

# Surgical Treatment of Thoracic Outlet Compression Syndrome

MARGARET F. LONGO,\* M.D., O. THERON CLAGETT,\*\* M.D.,  
JOHN F. FAIRBAIRN, II,\*\*\* M.D.

*From the Mayo Clinic and Mayo Foundation, Section of Surgery and of Medicine,  
Mayo Graduate School of Medicine, University of Minnesota,  
Rochester, Minnesota*

ROB and Standeven<sup>4</sup> were the first to popularize the term "thoracic outlet compression syndrome," in 1958. This is a collective term embracing previously described syndromes such as scalenus anticus, cervical rib, costoclavicular, hyperabduction, and shoulder girdle compression syndromes.

Etiologically, the symptoms and signs are due to bony or ligamentous compression of the neurovascular bundle at the thoracic outlet. This may be on a congenital basis, as with a cervical rib, or it may develop with narrowing of the thoracic outlet from sagging of the shoulder girdle with age.<sup>1</sup> It may also result from occupations that involve hyperabduction of the upper extremities or from trauma involving the clavicle and first rib.

Thirty-seven patients have been treated surgically for this syndrome at the Mayo Clinic from 1947 to 1966. Long-term follow-up has been obtained in these cases by reexamination or questionnaire in an attempt to determine the efficacy of surgical intervention in this disorder.

## Clinical Features

**Age and Sex Distributions.** Twenty-six of the 37 patients were female (70%).

At the time of onset of symptoms, the patients ranged in age from 22 months to 56 years; at the time of operation the ages were 9 to 56 years. Fifty-seven per cent of the patients were in the fourth and fifth decades of life (Table 1). The duration of symptoms was 2 weeks to 26 years, with an average duration of 46 months.

**Previous Therapy.** Seventy per cent of these patients had had previous therapy of some kind without relief (Table 2). Several patients had received multiple modalities of treatment. The usual period of temporary relief was 1 month.

**Symptoms and Signs.** Although most patients had histories compatible with both vascular and neurologic compression, 76% of those studied had predominant symptoms related to a vascular origin (Table 3). Among those patients having bruits located over the subclavian artery, this finding was constant in 25% and was related to limb position in the remainder.

Even though results of the Adson, costoclavicular, and hyperabduction maneuvers were not recorded in all cases, more than 80% of patients had positive results on one or two of the maneuvers. The costoclavicular maneuver was positive most frequently (67%); hyperabduction abnormality was found in 51% and, in the Adson maneuver, 24% were positive.

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\* Resident in Surgery.

\*\* Section of Surgery.

\*\*\* Section of Medicine.

TABLE 1. *Distribution of Patients by Age and Sex*

		Age range (years)	Decade													
			1st		2nd		3rd		4th		5th		6th		Total	
			No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Male	Onset	9-50	1	9	1	9	2	18	4	36	2	18	1	9	11	30
	Oper.	19-54	0	0	1	9	3	27	2	18	3	27	2	18	11	
Female	Onset	22*-56	2	8	2	8	3	12	6	24	9	36	3	12	25†	70
	Oper.	6-56	1	4	2	8	2	8	5	19	11	42	5	19	26	

\* Months.

† One patient was asymptomatic.

Sixty-five per cent of the patients had bilateral signs of the thoracic outlet compression syndrome, whereas only 35% had subjective symptoms bilaterally.

Twenty-four per cent of the patients had objective neurologic findings believed related to neurologic compression of the brachial plexus.

**Roentgenologic Survey.** Roentgenologic examination showed normal bony structure in 43% of the patients, cervical ribs in 35%, and some abnormality of the cervical vertebrae or first and second thoracic ribs in 22%.

### Surgical Procedures

Forty-four resections of the first thoracic rib, along with the cervical rib if present, were performed in these 37 patients (seven patients underwent bilateral procedures). Twenty resections (45%) were on the right side and 24 (55%) on the left. A dorsal sympathectomy was combined with rib resection in eight instances (18%) because of evidence of vascular insufficiency to the extremity (coldness, cyanosis, or ulceration of the digits).

A posterior thoracoplasty type incision was used in 41 resections, an anterior approach in two, and a transpleural approach in one. The pleural cavity was entered in 24 of the 41 resections by the posterior approach, and this was easily controlled with

temporary tube drainage and with suction during closure.

There were no deaths and only three patients had complications. One complication

TABLE 2. *Previous Unsuccessful Therapy: 37 Patients*

Therapy	Times used	
	No.	Per Cent*
Claviclectomy	1	3
Cervical rib resection	1	3
Radiation	2	5
Nerve block	2	5
Cervical traction	4	11
Anticoagulation	5	14
Cervical exploration	5	14
Scalenotomy	13	35

\* Of 37 patients.

TABLE 3. *Symptoms and Signs: 37 Patients*

	Manifestation	
	No.	Per Cent*
None	3	8
Bruit	28	76
Subclavian artery dilatation	9	24
Raynaud's phenomenon	7	19
Digital artery occlusion	7	19
Venous obstruction	5	14
Digital ulceration	3	8
Vascular thrombosis (brachial artery)	2	5
Maneuvers		
Positive in 3	4	11
Positive in 2	19	51
Positive in 1	11	30

\* Of 37 patients.

TABLE 4. *Subjective Improvement after Surgical Treatment*

Degree of Improvement (%)	Patients	
	No.	%
100	19	51
75	8	22
50	6	16
25	1	3
0	3	8
Total	37	100

was minor, a questionable brachial plexus injury which cleared spontaneously. Another patient bled severely from a duodenal ulcer 3 days postoperatively so that gastric operation was required. In the third instance, a hematoma developed with infection in the incision which required drainage; it subsequently healed.

#### Results of Surgical Treatment

The follow-up period ranged from 5 months to 18 years. Sixteen patients were evaluated by questionnaire only, six by re-examination only, and 15 by reexamination and questionnaire.

Results were excellent in 73% of patients; more than 50% reported complete relief (Table 4). Three patients had no relief after decompression of the thoracic outlet; in two of these the diagnosis had been incorrect (in one, scleroderma developed postoperatively; in the other, the patient had symptomatic relief with physiotherapy postoperatively and the primary lesion was defined as bursitis of the rotator cuff). The third patient without relief had the thoracic outlet compression syndrome on the basis of the history and examination but had return of all symptoms within a month after resection of the first thoracic rib.

The remaining seven patients had partial relief of symptoms. No patient reported worsening of symptoms.

Only four patients considered themselves partially disabled by the affected limb postoperatively. One, a physician, had pain in the extremity when exposed to cold; at follow-up examination 10 years later the result was excellent. A mechanic considered the involved arm weak but reported continuing improvement in strength 2 years postoperatively. A housewife had minimal persistent swelling of the affected arm and some pain but, on examination, was considered to have a good result. Another housewife reported only 25% improvement and persistent pain, but examination 9 months postoperatively showed excellent decompression of the thoracic outlet.

Of the 21 patients examined at least 5 months postoperatively, 16 had excellent results. The two patients with erroneous diagnoses had poor results by examination. Of the three with good results by examination, one had persistent edema (reported, by questionnaire, 100% improvement 4 years later), one had "good results" 9 months postoperatively but the various maneuvers were not recorded (reported 100% improvement without any disability 11 months later), and one had some residual, persistent pain 9 months postoperatively (reported 90% improvement and no difficulty 16 months postoperatively).

Eight dorsal sympathectomies were performed on seven patients (one patient had bilateral procedures). In four there was 100% improvement with the combined procedures. Two of these patients had thrombosis of the brachial artery preoperatively with cyanosis and coldness of the digits. Another (who had bilateral combined procedures) preoperatively had questionable occupational digital occlusion with pain, cyanosis and ulceration of multiple digits of one hand, and cyanosis and coldness of a digit of the other hand. Four other patients had only partial relief; all had Raynaud's phenomenon pre-

operatively. One patient examined 2½ months postoperatively was found to have an excellent result; however, 3 years later she reported, by questionnaire, only 50% improvement with weakness, fatigue, and aching of the arm and hand. Another patient reported, 24 months postoperatively, 50% improvement but some persistence of pain in the hand when exposed to cold. The third patient had excellent results by examination 1 year postoperatively; however, 1 year after that he reported only 75% improvement with some return of intermittent numbness in the fingers. The last patient had an excellent result 1 month postoperatively but, 7 months later, occupational arterial occlusion of a digit developed and stellate ganglionectomy was recommended.

Amputation of a digit was required in only one patient after thoracic outlet decompression.

### Discussion

That more than half the patients were in the fourth and fifth decades and that 70% were women are in accord with accepted theories as to etiology of this syndrome.<sup>3</sup> We performed a slight majority of resections on the left side, but in previous reviews<sup>3,6</sup> the opposite was true. Raaf<sup>3</sup> reported 8% bilaterality of involvement; one fifth of our patients had bilateral procedures performed, yet 35% had subjective symptoms bilaterally and 65% had objective findings of bilateral involvement. These findings support the belief that this syndrome results from shoulder sagging which predisposes to bilateral involvement.

Compression of the upper extremity neurovascular bundle is not a new entity; however, failure to recognize it is evidenced by the number of patients receiving inadequate treatment prior to surgical correction. The first report in this series was of a case treated 20 years ago but 50% of the

operations were performed in the last 2 years, again indicating that physicians are now recognizing the entity more often than previously.

In previous reports<sup>8</sup> neurologic symptoms were most frequent, but we did not find this so. More than 75% of our patients had symptoms interpreted as vascular. A frequent finding was a bruit over the subclavian artery. One fourth of these bruits were constant, indicating continuous compression of the artery secondary to narrowing of the outlet. Diagnostic maneuvers were most helpful in evaluations, but it must be recognized that these same findings may be present in healthy persons. Telford and Mottershead<sup>7</sup> found that, in 120 healthy medical students, 38% had alteration of radial pulses with shoulder depression, 68% had alteration with shoulder retraction, and 54% had alteration with shoulder abduction. It is our opinion that, during the performance of hyperabduction and in the Adson maneuvers also, compression of the subclavian artery often and perhaps always occurs at the costoclavicular space, making these tests merely confirmatory of costoclavicular compression. The degree and ease of compression are important in determining the presence or absence of a pathologic state. Physical examination, therefore, must be combined with a carefully taken history to permit a correct diagnosis.

An estimated 70% of all patients with mild thoracic outlet compression syndrome can be treated by conservative measures such as physiotherapy and exercises aimed at correcting posture and strengthening the shoulder support muscles. Surgical procedures are undertaken once muscular weakness or atrophy, persistent or easy arterial compression with or without poststenotic dilatation of the subclavian artery, or extremity ischemia is evident.

We found that resection of the first tho-

racic rib (and cervical rib if present) is best accomplished by a posterior thoracoplasty incision. Even though this incision is large and vascular, the exposure obtained justifies its use. Complete excision of the bony structures plus the periosteum is accomplished. The neurovascular bundle is visualized directly and can be evaluated as to complete release of compression. If dorsal sympathectomy is required, adequate exposure is available through this incision. The only disadvantage is that, if a major vessel is torn inadvertently during the procedure, repair requires closing the posterior incision and making another anterior incision with claviclectomy to control the vessel. This did not occur in any of our patients.

Roos<sup>5</sup> preferred the axillary approach; others have found this a difficult and inadequate incision for resection. Another approach is anterior<sup>2</sup>; this allows only partial rib resection with the possibility that structures may be injured postoperatively by the remaining rib segments.

Excluding two patients diagnosed incorrectly, all except one benefited from operation. The majority had excellent results, with many having total relief of symptoms. The few patients having residual symptoms are difficult to evaluate as to adequacy of surgical decompression versus permanent preoperative damage of the neurovascular bundle by compression. We believe the latter to be the explanation.

### Summary

Thirty-seven cases of thoracic outlet compression syndrome, in which 44 resections of first thoracic ribs (and cervical ribs if present) were performed, are reviewed. Long-term follow-up was obtained by questionnaire or reexamination. Our results indicate that excellent relief can be obtained after surgical treatment. Since this is a benign condition in relatively young persons still in active and economically productive stages of life, surgical correction is appropriate and rewarding.

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