SCIENTIFIC LETTER

SURGICAL RESOLUTION OF MECHANICAL PROSTHETIC DYSFUNCTION IN A PATIENT WITH A PORCELAIN AORTA

ABSTRACT

We present a clinical case with a satisfactory surgical outcome of a patient in the seventh decade of life with a diagnosis of dysfunction of a mechanical valve prosthesis in the aortic position and with a calcified aorta (porcelain aorta) from the root to the bifurcation of the iliac arteries. The decision for surgical replacement of the aortic valve was based on the presence of thrombosis and *pannus*, which, in addition, were the cause of severe aortic stenosis and secondary mitral insufficiency, also severe. This scenario is not accounted for in cardiovascular surgical risk scales, such as the EuroSCORE, the Society of Thoracic Surgeons (STS) risk scale, or the Parsonnet scale, among others. This adds a further risk for this procedure, as this fully calcified aortic morphology increases the predisposition for aortic dissection or rupture. For this reason, the repair is difficult because there is no adequate plane for the coaptation of the surgical suture. In this patient, age, the presence of comorbidities such as chronic renal failure, severe pulmonary hypertension, the need for reoperation, and tissues in poor condition are added as risk factors, despite which the postoperative result was satisfactory.

Keywords: *porcelain aorta, mechanical prosthetic dysfunction, high surgical risk, comorbidities, pulmonary hypertension, ventricular dysfunction.*

Authors

Rutilio Daniel Jiménez Espinosa[1], Luis León Hernández Trejo[1], Jesús Saucedo Castillo[1], Dalia Chacón Martell[2], Pavel Alger Hernández González[2], Ana Luisa Hernández Pérez[3]

[1]*Attending physicians.*
[2]*Resident physicians.*

Cardiovascular Surgery Service, High Specialty Medical Unit, Hospital de Cardiología del Centro Médico Nacional Siglo XXI, Mexico.

[3]*Anesthesiologist, ABC Medical Center.*

Corresponding author:
Rutilio Daniel Jiménez-Espinosa
rudajies@gmail.com

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INTRODUCTION

Severe aortic calcification, also called "porcelain aorta", has a significant effect on patient prognosis. This is a generic entity characterized by the widespread and complete calcification of the thoracic ascending aorta, resulting from excessive calcium accumulation in the aortic wall, which may be related to atherosclerotic plaque. Aortic calcification may be located in the tunica intima, be eccentric and begin at the base of necrotic fibroadipose plaques (atherosclerotic type), or it may involve the tunica media (non-atherosclerotic). Van Mieghem[1] defines porcelain aorta as "significant circumferential calcification or severe atheromatous plaques of the entire ascending aorta extending into the arch such that aortic clamping cannot be performed", which implies a significant risk during surgery.

The presence of porcelain aorta also influences the choice of procedure according to its location; however, to date there is no clear definition of how this term should be used when deciding the surgical technique, and it is often used as an exclusion criterion for conventional surgery in which aortic clamping and/or cannulation is required.

Amorim et al.[2] proposed a classification of porcelain aorta based on its location and the impact on the decision-making process in a heart team for specific therapeutic options, clarifying the types of procedures that carry a higher risk and are more suitable for the patient.

Amorin's classification recognizes two types of porcelain aorta. Type I involves the location of circumferential calcification in the ascending aorta. This is subdivided into type IA, with calcified aorta without the possibility of clamping (non-clampable), and type IB, with calcified aorta liable to undergo clamping (clampable). Type II deals with calcification of the descending aorta with or without inclusion of the aortic arch (*Figure 1*).

These cases can be satisfactorily resolved with excellent results through interventional procedures. However, such methods can only be performed in patients with a diseased native valve or dysfunctional biological valve prostheses. However, in patients with a dysfunctional mechanical prosthesis due to *pannus* with a high gradient, as in the case we present, the only option is surgical treatment despite the risks involved.

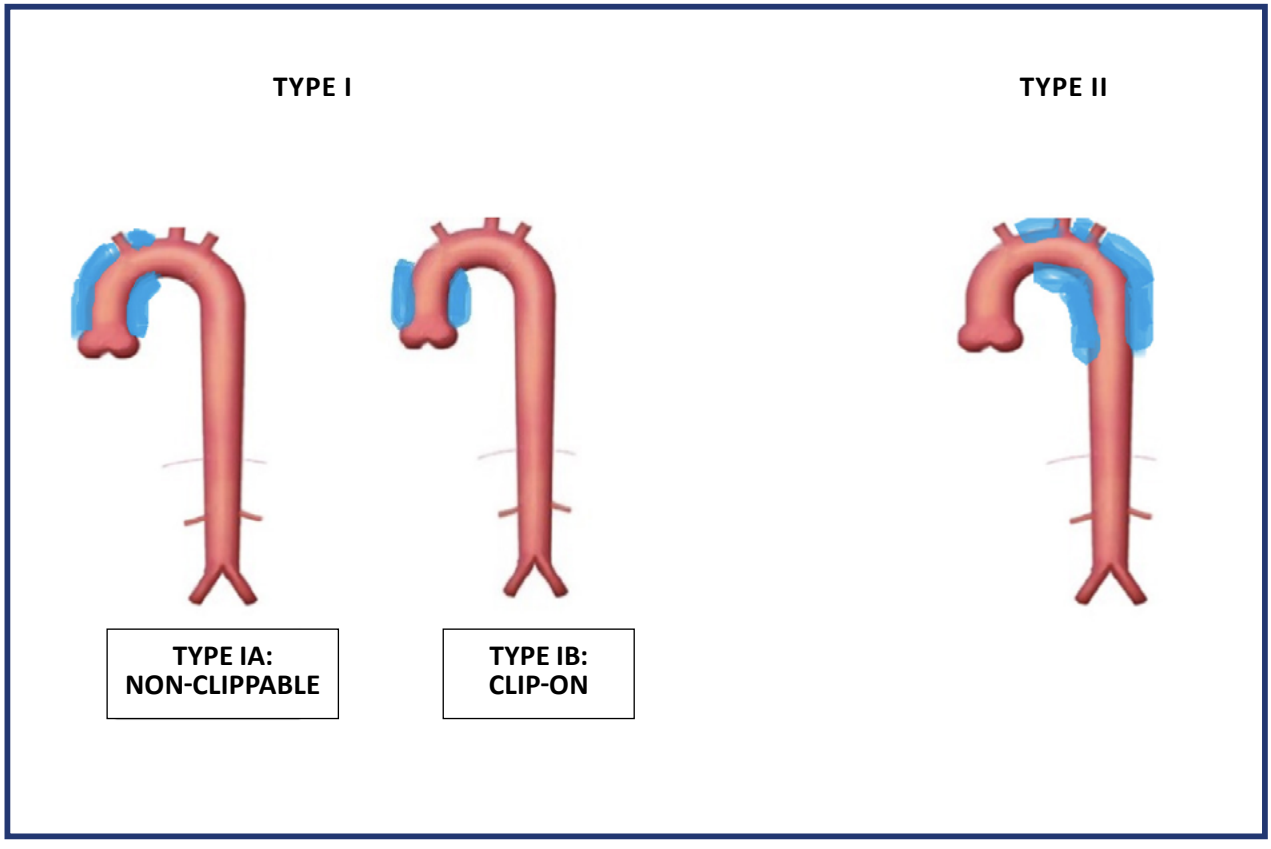

FIGURE 1. Amorin's classification of porcelain aorta, according to its location and the possibility of aortic clamping.

CLINICAL CASE

We present the case of a 67-year-old woman with a history of surgical reintervention 24 years ago for mechanical aortic valve replacement Carbomedics 21™ type in the aortic position due to valvular calcification. The patient presented systemic arterial hypertension of 10 years of evolution, type 2 diabetes mellitus diagnosed 8 years earlier, and hypothyroidism and chronic renal insufficiency stage 3b (both conditions of 5 years of evolution).

He consulted for dyspnea of one week's evolution. A transthoracic echocardiogram was performed, which showed the presence of a mechanical prosthesis in a dysfunctional bidisc aortic position with severe stenosis. The parameters studied showed a Vmax of 5.7 m/s, a maximum gradient of 107 mmHg, and a mean gradient of 57 mmHg. The aortic valve area was 0.27 cm2/m2. Aortic root with ectatic dilatation from the sinuses of Valsalva to the ascending aorta of 43 mm; mitral valve with undilated annulus (24 mm anteroposterior diameter and 30 mm bicommissural), thickened leaflets, predominantly the anterior and posterior leaflet with decreased mobility by tethering of its chordae tendineae, which conditions a severe mitral insufficiency with 9 mm vena contracta. The subvalvular apparatus showed no alterations. The left ventricular ejection fraction was 65%. Right ventricular dilatation was observed, with preserved global systolic function. Pulmonary artery systolic pressure was 85 mmHg.

The study protocol included a transesophageal echocardiogram, which reported the presence of a mechanical prosthesis in the aortic position with adequate posterior disc mobility and restriction of anterior disc mobility by mixed mechanism: *pannus* in the anterior annulus and a rounded, hypoechoic, vibratile image with dimensions of 8 × 6 mm at hour 6 compatible with a thrombus, mitral valve with thickened leaflets and severe insufficiency, and tricuspid valve also with severe insufficiency (*Figure 2*).

Cardiac catheterization was performed, which revealed no angiographic lesions but did show the presence of calcium plaques in the aortic root. Angiotomography was requested, reporting a porcelain aortic artery at the root, which continued into the descending aorta and extended to the bifurcation of the iliac arteries (*Figure 3)*.

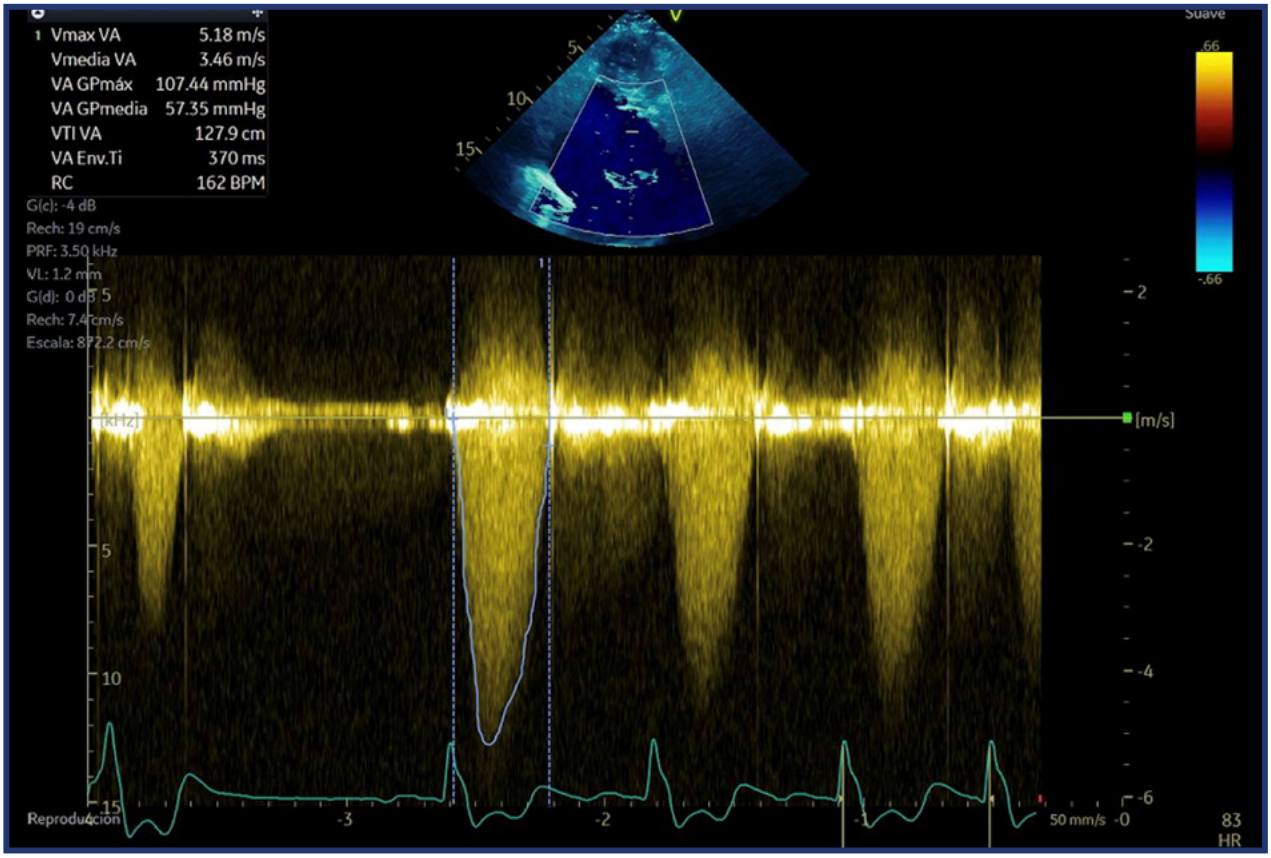

FIGURE 2. Mean transvalvular aortic gradient of 57 mmHg and a maximum velocity of 5.18 m/s are observed, suggesting severe aortic prosthetic dysfunction.

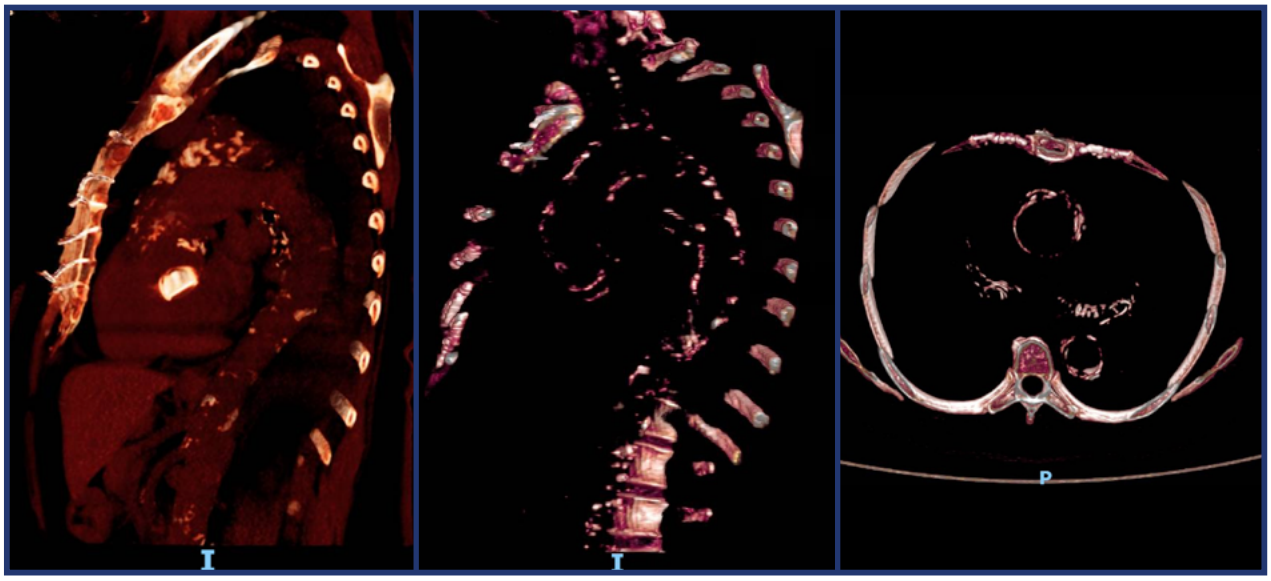

FIGURE 3. Angiotomographic image shows calcification of the aorta artery from its root to the bifurcation of the iliac arteries.

A medical-surgical session was conducted during which the patient's history and the diagnostic studies performed were reviewed. A EuroSCORE score of 78.5 was calculated, representing a very high risk. Nevertheless, a surgical resolution for valve replacement versus aortic valve toilette (prosthesis cleaning) plus mitral valve replacement was considered as the first option, so urgent programming was decided.

The patient presented with sudden hemodynamic deterioration and dyspnea, so she was transferred to the post-surgical intensive care unit, where she received advanced treatment for heart failure and renal failure with hemodialysis and adjustment by nephrology. She presented improvement in cardiac and renal functions, so it was decided to perform surgery. A median sternotomy was performed and, simultaneously, dissection and cannulation of the femoral artery were performed to avoid manipulation of the porcelain aorta. This surgical approach allowed, in the event of requiring aortic root replacement, the resection of most of the ascending aorta and the removal of adhesions remaining from the previous surgery. Central venous cannulation was performed in the right atrium to achieve better venous drainage instead of femoral vein drainage. Once the middle mediastinum was exposed, a calcified plaque was observed along the entire length of the ascending aorta (*Figure 4*). Cardiopulmonary bypass (CPB) was initiated, and a ventricular drainage cannula (Vent™) was placed in the right superior pulmonary vein, which brought the patient's temperature to 28 °C as part of the surgical plan, which included subsequent ventricular fibrillation. High aortic clamping was performed near the arch, where a minor amount of calcified plaque was noted, with aortotomy at the site of previous raffia. Anterograde cardioplegia (Custodiol™) was infused directly into the left coronary *ostium* and then into the right. Once cardiac arrest was reached, a 10 × 8 mm thrombus was observed on the aortic side of the valve prosthesis and *pannus* around the valve circumference on the ventricular side (*Figure 5*). A *toilette* with total resection was performed. Once the toilette was completed, persistent prosthetic dysfunction was detected due to restricted mobility in the hemi-discs, with inadequate opening and closing of both leaflets; therefore, prosthetic replacement was decided. The mitral valve had thickened leaflets and calcification in P2 and P3. It was agreed to resect and replace the mitral valve. A Mitris 27 Edwards Lifesciences™ prosthesis was placed in the mitral position, and an Inspiris 21 Edwards Lifesciences™ prosthesis in the aortic position. Aorto-orrhaphy with the Carrel technique was performed without incident. Cardiopulmonary bypass time was 112 minutes, and aortic clamping time was 115 minutes. Cardiopulmonary bypass was successfully destented with supportive infusion of vasoactive amines (noradrenaline) and inotropic amines (dobutamine).

DISCUSSION

The patient presented here had a porcelain aorta in its entirety, with severe calcification of the ascending aorta. This condition represents a surgical challenge and is associated with high morbidity during surgical aortic valve replacement to correct aortic stenosis.

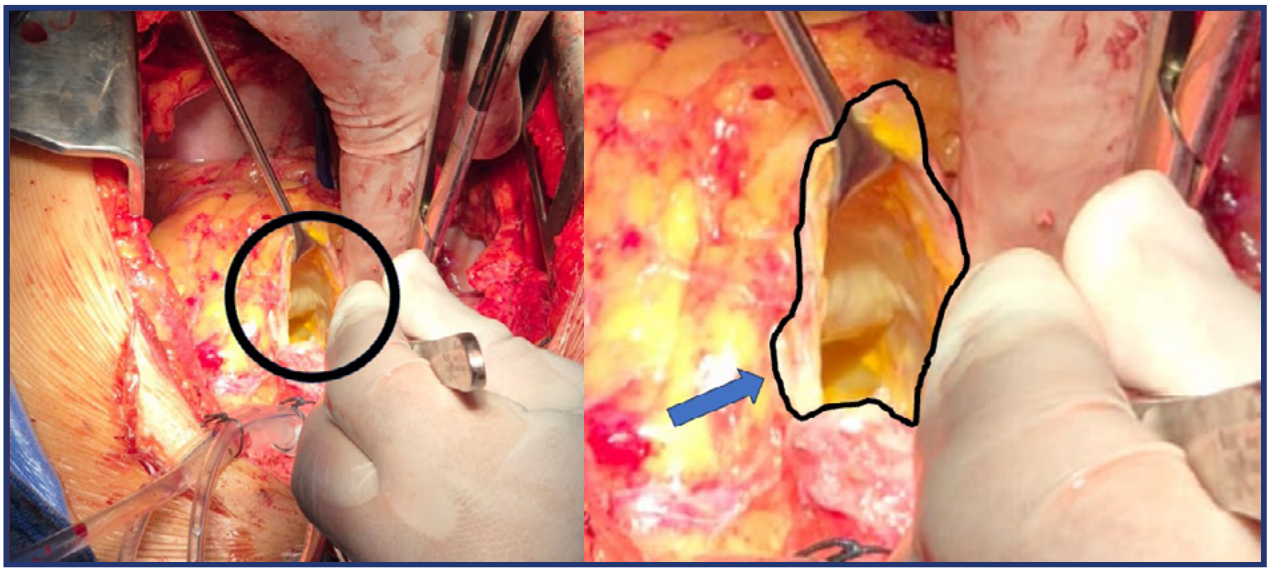

FIGURE 4. Intraoperative photograph showing calcification of the entire circumference of the aorta.

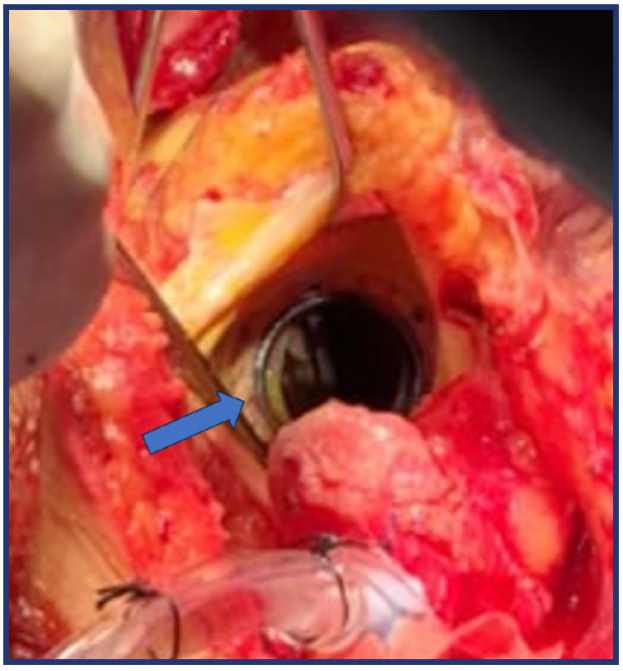

FIGURE 5. Presence of *pannus* on the ventricular side of the valve prosthesis, leading to severe stenosis.

Calcification of the aortic walls limits the options for aortic clamping and cannulation and increases the risk of embolism when the aorta is manipulated. For this reason, identification of risk factors associated with complications is essential.

A porcelain aorta is not an absolute contraindication for aortic valve replacement and/or coronary bypass grafts. Still, it requires a special strategy and individualized approach to minimize the risk of embolic complications and technical problems during aortotomy opening and/or closure.

As described by Carrel et al,[3] the overall incidence of significant calcification of the ascending aorta is 5-8% of patients scheduled for aortic valve replacement and/or coronary artery bypass graft placement. In our center, the incidence is 5% of cases. However, given the increased longevity of patients undergoing surgery and the diagnostic studies available today, the incidence may increase.

Porcelain aorta is generally considered a contraindication for conventional surgery because each aortic manipulation may involve a risk of calcific embolization, resulting in neurological complications.[4] For this reason, catheter-based procedures such as percutaneous aortic valve implantation (TAVI) are widely recommended, with good results.[5]

In this patient with mechanical prosthesis dysfunction in the aortic position, TAVI was not feasible. However, there are multiple strategies available to minimize the risk of complications during a surgical procedure in porcelain aorta; among them, individualize each case based on medical history (such as previous surgery). It is also essential to design various surgical plans with different therapeutic options before starting surgery, such as starting with femoral cannulation in reoperations and avoiding excessive manipulation of the aortic root, optimal cardiac emptying using ventricular drainage, moderate hypothermia to cause ventricular fibrillation, and infusing direct cardioplegia in the coronary *ostia* and avoiding cardioplegia cannula in the aortic root. If the patient has a history of previous surgery, it is recommended to perform the aortotomy, if possible, at the previous surgical site.

Kramer et al.,[6] compared the results of surgical versus transcatheter treatment. Analyses before and after the comparison demonstrated similar results, with slightly better outcomes, particularly in terms

of 5-year survival after surgery; this highlights the usefulness of surgical replacement with appropriate patient selection. Patients with smaller calcifications and pinchable aortas can often tolerate surgical replacement, which may be necessary in the context of concomitant disease. Regarding postoperative complications, improving tools for patient selection is critical to provide optimal treatment. Quantitative assessment of calcifications helps aid patient selection.

In the population of patients studied with porcelain aorta, there was a high prevalence of risk factors typical of atherosclerotic disease, history of peripheral artery disease, and coronary revascularization. Consequently, it is likely that, in this cohort of patients with porcelain aorta, the surgical risk was higher, given that porcelain aorta is not considered in risk scales such as EuroSCORE or STS.[2] This is important to consider from a purely surgical point of view, as risk is often underestimated when calculated on these scales. However, when these patients are evaluated with cardiohemodynamic studies, the risk is higher.

The case presented here is interesting because with comorbidities, heart failure, and chronic renal failure, the mortality rate is 75% when evaluated with the EuroSCORE; when the porcelain aorta is added, this rate increases to almost 100%. If we add to this the fact that the patient had a dysfunctional mechanical prosthesis, valve replacement can only be performed by a surgical approach, with an ominous prognosis. However, the postoperative outcome was satisfactory.

CONCLUSION

Patients with porcelain aorta should be meticulously evaluated when any procedure is considered, regardless of the operative treatment approach. In patients requiring concomitant procedures (as in this case, surgical replacement), it can be performed with a similar incidence of in-hospital complications and 5-year survival to those of the transcatheter procedure. The absence of a "clampable zone" and the increased total volume of calcifications are associated with increased morbidity and mortality.

Declarations

The authors declare no conflict of interest.

REFERENCES

1. Van Mieghem N, van der Boon R. Porcelain aorta and severe aortic stenosis: is transcatheter aortic valve implantation the new standard? Revista española de cardiología (English ed) 2013;66:765-7.

2. Amorim PA, Penov K, Lehmkuhl L, Haensig M, Mohr FW, Rastan AJ. Not all porcelain is the same: classification of circular aortic calcifications (porcelain aorta) according to the impact on therapeutic approach. The Thoracic and cardiovascular surgeon 2013;61:559-63.

3. Carrel T, Vogt PR. Porcelain aorta does not mean inoperability but needs special strategies. Interactive CardioVascular and Thoracic Surgery 2022;35:ivac222.

4. Nishimori H, Yamamoto M, Orihashi K. Cerebral infarction occurs particularly in patients with porcelain aorta. The Journal of Thoracic and Cardiovascular Surgery 2015;150:744-5.

5. Vahanian A, Beyersdorf F, Praz F, et al. 2021 ESC/EACTS Guidelines for the management of valvular heart disease: Developed by the Task Force for the management of valvular heart disease of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS). European heart journal 2022;43:561-632.

6. Kramer B, Vekstein AM, Bishop PD, et al. Choosing transcatheter aortic valve replacement in porcelain aorta: outcomes versus surgical replacement. European Journal of Cardio-Thoracic Surgery 2023;63:ezad057. doi: 10.1093/ejcts/ezad057.