A successful case of quirurgic mitral valve replacement with ultra-low aortic clamping in a patient with a porcelain aorta: A Case Report and Focused review of the literature

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Introduction

Porcelain aorta refers to the extensive circumferential or near-circumferential calcification of the ascending aorta, which reflects an underlying atherosclerotic process ⁱ. It is observed in 2.3% to 9.3% of patients prior to elective coronary bypass grafting (CABG) ² and in 0.7% to 7.5% of patients requiring cardiac surgery ³-⁶, making the ascending aorta harder to manoeuvre. Because of this, it has been considered a challenge in cardiac surgery by difficulting the cannulation artery, clamping the aorta artery, and performing aortocoronary bridges ¹. Furthermore, it has been associated with an increased rate of mortality and cardiovascular disease ¹. Besides, it has also been associated with increased morbidity and mortality, especially because of the increased perioperative stroke risk ⁷,⁸.

To deal with this problem and operate on these cases in patients with porcelain aorta and valve disease, several strategies depending on the type of valve surgery have been proposed, including replacement of the mitral or aortic valves without aortic clamping or “no-touch” strategies, deep hypothermia ventricular fibrillation with circulatory arrest and gradually clamping and unclamping of the aorta among others². Even though these techniques have been described, they are not free of complications.

Case history/Examination

A 64-year-old man with medical history of chronic angina, chronic heart failure, and severe mitral insufficiency secondary to rupture of chordae tendineae at the level of P2 who was receiving foundational quadruple therapy for heart failure, consulted the emergency department, explaining that he had presented with cough, fatigue, and dyspnea in the previous four weeks. Vital signs were within normal ranges at the admission physical examination; however, upon auscultation, pulmonary rales were seen in every lung field. Furthermore, it was discovered that hepatojugular reflux was associated with increased jugular venous pressure. It was normal for the remainder of the physical examination.

Upon admission, glucometry was normal, as were the hemogram and serum electrolytes. Besides, an electrocardiogram (ECG) revealed a sinus rhythm with a prolonged P wave, recalling left atrial enlargement, without other remarkable findings. Also, a transthoracic echocardiogram was performed, which confirmed a severe mitral insufficiency secondary to rupture of chordae tendineae at the level of P2. Nevertheless, a computed tomography (CT) of the chest showed the aorta artery was markedly calcified in in the sinotubular
junction, sinuses of valsalva and in its ascending portion, diagnosing a porcelain aorta (Figure 1). However, a low amount of calcium was observed at the level of the aortic root.

After holding a medical meeting between cardiology and cardiovascular surgery, the medical staff considered that the patient had severe symptomatic primary mitral insufficiency secondary to the rupture of the chordae tendineae at the level of P2, with an indication to intervene. Nonetheless, a quirurgical high risk of 18.1% for morbidity and mortality was measured by the STS-PROM score, and a risk of 1.2% according to the EuroSCORE II was also measured. Furthermore, highlighting the presence of porcelain aorta as a potential anatomical aspect affecting procedural performance.

**Differential diagnosis, investigations and treatment**

Consequently, a transcatheter edge-to-edge repair (TEER) was considered an initial intervention option. But after meticulously reviewing the chest CT images, it was considered possible to perform an approach with sternotomy and arterial cannulation of the brachiocephalic arterial trunk, subsequently performing an ultra-low clamping of the aorta at the level of the sinotubular junction and inserting the cardioplegia needle proximal to it. Therefore, this approach was carried out in addition to the rest of the valve replacement procedure without changes with respect to the usual technique (Figure 2), replacing the mitral valve with a biological prosthesis number 27. The extracorporeal circulation time of the intervention was 80 minutes, and the aortic clamping time was 61 minutes.

**Outcome and follow up**

During postoperative follow-up, a transesophageal echocardiogram was performed upon exiting extracorporeal circulation, revealing a normally functioning prosthetic valve without paravalvular leaks and adequate gradients (Figure 3). Likewise, he completed his postoperative period without complications, and during the 3-month follow-up, he reported an improvement in his dyspnea and his other previously described symptoms, as well as an improvement in his Kansas Cardiomyopathy Questionnaire (KCCQ).

**Discussion**

Although the European guidelines from the European Society of Cardiology (ESC) recommend performing percutaneous interventions in patients with valvular heart disease who are older or in those who are at high risk, taking into account a comprehensive risk stratification, which should include risk scores as the STS-PROM score, the EuroSCORE II, and also other risk factors such as fraility, chest radiation, and porcelain aorta, among others, in some cases of patients with porcelain aorta, a quirurgical valve replacement has been performed using different techniques that have been developed.

To deal with patients with a porcelain aortic who require cardiac surgery, several strategies have been developed, including off-pump surgery with an anaortic or “no-touch” technique, which has been recommended in patients with a porcelain aorta who undergo a coronary artery bypass graft (CABG) ; hypothermic fibrillatory arrest without clamping is also useful in this group of patients.

Moreover, excellent results after replacement of the ascending aorta have been described in patients with porcelain ascending aortas who required aortic valve replacement (AVR) . Additionally, AVR with balloon occlusion of the ascending aorta is an alternative technique that only requires a brief period of HCA. Furthermore, there have been some reports of successful aortic endarterectomy combined with HCA for AVR in patients with a calcified aorta; nevertheless, Stern et al. reported that the postoperative stroke rate was 34.9% following aortic endarterectomy in this clinical setting, which probably could discourages the use of this technique for some cardiovascular surgeons.

Besides, in cases where the porcelain aorta is an anatomical aspect affecting procedural performance, a comprehensive review of the porcelain aorta using CT allows to confirm the extent of aortic calcification, which is useful in choosing an appropriate approach for an optimal outcome before performing a valve replacement surgery. This CT approach allows us to assess the possibility of performing a surgical intervention using unusual techniques, as in our case.
Likewise, safe, fast, and easy devices such as the PAS-Port® have been designed for patients with a porcelain aorta who require a coronary bypass, which allows, after the vein is harvested and loaded through the stainless-steel deployment clasp, to securely attach and seal the loaded graft to the aorta at the turn of a knob. Also, it allows for the inserting of perpendicular grafts into the aorta for variable angles and anastomotic configurations.

Therefore, taking into account the possible techniques previously described and derived from observational and descriptive studies, as well as our described technique and approach, it is possible to conclude that, when aortic cannulation and/or clamping are necessary for conventional surgery, a porcelain aorta is not always a contraindication, and maybe, as was described by Amorín et al., not all porcelain aortas are the same, and probably their location involves which procedures would actually increase surgical risk and which could eventually be considered by a "heart team".

Consequently, for this reason, a classification proposed by Amorín et al. was designed to better classify porcelain aortic involvement. In this case, type 1 involves the location of a circumferential calcification of the ascending aorta; type 1A represents the calcified aorta without the possibility of being clamped, and type 1B represents the calcified aorta but with the possibility of being clamped, as in our case. Finally, type 2 includes calcification of the descending aorta, including or not the aortic arch.

Furthermore, it is worth mentioning that aortic clamping time (ACXT) in minimally invasive mitral valve surgery has been associated with higher mortality in several articles described in the medical literature and that, from these articles in consensus, an ACXT of 60 to 90 minutes has been considered safe, while mortality increases significantly when ACXT exceeds 120 minutes. In our case the ACXT was 61 minutes, which was in accordance with this described parameter and could eventually contribute to the favourable outcome in our case.

Finally, even though ultra-low clamping of the porcelain aorta in our case was a beneficial and feasible procedure to achieve with a favourable result and outcome, each patient should always be individualised, considering their surgical risk as well as considering the other risk factors that may have a negative impact on the surgical procedure and outcome.

Furthermore, although this anecdotal case describes an unusual and infrequent aortic clamp approach, more robust evidence, ideally derived from analytical design studies, must be provided to be able to recommend ultra-low clamping of a porcelain aorta with a better degree-class recommendation of evidence in these clinical scenarios.

Conclusions

In patients with a porcelain aorta with a low amount of calcium in the aortic root for whom surgical valve replacement is indicated, ultra-low clamping of the aorta should be considered as a useful and viable option technique to obtain a successful result and outcome.

Author contribution statement

Porras Bueno Cristian Orlando: conceptualization, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, supervision, validation, visualisation, writing (original draft), writing review, and editing.

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