BRIEF REPORT

Aortic Root Enlargement of a Small Annulus Using the Nicks Technique During Aortic Valve Replacement

Agrandamiento del Anillo Aórtico Pequeño con la Técnica de Nicks en la Cirugía de la Estenosis Valvular Aórtica

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ABSTRACT

Introduction: In patients with aortic stenosis and small aortic annulus, the surgical approach may lead to implantation of an aortic prosthesis without the necessary hemodynamic profile, conditioning the development of patient-prosthesis mismatch. In these cases, aortic root enlargement becomes a necessary procedure.
Objectives: The aim of this study was to describe the incidence of small aortic annulus and the outcomes of aortic root enlargement.
Methods: A total of 305 adults undergoing aortic valve replacement were prospectively studied between 2011 and 2013. Aortic root enlargement was performed in cases of small aortic annulus (< 21 mm) using the Nicks technique.
Results: Aortic root enlargement was required in 7.5% of cases. All these patients were women ($p < 0.001$) with mean age of 71.1 years. Height ($p < 0.001$) and body mass index ($p < 0.001$) were lower in the group with aortic root enlargement, and the procedure lasted 10 to 11 minutes more. Mortality associated with aortic root enlargement was 4.3% (1/23) versus 3.5% in patients not undergoing this procedure (RR 1.23, 95% CI 0.16-9.16; $p = 0.584$).
Conclusions: One out of every 14 aortic valve replacements required aortic root enlargement. Female gender and small body surface area were associated with the need of enlargement. The Nicks technique can be performed after a short learning curve, without an excessive increase in risk or operative time.

Key words: Aortic Valve Replacement - Small Aortic Root - Aortic Root Enlargement - Patient-prosthesis Mismatch

RESUMEN

Introducción: En pacientes con estenosis aórtica cuya anatomía se caracteriza por un anillo valvular aórtico pequeño, el abordaje quirúrgico puede conducir al implante de una válvula que no cumpla con el perfil hemodinámico adecuado; en estos casos hay situaciones en las que el agrandamiento quirúrgico del anillo aórtico se transforma en un procedimiento necesario.
Objetivos: Describir la incidencia de anillos aórticos pequeños en reemplazos valvulares aórticos y los resultados del agrandamiento del anillo.
Material y métodos: Entre 2011 y 2013 se estudiaron prospectivamente 305 adultos sometidos a reemplazo aórtico. En los casos con anillo aórtico pequeño (< 21 mm) se realizó agrandamiento anular con la técnica de Nicks.
Resultados: El 7,5% requirió agrandamiento anular. Todos estos pacientes fueron mujeres ($p < 0,001$), con edad promedio de 71,1 años. Tanto la altura ($p < 0,001$) como la superficie corporal ($p < 0,001$) fueron menores en el grupo con agrandamiento. Se requirieron 10 a 11 minutos más de cirugía para realizar el agrandamiento. La mortalidad asociada con el agrandamiento fue del 4,3% versus el 3,5% sin agrandamiento (RR 1,23, IC 95% 0,16-9,16; $p = 0,584$).
Conclusiones: Uno de cada 14 reemplazos aórticos requirió agrandamiento. Las variables asociadas con necesidad de agrandamiento fueron sexo femenino y superficie corporal pequeña. Con un corto aprendizaje, la técnica de Nicks puede realizarse sin incrementar excesivamente el riesgo ni el tiempo operatorio.

Palabras clave: Reemplazo valvular aórtico - Estenosis valvular aórtica - Raíz aórtica pequeña - Agrandamiento raíz aórtica - Mismatch paciente-prótesis

INTRODUCTION

In Argentina, it is common to find elderly women of Mediterranean descent with small body surface area requiring surgical treatment for aortic stenosis. A small aortic annulus is frequently seen in these patients. The surgical approach may lead to implantation of an aortic prosthesis without the necessary hemodynamic profile, conditioning the development

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of patient-prosthesis mismatch.

Surgeons have several options when confronted with a small aortic annulus: use of a small prosthesis (< 21 mm) admitting some degree of patient-prosthesis mismatch, aortic root enlargement, total replacement of the aortic root with implantation of a supra annular aortic valve, a stentless prosthesis or a homograft, or the Ross procedure. The last three options, despite having better hemodynamic profiles, are associated with an almost threefold higher operative risk. (1) Stentless bioprostheses show structural deterioration over time (2) and homograft banks are not always available.

Aortic root enlargement was described many years ago, but the different techniques have only been adopted by a few surgical groups. (3-5) Reluctance to perform this procedure seems to be related with surgical demands and the availability of mechanical supra-annular prostheses. (6, 7) However, in certain situations, surgical enlargement of the aortic annulus becomes a necessary procedure to avoid the implantation of prosthesis < 21 mm or the accidental obstruction of a coronary ostium. (8)

The aim of this study was to describe the in-hospital morbidity and mortality of a prospective series of aortic valve replacements, reporting the incidence of small aortic annulus in this population and the outcomes of aortic root enlargement to avoid patient-prosthesis mismatch.

METHODS

Between 2011 and 2013, 305 adult patients undergoing aortic valve replacement for severe aortic stenosis were prospectively included. All the surgical procedures were performed at three centers associated with the University of Buenos Aires. All the patients included had aortic stenosis, either isolated or associated with coronary artery disease, and underwent isolated aortic valve replacement or combined with myocardial revascularization surgery. Patients with pure aortic regurgitation, aneurysm of the ascending aorta or those requiring double valve replacements were excluded. A mechanical prosthesis or a bioprosthesis was implanted in the intra-annular position to all the patients. Aortic root enlargement was performed in the cases of small aortic annulus using the Nicks technique. (9) A small aortic annulus was defined as an annulus with diameter that did not allow the implantation of prosthesis of at least 21 mm. A transverse aortotomy was carried down through the non-coronary sinus of Valsalva across the aortic annulus extending the incision into the endocardium of the mitral valve, without sectioning the right cardiac chambers. The created defect was closed with continuous suture of a losangic-shaped bovine pericardial patch fixed in glutaraldehyde (Figures 1 and 2). The enlargement allowed the implantation of 21 mm valve prosthesis in all the cases.

The incidence of small aortic annulus, the complications and in-hospital mortality associated with aortic root en-

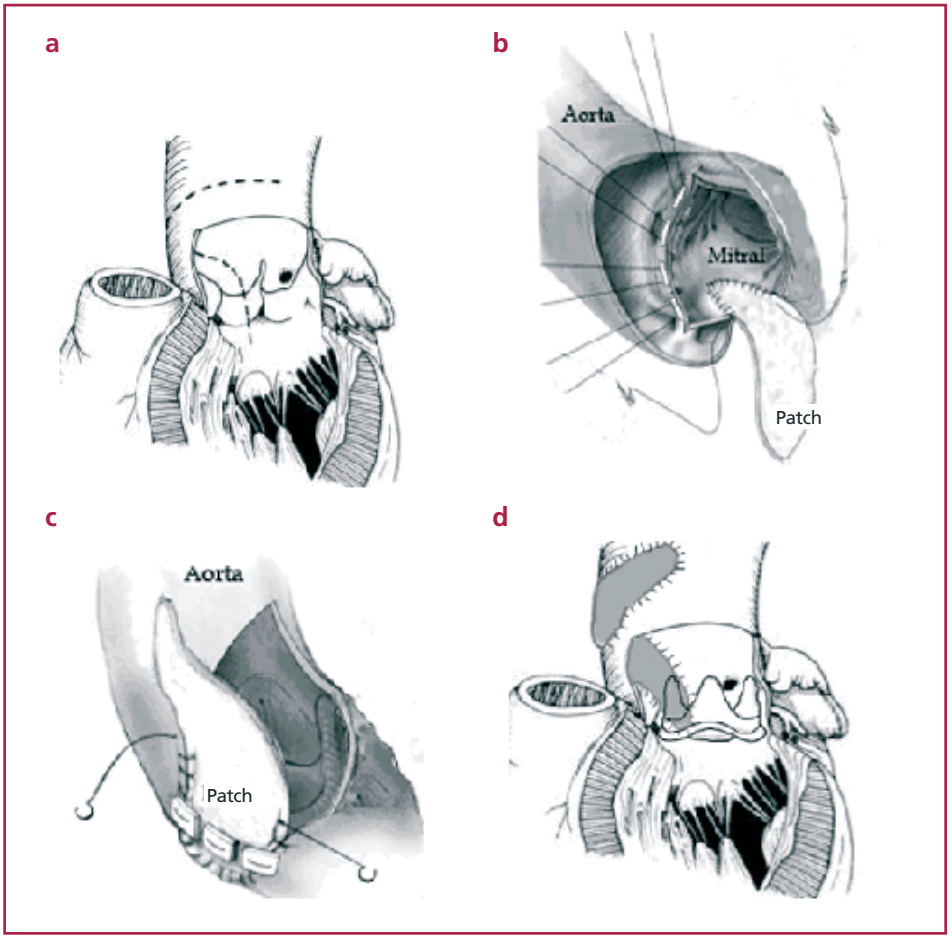

Fig. 1. Diagram showing the Nicks procedure for enlarging a small aortic annulus during aortic valve replacement. **a.** Direction of the aortotomy from the anterior aorta to the valvular annulus at the level of the non-coronarian leaflet. **b.** Suture of the losangic-shaped patch during aortic root enlargement. **c.** Sutures with pledgets fixing the prosthetic annulus through the pericardial patch **d.** Diagram of aortic root enlargement with the valve in situ.

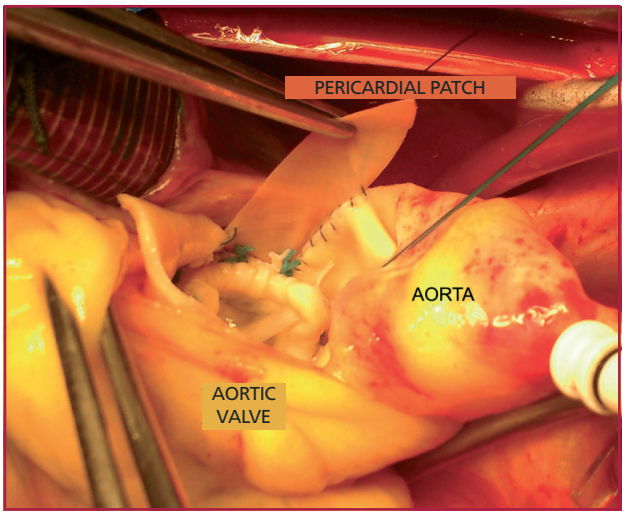

Fig. 2. Intraoperative photograph showing the losangic pericardial patch enlarging the aortic root and the already implanted biological prosthesis.

largement were analyzed. Statistical analysis was performed using SPSS 17.0 statistical package. The results were expressed as percentages, mean values and 95% confidence intervals or median and ranges. The normality of variable distribution was analyzed using the Kolmogorov-Smirnov test. Continuous variables were compared with Student's t test or the Mann-Whitney test, and the chi square test or Fisher's exact test were used to compare proportions. A two-tailed p value = 0.05 was considered statistically significant.

RESULTS

BA total of 305 patients were operated on. Mean age was 69.9 years (range 43-92) and 57.7% (n=176) were men. Isolated aortic valve replacement was performed in 73.8% of patients (n = 225) and the rest underwent valve replacement combined with coronary artery bypass graft surgery, using the internal mammary artery in 63.8% (51/80) of cases. One hundred and seventy five porcine or bovine pericardial biological prostheses (57.4%) and 130 bileaflet mechanical valves were implanted in the intra-annular position. EuroSCORE II expected mortality was 3.0% (95% CI 2.4-3.6%) and observed mortality was 3.5% (n = 10) (chi² 0.230, p = 0.632). Postoperative complications are summarized in Table 1.

Of all the patients operated on, 7.5% (n = 23) required aortic root enlargement for small annulus and all these patients received a 21-mm prosthesis. A biological valve was implanted in 69.6% (16%23) of cases, and 87.0% corresponded to isolated aortic valve replacement. All these patients were women (p < 0.001) with mean age of 71.1 years (median 74 years, range 49 - 83), mean height of 158 cm (95% CI 155-162) and body surface area of 1.66 m² (95% CI 1.55–1.77). After comparing these patients with those not requiring aortic root enlargement, there were no differences in age (mean 68.9 years, range 43-92, Mann-Whitney test p = 0.627), although height and body surface area were significantly higher in the group without enlargement [mean height 171 cm, 95% CI 168–173 cm, (p < 0.001) and body surface area 1.89 m², 95% CI 1.84–1.94, (p < 0.001)].

Table 1. Complications associated with aortic valve replacement (n = 305)

Complication	n (%)
Reoperation due to bleeding	2 (0.7)
AV block	3 (1.0)
Low cardiac output	6 (2.0)
Pneumonia	5 (1.6)
Mediastinitis	3 (1.0)
Stroke	3 (1.0)
Dialysis	3 (1.0)

Cardiopulmonary bypass time and aortic cross-clamp time were longer in the patients undergoing aortic root enlargement (median 70 vs. 60 min, Mann-Whitney test p = 0.002 and 55 vs. 45 min, Mann-Whitney test p < 0.001, respectively) and the procedure was 10 to 11 minutes longer than with the standard technique. Mortality was 4.3% (1/23) in aortic root enlargement vs. 3.5% for the rest of the patients (10/282) (Fisher test p = 0.584). Although this difference is not statistically significant, the relative risk associated with aortic root enlargement was 1.23 (95% CI 0.16-9.16) and the statistical power would reach only 20% due to the small sample size.

DISCUSSION

Aortic root enlargement should ideally be planned before the intervention and should be immediately performed if needed. About one out of every 14 aortic valve replacements in this series required aortic root enlargement due to small aortic annulus. This prevalence was similar to the one reported by Rammos el al. (10) (6.8%) and recently by Coutinho et al. (1) (6.5%) in Greece and Portugal, respectively. Cardiopulmonary bypass time using the Nicks procedure was 10 to 11 minutes longer than for standard surgery. Other authors also reported between 10 and 13 extra minutes to perform the same procedure. (1, 7)

Although there were no significant differences in mortality between the patients undergoing aortic root enlargement and the rest of the patients, this may probably be due to the low power provided by the small sample size. Nonetheless, different authors have reported mortality rates between 0.0% and 7.0% for this type of procedure. (1, 6, 7, 10-12)

An experimental study evaluating the different techniques of aortic root enlargement demonstrated that the Nicks procedure was the one with the lowest increase of annular diameter compared to other methods. Although this may probably be the case, the Nicks technique is the easiest procedure and the im-

plantation of a larger prosthesis is possible by obliquely inserting the valve over the patch. (4)

The development of pseudoaneurysms secondary to patch dilation or rupture is uncommon. The benefit of aortic root enlargement to avoid patient-prosthesis mismatch is controversial. Subgroup analysis would suggest that patient-prosthesis mismatch is relevant in patients < 70 years as only in this case it would reduce long-term survival. (14) However, bioprostheses are mostly implanted in the elderly, and in this type of prosthesis patient-prosthesis mistmatch produces degeneration and structural damage. In addition, it is difficult to perform the Nicks technique in vey calcified aortas, as seen in the elderly. Prosthesis implantation in the supra-annular position does not exclude aortic root enlargement in case 21-mm prosthesis cannot be implanted or there is risk of mechanical occlusion of the coronary ostia. (15)≥

The small number of cases is one of the limitations of this study, even though patients were included in only 3 years. Another limitation is that we have not analyzed the need of enlarging the aortic root in patients with large body surface area (> 2 m2) in order to implant a prosthesis that avoids patient-prosthesis mismatch.

CONCLUSIONS

The prevalence of small aortic annulus in the Argentine urban population requiring aortic valve replacement is about 7.5% and is mainly constituted by short-stature elder women with small body surface area. Aortic root enlargement with the Nicks technique is a relatively easy method that reduces patient-prosthesis mismatch and, in occasions, is the only way of implanting a valve in very small annuli (< 19 mm). This is a necessary technique for the surgeon when the size of the aorta does not allow an adequate valve implant. The Nicks technique can be performed after a short learning curve, without an excessive increase in risk or operative time.

Conflicts of interest

None declared.

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