# Aortic Root Homograft in the Surgical Treatment of Aortic Valve Disease With Dilated Ascending Aorta

Ángel González Pinto, Ricardo J. Vázquez, Andrés Sánchez, Jorge R. Roda, Virginia Badorrey, Isidre Vilacosta, Javier Parra, Juan L. Delcán, Juan Medina, and Milagros Sancho

Servicio de Cirugía Cardíaca, Hospital Madrid Montepríncipe, Boadilla del Monte, Madrid, Spain.

**Introduction and objectives.** Patients with aortic valve disease and a dilated ascending aorta are usually treated with a composite graft comprising a valve and conduit. We review here the results of treatment with an aortic root homograft as a valid alternative.

**Patients and method.** Twenty-two consecutive patients with a mean age of 64.8 (8.8) years were studied. Mean ascending aorta dilation was 54.55 mm, aortic valve insufficiency was present in 16 patients, and a combined lesion was present in 6. In all cases a cryopreserved aortic root homograft was used to replace the aortic valve and ascending aorta. In 9 cases a Dacron conduit was used beyond the sinotubular junction to restore continuity between the homograft and the native aorta.

**Results.** All patients survived surgery. One patient had postoperative systemic inflammatory response syndrome and one patient was re-explored for excessive bleeding. Mean duration of follow-up was 12.1 months (range 2-36 months). No patient was given anticoagulants, and one had an early transient cerebrovascular accident followed by complete recovery. At one month postsurgery the left ventricular systolic ($P$<.001) and diastolic ($P$<.009) diameters had decreased significantly on echocardiography, and these decreases persisted throughout follow-up. The caliber of the ascending aorta was normal in all patients (≤30 mm) except one.

**Conclusions.** Aortic root homografts are a valid alternative in the treatment of aortic valve disease with ascending aorta dilation. The main advantages of this therapy are that permanent anticoagulation is not needed, and that left ventricular dimensions recover rapidly.

**Key words:** *Surgery. Aortic valve. Ascending aorta. Homograft.*

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**Homoinjerto de raíz aórtica para el tratamiento quirúrgico de las afecciones de la válvula aórtica con aorta ascendente dilatada**

**Introducción y objetivos.** Los pacientes con afección de la válvula aórtica y dilatación de la aorta ascendente son tratados habitualmente con tubos valvulados. Revisamos los resultados del uso de homoinjertos de raíz aórtica como alternativa terapéutica válida.

**Pacientes y método.** Se incluyó en el estudio a un total de 22 pacientes consecutivos con una edad media, 64,8 ± 8,8 años. La dilatación media de la aorta ascendente fue de 54,45 mm y la válvula aórtica presentaba insuficiencia pura en 16 pacientes; en 6 pacientes había doble lesión. En todos los casos se usaron homoinjertos criopreservados para sustituir la raíz aórtica y la aorta ascendente. En 9 casos se prolongó la unión sinotubular con una prótesis para restablecer la continuidad entre el homoinjerto y la aorta nativa.

**Resultados.** No hubo muertes hospitalarias ni en el seguimiento. Un paciente padeció un síndrome de respuesta inflamatoria sistémica y otro fue reintervenido por hemorragia. El seguimiento medio fue de 12,1 meses (rango, 2-36 meses). No se administró anticoagulación a ningún paciente. Un paciente tuvo un accidente cerebrovascular transitorio sin secuelas. Se observó mediante ecocardiografía una reducción estadísticamente significativa de los diámetros ventriculares al mes de la cirugía (diámetro sistólico del ventrículo izquierdo $p < 0,001$; diastólico, $p < 0,009$) que se mantuvo durante el seguimiento. Todos los enfermos presentan calibre normal de la aorta ascendente (≤ 30 mm), excepto uno.

**Conclusiones.** Los homoinjertos de raíz aórtica constituyen una alternativa válida para el tratamiento de las afecciones de la válvula aórtica asociadas a dilatación de la aorta ascendente. La no necesidad de anticoagulación y la rápida recuperación de los diámetros ventriculares izquierdos son los pilares fundamentales de este tratamiento.

**Palabras clave:** *Cirugía. Válvula aórtica. Aorta ascendente. Homoinjerto.*

Correspondence: Dr. A. González Pinto.
Juan A. Mendizábal, 50. 28008 Madrid. España.
E-mail: agp@eresmas.net

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## INTRODUCTION

The number of patients with disease of the aortic valve and ascending aorta requiring surgical repair of

both structures is constantly growing. Although valve-sparing repair procedures have gained ground recently, for more than 30 years the classic Bentall prodedure[1] has been the conventional surgical treatment with excellent short- and long-term results even in patients with Marfan's syndrome.[2] Physiologically, repair operations are preferable to valve replacement as they preserve aortic root anatomy and eliminate the need for permanent anticoagulation.[3-5]

However, little has been published on the use of homografts and autografts for these conditions. These prostheses favor improved physiology of the aortic root, reduced incidence of endocarditis, and low incidence of thromboembolic disease, and eliminate the need for anticoagulant treatment.[6-11]

In the present study, we describe our first experience of aortic root and ascending aorta replacement with cryopreserved homografts.

## PATIENTS AND METHODS

Between October 1999 and August 2003, 22 consecutive patients underwent procedures for disease of the ascending aorta and aortic valve. Patient characteristics are in Table.

All patients underwent preoperative transthoracic and transesophageal echocardiography and spiral computed tomography (CT) to determine the condition of the thoracic aorta, and coronary angiography to determine coronary artery status.

Ascending aorta replacement was indicated for diameter >50 mm, dissection, or diameter twice that of the descending aorta. Indication for surgery was dilated ascending aorta in all cases.

Cryopreserved homografts were obtained from external tissue banks and thawed according to supplier protocols.

### Surgical Technique

Operations were performed with extracorporeal circulation (ECC) by median sternotomy with moderate hypothermia even in the 4 patients who required repair of the dissection or aortic arch. Femoral cannulation was used to establish ECC.

Homograft size was determined from aortic annulus measurement in preoperative transthoracic echocardiography by reference to the short axis of the left ventricular outflow tract from the aortic-mitral valvar curtain to the interventricular septum. Mean diameter was 24.26 mm (range, 23-27 mm). Homograft implantation was performed by total root replacement with reimplantation of coronary arteries in all patients. Resection of the ascending aorta, aortic valve and coronary arteries left a ≈2 mm aorta button. Homografts were prepared by trimming the muscle of the mitral valve and trigonum fibrosum leaving the cylindrical form of the left ventricle outflow tract. An interrupted 4/0 suture was performed following the anatomical form so the structures would coincide. Coronary arteries were reimplanted with 6/0 polypropylene continuous sutures and followed by direct distal anastomosis with the native aorta or aortic arch. In 6 patients, homograft length was insufficient for direct anastomosis distal to the aorta and a prosthetic conduit was needed. In these patients, we conserved the sinotubular junction of the homograft to maintain total functionality of the aortic root. During surgery, hemodynamic performance was constantly monitored by transaortic gradient and echocardiography to determine aortic root function (valve failure, dilation, etc).

One-month, six-month and one year follow-up consisted of personal clinical interview to analyze functional status, echocardiography to measure ventricular

TABLE.1. **Characteristics of Patients (n=22)**

| | |
|---|---|
| Mean age, years | 64.77±8.8 (range, 38-79) |
| Gender M/W | 17/5 (ratio, 3:4) |
| Mean ejection fraction | 60.86±8.6 (range, 32-74) |
| Etiology and associated disease | |
| Degenerative | 13 (59.1%) |
| Ischemic heart disease | 5 (22.7%) |
| Aortic dissection | 3 (13.6%) |
| Marfan's syndrome | 1 (4.5%) |
| Diseased aortic arch | 3 (13.6%) |
| Hemodynamic performance of aortic valve | |
| Pure insufficiency | 16 (72.7%) |
| Combined lesion | 6 (27.3%) |
| Ascending aorta diameter, mm | 54.45±5.05 (range 47-65) |
| Preoperative diastolic diameter VI, mm | 58.86±6.4 (range 44-76) |
| Preoperative systolic diameter VI, mm | 39.56±7.1 (range 25-50) |
| Presence of calcium in valve or annulus | 14 (63.6%) |
| Postoperative diastolic diameter, mm | 47.85±6.6 ($P$<.002) |
| Postoperative systolic diameter, mm | 30.42±6.5 ($P$<.005) |
| Postoperative transvalvular gradient, mm Hg | 5.17±4.09 (range, 0-21) |

function (systolic and diastolic diameters, left ventricular wall thickness, ascending aorta size), and continuous, color-contrast pulsed Doppler to determine homograft and aortic valve function. Aortic root morphology was monitored by spiral CT. No patient received anticoagulant therapy during follow-up.

## RESULTS

### In-Hospital

All patients survived surgery. One required reoperation for bleeding, 3 had atrial fibrillation episodes requiring restoration of sinus rhythm with amiodarone, and 1 evolved slowly presenting systemic inflammatory response syndrome. Mean hospital stay was 7.85 days. Mean duration of ischemia was 89.17±13.97 min (range, 66-117 min) and bypass time was 117.83±18.61 min (range, 90-156 min). One patient required >6 h inotropic support but no untoward neurological effects were observed.

### Follow-up

Mean follow-up was 12.1 months (range, 2-36 months). Echocardiographic studies detected mild aortic insufficiency in 2 patients. Mean postoperative aortic valve gradient was 5.17±4.09 mm Hg. Reduction in ventricular diameters was statistically significant at 1-month and this was maintained throughout the follow-up (Table and Figure 1). Ascending aorta size measured by CT was normal (≈30 mm) (Figure 2) in all but 1 of the patients, who presented a 40 mm caliber (this patient presented previous atherosclerotic disease in ascending aorta). We did not observe morphological changes such as the presence of calcium or pseudoaneurysms in the aortic root or ascending aorta. None of the patients presented signs of myocardial ischemia. One patient presented a transient thromboembolic event at 2 months after surgery, making a full recovery.

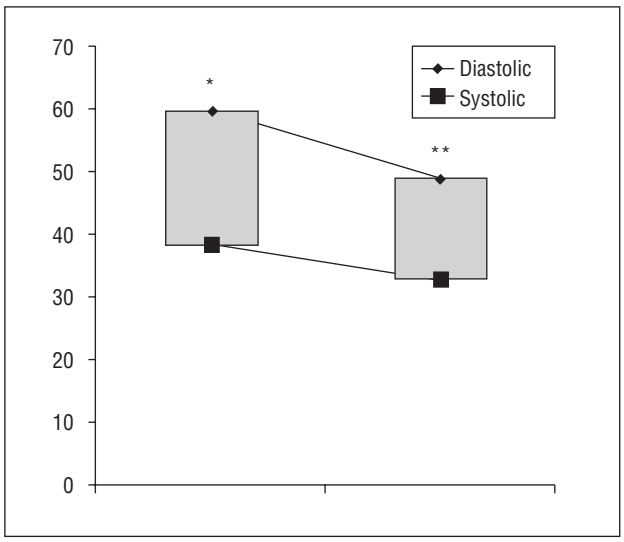


**Fig. 1.** Reduction of ventricular diameters (*$P$<.002; 95% CI, 5.82-15.18. **$P$<.005; 95% CI, 1.69-9.11).

## DISCUSSION

The aortic root is a complex structure and all components from the sinotubular junction to the left ventricular outflow tract are essential to its correct functioning. Preserving anatomy and physiology in aortic root repair procedures is essential.[11,12] This has led to the current trend for aortic root repair operations for patients with aneurysms[3-5] and the use of homografts to correct valvular disease.[6,7]

In the literature, there are few references to the number of patients with aortic valve and ascending aorta disease who have received homografts as the elective surgical technique.[8] However, reports on large-scale series of homografts do include some references.[6,7]

We believe the procedure has not gained popularity because of the technical difficulties caused by differences in homograft and native aortic root diameters. However, allograft replacement of the aortic root and ascending aorta enables us to conserve the anatomy of the sinotubular junction thus maintaining aortic root function. This is especially important in patients who need prosthetic extension of the ascending aorta by locating a conduit above the junction.

The use of homografts for aortic root replacement favors restoration of normal or nearly normal flow in the aortic root, sinuses of Valsalva and coronary flow[3,7], resistance to infection, reduced thromboembolism, and maintenance of total aortic root physiology ensuring better hemodynamic performance; it also removes the need for permanent anticoagulation. This leads to improved recovery of left ventricular function with a reduction in left ventricular hypertrophy as it presents significantly lower gradients than those associated with conventional prostheses.[13,14] Our patients had a statistically significant reduction in ventricular diameters. This is important as long-term survival studies of homografts indicate it improves homograft durability.[3]

Major disadvantages of homograft use are durability, the more demanding surgical technique, and the limited supply of homografts by comparison with conventional prosthetic valves. However, we know that cryopreserved homografts implanted in total aortic root replacements give better long-term results than antibiotic-sterilized homografts and subcoronary implants.[6,7,15,16] This may be because total root replacement preserves the anatomy and valve function from the left ventricular outflow tract to the sinotubular junction.[7,15] In our study this is important as all pa-

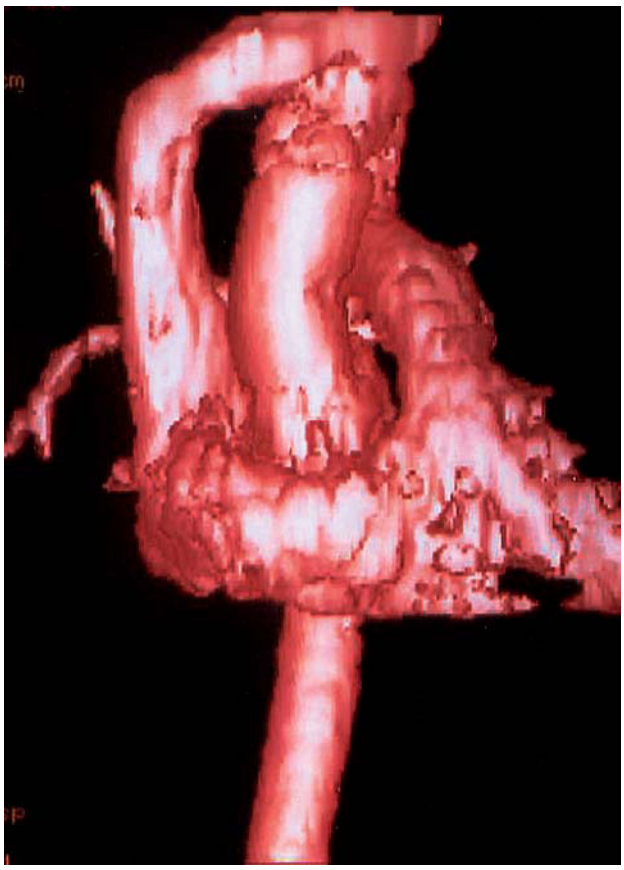

**Fig. 2.** CT image of homograft replacement for native ascending aorta.

tients received cryopreserved homografts in total root replacement procedures. Durability is also influenced by other factors, most of which depend on donor age.[6,7]

Homograft failure appears in the form of calcification and valve failure. In these patients, primary tissue failure is of considerable importance and any measure destined to reduce this is desirable. Tissue failure seems to be associated with degenerative processes[17] but due to our limited follow-up period we have not detected it.

In patients of this kind, stentless bioprostheses can be used in total aortic root[18] and aortic valve reconstruction procedures as alternatives to biological material.

Reconstruction procedures were not used with our patients due to calcium present in valves and annulus or because valve anatomy was thought likely to impede adequate repair. Subcoronary homograft implantation is impossible in patients with dilated aorta because of the aortic geometry.

Absence of thromboembolism during long-term follow-up was positive. Only one event occurred and this was probably associated with surgery as it happened within the first 3 months in the absence of atrial fibrillation and carotid artery disease. As yet, follow-up has been short-term. In 1 patient with arteriosclerosis we found allograft dilatation to a diameter of 40 mm, but ascending aorta measurements in the rest of the patients are within normal range. We found no dysfunction due to calcium or degeneration. This would be more likely in younger patients[19] and the mean age of our group was high. We think the procedure is a valid alternative for these patients, and concur with several authors who advocate the use of homografts in treating complex aortic root disease.[20]

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