Eur J Vasc Endovasc Surg (2018) ■, 1–6

Extra-Thoracic Supra-aortic Bypass Surgery Is Safe in Thoracic Endovascular Aortic Repair and Arterial Occlusive Disease Treatment

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WHAT THIS PAPER ADDS

The necessity and safety of extra-thoracic, supra-aortic bypass surgery in the context of thoracic endovascular aortic repair is the subject of ongoing debate. The present retrospective study included 107 patients undergoing supra-aortic bypass surgery as debranching in the case of endovascular aortic therapy or as bypass surgery in supra-aortic arterial occlusive disease. The results demonstrate high mid-term bypass patency rates and low complication rates, demonstrating the feasibility of this treatment option.

Objective: The safety and feasibility of supra-aortic debranching as part of endovascular aortic surgery or as a treatment option for arterial occlusive disease (AOD) remains controversial. The aim of this study was to assess the clinical outcome of this surgery.

Methods: This single centre, retrospective study included 107 patients (mean age 69.2 years, 38.4% women) who underwent supra-aortic bypass surgery (carotid–subclavian bypass, carotid–carotid bypass, and carotid–carotid–subclavian bypass) because of thoracic or thoraco-abdominal endovascular aortic repair (57%; 61/107) or as AOD treatment (42.9%; 46/107) between January 2006 and January 2015. Mortality, morbidity with a focus on neurological complications, and patency rate were assessed. Twenty-six of 107 (14.2%) of the debranching patients were treated under emergency conditions because of acute type B dissection or symptomatic aneurysm. Follow up, conducted by imaging interpretation and telephone interviews, continued till March 2017 (mean 42.1, 0–125, months).

Results: The in hospital mortality rate was 10.2% (11/107), all of these cases from the debranching group and related to emergency procedures ($p < .0001$). One procedure related death of a patient in the debranching group, who had a lethal stroke 72 months post-operatively following bypass occlusion was observed. Early neurological complications were recognised in 10 patients, including two transient cases of Horner syndrome and vocal cord paralysis as well as six cases of phrenic nerve apraxia. Three cases of stenosis and one case of occlusion were successfully treated. In three AOD patients, the graft had to be exchanged because of peri-graft reaction. Primary and secondary patency rates of 96 patients after 36 months were 95% (SE 2.6%) and 98% (SE 1.8%), respectively.

Conclusions: Extra-thoracic supra-aortic bypass surgery involves low complication rates and high mid-term bypass patency rates. It is a safe and feasible treatment option in the form of debranching in combination with endovascular aortic aneurysm repair and in AOD.

Article history: Received 3 June 2017, Accepted 17 March 2018, Available online XXX

Keywords: Debranching, Carotid subclavian bypass, Thoracic endovascular aortic repair, Stroke, Spinal cord ischaemia

INTRODUCTION

Extra-thoracic, supra-aortic bypass surgery is an established option to treat arterial occlusive disease (AOD) involving the supra-aortic vessels, with reported favorable patency rates and low mortality rates.[1–5] Today, angioplasty of the supra-aortic vessels has become the predominant treatment option for AOD.[6,7]

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1078-5884/

https://doi.org/10.1016/j.ejvs.2018.03.020

Please cite this article in press as: Gombert A, et al., Extra-Thoracic Supra-aortic Bypass Surgery Is Safe in Thoracic Endovascular Aortic Repair and Arterial Occlusive Disease Treatment, European Journal of Vascular and Endovascular Surgery (2018), https://doi.org/10.1016/j.ejvs.2018.03.020

In the era of endovascular aortic aneurysm repair, supra-aortic debranching as well as intentional coverage and secondary revascularisation are established treatment modalities, but both procedures carry risks of complications such as stroke, spinal cord ischaemia, upper extremity ischaemia, and vocal cord paralysis.[8–15] One frequent argument against supra-aortic debranching is the rate of peri-operative mortality and morbidity.[11] Even though supra-aortic bypass implantation has been assumed to trigger severe complications, few studies have attempted to substantiate this. Thus, the aim of the current study was to assess the safety and patency of supra-aortic bypass surgery with respect to related morbidity and mortality rates.

METHODS

Study design and patient population

The internal review board of the hospital approved this retrospective study in January 2015 (Number 287/14). All patients (entire cohort = 107) who had undergone supra-aortic bypass surgery between January 2006 and January 2015 were included. Data were acquired from electronic hospital patient files.

Extra-thoracic, supra-aortic bypass surgery was performed in patients with AOD and in patients undergoing endovascular repair of a thoraco-abdominal aortic aneurysm with coverage of the left subclavian or left carotid artery. Patients with pathologies solely involving the aortic arch or the ascending aorta were excluded. All patients in the cohort who were treated by thoracic endovascular aortic repair with coverage of the left subclavian artery (LSA) orifice underwent carotid—subclavian bypass (CSB) implantation, which is the standard departmental procedure. All emergency cases also received a supra-aortic bypass implant if they were haemodynamically stable. Mortality, patency rates, and early as well as mid-term complication rates with a focus on the neurological status were recorded. In addition to stroke and spinal cord injury (SCI), procedure related complications such as vocal cord paralysis and an elevated diaphragm, as the clinical expression of apraxia of the phrenic nerve, were registered.

Patient characteristics

The mean age was 69 years (SD 12.8 years). The mean body mass index was 26.0 kg/m^2 (SD 6.6 kg/m^2). There were significantly more women in the AOD group (54%) than in the debranching group (28%) ($p = .005$).

Comorbidities

Comorbidity details are given in Table 1. The incidence of diabetes and peripheral artery disease was higher in the AOD group than in the debranching group (32% vs. 7%, $p = .00068$, and 35% vs. 13%, $p = .0101$). The incidence of prior stroke was higher in the AOD group than in the debranching group (35% vs. 10%, $p = .003$). No patient included in the AOD group suffered from acute stroke in the 6 months pre-intervention.

Indications

Fifty-seven percent (61/107) of the patients received debranching surgery, and 42.9% (46/107) had bypass implantation because of AOD. Of all the procedures, 24.3% (26/107) were emergency procedures, all from the debranching group. Further details, including the indications for emergency treatment, are given in Table 2.

Surgical technique

A longitudinal supraclavicular incision was performed. With left vagus nerve protection, the common carotid artery was exposed. To dissect the left subclavian artery, the anterior scalene muscle was divided after identification of the phrenic nerve.

The subclavian prosthetic anastomosis (side to end) was distal to the vertebral and internal mammary artery. Clamping was performed distal to the orifice of vertebral artery to maintain antegrade vertebral artery perfusion. A side to end anastomosis was created between the common carotid artery and the prosthesis. Finally, the proximal left subclavian artery was closed by a suture at the end of surgery or an intravascular occlusion plug (Amplatzer occluder Vascular Plug II, St. Jude Medical, St. Paul, MO, USA) was placed proximal to the orifice of the vertebral artery during the TEVAR procedure.

For carotid—carotid—subclavian bypasses, the right common carotid artery was also dissected by a longitudinal incision ventral to the right sternocleidomastoid muscle. The exposure of the left sided vessels was performed identically to the carotid subclavian bypass exposure. First

Table 1. Comorbidity profile of the patients.

Comorbidities	All (%/[n])	AOD (%/[n])	Debranching (%/[n])	*p*
Smoking	57 (61/107)	61 (28/46)	54 (33/61)	.551
Arterial hypertension	84 (90/107)	76 (35/46)	90 (55/61)	.062
Diabetes	18 (19/107)	32 (15/46)	7 (4/61)	.00068*
PAD	22 (24/107)	35 (16/46)	13 (8/61)	.0101*
Coronary heart disease	36 (38/107)	35 (16/46)	36 (22/61)	1
History of myocardial infarction	12 (13/107)	15 (7/46)	10 (6/61)	.551
Chronic renal failure	11 (12/107)	15 (7/46)	8 (5/61)	.355
History of stroke	21 (22/107)	35 (16/46)	10 (6/61)	.003*
History of PTCA	29 (31/107)	26 (12/46)	31 (19/61)	.668
History of aorto-coronary bypass	9 (10/107)	11 (5/46)	8 (5/61)	.742
History of thoracic operation	20 (21/107)	4 (2/46)	31 (19/61)	.0024*

PTCA = percutaneous coronary angiography; PAD = peripheral artery disease; * significant.

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