Technique of supraclavicular decompression for neurogenic thoracic outlet syndrome

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The supraclavicular approach to scalenectomy and first rib resection has been modified since the original description in 1985. The incision is 1 to 2 cm above the clavicle, 1 cm lateral to the midline, and 5 to 7 cm long. Subplatysmal skin flaps are created. The sternocleidomastoid muscle is mobilized on its lateral edge and retracted but not divided. The scalene fat pad is split vertically, the omohyoid muscle excised, and the C5 nerve root dissected free. The accessory phrenic nerve is identified, if present, arising medially from C5, and preserved. The rest of the plexus is dissected free, muscular and connective tissue removed from all nerve roots and trunks, and the subclavian artery identified. The phrenic nerve is identified on the medial edge of the anterior scalene muscle (ASM). The ASM is divided on the first rib. The ASM is elevated, freed, and divided as high as possible and free of C5. The middle scalene muscle is dissected. C5 and C6 branches of the long thoracic nerve are identified and protected as the portion of middle scalene muscle adjacent to the nerves of the plexus is excised. The decision on whether the first rib is to be removed is determined by whether the lower trunk of the plexus is touching the first rib. If the rib is removed, its posterior end is freed, divided, and 1 cm excised. The rest of the rib is freed from the intercostal muscles with a periosteal elevator or harmonic scalpel, the pleura is separated from the inner surface of the rib, and the anterior end divided with an infraclavicular rib cutter. The operation has been made safer by identifying and dissecting the C5 nerve root before looking for the phrenic nerve. (J Vasc Surg 2015;61:821-5.)

Brachial plexus (BP) decompression by the transaxillary approach was described by Roos and Owens[1] in 1966 and continues to be a challenging technical procedure. An alternative is supraclavicular scalenectomy, with or without first rib resection. This is an expansion of the original anterior scalenectomy described by Adson and Coffey[2] in 1927 by the addition of middle scalenectomy and the option of first rib resection. This report adds refinements to the approach that we described in 1985.[3] The changes are designed to make the procedure safer.

TECHNIQUE

Position on the table. The anesthetized and intubated patient is supine, in a beach-chair position, with the back a little elevated and the legs a little down. This helps stretch the neck and lets the breasts fall to enhance exposure. To help relax the BP, a folded towel is placed under the shoulder of the operated-on side, and the operated-on arm is laid across the abdomen, accomplished by crossing the wrists on the abdomen and holding them with a foam wrap. The head is secured with tape in a neutral position to avoid injury if the table is rotated during the operation to improve exposure (Fig 1)

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Incision. The incision is transverse, 1 to 2 cm above the clavicle, beginning 1 cm lateral to the midline, and running parallel to the clavicle for 5 to 7 cm. Incising along skin lines minimizes postoperative scaring. The incision should extend to the lateral edge of the sternocleidomastoid muscle (SCM). Length depends on the width of the patient's neck; large patients require a longer incision than thin patients, but not too short, because getting the upper skin flap high enough requires at least 5 cm of skin incision (Fig 2).

Subplatysmal skin flaps. The platysma muscle is divided. Subplatysmal skin flaps are elevated. The plane for the flap is immediately above the SCM (Fig 2, *B*). The superior flap should be extended ≥5 cm to provide exposure high in the neck. The lower skin flap extends to the clavicle. Sensory fibers to the neck and chest wall lie above the SCM. Efforts are made to preserve these nerves to reduce postoperative neck paresthesia.

Mobilize SCM lateral edge. The lateral head of the SCM is mobilized, but not divided. Division is unnecessary and causes deformity. Dividing the lateral head of the SCM can leave a depression; muscular repair is often unsuccessful. Mobilizing the lateral edge of the SCM provides excellent scalene exposure. The lateral edge of the SCM is thus mobilized from the clavicle 7 cm cephalad, preserving the often-present sensory nerve, which crosses the lateral edge of the SCM near the superior limit.

The external jugular vein is encountered at the lateral edge of the SCM and should be preserved. However, if the vein is injured and cannot be repaired, it should be ligated and the superior end dissected cephalad, high in the neck, to avoid a visible jugular vein in thin-necked patients.

Insert self-retaining retractor. Use of a self-retaining retractor greatly assists exposure, eliminating the need for a second assistant. A table-mounted mini self-retaining retractor with two arms and four small blades is ideal (Omni-Tract

Fig 1. Patient is placed on the operating table in the beach chair position, with hands crossed over the abdomen, and a towel under the shoulder on the side to be operated on.

Surgical, St. Paul, Minn; Fig 3, *A*). When positioning retractor blades, moist sponges are used to protect skin edges and the SCM muscle. Care is taken to avoid retracting nerves.

Scalene fat pad. The scalene fat pad is divided vertically with scissors or the Harmonic scalpel (Ethicon, division of Johnson and Johnson, New Brunswick, NJ), if available (Figs 2, *C* and 3, *B*). In the left neck, lymphatic channels and the thoracic duct may be encountered in the fat pad at the level of the clavicle. The Harmonic scalpel can seal lymphatics during division. Lymphatic leaks at this point are meticulously addressed: effective tools include hemoclips, cautery, Harmonic scalpel, and suture ligature as a last resort.

Omohyoid muscle, transverse cervical artery, and phrenic nerve. The omohyoid is divided, and 1 to 2 cm is excised. At the bottom of the fat pad, the transverse cervical artery is seen and divided. The phrenic nerve lies just deep to this artery, although it usually is not seen at this time.

C5 nerve root and accessory phrenic nerve. Rather than identifying the main phrenic nerve at this point, a safer approach is to first find C5 and expose it to the suprascapular nerve, looking carefully for a small accessory phrenic nerve, often arising from the medial aspect of C5 (Fig 2, *D*). This C5 contribution to the phrenic nerve runs medially toward the main phrenic nerve, but the point where it joins the phrenic nerve is variable and may be out of the field. When present, it requires protection throughout the procedure.

Dissect the anterior surface of C5, then find the remaining nerve roots, trunks, and subclavian artery. Dissection proceeds deep to C5, freeing C6, C7, and upper and middle trunks. C8 and T1 lie still deeper, often covered by slips of middle scalene muscle (MSM), scalene minimus muscle, or scalene bands (Fig 2, *E*). All of these structures are excised when encountered. Muscular and connective tissue on the BP is excised at the mesoneurial level, leaving the sheath and its blood supply intact. The pleura and Sibson fascia is seen at the floor of dissection. The subclavian artery (SA) lies deep to the anterior scalene muscle (ASM) and can be looped to aid dissection.(Fig 2, *E*)

Identify the anterior scalene muscle and phrenic nerve. Having dissected the BP, the lateral edge of ASM is usually exposed medial and just superficial to the SA. The lateral edge of ASM is freed and the phrenic nerve identified, usually on the medial edge of ASM. Lying in this position, it can be left untouched. Unnecessary manipulation of the phrenic nerve can cause postoperative diaphragmatic dysfunction, which can persist for several months. In a few patients, the phrenic nerve lies on the lateral edge of the ASM, making dissection more difficult. In these patients, the phrenic nerve is in the center of the field, and a vessel loop around it, held gently by an assistant, may be the safest way to avoid phrenic nerve injury.

The ASM is isolated and divided at its first rib insertion (Fig 2, *F*). The Harmonic scalpel usually works well here, but if space is tight, bipolar cautery and scissors may be safer. The phrenic nerve should be visualized while doing this. The divided insertion of ASM is grasped with a clamp, elevated, and dissected cephalad. The ASM origin is divided high, as close as is comfortable, next to the nerve roots (Fig 2, *G*). The ASM is removed. In the past, excision of the entire ASM back to transverse process has been performed, but it probably is necessary to remove only the portion in contact with nerve roots.

Posterolateral to C5, MSM, and long thoracic nerve. Dissection now proceeds to the MSM, where buried within its fibers are the C5 and C6 branches of long thoracic nerve (LTN). The MSM fibers that are closest to the BP are divided and excised down to their first rib attachment. Proximally, enough MSM is removed so the C5 and the upper trunk are not touching the MSM. The branches of the LTN must be protected but need not be dissected out or isolated (Fig 2, *H*). Rarely the dorsal scapular nerve is seen passing through the MSM at the upper limit of the field. This nerve can be dissected free in patients suspected of having compression of this nerve.

Visualize the lower trunk over the first rib, and if touching, excise the first rib. The first rib is observed below the SA. If the lower trunk is resting on bone or $\leq$1 mm of bone, the rib is removed. If there is comfortable space between the nerve and the rib, the first rib is left alone and the wound closed. This approach is subjective and supported by data showing no significant difference in success rates between scalenectomy with or without first rib resection.[4] In general, the wide first rib, the one most difficult to remove through the neck, is the one left intact. Very few patients, estimated at 1% to 2%, have required reoperation to remove the first rib at a later date. Rib removal adds complexity to the procedure, especially dividing intercostals beneath the plexus. Some surgeons believe that the first rib should always be removed to prevent recurrence. In our experience, this is not always necessary. First rib removal adds a degree of difficulty and can increase morbidity.

A clue to whether the first rib requires excision can be obtained from the chest X-ray image. Although no data have been published to support this view, our observations indicate that ribs that are fairly straight on X-ray imaging usually require excision, whereas first ribs with a generous C curve usually can be left alone (Fig 4).[5]

First rib resection begins by freeing the intercostal muscles from the lateral and medial rib edges with a periosteal