Upper Plexus Thoracic Outlet Syndrome

—Case Report—

Takeshi MATSUYAMA, Kazuo OKUCHI, and Kazuo GODA*

Department of Emergency and Critical Care Medicine, Nara Medical University, Kashihara, Nara; *Department of Neurosurgery, Heisei Memorial Hospital, Kashihara, Nara

Abstract

A 47-year-old right-handed female became aware of proximal ache and muscle weakness in the right shoulder and elbow in 1997. Atrophy of the right biceps muscle was recognized and the right deltoid, triceps, supraspinatus, and infraspinatus muscles were weak. The Morley test and elevated arm stress test were positive. Neurolysis of the brachial plexus and anterior scalenectomy were performed via a right supraclavicular approach. An abnormal fibromuscular band was identified passing between the upper and middle trunks and constricting the middle trunk. Another scalene muscle anomaly was found passing between the C-5 and C-6 nerve roots and connecting the anterior and middle scalene muscles. These muscles were resected, and thorough neurolysis was performed around all nerves and the trunks. Postoperatively, all symptoms completely resolved and the patient was discharged 5 days after surgery. Thoracic outlet syndrome (TOS) manifests as symptoms of lower cervical nerve involvements with hypesthesia and paresthesia. However, upper plexus TOS manifests as symptoms due to the involvement of the C-5 to C-7 nerve roots, and is relatively rare. Transaxillary first rib resection is performed as the primary operation for TOS, but supraclavicular scalenectomy is effective for upper plexus TOS.

Key words: thoracic outlet syndrome, upper plexus, scalene muscle anomaly

Introduction

Thoracic outlet syndrome (TOS)¹⁰⁾ is a well-known entity caused by compression or irritation of the brachial plexus, subclavian artery, or subclavian vein at the point where these structures pass through the thoracic outlet.^{6,14-17,19)} This compression may be caused by the anterior scalene muscle, congenital fibrous bands, cervical ribs, and clavicular deformity.^{9,13,17,19)} TOS due to compromise of the brachial plexus is known as neurogenic TOS.^{2,4,5)} Classic TOS presents with lower cervical nerve involvement (C8-T1 nerve roots or lower trunk) with hypesthesia and paresthesia along the distribution of the ulnar nerve. Upper plexus TOS presents with symptoms due to the involvement of the C-5 to C-7 nerve roots, is relatively rare, and can be mistaken for cervical disc disease.^{12,17,18,20)} Transaxillary first rib resection is performed as the primary operation in most cases.

We recently treated a patient with upper plexus TOS and muscle weakness of the shoulder and up-

per arm, which was completely relieved by neurolysis of the brachial plexus and resection of the abnormal interconnecting muscles between the anterior and middle scalene muscles via a supraclavicular approach.

Case Report

A 47-year-old right-handed female became aware of proximal ache and muscle weakness in the right shoulder and elbow in 1997. The symptoms were exacerbated by elevating the right hand above the head. The patient also became aware of motor weakness and atrophy of the biceps muscle. She had suffered domestic violence from her husband and was hit on the right shoulder in 1996. She was generally healthy.

Physical examination found slight paresthesia of the lateral aspect of the right upper arm and ache in the right shoulder blade. Atrophy of the right biceps muscle was recognized and the muscle strength was Medical Research Council (MRC) grade 3/5. The right deltoid, triceps, supraspinatus, and infraspinatus muscles had strengths of MRC 4/5. The Wright

Fig. 1 Intraoperative photograph (left) and drawing (right) showing an abnormal fibromuscular band (arrow) between the upper (UT) and middle trunks. ASM: anterior scalene muscle, PN: phrenic nerve.

and Adson tests were negative. However, the Morley test and elevated arm stress test were positive. The nerve conduction test and sensory evoked potentials found no abnormalities. Chest and cervical radiography and magnetic resonance imaging of the spine revealed no abnormalities. The diagnosis was upper plexus TOS based on the patient's history and physical examination.

She was treated by conservative therapy including anti-inflammatory agents and physiotherapy for 3 months. However, the symptoms persisted without improvement. Surgical exploration was performed on August 31, 2001.

Neurolysis of the brachial plexus and anterior scalenectomy were performed via a right supraclavicular approach. The patient was placed in a supine position with rolled sheets under the posterior aspect of the upper thorax. A skin incision was made from the posterior border of the sternocleidomastoid muscle at the level of the thyroid cartilage to the upper level of the clavicle, then following the superior border of the clavicle laterally and crossing the midpoint of the clavicle. The posterior triangle of the neck was deeply dissected with the clavicular portion of the sternocleidomastoid muscle and the omohyoid muscle being divided and tagged. These muscles were reapproximated at the time of skin closure. The anterior scalene muscle was identified and the phrenic nerve lying on its surface was dissected out and mobilized medially for scalenectomy. The scalene muscle was normal and exerted no severe constricting effect on the brachial plexus. The upper and middle trunks were identified, but when neurotization was attempted from the anterior and middle scalene mus-

cles, an abnormal fibromuscular band was identified passing between the upper and middle trunks and constricting the middle trunk (Fig. 1). This band was very tough and apparently consisted of muscle fibers interconnecting between the anterior and middle scalene muscles. Cutting of this band freed the middle trunk. During the dissection, another scalene muscle anomaly was found passing between the C-5 and C-6 nerve roots and connecting the anterior and middle scalene muscles (Fig. 2). This pencil-sized muscle string, which displaced the C-5 nerve upward and depressed the C-6 nerve downward, was carefully dissected to avoid injuring the nerves. After resection, the course of the upper trunk was normalized. The anterior scalene muscle was cut using a monopolar coagulator and removed from the anterior tubercles of the vertebral column (Fig. 3). Thorough neurolysis was performed around all nerves and the trunks. The lower trunk was intact. Careful inspection revealed no bony anomalies. After the brachial plexus was completely freed, the sternocleidomastoid and omohyoid muscles were reapproximated, and the skin was closed.

Postoperatively, all symptoms completely resolved and the patient was discharged 5 days after surgery.

Discussion

Neurogenic TOS caused by compression of the brachial plexus manifests as two symptom patterns, depending on which of the upper or lower portions of the brachial plexus is primarily affected. Lower plexus or common TOS presents with diverse symptoms due to lower plexus involvement. Paresthesia

Fig. 2 Intraoperative photograph (left) and drawing (right) showing that the pencil-sized muscle string (arrow) passed between the C-5 (C-5) and C-6 nerve roots (C-6) and interconnected the anterior (ASM) and middle scalene muscles. The C-5 nerve was displaced upward and the C-6 downward. PN: phrenic nerve, UT: upper trunk.

Fig. 3 Intraoperative photograph (left) and drawing (right) showing that the anterior scalene muscle (ASM) was resected. C-5: C-5 nerve, C-6: C-6 nerve, PN: phrenic nerve, UT: upper trunk.

along the inner side of the arm to the fourth and fifth digits is common. Pain in the supraclavicular area, back of the neck, and radiating down the inner brachium, elbow, and forearm to the fourth and fifth digits is often reported. Muscle weakness may be identified in the arm and hand along the ulnar nerve distribution, and aggravated by elevation of the affected arm or lifting.

Upper plexus TOS symptoms are caused by C-5, C-6, and C-7 nerve root compression,¹⁸⁾ and is relatively rare, comprising only 3–12% of all cases of

TOS.^{12,18,20)} Sensory changes are predominantly found in the first three digits. Hypesthesia and paresthesia often occur in the cheek, earlobe, back of the shoulder, or outer arm. Pain is reported in the neck, radiating up to the face, mandible, and ear with occipitalgia.¹²⁾ Radiation posteriorly to the rhomboid area or upper pectoral region down to the outer arm can also occur. Dizziness, vertigo, and blurred vision is recognized in some patients.²¹⁾ Muscle weakness is identified in the arm and wrist, and aggravated by rotating or tilting the head and

neck. Upper plexus TOS manifests as more diverse symptoms than common TOS and can be overlooked if the physician is not familiar with this rare form of TOS.

The diagnosis of TOS can be difficult and is best established by exclusion of the alternatives. No single characteristic finding or test is available to aid diagnosis. Careful clinical evaluation is essential. Electromyography, nerve conduction study, arteriography, and venography are not helpful for neurogenic TOS. However, careful attention should be paid to the nerves from the brachial plexus to the fingertips. Change of sensation and individual muscle strength according to each level of the plexus should be examined. Local tenderness primarily occurs on the most affected cervical nerves. The Morley test, which detects tenderness of the brachial plexus beneath the anterior scalene muscle, is relatively reliable. Upper plexus TOS frequently manifests as weakness of the deltoid, biceps, and triceps due to direct C-5, C-6, and C-7 nerve compression. Light percussion on the upper plexus is intolerable and suggests the site of maximum involvement.¹²⁾ Tilting the head from the affected side provokes neck pain.

Common TOS may be caused by congenital anomalies such as cervical rib, elongated C-7 transverse process, or hypertrophy of the suprapleural membrane (Sibson's fascia) or first rib.^{4,5,11,17,19)} Fibromuscular bands or scalene muscle anomalies are also common. In particular, scalene muscle anomalies are the predominant etiological factor in upper plexus TOS. There are five types of scalene muscle anomaly affecting the upper plexus¹²⁾: Type 1 is direct attachment of anterior scalene muscle on the perineurium of the major nerves; type 2 is a pencil-sized muscle bundle connecting the anterior and median scalene muscles; type 3 is abnormal development of the upper part of the anterior scalene muscle posterior to C-5 and C-6 nerves, and displacing the upper two nerves anteriorly; type 4 is a single mass of scalene muscle with the individual nerves penetrating the muscle body; and type 5 is strong fibrous bands or ligaments crossing the cervical nerves vertically behind the anterior scalene muscle. Persistent contraction of these muscular anomalies on the cervical nerves of the plexus causes nerve compression, leading to pain and muscle weakness. Complete resection of these scalene muscle anomalies is essential to relieve the upper plexus symptoms.¹²⁾

Patients with mild to moderate neurogenic symptoms can be treated conservatively. However, if conservative therapy is not effective and symptoms are exacerbated, surgery should be considered. Transaxillary first rib resection and supraclavicular

scaleneotomy are commonly used for the surgical treatment of TOS.^{1-3,6,8,17)} Transaxillary first rib resection has been used to treat upper plexus TOS.^{18,20)} Supraclavicular scaleneotomy was performed in 93 patients with upper plexus TOS but in only six patients as the primary operation.¹²⁾ Neurolysis was performed via the supraclavicular approach for recurrent or failed TOS.¹²⁾ Soft tissue anomaly is the most common causative factor and occurs very close to the spine.^{4,7)} Thorough external neurolysis of the affected brachial plexus is essential without first rib resection.^{4,7)} Scalene muscle anomalies should be removed to relieve the symptoms of upper plexus TOS. Supraclavicular scaleneotomy is the primary operation of choice because resection of abnormal muscles cannot be performed from the transaxillary route. In our case, a type 2 scalene muscle anomaly affected C-5 and C-6 nerves and the middle trunk. The anomaly was resected completely via the supraclavicular approach. We recommend supraclavicular scaleneotomy as the best method to relieve upper plexus TOS.

References

- 1) Donaghy M, Matkovic Z, Morris P: Surgery for suspected neurogenic thoracic outlet syndromes: a follow up study. *J Neurol Neurosurg Psychiatry* 67: 602-606, 1999
- 2) Edwards DP, Mulkern E, Raja AN, Barker P: Transaxillary first rib excision for thoracic outlet syndrome. *J R Coll Surg Edinb* 44: 362-365, 1999
- 3) Fernandez E, Pallini R, Marchese E, Lauretti L, Palma P, Miscusi M, Scogna A: Neurosurgery of the peripheral nervous system: entrapment syndromes of the brachial plexus. *Surg Neurol* 53: 82-85, 2000
- 4) Kline DG, Hudson AR: *Nerve Injuries: Operative Results from Major Nerve Injuries, Entrapments, and Tumors*. Philadelphia, WB Saunders, 1995, 611 pp
- 5) Leffert RD: Thoracic outlet syndromes. *Hand Clin* 8: 285-297, 1992
- 6) Leffert RD, Perlmutter GS: Thoracic outlet syndrome. Results of 282 transaxillary first rib resections. *Clin Orthop* (368): 66-79, 1999
- 7) Mackinnon SE, Dellon AL: *Surgery of the Peripheral Nerve*. New York, Thieme Medical Publishers, 1988, 638 pp
- 8) McCarthy MJ, Varty K, London NJ, Bell PR: Experience of supraclavicular exploration and decompression for treatment of thoracic outlet syndrome. *Ann Vasc Surg* 13: 268-274, 1999
- 9) Parry DJ, Waterworth A, Scott DJ: Post-traumatic clavicular pseudo-arthritis—an unusual case of venous thoracic outlet syndrome. *Eur J Vasc Endovasc Surg* 20: 403-404, 2000
- 10) Peet RM, Henriksen JD, Anderson TP, Martin GM: Thoracic outlet syndrome: evaluation of a therapeutic exercise program. *Proc Mayo Clin* 31: 281-287,

- 1956
 - 11) Roos DB: Transmaxillary approach to the first rib resection to relieve thoracic outlet syndrome. *Ann Surg* 163: 354-358, 1966
 - 12) Roos DB: The place for scalenectomy and first-rib resection in thoracic outlet syndrome. *Surgery* 92: 1077-1085, 1982
 - 13) Sales de Gauzy J, Baunin C, Puget C, Fajadet P, Cahuzac JP: Congenital pseudarthrosis of the clavicle and thoracic outlet syndrome in adolescence. *J Pediatr Orthop B* 8: 299-301, 1999
 - 14) Sanders RJ, Haug C: Subclavian vein obstruction and thoracic outlet syndrome: a review of etiology and management. *Ann Vasc Surg* 4: 397-410, 1990
 - 15) Sanders RJ, Haug C: Review of arterial thoracic outlet syndrome with a report of five new instances. *Surg Gynecol Obstet* 173: 415-425, 1991
 - 16) Urschel HC Jr: Neurovascular compression in the thoracic outlet: changing management over 50 years. *Adv Surg* 33: 95-111, 1999
 - 17) Urschel HC Jr: The history of surgery for thoracic outlet syndrome. *Chest Surg Clin N Am* 10: 183-188, x-xi, 2000
 - 18) Urschel HC Jr, Razzuk MA: Upper plexus thoracic outlet syndrome: optimal therapy. *Ann Thorac Surg* 63: 935-939, 1997
 - 19) Wilbourn AJ: Thoracic outlet syndromes. *Neurol Clin* 17: 477-497, vi, 1999
 - 20) Wood VE, Ellison DW: Results of upper plexus thoracic outlet syndrome operation. *Ann Thorac Surg* 58: 458-461, 1994
 - 21) Wood VE, Twito R, Verska JM: Thoracic outlet syndrome. The results of first rib resection in 100 patients. *Orthop Clin North Am* 19: 131-146, 1988
-
- Address reprint requests to: T. Matsuyama, M.D., Department of Emergency and Critical Care Medicine, Nara Medical University, 840 Shijo-cho, Kashihara, Nara 634-0813, Japan.
e-mail: tmatsuya@nmu-gw.naramed-u.ac.jp.