clin Proc. 2018;93:488-508.
2. Imamura Y, Kowatari R, Koizumi J, Tabayashi A, Saitoh D, Kin H. Twenty-year experience following aortic valve replacement in patients younger than 60 years of age. J Cardiothorac Surg. 2024;19:279.
3. Vahanian A, Baumgartner H, Bax J, Butchart E, Dion R, Filippatos G, et al. Guidelines on the management of valvular heart disease: the task force on the management of valvular heart disease of the European society of cardiology. Eur Heart J. 2007;28:230-68.
4. Sevilla T, Revilla-Orodea A, Román JA. Timing of intervention in asymptomatic patients with aortic stenosis. Eur Cardiol Rev. 2021;16:e32.
5. Généreux P, Pibarot P, Redfors B, Mack MJ, Makkar RR, Jaber WA, et al. Staging classification of aortic stenosis based on the extent of cardiac damage. Eur Heart J. 2017;38:3351-8.
6. Lindman BR, Alexander KP, O'Gara PT, Afilalo J. Futility, benefit, and transcatheter aortic valve replacement. JACC Cardiovasc Interv. 2014; 7:707-16.
7. Hugo GS, Lourdes VA, Carlos RP, Gonzalo de la M, Covadonga FG, Carmen A, et al. Prognosis of patients with severe aortic stenosis after the decision to perform an intervention. Rev Esp Cardiol. 2019;72: 363-436.
8. Mejia OA, Borgomoni GB, Zubelli JP, Dallan LR, Pomerantzeff PM, Oliveira MA, et al. Validation and quality measurements for STS, EuroSCORE II and a regional risk model in Brazilian patients. PLoS One. 2020;15:e0238737.
9. Kilic A, Magruder JT, Grimm JC, Dungan SP, Crawford T, Whitman GJ, et al. Development and validation of a score to predict the risk of readmission after adult cardiac operations. Ann Thorac Surg. 2017;103:66-73.
10. Miura S, Arita T, Kumamaru H, Domei T, Yamaji K, Soga Y, et al. Causes of death and mortality and evaluation of prognostic factors in patients with severe aortic stenosis in an aging society. J Cardiol. 2015;65:353-9.
11. Malvindi PG, Luthra S, Giritharan S, Kowalewski M, Ohri S. Long-term survival after surgical aortic valve replacement in patients aged 80 years and over. Eur J Cardiothorac Surg. 2021;60:671-8.
12. Du D (Tony), McKean S, Kelman JA, Laschinger J, Johnson C, Warnock R, et al. Early mortality after aortic valve replacement with mechanical prosthetic vs bioprosthetic valves among medicare beneficiaries: a population-based cohort study. JAMA Intern Med. 2014;174:1788-95.
13. Weber L, Rickli H, Haager PK, Joerg L, Weilenmann D, Chronis J, et al. Hemodynamics prior to valve replacement for severe aortic stenosis and pulmonary hypertension during long-term follow-up. J Clin Med. 2021;10:3878.