

Endovascular Stent-Graft and First Rib Resection for Thoracic Outlet Syndrome Complicated by an Aneurysm of the Subclavian Artery

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Key words. Arterial thoracic outlet syndrome ; aneurysm ; endovascular treatment ; stent-graft.

Abstract. *Purpose :* To report our experience with a combined endovascular and surgical approach for arterial thoracic outlet syndrome (TOS) complicated by an aneurysm of the subclavian artery.

Methods : We treated three consecutive patients suffering from arterial thoracic outlet syndrome complicated by an aneurysm of the subclavian artery by the use of a stent-graft and a first rib resection. These patients were reviewed retrospectively.

Results : At a mean follow-up of 37.3 months all patients were free of symptoms without late complications.

Conclusions : Endovascular stent-grafting followed by decompression of the costoclavicular space is an attractive alternative to the conventional surgical approach of complicated arterial TOS.

Introduction

Thoracic outlet syndrome (TOS) is caused by compression of the neurovascular cord in the region of the scalene triangle and costoclavicular space (thoracic outlet area). In cases of arterial TOS it is the subclavian artery that is involved most. The presenting symptoms of arterial TOS are based on compression of the artery and, in time, the formation of a stenosis or aneurysm at the place of compression. Arterial TOS is a rare condition, only representing 5% of all TOS cases. But although small in absolute numbers, arterial TOS comprises a large percentage of the serious disabilities resulting from TOS (1, 2). We present here three consecutive patients with an aneurysm of the subclavian artery complicating arterial TOS.

Case reports

Case 1

A 39-year-old woman presented with a pulsatile supraclavicular mass on the right side. The Adson test was positive and, on bringing the right arm in abduction, a subclavian bruit appeared. The arm blood pressure was 110/80 mmHg on the right side and 130/90 mmHg on the left side. The rest of the physical examination was unremarkable.

A cervical spine X-ray revealed a bilateral prominent process transversus.

Arteriography of the thoracic aorta and right subclavian artery revealed an aneurysm of the right subclavian

artery and compression of the aneurysm on bringing the arm in abduction (Fig. 1a).

Based on these findings the diagnosis of arterial TOS was made with secondary aneurysm formation of the right subclavian artery.

Via a puncture of the right brachial artery under local anaesthesia a Passenger 8/60 stent-graft (Boston Scientific, USA) was placed and dilated to 8 mm. The aneurysm was completely excluded (Fig. 1b). The patient was sent home with Acetyl Salicylic Acid (ASA).

Two months after this procedure, a resection of the right first rib was performed, using a transaxillary route. The postoperative course was uneventful.

At the last follow-up at 80 months, the patient was asymptomatic with no significant difference in blood pressure between both arms.

Case 2

A 46-year-old woman became stuck with her right arm wedged in a car door. This caused a large bruise with pain and heaviness of the right arm and paresthesia of the hand at night. The initial diagnosis of carpal tunnel syndrome was made and she was treated with infiltrations, but there was no improvement. Five months later she developed progressive ischemia with rest-pain of the right arm with disappearance of peripheral pulsations.

A chest X-ray revealed a bilateral cervical rib. Arteriography in another hospital showed occlusion of the right axillary artery which was successfully treated with local thrombolysis. Further investigation could not reveal any cardiac causes for embolisation. The

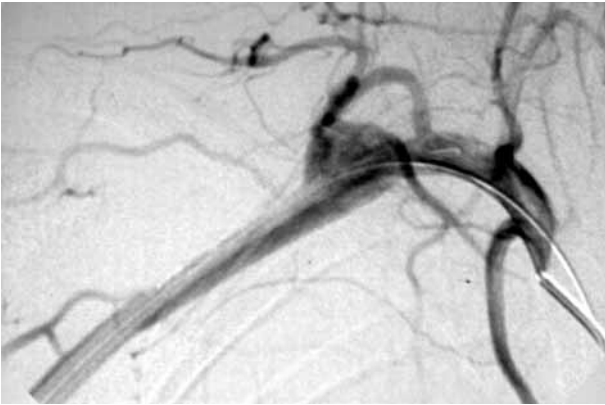


Fig. 1a

Arteriography : aneurysm of the right subclavian artery

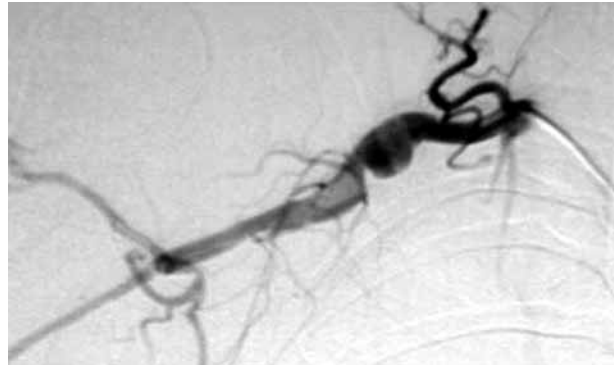


Fig. 2

Arteriography : aneurysm of the right subclavian artery



Fig. 1b

Arteriography : exclusion of the aneurysm by a stent-graft

presumptive diagnosis of posttraumatic dissection of the axillary artery was made and oral anticoagulation was instituted for 6 months.

Four months later she developed pain in the neck and the right arm after a sudden movement of this arm. At physical examination the right axillary artery was weak and there was a bruit detectable.

Arteriography at that time showed an aneurysm of the axillary artery (Fig. 2). The brachial and radial artery were slightly irregular but patent. The ulnary artery was occluded.

A self-expandable Passenger stent-graft 10/60 (Boston Scientific, USA) was placed in the right subclavian artery aneurysm. During the same session a resec-

tion of the right cervical and first rib was performed, using supraclavicular access. Because of distal artery occlusion, an additional thoracic sympathectomy was performed.

The evening after the procedure the patient developed an apical haemothorax and a thrombosis of the endoprosthesis, which demanded revision. The blood collection was drained and a thrombectomy was performed, regaining pulsations in the radial artery. After-care consisted of ASA 160 mg/day.

At 3 months follow-up an EMG of the right arm was performed because of persistent neuralgic pain. This revealed moderate damage to the lower part of the right brachial plexus in evolution. Carbamazepine was started for the neuralgic pain. A duplex revealed a patent endoprosthesis.

One year postoperatively, there was no longer any significant difference in blood pressure and there was a regression of the neuralgic pain. Duplex examination showed a patent endoprosthesis.

Case 3

A 40-year-old man presented with recurrent pallor, pain and paresthesia of the right hand. Physical examination revealed absence of the brachial pulse. The upper extremity was cold and pale. A supraclavicular pulsatile mass was palpable.

A chest X-ray revealed a cervical rib. Arteriography revealed an aneurysm of the right subclavian artery and a distal occlusion of the right brachial artery (Fig. 3a).

Local thrombolysis was started, which was successful, and secondarily, a Passenger stent-graft 8/100 (Boston Scientific, USA) was placed in the subclavian aneurysm (Fig. 3b). The procedure was complicated by an extensive retroperitoneal blood collection (7 × 4 × 2 cm) accompanied by a drop of haemoglobin from 15 g/dl to 8.2 g/dl, which was managed conservatively. At that

Table I
Stages of arterial compression and treatment (2, 3)

Stage	Presentation	Treatment
0	Cervical rib without symptoms and without any arterial damage.	Conservative.
1	Cervical rib with minimal stenosis and post-stenotic dilatation of the subclavian artery.	Arterial decompression by resection of the cervical or abnormal first rib.
2	Cervical rib with subclavian aneurysm, intimal damage and mural thrombus.	Resection of the first rib, and excision and repair, or ligation and bypass, of the aneurysm.
3	Cervical rib with additional distal embolization.	Resection of the first rib and repair of the subclavian artery, often also distal embolectomy and dorsal sympathectomy.

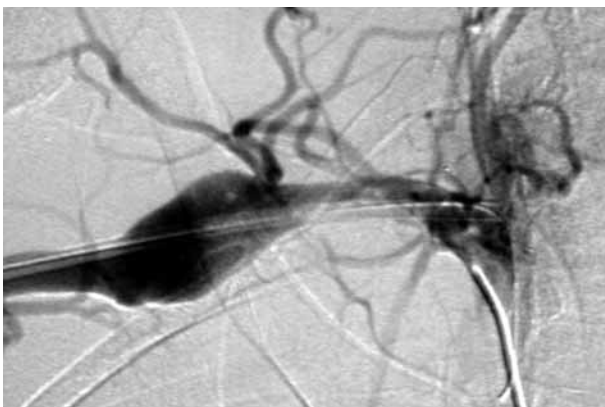


Fig. 3a

Arteriography : aneurysm of the right subclavian artery



Fig. 3b

Arteriography : exclusion of the aneurysm by a stent-graft

time the patient refused further treatment and was discharged on ASA 160 mg/day.

One month later the patient presented again with coldness and pallor of the right arm, especially with the arm in abduction. Physical examination confirmed the disappearance of the radial pulse with the arm in abduction.

At that time a transaxillary resection of the first and cervical rib was performed. On the first postoperative day the patient developed a thrombosis of the endoprosthesis. A thrombectomy was performed. On the fourth postoperative day radial pulses weakened again. Arteriography revealed a severe stenosis, proximal to the brachial artery which was balloon dilated.

The patient was discharged on the sixth postoperative day on ASA.

At 20 months follow-up no significant difference in blood pressure was measured and flow in the right subclavian artery was normal.

Discussion

Arterial complications of thoracic outlet compression present in fewer than 5 per cent of patients operated on

for TOS (1, 2). However, they may severely impair the viability of the affected limb. Longstanding compression of the subclavian artery may lead to intimal injury and stenosis, leading to a poststenotic dilatation and/or aneurysm. Intimal injury as well as an aneurysm can be accompanied by the formation of a mural thrombus that can produce embolization and arterial occlusion (2-5). The traditional treatment of arterial complications of TOS is surgical (Table I). The thoracic outlet is decompressed by resection of the first rib and, if present, resection of the cervical rib. In the presence of an arterial aneurysm or mural thrombus, arterial reconstruction is necessary (2-4). The type of vascular reconstruction has to be tailored to the arterial lesion, but is always technically difficult, delicate and very demanding.

In order to simplify the procedure, we proposed a combined endovascular and surgical procedure to our patients. The aneurysm was treated by an endoprosthesis. However, because the subclavian artery is prone to compression between the clavicle and the first rib, deformation, intimal hyperplasia and stent fracture of endoprostheses in subclavian position are a well-known complication (6-8). To avoid this, a first rib resection was

offered as soon as possible thereafter to avoid compression of the endoprosthesis. Stent-fracture has never been described in patients after first rib resection. In fact, our third patient who returned because of ischemic signs due to repetitive endoprosthetic compression, initially refused first rib resection.

The fact that we had two early postoperative thromboses of the endoprosthesis was rather disappointing. One of these was clearly due to an outflow problem related to a high grade stenosis on the brachial artery. The second might however be due to peroperative manipulations. Therefore, the timing of the endovascular reconstruction might be crucial.

To avoid peroperative trauma and eventual embolisation from the subclavian artery we preferred to perform the endoprosthesis first, followed by first rib resection as soon as possible. Surgical decompression first, followed immediately during the same operative session by endoprosthetic insertion, might be an alternative in these cases.

The mean follow-up of our patients was 37.3 months. All our patients were free of symptoms and there were no late complications. We can therefore conclude that combined endovascular and surgical treatment represents an attractive alternative to the traditional surgical approach of complicated arterial TOS, although it is not yet the treatment of first choice, since the long-term results must still be confirmed.

References

1. SÅLLSTRÖM J. The thoracic outlet syndrome : a clinical study with special reference to diagnosis, incidence and treatment. University of Lund : Malmö, 1983.
2. SANDERS R. J., HAUG C. Review of arterial thoracic outlet syndrome with a report of five new instances. *Surg Gyn and Obst*, 1991, **173** : 415-25.
3. SHINDO S., KAMIYA K., SUZUKI O., KOBAYASHI M., TADA Y. Distal arterial reconstruction using Esmarch's bandage technique to salvage upper extremity function in thoracic outlet syndrome caused by cervical ribs : a report of two cases. *Jpn J Surg*, 1994, **24** : 1107-10.
4. CORMIER J. M., AMRANE M., WARD A., LAURIAN C., GIGOU F. Arterial complications of the thoracic outlet syndrome : fifty-five operative cases. *J Vasc Surg*, 1989, **9** : 778-87.
5. ENGEL A., ADLER O. B., CARMELI R. Subclavian artery aneurysm caused by cervical rib : case report and review. *Cardiovasc Intervent Radiol*, 1989, **12** : 92-4.
6. SCHODER M., CEJNA M., HÖLZENBEIN T. *et al.* Elective and emergent endovascular treatment of subclavian artery aneurysms and injuries. *J Vasc Ther*, 2003, **10** : 58-65.
7. PHIPP L. H., SCOTT D. J. A., KESSEL D., ROBERTSON I. Subclavian stents and stent-grafts : cause for concern ? *J Endovasc Surg*, 1999, **6** : 223-6.
8. SITSSEN M. E., HO G. H., BLANKENSTEIN J. D. Deformation of self-expanding stent-grafts complicating endovascular peripheral aneurysm repair. *J Endovasc Surg*, 1999, **6** : 288-92.

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