Subclavian artery stenosis caused by a prominent first rib

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Abstract
Thoracic outlet syndrome is a mechanical space problem in which the brachial plexus and/or subclavian vessels are compressed. Arterial compression is least common and almost always associated with a bony anomaly. We present a case of a 49-year-old woman with a prominent first rib which caused a subclavian artery stenosis. There are many options for subclavian artery repair through open surgery. In high-risk patients, minimal invasive techniques are favorable. To date, few case reports exist on an endovascular artery repair combined with open first rib resection. While long-term follow-up will be necessary, our preliminary results seem promising.

Keywords
Cyanotic fingers, subclavian artery stenosis, thoracic outlet syndrome

Introduction
Thoracic outlet syndrome (TOS) is a mechanical space problem in which the brachial plexus and/or subclavian vessels are compressed on their way to the axilla. Distinction should be made between nervous, venous, or arterial compression. Arterial compression is the least common, accounting for no more than 1%, and almost always associated with a bony anomaly.1

We present a case in which a prominent first rib caused a subclavian artery thrombosis.

Case report
Please note that our institution does not require ethics approval for reporting individual cases. Informed consent was obtained.

A 49-year-old woman presented to the emergency department with pain in the fingertips of the left hand. Clinical examination showed cyanosis of the fingertips that were hyperesthetic on palpation. Capillary refill was absent. Radial pulse was weaker on the left.

Duplex sonography showed arguments for occlusion of the palmar arch. Additional computed tomography (CT)-angiography was performed, which revealed an important soft tissue plaque with concentric narrowing of the proximal part of the left subclavian artery caused by compression of a prominent first rib (Figure 1).

Because the cyanosis of the fingertips was caused by distal embolization, embolectomy of these small vessels was not possible. Low-molecular-weight heparins were therefore administered.

Initial treatment consisted of the first rib resection and dorsal sympathectomy by transaxillary approach in order to cause a distal vasodilatation which helped restore blood flow. Because of the need of heparin administration, the endovascular procedure was performed 2 days later. A percutaneous balloon dilatation with stenting of the subclavian artery was performed with access in the right femoral artery. After puncture a 5Fr introducer was placed. Heparin was administrated systemically (5000 units). A guide wire was brought in the subclavian artery under radioscopic guidance. Angiography confirmed the proximal stenosis of the subclavian artery (Figure 2). Stenting was performed by means of an Omnilink Elite 6 mm × 29 mm balloon expandable stent which was

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positioned in the proximal subclavian artery, before the bifurcation with the vertebral artery. Final angiography was satisfactory without any dissection or residual stenosis. After removal of the angiographic catheter, the puncture hole was manually compressed for 20 min. No closure device was used.

Postoperatively, the patient was prescribed 3 weeks of low-molecular-weight heparins (preventive dosing), 3 months of clopidogrel 75 mg, and lifelong aspirin dose of 80 mg.

Immediate clinical examination in the recovery room showed complete recovery of the left fingertips, with strong palpable pulses of the radial and ulnar artery. Blood pressure measured left and right were equal. The following days there was only mild discomfort on the scar of the transaxillary approach. Mobility of the shoulder returned to normal in the next couple of weeks.

Follow-up at 6 months showed no residual discomfort.

Discussion
Arterial TOS is usually caused by compression of the subclavian artery between the anterior scalene muscle and a large bony anomaly: a fully formed cervical rib, a protuberant supernumerary bony process, or a deformed first thoracic rib.\textsuperscript{2}

Compression causes stenosis, intimal injury, and mural thrombosis. Some patients develop a poststenotic dilatation with or without formation of an aneurysm.\textsuperscript{3}

Arterial compression leads to decreased blood flow distally, with decreased capillary refill, extremity coolness, and diminution or absence of distal pulses. The latter feature may only be recognizable when the upper extremity is elevated. Rarely, thrombosis produces intermittent embolic events.\textsuperscript{2} In the absence of obvious ischemia, significant arterial pathology may not be suspected and treatment may be unnecessarily deferred.\textsuperscript{4}

Treatment depends on clinical presentation. In bone anomalies without aneurysm, treatment is usually conservative, except when symptoms exist (Table 1). When a poststenotic dilatation or aneurysm is present, a first rib resection should be performed. In case of aneurysms >2 cm or intima damage or thrombus, an indication exists for additional subclavian artery repair or replacement. In few cases where distal embolization occurs, a thromboembolectomy and/or dorsal sympathectomy should be considered in combination with a first rib resection.\textsuperscript{3} The dorsal sympathectomy causes a distal vasodilatation which helps restore blood flow. This is particularly helpful in cyanosis or even necrosis of the fingertips, where embolectomy of the small vessels is not possible.

There are many options for subclavian artery repair or replacement through open surgery. The most common is replacement with polytetrafluoroethylene or venous interposition grafts or end-to-end arterial anastomosis after resection of the dilated part or aneurysm.\textsuperscript{4} Often, subclavian artery thrombosis is based on atherosclerosis in high-risk patients, where minimal invasive techniques are favorable even with long-term patency rates that may be slightly inferior compared with surgery. Results with stenting seem superior to results with conventional balloon angioplasty.\textsuperscript{6}

For ostial lesions, balloon expandable stents are more precise with regard to placement. Self-expanding stents have more relevance in long lesions in middle and distal subclavian artery.\textsuperscript{5} For TOS, to date, few case reports exist on an endovascular approach for artery repair combined with open first rib resection. We describe an elegant technique for a combined endovascular and open surgical approach. While

| Table 1. Treatment indications for subclavian artery stenosis.\textsuperscript{5} |
|-------------------------------------------------|
| Upper limb claudication, embolization in hands and fingers |
| Posterior and right sided anterior cerebral ischemia (Amaurosis fugax, TIA, strokes) |
| Planned coronary artery bypass surgery needing patent internal mammary artery |
| Flow reversed subclavian steal syndrome |
| LIMA graft angina |

TIA: transient ischemic attack; LIMA: left internal mammary artery.
long-term follow-up will be necessary, our preliminary results seem promising.

**Declaration of conflicting interests**

There was no conflict of interest.

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