Operative Techniques in
Thoracic and
Cardiovascular Surgery

Supraclavicular Approach to First Rib Resection for Thoracic Outlet Syndrome

Susan Mackinnon, MD, G. Alexander Patterson, MD, FRCS(C), FACS, and Stephen H. Colbert, MD

Thoracic outlet syndrome (TOS) refers to compression of the subclavian vessels and brachial plexus in the region of the superior aperture of the chest, with most compression of these structures directed against the first rib. Historically, the diagnosis and treatment of TOS have been difficult and controversial topics. Symptoms may be vascular or neural, depending on the predominant target of compression. Neurologic signs and symptoms can range from mild paresthesia and numbness to intrinsic hand muscle atrophy, and many times there will be more than one site of nerve compression. Often, particularly in neurogenic TOS, there is no reliable objective test to identify the cause. Nerve conduction studies are useful for detecting sites of concomitant distal compression, such as the median nerve at the carpal tunnel or the ulnar nerve at the elbow, but neither they nor somatosensory-evoked potentials are universally accepted as helpful in the diagnosis of TOS. In these cases, the diagnosis is suggested by physical examination. Though many provocative tests exist, we have found the most logical and reliable to be the reproduction of symptoms within 1 minute of arm elevation, with the wrist neutral and elbow extended. This position prevents the confounding incitement of peripheral nerve compression at the elbow or wrist. Symptoms may occur more briskly with concomitant digital pressure on the supraclavicular brachial plexus. Most patients with neurogenic TOS will achieve relief with specific and directed physical therapy. However, those with an easily identifiable cause of vascular or nervous compression, and some of those without an identifiable cause and incomplete relief from conservative management, may benefit from surgical decompression.

The supraclavicular approach to relieve thoracic outlet syndrome by decompression of the brachial plexus and excision of the first rib releases structures that compress soft tissue in the region of the interscalene portion of the brachial plexus. The lower nerve trunk and C8 and T1 nerve roots can be completely identified and protected as the most posterior aspect of the first rib is resected under direct vision. Any cervical ribs or prolonged transverse processes are easily removed by this supraclavicular approach.

Department of Surgery, Washington University School of Medicine, St. Louis, Missouri.
Address reprint requests to Susan Mackinnon, MD, 660 South Euclid, Campus Box 8238, St. Louis, Missouri 63110. E-mail: Schultzl@wustl.edu

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Operative Technique

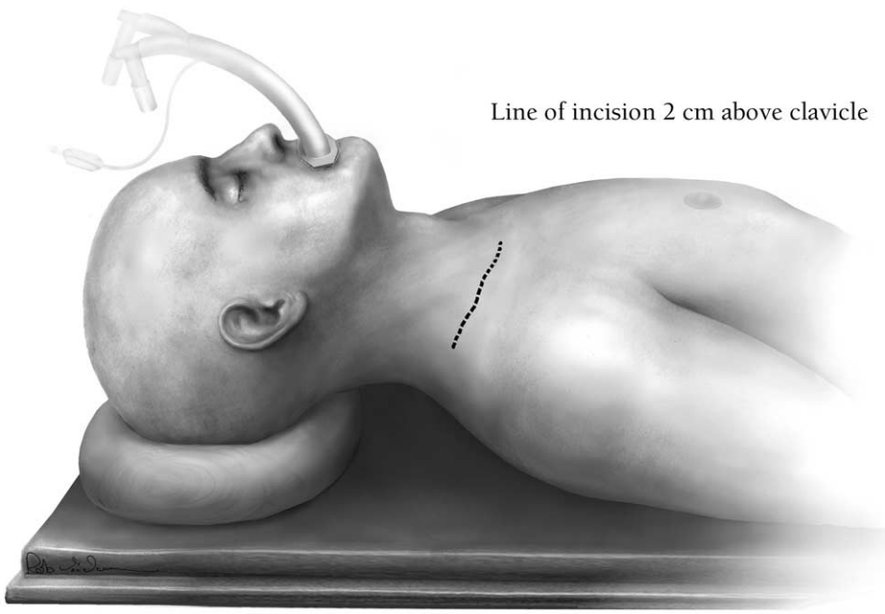

Figure 1 Loupe magnification ([times]4.5) and microbipolar cautery are used, and a portable nerve stimulator (Concept 2, Clearwater, FL) is frequently applied throughout the procedure. A sandbag is placed between the scapulae and the neck extended to the nonoperative side. Long-acting paralytic agents are avoided. An incision is made in the supraclavicular fossa, in a neck crease parallel to and 2 cm above the clavicle.

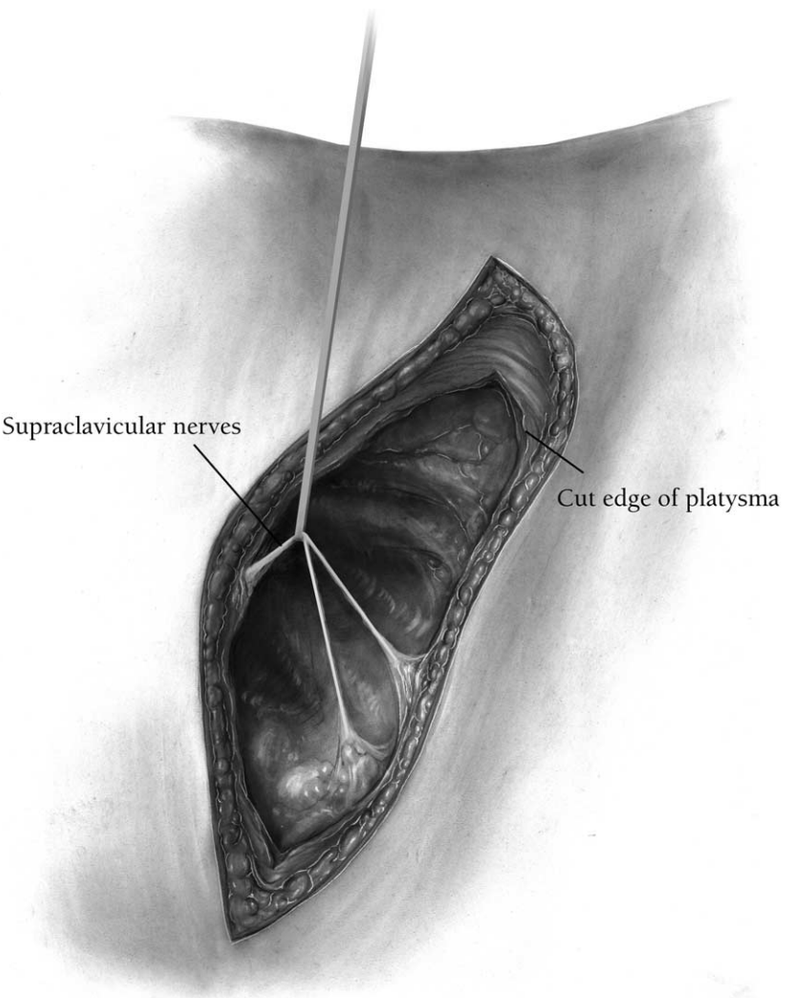

Figure 2 The supraclavicular nerves are identified just beneath the platysma and mobilized to allow vessel loop retraction.

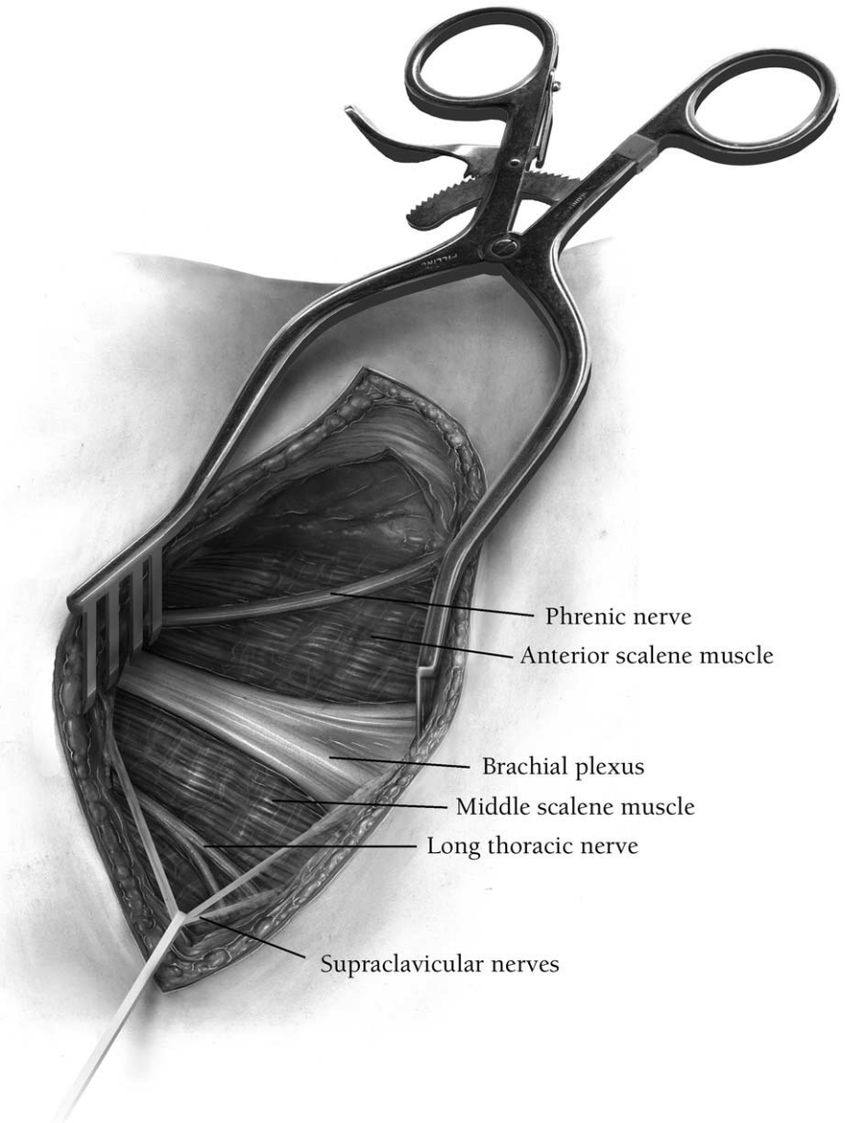

Figure 3 The omohyoid is divided and the supraclavicular fat pad is elevated, after which the scalene muscles and the brachial plexus are easily palpated. The lateral portion of the clavicular head of the sternocleidomastoid is divided and at the end of the procedure is repaired. The phrenic nerve is seen on the anterior surface of the anterior scalene muscle; the brachial plexus is noted at the interscalene position, and the long thoracic nerve is noted on the posterior aspect of the middle scalene muscle.

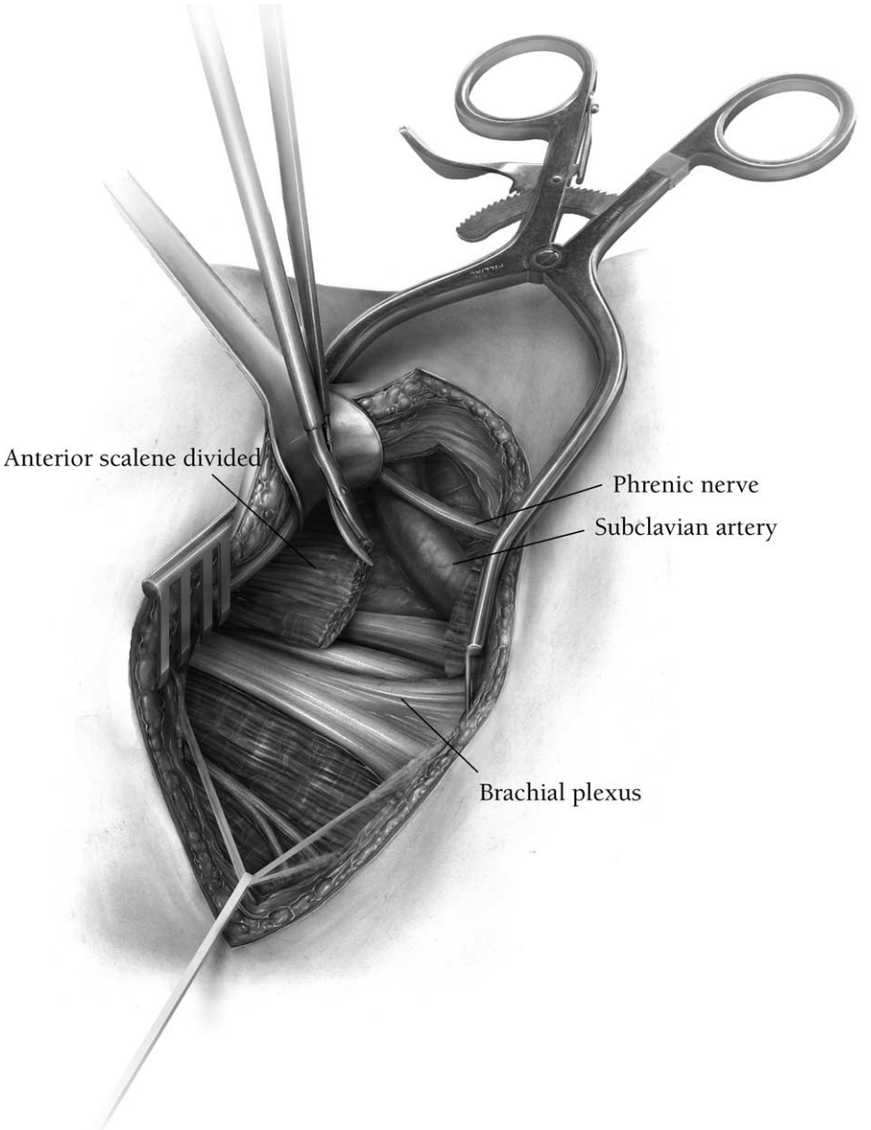

Figure 4 The anterior scalene muscle is divided from the first rib, and the subclavian artery is noted immediately behind this. An umbilical tape is placed around the subclavian artery. The phrenic nerve is not mobilized, but rather is protected by direct visualization, while the anterior scalene muscle is divided.

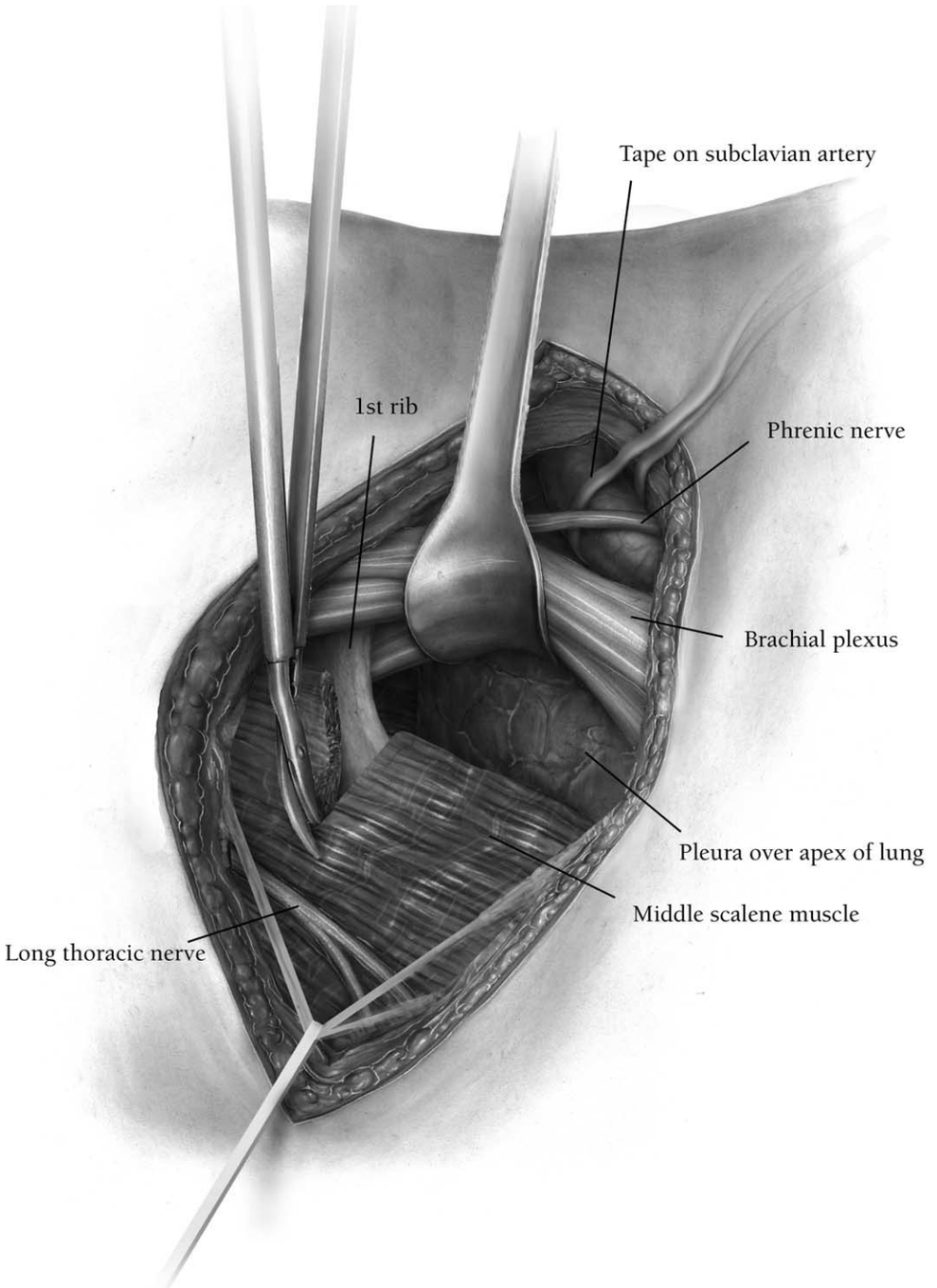

Figure 5 The upper, middle, and lower trunks of the brachial plexus are easily visualized and gently mobilized. The middle scalene muscle is now divided from the first rib. It has a broad attachment to the first rib, and care must be taken to avoid injury to the long thoracic nerve, which in this position may have multiple branches and may pass through or posterior to the middle scalene muscle.

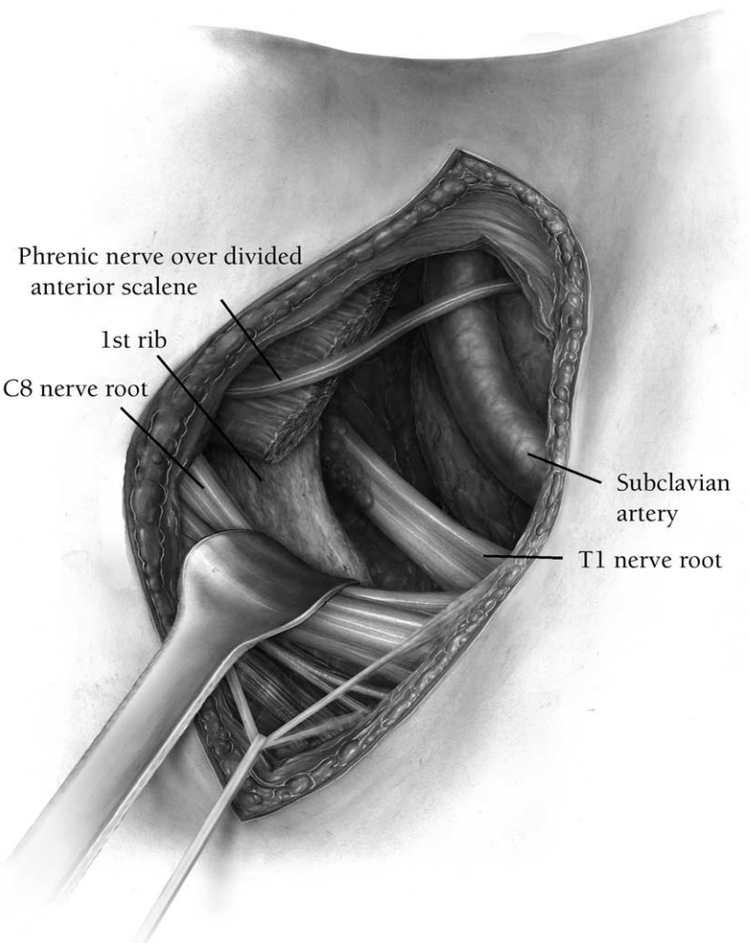

Figure 6 With division of the middle scalene muscle, the brachial plexus is easily visualized and mobilized, and the lower trunk is identified with the C8 and T1 nerve roots resting above and below the first rib, respectively. Congenital bands and thickening in Sibson's fascia are divided.

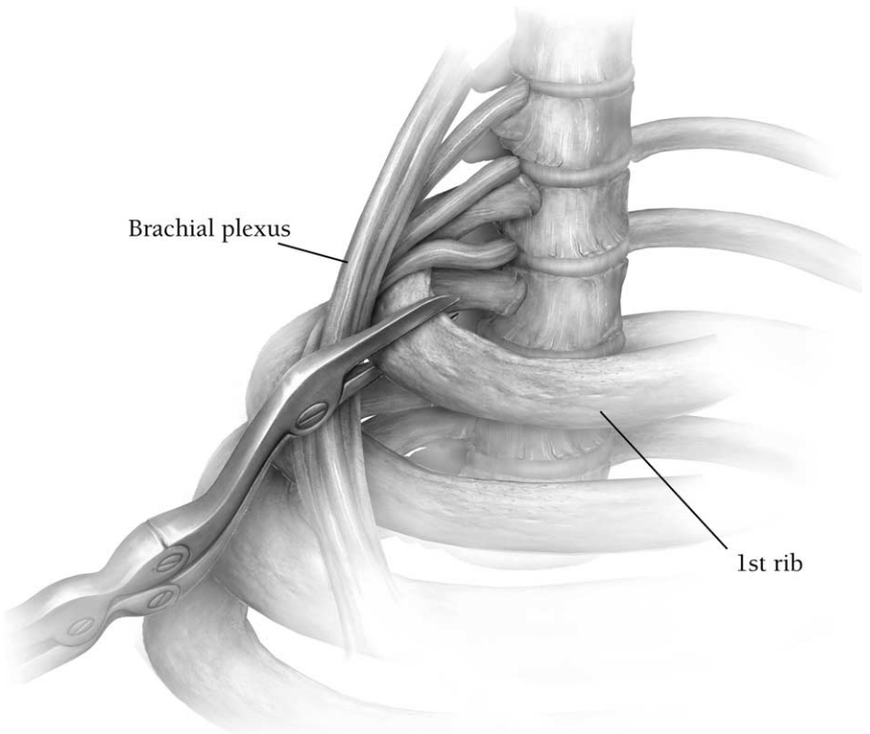

Figure 7 The first rib is then encircled and divided where it is easily visible with bone-cutting instruments. Note the relationship of the C8 and T1 nerve roots with the head of the first rib. These roots are reflected and protected to allow maximum exposure of the first rib.

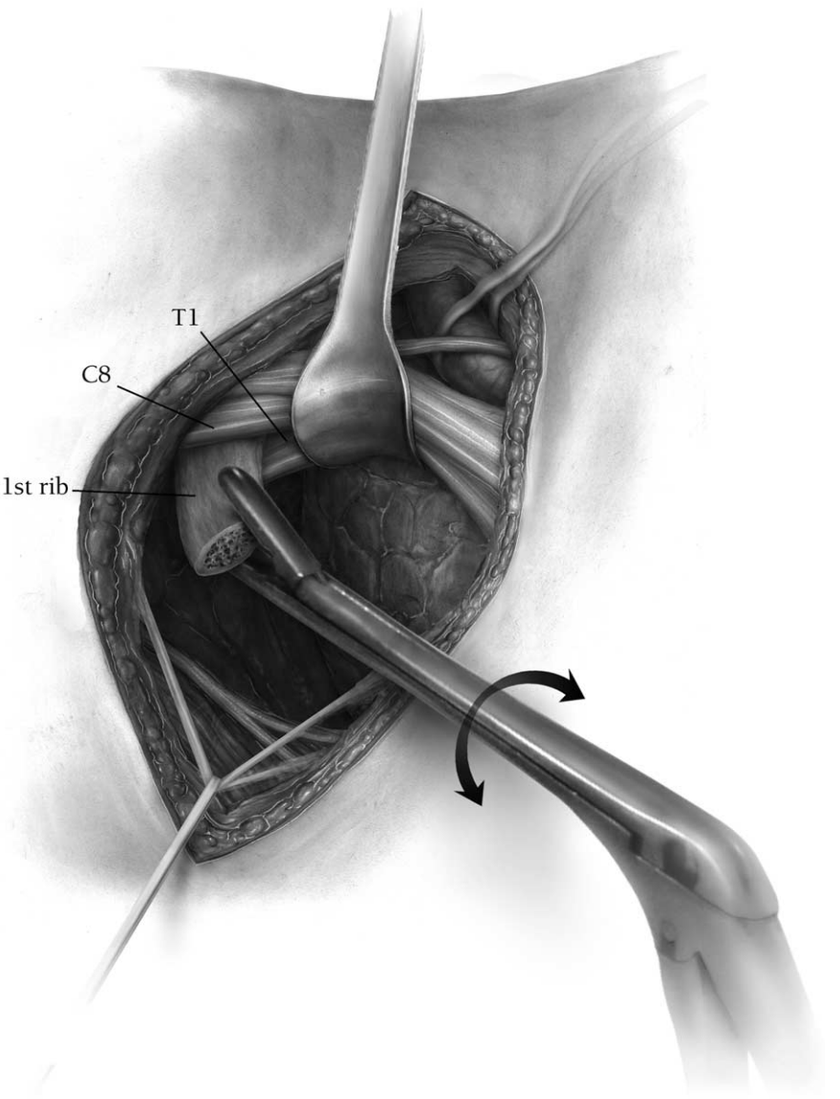

Figure 8 With the nerve roots reflected anteriorly, the posterior segment of the divided first rib is removed back to its spinal attachments by rongeur technique. By using a fine elevator, the soft-tissue attachments to the first rib are separated. The posterior edge of the first rib is grasped firmly with a rongeur, and a rocking and twisting motion is used to remove the entire aspect of the rib. This technique facilitates removal of the entire posterior portion of the rib to ensure residual bone does not remain, thereby preventing new bone formation and the potential for production of recurrent compression.

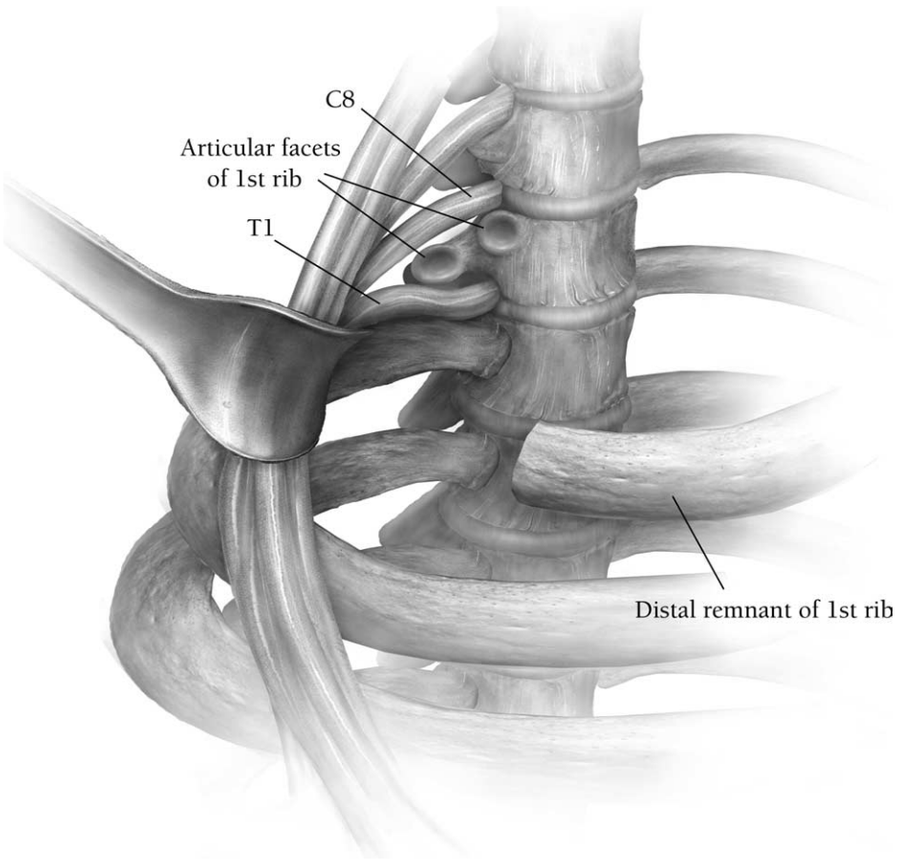

Figure 9 With the posterior segment of the first rib removed in this fashion, the cartilaginous components of its articular facets with both the costovertebral and the costotransverse joints can be identified on the specimen. The anterior portion of the first rib is removed in a similar fashion to decompress the neurovascular elements. Cervical ribs or long transverse processes are removed by the same technique.

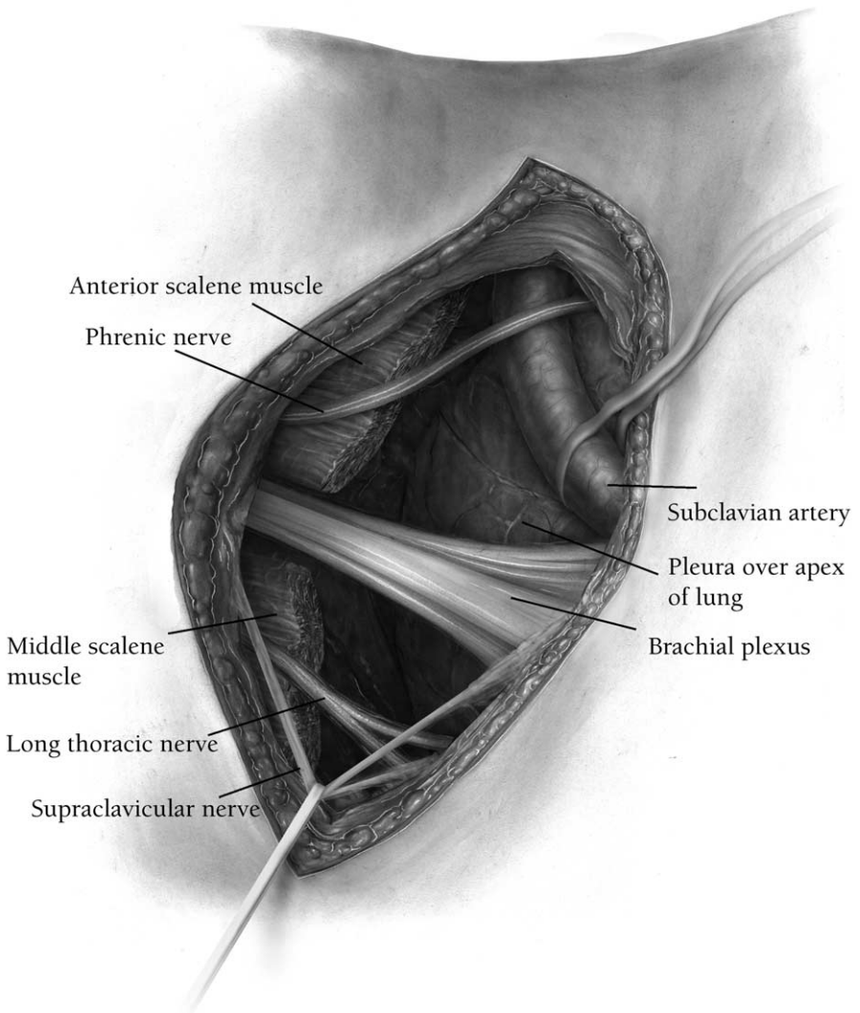

Figure 10 Complete decompression of the neurovascular elements of the brachial plexus is now confirmed. The brachial plexus, subclavian artery, phrenic nerve, and long thoracic nerve have been protected. We use a technique described by Nelems to open the pleura, facilitating drainage of any postoperative blood collection into the chest cavity rather than allowing the blood to collect in the operative site around the brachial plexus. When opening the pleura, care is taken to protect the intercostal brachial nerve, which is noted on the dome of the pleura. Bupivacaine (Marcaine, Hospira Health Care Corporation, Saint-Laurent, Quebec, Canada) is injected into the wound for postoperative comfort and a bupivacaine-filled pain pump (I-Flow Corporation, Lake Forest, CA) is also utilized. The sternocleidomastoid muscle is repaired; the wound is closed in a subcuticular fashion over a simple suction drain, and the drain is sealed after maximal inflation of the lungs by the anesthetist.

Postoperatively, gentle range of motion exercises are started on the first postoperative day and the drain and pain pump are removed on the second or third postoperative day. Supervised physiotherapy is started 2 weeks after surgery.

Conclusions

Thoracic outlet syndrome is a compression syndrome with varying causes and treatments. The diagnosis and treatment of patients with symptoms of brachial plexus compression with no objective cause remain controversial. In these patients, the diagnosis of TOS is made by provocative testing and the exclusion of other potentially causative conditions. Most patients improve with conservative management, including activity and posture modification and physical therapy. Those with persistent significant symptoms are candidates for surgical decompression with first rib resection.

Suggested Reading

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