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Outcome following Surgery for Thoracic Outlet Syndrome

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Introduction: *the diagnosis of thoracic outlet syndrome (TOS) relies heavily on subjective rather than objective assessment criteria. Subsequently, published results after surgical decompression vary considerably. This study aimed to use a symptom-based patient-directed questionnaire to assess the outcome after decompression for TOS.*
Methods: *sixty patients who underwent decompression procedures were identified from a prospectively maintained vascular database. Patient records were analysed for details regarding initial presentation, investigation, type of procedure used for decompression and management. Outcome questionnaires were sent to all identified patients to give a patient-based outcome measure.*
Results: *eighty-four per cent of patients responded. In 90% of these patients there was an improvement in symptoms post-surgery with a median follow up of 43 months. The results were not influenced by the procedure or approach used.*
Conclusion: *surgery remains an effective tool in the management of TOS. A simple patient-directed questionnaire as used in this study could assist in the standardisation of outcome assessment.*

Key Words: Thoracic outlet syndrome; Surgery; Outcome; Questionnaire.

Introduction

Thoracic outlet syndrome (TOS) encompasses several diverse clinical disorders, which result from compression of the brachial plexus and/or subclavian vessels as they pass through the thoracic outlet.[1,2] This is usually due to a congenital bony abnormality such as a cervical rib, long transverse process of C_7 or a hypoplastic first rib or fibrous band, although in some cases no obvious cause is ever identified.[3] Overall 95% of the cases present with neurogenic symptoms, 2% with venous compression and in only 1% is the aetiology arterial.[4,5]

The incidence of TOS has been estimated at 5:100 000 per year in the U.K.,[6] although the true figure is unknown.[6–8]

To date, there is no universally reliable and accurate diagnostic test for TOS.[9] The diagnosis is essentially clinical, following exclusion of cervical and distal neuropathies.[1,10–13]

Although, the majority of patients appear to benefit from surgery when appropriately chosen, the procedures are not without the risk of significant complications.[2,14] In addition, conservative management, particularly physiotherapy, has been shown to relieve symptoms completely in a significant proportion of patients.[15–17] Controversy, therefore, remains regarding the role of surgery in the treatment of TOS, particularly in the absence of an unequivocal diagnostic test for TOS.[18]

The aim of this study was to determine the outcome of surgical decompression for the treatment of TOS based upon patients' perception of symptomatic improvement using a simple questionnaire. This was based on a broad classification set out by Saunders[19] and previously used by Nasim *et al*.[20]

Material and Methods

Sixty patients who had undergone surgical decompression for TOS between February 1993 and April 2001 were identified from a hospital database. The median age was 37 years (range 18–57 years) and the majority (87%) were female (Table 1). All procedures (70 procedures, 10 bilateral) were performed by 3 vascular consultants with a special interest in TOS. A retrospective analysis of the notes provided details of referral, presentation and treatment.

All patients identified were sent an outcome questionnaire (Fig. 1), an accompanying letter explaining the purpose of the study and a pre-paid reply envelope.

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Table 1. Demographic data of patients at presentation.

	$n=70$
Age	
Median	37 years
Range	18–57 years
Sex	
Male/female	8/62
Presentation	
Neurological	50
Arterial	16
Venous	4
Emergency	4
Elective	66
Source of referral	
GP	34
Neurology	11
Peripheral Hosp	17

1. Are your symptoms now better, same or worse than *before* the operation?
2. Are your symptoms now better or worse than *soon after* the operation?
3. How do you classify the results of your operation?
   - Excellent (complete relief of all your symptoms)
   - Good (relief of most of your symptoms)
   - Fair (relief of some symptoms but persistence of others)
   - Poor (no improvement)
4. In your operated arm do you experience?
   - Pain
   - Swelling
   - Tingling and numbness
   - Weakness
5. Do your symptoms affect your day to day activities?

Fig. 1. The patient-directed outcome questionnaire.

The questionnaire asked patients to grade their perception of symptomatic relief using terms as defined below:

Excellent	complete relief of symptoms
Good	relief of most major symptoms
Fair	relief of some symptoms, but persistence of other symptoms
Poor	no improvement

The procedure was considered a success if the patient reported an excellent, good or fair result.[21]

If the questionnaire was not returned within 2 weeks, another questionnaire was dispatched. Patients who did not return their questionnaires were contacted directly by telephone.

Results

Presentation

Patients were referred from General Practitioners (55%), neurologists (18%) and peripheral hospital units (27%).

In 50 cases (71%) the presentation was predominantly neurological with symptoms ranging from pins and needles in the arm to severe pain, loss of function and muscle wasting. In 16 cases (23%) the major symptom was deemed to be arterial, including arm claudication, coldness, Raynaud's phenomenon and distal embolisation. Four cases (6%) presented with swelling and congestion consistent with venous compression. Four patients presented as emergencies with acute arterial embolisation (3) or venous thrombosis (1).

Investigations

All patients had plain X-rays of the neck and thoracic outlet. An abnormality was detected in 26 cases (37%): in 25 cases a cervical rib was visible and in one patient hypoplasia of the anterior part of the first rib was seen.

Arteriography and venography were performed with the arms in adduction and abduction in all patients presenting with predominantly arterial or venous symptoms. Positive findings of vascular compression or occlusion were found in all cases. Figure 2 shows an arch aortogram performed for a patient who presented with bilateral upper limb claudication. Abduction of the arms (Fig. 2b) leads to complete occlusion of the subclavian artery on the left and partial occlusion on the right. In addition 13 angiograms were performed in patients presenting with predominantly neurogenic symptoms. Eleven of these also demonstrated vascular compression. Duplex scans were performed in 9 cases and provided no additional information.

Magnetic resonance imaging (MRI) or computer tomography (CT) was performed in 24 cases. In the vascular group 6 out of 7 scans performed showed positive findings, whilst in the neurogenic group 8 out of 17 scans performed demonstrated anatomical abnormalities.

All electromyographic (EMG) studies were performed prior to referral to our unit by the neurologists. Abnormalities were detected in 3 of 10 assessments done (30%). One patient exhibited signs of obvious muscle wasting. In the 2 remaining patients, one presented with severe brachial plexus neuropathy and the other with severe C7 radiculopathy.

Procedures

The procedures used for decompression of TOS are shown in Table 2. A supraclavicular approach was used in all cases of cervical rib removal, band division or scalenectomy. For patients undergoing first rib resection, 74% underwent a transaxillary approach.

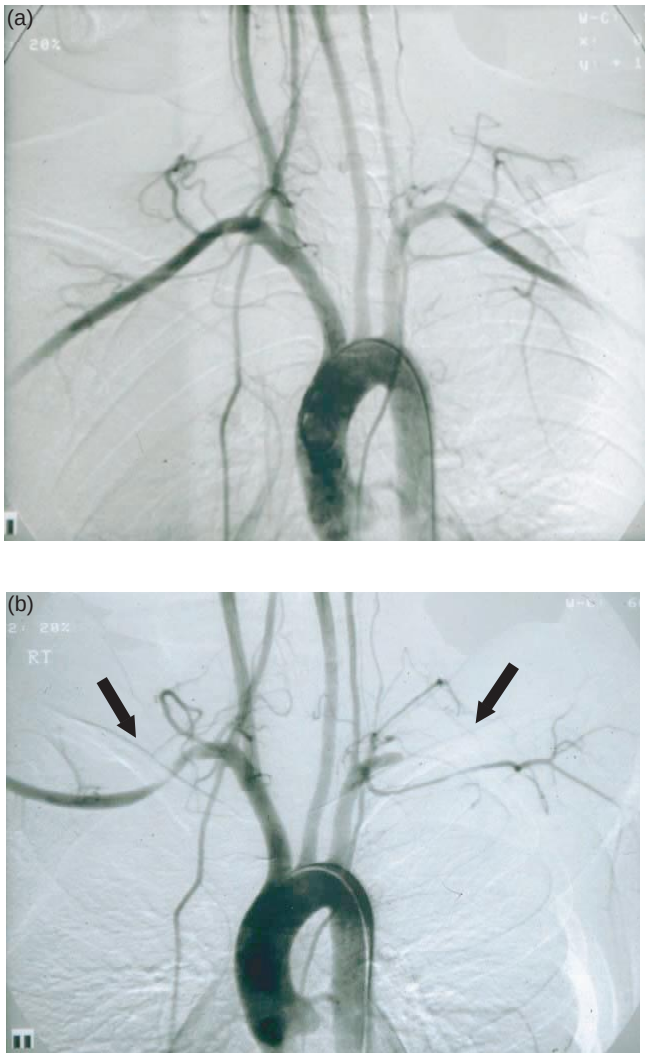

Fig. 2. Arch aortogram of a patient with bilateral thoracic outlet syndrome. (a) with arms in adduction; and (b) in abduction demonstrating complete occlusion of the subclavian artery on the left and partial occlusion on the right.

Table 2. Surgical procedures and approaches used.

Approach	Excision of scalenus anterior and fibrous bands	Cervical rib excision	First rib excision	Total number of procedures
Supraclavicular	26	25	5	56
Transaxillary	0	0	14	14

There were 4 complications: 2 patients developed pneumothoraces, 1 required a pleural suction drain during the procedure, however, both made complete recoveries. 1 patient developed a temporary phrenic nerve palsy (noted on post-operative chest X-ray) and 1 patient bled during the excision of an associated subclavian aneursym, requiring transfusion.

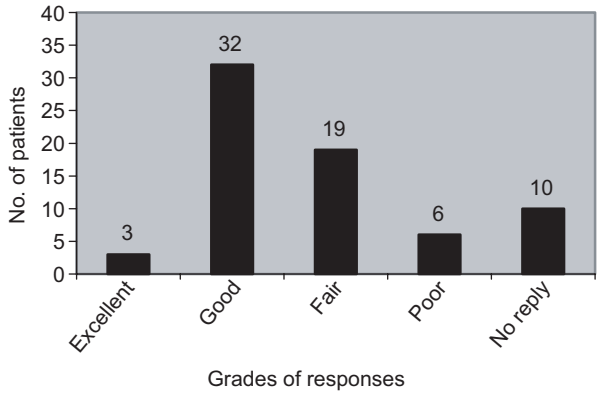

Fig. 3. Overall outcome after surgery for TOS.

Table 3. Questionnaire results.

Technique	No. of ops	Excellent/ good	Fair	Poor	No reply
Excision of bands scalenectomy	26	12 (52.7%)	8 (34.8%)	3 (13%)	3 (7.7%)
Cervical rib excision	25	11 (57.9%)	7 (36.8%)	1 (5.3%)	6 (24%)
First rib resection	19	12 (66.7%)	4 (22.2%)	2 (11.1%)	1 (18.7%)

Outcome – postal questionnaire

A total of 52 patients returned a completed questionnaire, representing an 84% response rate. The remaining 8 patients (2 had bilateral decompressions) had been lost to follow-up and could not be contacted.

The median follow-up period was 43 months (range 4–102 months).

Figure 3 shows the distribution of responses in 60 operations. Using the definition of success as excellent + good + fair, the success rate was 90%.

Analysis of the results in relation to the procedures used (excision of fibrous band with scalenectomy, cervical rib excision or first rib excision) showed no significant differences in success rates (Table 3) (Fig. 4).

Six patients reported poor results. In 3 of these cases there was no improvement in symptoms post procedure. Of the 3 remaining, 2 patients described their symptoms as worse, whilst 1 patient developed severe symptoms following surgery. Two of these procedures had been performed for recurrent symptoms.

Discussion

The widely accepted definition of true neurogenic TOS (N-TOS) involves brachial plexus neuropathy

and muscle wasting combined with abnormal nerve conduction studies.[3] However, in the absence of such positive findings the diagnosis of TOS remains "disputed".[3,22,23] This has led to wide variations in estimates of the incidence of TOS, both within the U.K. and abroad,[6,7] with an increased propensity for diagnosis in the U.S.A.[7,20,24–26] In our series, 71% of the cases presented with neurological symptoms. Twenty-three per cent of cases presented with predominantly arterial symptoms which is significantly higher than the literature would suggest (1%).[19] This is likely to reflect the practice of referral to a designated Vascular Unit, and the subjective nature of the diagnosis of TOS.[27] Although, 17 patients were referred from a neurology unit, these patients represented patients in whom conservative management was deemed either ineffective or inappropriate.

In the majority of cases the diagnosis was made on clinical presentation alone. A bony abnormality was detected in only 37% of plain X-rays. EMG studies were abnormal only in the 3 cases with obvious signs of neurological impairment. These patients continued with residual symptoms post operatively. Nerve conduction patterns do not become abnormal until late into the progression of the disease, by which time the patients will often present with signs of muscle atrophy.[3] Recovery after surgical decompression in such cases is likely to be incomplete.[28] In fact, Wilbourne,[3] recommended that in cases of true N-TOS a trial of conservative management is not indicated as surgery should be performed as soon as it is recognised.

Angiography confirmed vascular compression or occlusion in all patients with vascular symptoms tested in this group. It can also highlight subclavian stenoses, aneurysms or irregular filling defects, consistent with mural thrombus, and allows for dynamic views of the subclavian and axillary vessels with the arms in abduction and adduction. This can substantially aid in pre-operative planning, and remains a helpful part of the assessment of patients presenting with predominantly vascular symptoms.[29] Duplex imaging provided no additional information.

CT and MRI imaging was largely unhelpful, providing no additional information to that obtained by X-ray or angiography. This is consistent with the findings of previous studies.[27,30] MRI investigation is, however, useful in ruling out other causes of neurogenic symptoms such as herniated cervical discs and spinal stenosis and, therefore, should remain as part of the investigative process in these patients, but it plays no part in the investigation of patients presenting with predominantly vascular symptoms.

The choice of procedure and approach for decompression of the thoracic outlet was unrelated to symptomatic presentation, and was primarily based on the preference of the operating surgeon. As in many previous studies the approach used had no significant impact on the success of the operation in relation to the suspected anatomical site of compression[21,31,32] (Table 3).

Differing studies have reported the success of surgical decompression as 43–96% (Table 4).[7,19,33] This variability may well be due to variations in the definition used to denote success, from "worthwhile or not",[20] "excellent + good + fair"[21] to "complete relief of symptoms".[33,34] In addition, some authors have changed their own criteria for improvement in later publications.[35] This variation of outcome assessment adds to the lack of consensus. The small numbers involved in such studies and the differences in time to follow-up have made it difficult to compare the outcomes of surgical decompression between studies. In this study, success was based on Sanders original

Table 4. Outcome after surgery for TOS.

Centres	Procedure(s)	Follow up period (median, range)	Method of assessment	Rate of success (%)
Freeman ($n=60$)	Anterior scalenectomy + Fibrous bands, Cervical rib excision First rib resection	43 months	Excellent + good + fair	90
Peterborough ($n=52$)[6]	Transaxillary 1st rib excision	33 months	Resolution of symptoms	73
Leicester ($n=37$)[13]	Cervical rib excision 1st rib excision Cervical band excision	44 months	Worthwhile or not	87
Finland ($n=45$)[31]	Cervical rib excision Transaxillary 1st rib resection	8 years	Complete resolution of symptoms	43
U.S.A. ($n=338$)[19]	Anterior scalenectomy	4–240 months	Good + fair	88
U.S.A. ($n=3444$)[19]	Transaxillary 1st rib resection	6–180 months	Good + fair	88
U.S.A. ($n=715$)[19]	Supraclavicular rib resection	1–84 months	Good + fair	96

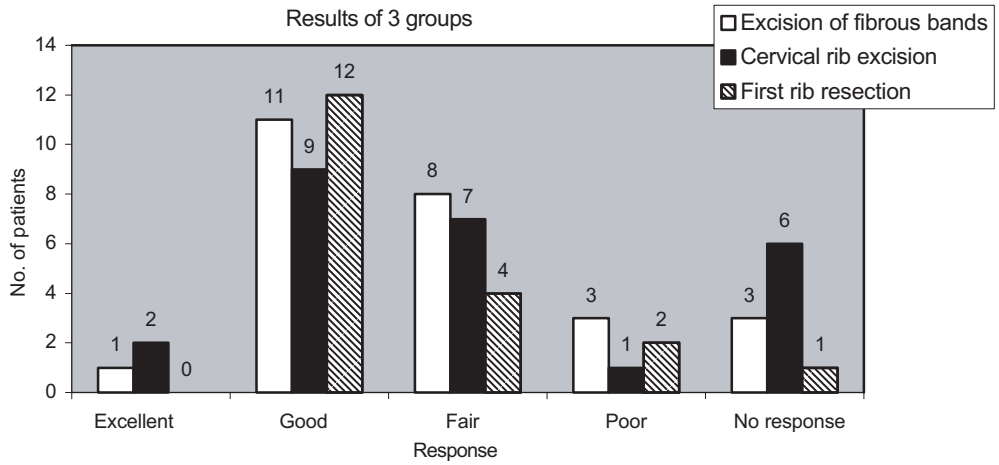

Fig. 4. Graphical depiction of results after surgical decompression for TOS.

criteria of "excellent" + "good" + "fair", using a questionnaire similar to that applied by Nasim *et al*.,[20] and therefore denoting improvement in symptoms and not cure. Thus, our overall success rate of 90% was comparable to that published by similar studies.

Conservative treatment has been reported to produce 100% relief of symptoms in some cases.[8,36] Lack of objective measures to assess initial severity in TOS and to assess outcome post treatment has led to the adoption of a conservative management approach in many centres, even though surgical decompression is beneficial in selected patients.[7,20,31] But our results show that surgical decompression should be considered when the symptoms have not been relieved by conservative treatment. The decision to operate is based on objective investigations but also significantly on the patients' perception of their symptoms. The patients' view of their surgery in the form of the questionnaire described may, therefore, form a valid method for the assessment of the outcome of the procedure and could form the basis for comparison across published series in the future.

Conclusion

When patients have failed to respond to conservative management of their TOS, surgery may confer benefit to a significant number. While not always curative, it should remain an integral part of the management of this complex syndrome. A simple patient-directed questionnaire could prove useful in standardising and evaluating the results of studies involving surgical decompression of the thoracic outlet and aid in comparison across studies.

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