Surgical treatment of thoracic outlet syndrome: immediate and mid-term results

Giovanni Bertoletti, Alessandro Varroni, Laura Capoccia, Giulia Ianni, Vincenzo Genovese, Hadi Abi Rached, Filippo Napoli, Barbara Praquin, Marco Massucci

Vascular Surgery Unit, Ospedale S. Maria Goretti, Latina, Italy

Submitted: 25 July 2007
Accepted: 3 October 2007

Arch Med Sci 2007; 3, 4: 355-359

Corresponding author:
Laura Capoccia
U.O. di Chirurgia Vascolare
Ospedale S. Maria Goretti via G. Reni snc.
Latina, Italy
Phone: 0773 6553472, 0347 6723011
Fax: 0773 6553470
E-mail: lauracapoccia@yahoo.it

Abstract

Introduction: We report the results from a consecutive series of patients treated by scalenectomy or cervical rib resection for clearly symptomatic or *pauci*symptomatic thoracic outlet syndrome (TOS) over a 6-year period.

Material and methods: From September 1999 to August 2005, 14 surgical decompressions were performed in 12 patients with unremitting signs and symptoms of nerve or vascular compression at the thoracic outlet. The symptoms of TOS were due to involvement of the brachial plexus in 8 cases (57.1%). A sign of vascular obstruction could be detected in 10 cases (71.4%): in 6 cases (42.8%) the presentation was predominantly arterial (arm claudication, coldness, Raynaud's phenomenon and distal embolisation) and in 4 cases (28.5%) was related to vein compression with congestion and swelling of the affected arm or vein thrombosis. Two patients presented as emergencies with critical upper limb ischaemia or distal vessel embolisation.

Results: The median follow-up period was 28.2 months (range 8-78 months). Results were evaluated in terms of technical success, lack of complications (temporary or permanent plexus injury, temporary or permanent phrenic palsy), relief of symptoms. Outcome data were divided into immediate/perioperative and mid-term results. Perioperative results: There was no operative mortality. Technical success was achieved in all patients in excision of the fibrous band with scalenectomy and in cervical rib excision. Mid-term results: In 4 patients with venous symptoms complete relief was achieved in 75%. In all patients who experienced arterial complications we registered complete relief. In patients with neurological presentation we detected complete relief in 5 (62.5%), relief of some symptoms in 2 (25%) and no improvement in 1 (12.5%).

Conclusions: Scalenectomy performed by a standard supraclavicular approach seems to allow relief in the majority of patients with symptoms of neurological, arterial or venous compression at the thoracic outlet. Nevertheless, we emphasize the importance of an objective method of evaluation and the necessity of a prolonged follow-up.

Key words: thoracic outlet syndrome, scalenectomy, cervical rib resection.

Introduction

Subclavian artery or vein occlusion is an uncommon but potentially disabling condition that affects relatively young people. Thoracic outlet syndrome (TOS) can occur with symptoms of nerve or vessel compression as they pass through the thoracic outlet. The majority of symptoms associated with TOS are neurogenic, accounting for more than 95% of initial symptoms,

Table I. Clinical features

Age	31.4 years	20-42 years
Male	2	16.7%
Female	10	83.3%
Right side	4	33.3%
Left side	6	50%
Bilateral	2	16.7%
History of trauma	0	0
Duration of symptoms	6.2 months	0-24 months
Acute presentation	6	42.8%

Table II. Initial symptoms and signs

Shoulder and/or arm pain	5 (35.7%)
Pulse deficit	1 (7.1%)
Digital vessel embolization	1 (7.1%)
Acute upper limb ischaemia	1 (7.1%)
Raynaud's phenomenon	1 (7.1%)
Upper limb vein thrombosis (congestion, swelling)	4 (28.5%)
C8-T1 sensory disturbance	8 (57.1%)
Hands up test positive	2 (14.2%)

with venous or arterial compression symptoms accounting for 2 and 1% respectively according to the literature [1-3]. Cervical rib or first rib anomalies can be detected in 8.5% of symptomatic TOS in major series; an anomaly of the scalene muscles appear to be responsible for TOS in 43% of cases [4]. Some studies have underlined the importance of predisposing morphological variations, structural modifications conditioned by functional requirements and changes in fibre type or myosin isoform consequent to trauma in development of TOS [5, 6].

In patients with symptoms of nerve or vascular compression surgical decompression at the thoracic outlet is mandatory. It can be achieved by cervical or first rib resection, scalenectomy and vascular reconstruction if necessary.

Surgical treatment of TOS began in 1861 with the first cervical rib excision performed by Coote [7]. Currently the two techniques that predominate are the transaxillary approach for resection of the first rib as introduced in 1966 by Roos and Owens [8], and scalenectomy, which was described in 1927 by Adson and Coffey [9]. In 1979 Sanders et al. [10] reported the first successful series of scalenectomies.

Although the majority of patients appear to benefit from surgery when appropriately performed, conservative management, particularly physiotherapy, seems to relieve symptoms completely in a significant proportion of patients. Moreover, because of the high recurrence of symptoms in surgically treated *pauci*symptomatic patients (15-20%) [11, 12] the type and role of surgery in this syndrome are controversial.

We report the results in a consecutive series of patients treated by scalenectomy or cervical/first rib resection for clearly symptomatic or *pauci*symptomatic thoracic outlet syndrome over a 6-year period.

Material and methods

From September 1999 to August 2005 at our institution, 14 surgical decompressions were performed in 12 patients with unremitting signs and symptoms of nerve or vascular compression at the thoracic outlet.

In 8 cases surgery was performed after failure of a 6-month period of physical therapy [13], 2 underwent emergency surgery, and 4 were previously treated for deep vein thrombosis and then were submitted to operation.

Median age was 31.4 years, with a range of 20 to 40 years, and the majority of patients were female (83%). No history of trauma was reported. Duration of symptoms related to thoracic outlet was 0 to 24 months. The side affected was right in 4 cases (33.3%) and left in 6 cases (50%). In two cases the syndrome was bilateral (Table I). Initial symptoms and signs are listed in Table II. As in most series neurogenic symptoms and shoulder or arm pain were reported by the majority of cases (13, 92.8%). The symptoms of TOS were due to involvement of the brachial plexus in 8 cases (57.1%). A sign of vascular obstruction could be detected in 10 cases (71.4%): in 6 cases (42.8%) the presentation was predominantly arterial (arm claudication, coldness, Raynaud's phenomenon and distal embolisation) and in 4 cases (28.5%) was related to vein compression with congestion and swelling of the affected arm or vein thrombosis. Two patients presented as emergencies with critical upper limb ischaemia or distal vessel embolisation.

Diagnosis was achieved by clinical examination with provocative tests, chest X-rays for cervical or first rib anomalies detection, Duplex Doppler with provocative tests, electromyography, CT scans or MR examination for fibrous band or scalene muscle anomaly detection. Arteriography and venography were performed with the arm in adduction and abduction in 9 patients presenting with predominantly arterial or venous symptoms (Figure 1).

In 3 cases the vasculopathy was caused by a supernumerary cervical rib that was in an intermediate stage of development with a fibrous band attaching it to the first rib. Hypertrophic anterior scalene muscle was found in all cases.

The median follow-up period was 28.2 months (range 8-78 months).

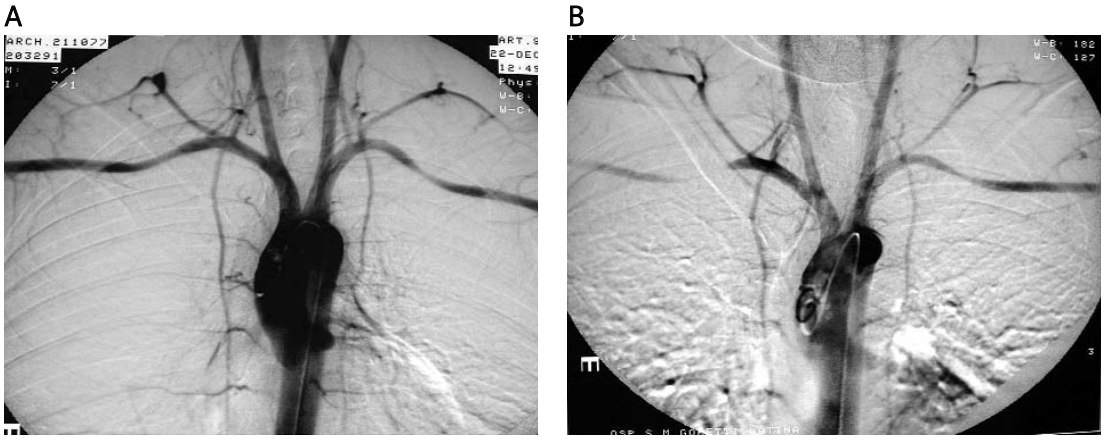

Figure 1. Arch aortogram of a patient with right thoracic outlet syndrome: (A) with the right arm in adduction; (B) in abduction demonstrating complete occlusion of the right subclavian artery

Results

Results were evaluated in terms of technical success, lack of complications (temporary or permanent plexus injury, temporary or permanent phrenic palsy), and relief of symptoms. Outcome data were divided into immediate/perioperative and mid-term results.

All patients had an anterior scalenotomy through a standard supraclavicular approach (Table III). First transaxillary approach was not used in this series. In 3 patients we performed a cervical rib excision with an extended surgical approach: all of them presented an incomplete cervical rib with a fibrous band connecting it to an identifiable promontory on the first thoracic rib. No patients needed first rib resection or arterial or vein reconstruction (Table III). A 23-years-old female presented with acute left upper limb ischaemia (Figure 2); we performed at first locoregional fibrinolysis with urokinase (initial bolus of 300,000 UI followed by 50000 UI/h) for 24 hours and then we treated the subclavian artery lesion with PTA and stenting (Easy Wallstent, Boston Scientific; Figure 3); during endovascular treatment digital

Table III. Operative management

Anterior scalenectomy	14
First rib resection	0
Cervical rib resection	3
Subclavian artery stenting	1

Figure 2. Left upper extremity arteriogram demonstrating complete occlusion of the subclavian artery

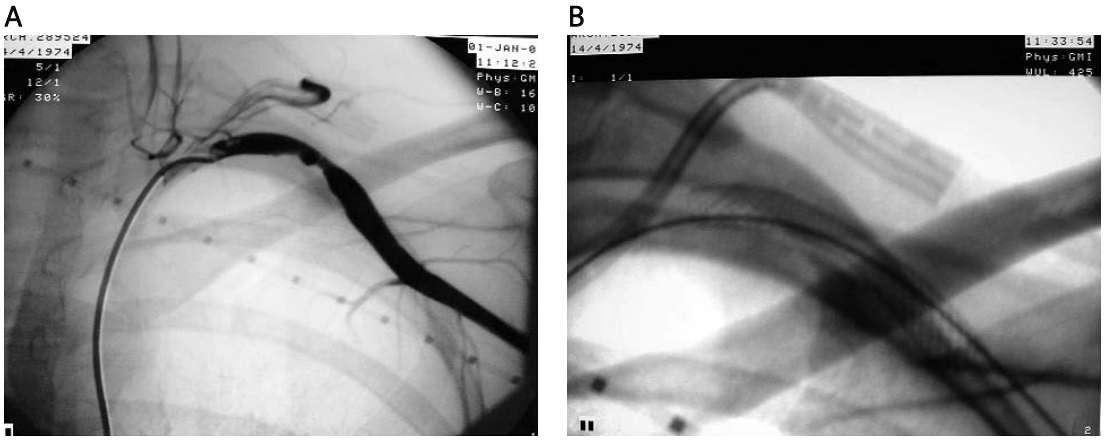

Figure 3. Left upper extremity arteriogram: (A) preoperative arteriogram after successful thrombolysis demonstrates subclavian artery stenosis within the costoclavicular space; (B) completion arteriogram after PTA and stenting demonstrates patent subclavian artery with compression by an incomplete cervical rib

subtraction angiography demonstrated compression of the subclavian artery by an incomplete cervical rib so we finally performed cervical rib excision and scalenotomy. At present she is asymptomatic and the arm is well perfused with symmetrical brachial occlusion pressures.

Perioperative results

There was no operative mortality. Two patients (14%) developed a temporary phrenic palsy that made complete recovery within seven days. Technical success rate was achieved in all patients in excision of fibrous band with scalenectomy and in cervical rib excision. Moreover we registered no postoperative bleeding or wound infection/dehiscence. Median postoperative in-hospital stay was 2.7 days (range 2-8 days).

Mid-term results

The median follow-up period was 28.2 months. Follow-up clinical examination was divided in terms of their neurological, arterial or venous presentation; relief of symptoms was evaluated as complete, partial, none or as worsening of them.

There was no procedure-related deaths. In 4 patients with venous symptoms complete relief was achieved in 75%. In all patients that experienced arterial complications we registered complete relief. In patients with neurological presentations we detected complete relief in 5 (62.5%), relief of some symptoms in 2 (25%) and no improvement in 1 (12.5%).

Discussion

In our series 42.8% of the cases presented with arterial symptoms. This can partially be explained by the small sample size of our series and the lack of a designated vascular unit in a 100 km^2 area. Moreover, it underlines the importance of angiography in the detection and diagnosis of TOS. In one case presenting with critical upper limb ischaemia digital subtraction angiography was performed with diagnostic and therapeutic purposes. Fibrinolysis and stenting of the subclavian artery allowed us to readily save the affected arm. Nevertheless the manifestation of a new acute ischaemia after one day led us to choose a surgical treatment.

Technical success was achieved in all patients by a supraclavicular approach with scalenectomy performed in every patient and additional cervical rib excision wherever detected. We needed no transaxillary surgical approaches because no first rib compression of the nerve or vessels crossing the thoracic outlet was detected on provocative tests and imaging. Supraclavicular incision with extended edges provided good exposure of the cervical rib and anterior scalene muscle for excision and good exposure of vessels for eventual reconstruction or vascular complication requiring direct intervention [4].

In most of the series detection of an obvious anatomical anomaly led to better results. Makhoul et al. [4] reviewed the anatomical anomalies encountered in their extensive experience of 200 patients submitted to surgery for symptoms of thoracic outlet compression: it is of interest to note that only 8.5% of their patients had a cervical rib or an anomaly of the first rib, while an anomaly of the scalene muscle was identified in 43% of patients, with 22.5% of patients having more than one anomaly. Desai and Robbs [14] reported a complete cervical rib in 60% of their patients surgically treated for TOS. In Lindgren et al. [15] the result of surgery was considered successful in 59% at a two-year follow-up; patients with a favourable outcome of surgery had a significantly higher incidence of an anomaly when compared to patients with poor results after surgery. In our series cervical rib accounted for just 21.4% of symptoms of TOS; our experience underlines the importance of the role of scalene muscle and its development in response to growth or functional *hypertrophy* in occurrence of symptoms of TOS.

Numerous surgical case series have been reported that have claimed good to excellent results in 50 to 90% of patients undergoing thoracic outlet decompression [3, 10, 15-22]. Narakas et al. [23] reported satisfactory results in 65% of patients. Nevertheless, in all series reported no objective evaluation method is described; the results are reported by the operating surgeon and this can introduce bias because function results can only be reported in subjective terms. Furthermore the length of follow-up in these studies is variable: at prolonged follow-up data seem to indicate a worsening of results. Lepäntalo et al. [24] reported the follow-up of 75 patients undergoing first rib resection for TOS. One month after surgery 52% of limbs were asymptomatic and 77% were improved. At a mean follow-up of 6 years, patients were re-evaluated by independent examiners: a permanent success rate of the operation of only 37% was reported. Sanders in 1996 [25] reported a complete resolution of symptoms in just 43% at an eight-year follow-up. In a recent report by Urschel and Kourlis [26] on their fifty-year experience at Baylor University Medical Center in 5102 patients treated for TOS, the first-operation results were good in 85%, fair in 12% and poor in 3%; in patients with classic TOS 95% reported improvement shortly after surgery, while 90% reported improvement at 5-year follow-up; in those with cervical spine involvement 75% reported early improvement and 50% late improvement; finally in patients undergoing a therapeutic trial early and late improvement were reported respectively in 70 and 50%.

In conclusions we emphasize the importance of an objective method of evaluation and the necessity

of a prolonged follow-up [27]. In our experience patients treated at first with physical therapy were subsequently submitted to surgical decompression, in most of the cases gained with anterior scalene muscle resection. These data cause a lack of "control cases" in our series to compare surgery versus physiotherapy but seem to indicate better results in terms of relief of symptoms and return to work after surgery.

References

1. Dale W, Lewis MR. Management of thoracic outlet syndrome. Ann Surg 1975; 181: 575-85.
2. Sanders R, Cooper M, Hammond S. Neurogenic thoracic outlet syndrome. In: Rutherford (ed.) Textbook of Vascular Surgery. Philadelphia, Pa, WB Saunders Co, 2000; 1184-200.
3. Kelly TR. Thoracic outlet syndrome: current concept of treatment. Ann Surg 1979; 190: 657-62.
4. Makhoul RG, Machleder HI. Developmental anomalies at the thoracic outlet: an analysis of 200 consecutive cases. J Vasc Surg 1992; 16: 534-45.
5. Edwards PR, Moody AP, Harris PL. First rib abnormalities in association with cervical ribs: a cause for postoperative failure in the thoracic outlet syndrome. Eur J Vasc Surg 1992; 6: 677-81.
6. White JC, Poppel MH, Adams R. Congenital malformations of the first thoracic rib. Surg Gynecol Obstet 1945; 81: 643-59.
7. Coote H. Exostosis of the left transverse process of the seventh cervical vertebra surrounded by blood vessels and nerves: successful removal. Lancet 1861; 1: 360-1.
8. Roos DB, Owens JC. Thoracic outlet syndrome. Arch Surg 1966; 93: 71-4.
9. Adson AW, Coffey JR. Cervical rib-a method of anterior approach for relief of symptoms by division of the scalenus anticus. Ann Surg 1927; 85: 839-57.
10. Sanders RJ, Monsour JW, Gerber WF, Adams WR, Thompson N. Scalenectomy versus first rib resection for treatment of thoracic outlet syndrome. Surgery 1979; 85: 109-21.
11. Bhattacharya V, Hansrani M, Wyatt MG, Lambert D, Jones NA. Outcome following surgery for thoracic outlet syndrome. Eur J Endovasc Surg 2003; 26: 170-5.
12. Landry GJ, Moneta GL, Taylor LM Jr, Edwards JM, Porter JM. Long-term functional outcome of neurogenic thoracic outlet syndrome in surgically and conservatively treated patients. J Vasc Surg 2001; 33: 312-9.
13. Ingesson EE, Ribbe EB, Norgren LE. Thoracic outlet syndrome: evaluation of a physiotherapeutical method. Manual Med 1986; 2: 86-8.
14. Desai Y, Robbs JV. Arterial complications of the thoracic outlet syndrome. Eur J Vasc Endovasc Surg 1995; 10: 362-5.
15. Lindgren SH, Ribbe EB, Norgren LE. Two year follow-up of patients operated on for thoracic outlet syndrome. Effects on sick-leave incidence. Eur J Vasc Surg 1989; 3: 411-5.
16. McGough EC, Pearce MB, Byrne JP. Management of thoracic outlet syndrome. J Thorac Cardiovasc Surg 1979; 77: 169-74.
17. Hempel GK, Rusher AH Jr, Wheeler GC, Hunt DG, Bukhari HI. Supraclavicular resection of the first rib for thoracic outlet syndrome. Am J Surg 1981; 141: 213-5.
18. Sällström J, Gjöres JE. Surgical treatment of the thoracic outlet syndrome. Acta Chir Scand 1983; 149: 555-60.
19. Roos DB. The place for scalenectomy and first rib resections in thoracic outlet syndrome. Surgery 1982; 92: 1077-85.
20. Dale WA. Thoracic outlet compression syndrome. Critique in 1982. Arch Surg 1982; 117: 1437-45.
21. Lindgren KA, Oksala I. Long-term outcome of surgery for thoracic outlet syndrome. Am J Surg 1995; 169: 358-60.
22. Thompson JF, Jannsen F. Thoracic outlet syndromes. Br J Surg 1996; 83: 435-6.
23. Narakas A, Bonnard C, Egloff DV. The cervico-thoracic outlet compression syndrome. Analysis of surgical treatment [English, French]. Ann Chir Main 1986; 5: 195-207.
24. Lepäntalo M, Lindgren KA, Leino E, et al. Long-term outcome after resection of the first rib for thoracic outlet syndrome. Br J Surg 1989; 76: 1255-6.
25. Sanders RJ. Results of the surgical treatment for thoracic outlet syndrome. Semin Thorac Cardiovasc Surg 1996; 8: 221-8.
26. Urschel HC, Kourlis H. Thoracic outlet syndrome: a 50-year experience at Baylor University Medical Center. Proc (Bayl Univ Med Cent) 2007; 20: 125-35.
27. Naarden AL. Thoracic outlet syndrome: a 50-year experience. Proc (Bayl Univ Med Cent) 2007; 20: 256.