Original Research

Ross Procedure: Medium-Term Results

Antonis A. Pitsis, Timotheos G. Kelpis, Petros S. Dardas, Nikolaos E. Mezilis, Dimitrios D. Tsikaderis, Harisios K. Boudoulas

Thessaloniki Heart Institute, St. Lucas Hospital, Thessaloniki, Greece

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Introduction: The Ross procedure is a safe alternative option for aortic valve replacement in selected patients. Here we present the medium-term results of our experience with this procedure.

Methods: Between December 1998 and January 2004, 21 patients (16 male, 5 female, mean age 42 years) underwent aortic valve replacement using the Ross operation. Indications for operation were aortic stenosis in 5 patients, aortic regurgitation in 5 patients, aortic stenosis and regurgitation in 9 patients, acute septic endocarditis of a native aortic valve in 1 patient and of a mechanical aortic valve in 1 patient. The root replacement technique was used in 17 patients (81%) and the subcoronary insertion technique in 4 patients (19%).

Results: Hospital mortality was 4.7% (1 patient) and late mortality is zero. Mean follow up duration was 4 years (range 1-6 years). On follow up all of the patients were in New York Heart Association class I. One patient developed neo-aortic root dilatation (5.1 cm) with mild neo-aortic valve regurgitation and underwent a modified David I procedure using a Valsalva graft. None of the patients had a gradient of more than 10 mmHg through the pulmonary autograft. Sixteen patients had no aortic insufficiency, while mild aortic regurgitation developed in three patients. Pulmonary valve regurgitation developed in 11 patients (range 8-75 mmHg) but only one patient (75 mmHg) developed significant asymptomatic stenosis.

Conclusions: Our experience with the Ross procedure suggests that aortic root replacement with a pulmonary autograft can be performed safely in adult patients. Pulmonary homograft degeneration requiring reintervention might be a rare complication.

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Address:
Antonis A. Pitsis

9 Nimfon St., Panorama
55236 Thessaloniki
Greece
e-mail:
apitsis@otenet.gr

The Ross procedure involves replacement of the diseased aortic valve with the patient's own pulmonary valve (autograft) and reimplantation of a biological valve (homograft) in the pulmonary position.[1,2] The Ross procedure has potential advantages over conventional surgical techniques of aortic valve replacement (mechanical or biological prosthesis).

The complexity of the Ross procedure and the need for the patient's consent to a double valve operation are balanced by its benefits in the form of excellent haemodynamics, the potential for permanent replacement of the aortic valve, the low risk of endocarditis and the avoidance of lifelong anticoagulation.

The Ross procedure is indicated in patients when anticoagulation is contraindicated (e.g. women of reproductive age), in patients with an active life style (e.g. athletes), or in patients who refuse to or cannot take anticoagulants (e.g. poor compliance or allergy).

The use of the Ross procedure increased during the 1990s as a result of improved surgical techniques (method and cardioplegia) and the increasing availability of cryopreserved homografts. In this paper we report our experience from 21 patients who underwent the Ross procedure, performed by a single surgeon at a single hospital.

Methods

Patients

Between December 1998 and January 2004, 21 patients (mean age 42 years, range 16-

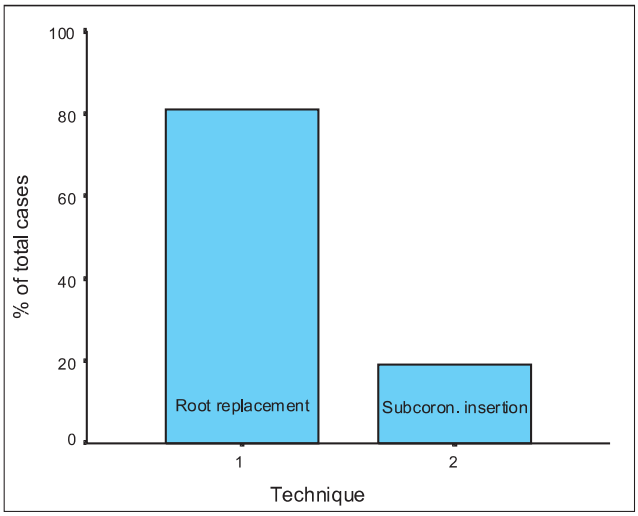

Figure 1. Technique of autograft implantation.

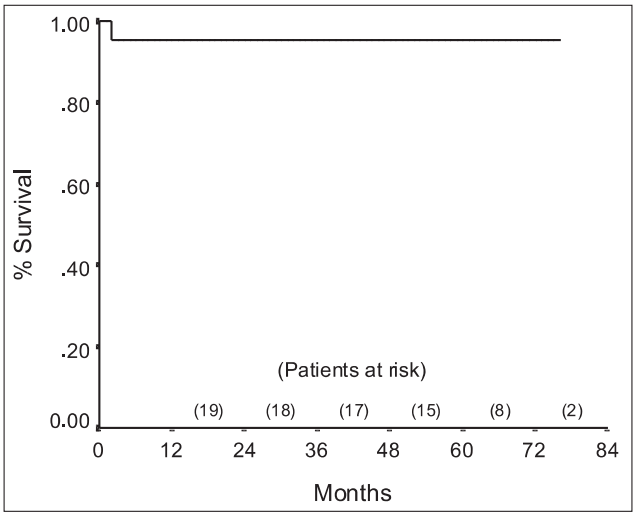

Figure 2. Actuarial patient survival.

55) underwent aortic valve or root replacement with the use of a pulmonary autograft. Indications for operation were aortic stenosis in 5 patients, aortic regurgitation in 5 patients, aortic stenosis and regurgitation in 9 patients, acute septic endocarditis of a native aortic valve in 1 patient and of a mechanical aortic valve in 1 patient.[3]

Operative technique

The root replacement technique was used in 17 patients (81%) and the subcoronary insertion technique in 4 patients (19%) (Figure 1). Twenty pulmonary homografts (size 22-27 mm) and one porcine xenograft (size 27 mm) were used for reconstruction of the right ventricular outflow tract. Two patients underwent associated procedures (myectomy for hypertrophic obstructive cardiomyopathy and mitral valve repair in one patient, and ascending aortic replacement with a tubular graft in the second patient). Previous repair of aortic coarctation had been performed in one patient 40 days prior to the Ross procedure.

Follow up

Early mortality was defined as any death occurring within 30 days of surgery or during initial hospitalisation. Postoperative valve-related morbidity and mortality were evaluated and reported according to standard definitions.[4] All patients underwent a clinical examination by a single cardiologist and were monitored by chest radiography, electrocardiography and colour flow Doppler echocardiography before discharge and at yearly intervals thereafter in the outpatient clinic. Aortic valve regurgitation was graded according to the method described by Perry et al.[5]

Results

Hospital mortality was 4.7% (1 patient). Late mortality is zero (Figure 2). One patient developed right coronary artery embolisation secondary to endocarditis and subsequently suffered asystolic arrest and died 23 days postoperatively. One autograft was explanted six months postoperatively, because of endocarditis, and was replaced successfully with a mechanical prosthesis (Figure 3). One patient developed neo-aortic root dilatation (5.1 cm) with mild neo-aortic valve regurgitation and underwent a modified David I procedure using a Valsalva graft.

Mean follow up duration was 4 years (range 1-6 years). On follow up all of the patients were in New York Heart Association class I. None of the patients had a gradient through the pulmonary autograft of more than 10 mmHg. Three patients developed mild aortic regurgitation and the rest of the patients had no aortic insufficiency. Pulmonary valve regurgitation developed in 11 patients (mean gradient: 24.4 mmHg, range 8-75) but only in one patient was the gradient significant (75 mmHg). The patient remained asymptomatic and did not require re-operation.

Discussion

Clinicians taking care of patients with significant aor-

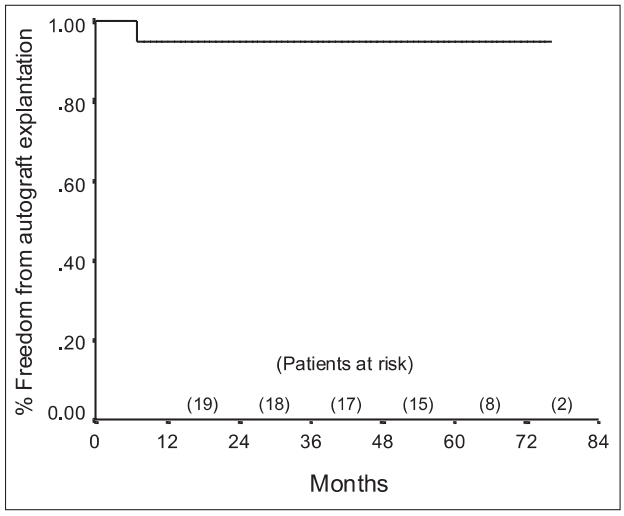

Figure 3. Freedom from autograft reoperation.

tic valve disease often face the problem of what graft material to implant. In practice, the choice is usually between mechanical prosthesis, homografts and xenografts. Mechanical prostheses are long-lasting but require anticoagulation, continuous exposure to the threat of infection, and may display suboptimal haemodynamic performance.[6] Homografts have limited durability (average 15 years) and often require reoperation. Xenografts often exhibit worse haemodynamic performance than mechanical prostheses or homografts and their durability is also limited.[7]

The Ross procedure was introduced in 1967[1] as a possible alternative for aortic valve replacement. However, it was not until the 1990s that the Ross procedure garnered interest among cardiovascular surgeons, probably because of the many technical difficulties inherent to the procedure and the unpredictable outcome of the double valve replacement. Despite these initial concerns, results of large clinical studies demonstrated that this procedure is safe, with favourable short- and long-term results.[8,9]

In our series, the hospital mortality was 4.7%: one patient developed right coronary artery embolisation secondary to endocarditis and subsequently died from asystolic arrest 23 days postoperatively. Late mortality is zero.

Two patients developed endocarditis. One of them underwent neo-aortic valve explantation and replacement with a mechanical prosthesis six months after the initial operation and the second patient died from right coronary artery embolisation and subsequent asystolic arrest.

One patient underwent re-operation, a modified David I procedure using a Valsalva graft,[10] 52 months after the initial operation, because of neo-aortic root dilatation (5.1 cm) and mild neo-aortic valve regurgitation.

Pulmonary allograft degeneration is a common complication of the Ross procedure. Continued follow up has confirmed development of moderate pressure gradients across the pulmonary allografts in the right ventricular outflow tract.[11,12,13] In our series, a pressure gradient through the pulmonary valve developed in 11 out of 21 patients. Only in one patient was the gradient significant (75 mmHg - pulmonary homograft stenosis) but it did not require reoperation because the patient remained asymptomatic.

In conclusion, our current experience with the Ross procedure suggests that aortic root replacement with a pulmonary homograft can be performed safely in adult patients. Pulmonary homograft degeneration, requiring re-intervention, might be a rare complication in the medium-term follow up.

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