SURGICAL TECHNIIQUE

Aortic endoluminal occlusion: a technique for porcelain aorta cross-clamping

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The incidence of severe aortic atheromatous disease (porcelain aorta) varies from a 14 to a 22%. Surgical handling in this scenario carries a high morbidity and mortality. A large part of these patients presents with systemic arteriopathy, which precludes aortic cannulation of femoral arteries. We describe the use of innominate artery for cannulation, and endoluminal occlusion of ascending aorta for cardiopulmonary bypass in two cases, using a Foley catheter.

***Key words*: Aortic cannulation; Aortic endoclamp; Aortic surgery; Foley catheter; Porcelain aorta**

La incidencia de enfermedad ateromatosa severa de la aorta ascendente (aorta en porcelana) varía desde un 14 a 22%. La manipulación quirúrgica en éste escenario conlleva una alta morbimortalidad. Gran parte de éstos pacientes presentan una espectro de arteriopatía sistémico, que imposibilita la canulación de arterias femorales. Se describe el uso de la arteria innominada para la canulación, y la oclusión endoluminal de la aorta ascendente para la circulación extracorpórea, usando una sonda Foley en dos casos.

***Palabras clave:* Canulación aórtica; Oclusión endoluminal aórtica; Cirugía aórtica; Sonda de Foley; Aorta en porcelana.**

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The incidence of severe aortic atheromatous disease (porcelain aorta) varies from a 14 to a 22 % [1]. Surgical handling in this scenario carries a high morbidity and mortality, due to embolism, laceration and/or aortic dissection[2]. A great part of these patients present with systemic arteriopathy, with involvement of the abdominal aorta and the aorto-iliac axis, which precludes arterial cannulation of femoral arteries [3].

Porcelain aorta demands planning some trans-operative strategies aimed to avoid aortic clamping, minimize aortic manipulation, and considering alternative sites of arterial cannulation for cardiopulmonary bypass.

This report herein describes the use of innominate artery for cannulation, and endoluminal occlusion of ascending aorta for cardiopulmonary bypass using a Foley catheter.

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Case 1

A 78-year-old man with past medical history of tobacco use, systemic arterial hypertension and dyslipidemia presented with dyspnea and functional class deterioration. Transesophageal echocardiography (TEE) showed severe aortic stenosis. CT scan revealed severe ascending aorta calcification, with no evidence of atheromatous plaque in supraaortic arteries. Cardiac catheterization showed no coronary lesions and extense ascending aorta calcification. Surgery was performed; previous visual and tactile demonstration of atheromatous disease of aorta, arterial cannulation was performed via the innominate artery with the cannula tip directed toward the aortic arch **(Fig. 1).** The right atrium was cannulated in a standard fashion, a left vent was placed placed through the right upper pulmonary vein to drain out the left ventricle. Cardiopulmonary bypass was started and the patient was cooled to 25°C, cardiac arrest was performed (total time 4 minutes), with retrograde cerebral perfusion from the superior vena cava (SVC). Aortotomy was performed and a Foley catheter was introduced through. The balloon was insufflated achieving complete and hermetic occlusion of the ascending aorta. Cardioplegia was directly administered into the coronary ostia. Extracorporeal circulation was regained,

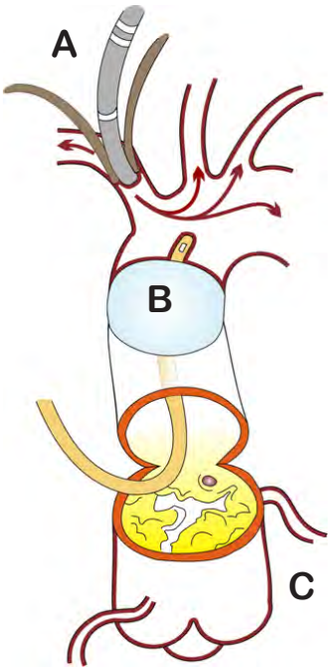

Figure 1. Aortic endoclamp through aortotomy. A) arterial cannulation into innominate artery. B) Foley catether intoduced through the aortotomy and occluding the ascending aorta making the function of "aortic clamp". C) exposed stenotic aortic valve.

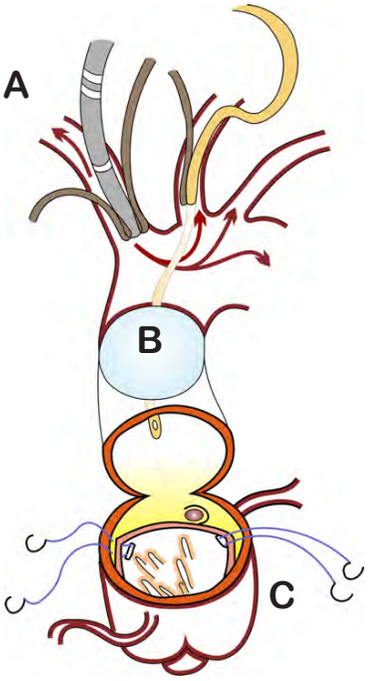

Figure 2. Aortic endoclamp through the proximal left carotid artery. A) arterial cannulation into innominate artery. B) Foley catether intoduced through the carotid artery and occluding the ascending aorta making the function of "aortic clamp". C) working area after removal of the stenotic valve. The red arrows mark the arterial flow from the cannula.

warming up the patient up to 32°C. The native valve was resected and a mechanic 21 mm prosthetic valve was placed in aortic position with no complications. The remaining portion of the surgery was carried out as usual. The aortic closure was performed with autologous pericardium reinforcement, Teflon strips and running suture. Seconds before removal of the catheter the cardiac output of the cardiac bypass was decreased to the minimum allowed. The catheter was removed. The postoperative follow-up coursed with no complications; with complete recovery and early hospital discharge.

Case 2

A 71-year-old male with past medical history relevant for Chronic Obstructive Pulmonary Disease, systemic arterial hypertension, dyslipidemia and tobacco use presents with chest pain and dyspnea. Transthoracic echochardiography revealed evidence of severe aortic stenosis. CT scan confirmed a porcelain aorta, supraortic vessels showed no evidence of calcified wall. Cardiac catheterization revealed coronary arteries with no lesions and severe ascending aortic wall calcification. Cardiopulmonary bypass was performed in the same fashion as previously described above (aorta and supraaortic vessels inspection and palpation, innominate artery cannulation, right atrium cannulation and left cavities vent placement through the right upper pulmonary vein). A purse string suture was placed in the proximal left carotid artery. Cardiac arrest was performed at 25°C, using retrograde cerebral perfusion, while aortotomy performed. A 16-French Foley catheter was introduced through an incision in the purse string suture on the left carotid artery **(Fig. 2)**. Using a clamp through the aortotomy, the tip of the Foley catheter was placed on position on the ascending aorta, inflating the balloon, achieving atraumatic and hermetic occlusion. Cardioplegia was directly administered into the coronary ostia. Cardiopulmonary bypass circulation was reinitiated warming up the patient up to 32° C. The native valve was resected and a 21mm mechanical prosthesis was placed in aortic position. The aortotomy was closed with a continuous suture, reinforced with Teflon and autologous pericardium strips. The aortic balloon was deflated and partially withdrawn, bypass was reinitiated. The rest of the procedure was performed on the usual way without complications. The Foley catheter was removed and carotid arteriorraphy was performed with continuous suture. The postoperative course without was uneventful.

COMMENT

Stroke is one of the most devastating complications on cardiac surgery. Embolization of atheroma from the aorta and/or aortic arch is still the main cause. Porcelain aorta leads to a high risk of morbidity and mortality as well as the usual manipulation of tissue during the procedure e.g. aortic cannulation and clamping of the aorta, which can lead to cerebral or peripheral embolism. This is a consequence of atheromatous particles from the aorta. Aortic fracture or transmural laceration can occur, added to the possibility of creating an origin of aortic dissection [3], this is why a severely calcified aorta can contraindicate valvular surgery.

Amorim et al. [4] stratified the level of aortic circumference damage, emphasizing the feasibility of the clamping of the aorta. Nishi et al [5]. correlated this concept with the percentage of calcification of the aorta. Both systems are proposed to standardize concepts establishing when aortic-cross clamping is considered safe under these circumstances.

Both cases described in this paper represented an IA stage on the Amorim classification [4]. This means our patient had an elevated risk of complications after aortic clamping. There are several strategies reported to solve this problem, which include circulatory arrest with aortic endarterectomy, replacement of the ascending aorta plus valve replacement [6].

There are reports of aortic clamping following meticulous intraluminal inspection that allows the surgeon to identify a safe zone. An ultrasonic device used for aortic decalcification obtaining an appropriate site for clamping is described [7]. Likewise, the trans-apical aortic valved graft [8] and the apical-brachiocephalic bypass have proven to be feasible and useful strategies [9]. With this regard, Several methods using a Foley catheter for endoluminal clamping have been reported. In 1983, Crosgrove et al. described the use of an endoluminal occlusion balloon for porcelain aorta [10]. A very sick, atheromatous aorta with parietal calcification is largely correlated to systemic vascular affection, including the aortoiliac axis and the femoral arteries. All this above makes very difficult to almost impossible to get an adequate femoral cannulation, with a high risk of complications.

Particularly in our first case, is important to consider the technical detail of placing the endoclamp trough the aortotomy, from the same line of suture. Those aspects were modified radically with the technique described in our second case. The catheter placement through the carotid artery offers a free site for implantation inside the aorta and makes the removal of the catheter simpler, safer and orthodox. Ooi et al. [9]. described the Foley catheter placement without circulatory arrest directly from a very sick free aorta [11]. We preferred not to touch any aortic zone, used brief circulatory arrest and place the catheter under direct vision. We had no surgical adverse related event. Even when the aortic occlusion using Foley catheter is effective, any risk of stroke remains. Even though the circulatory arrest used for our patient was so short, the chances for adverse events related to this maneuver is always present.

In conclusion, porcelain aorta is not an absolute contraindication for valvular aortic surgery. We recommend the endoluminal aortic occlusion technique using Foley catheter in cases with advanced atheromatous aortic disease. We highly recommend this approach for patients with an extensive calcified aorta and higher risk for conventional aortic-cross clamping.

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