65 Surgical Techniques: Operative Decompression Using the Infraclavicular Approach for VTOS with Intraoperative Venography

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Abstract

The infraclavicular approach provides direct access to the costoclavicular space for focused treatment of VTOS. Using this approach anterior first rib resection and subclavian venolysis can be performed within the same procedure without unnecessary exposure or manipulation of the brachial plexus or subclavian artery. Additionally, sacrifice of collateral veins that usually exist in the supraclavicular and axillary areas is easily avoided. Finally, the infraclavicular approach provides excellent exposure for surgical reconstruction of the subclavian vein with either patch angioplasty or interposition bypass grafting if required. This approach offeres excellent technical and clinical results as have been reported by multiple groups.

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Critical Take-Home Points

1. Treatment of venous thoracic outlet syndrome requires decompression of the *anterior* thoracic outlet—the costoclavicular junction.
2. This approach allows imaging, external venolysis, and extension to more aggressive exposure, if needed.
3. Outcomes using this technique are excellent, with "cure" rates reported from 95 to 100%.

65.1 Introduction

Transaxillary, supraclavicular and paraclavicular approaches are commonly used for thoracic outlet decompression and provide excellent access to the neurovascular structures within the interscalene space for treatment of neurogenic and arterial thoracic outlet syndromes. Many surgeons utilize the aforementioned techniques in the treatment of venous thoracic outlet syndrome as well, likely due to familiarity with these approaches. In the case of VTOS, however, the relevant anatomic structures and pathology (i.e., the subclavian vein) are located within the more anterior costoclavicular space rather than the more posterior interscalene space. Since the costoclavicular space, first rib, and subclavian vein may be directly accessed via an infraclavicular approach it has become our preferred approach for treatment of VTOS.

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First described by Gol in the neurosurgical literature in 1968 for the treatment of NTOS, the infraclavicular approach is best suited to treatment of VTOS by providing direct access to the subclavian vein and first rib within the costoclavicular space [1]. Potential advantages of the infraclavicular approach include avoiding dissection and manipulation of the brachial plexus, phrenic nerve, and subclavian artery, which are not typically involved in VTOS. Collateral veins, which course through the supraclavicular space to enter the jugular veins and through the axilla to enter chest wall veins, may be interrupted by other surgical approaches but also are avoided by the infraclavicular approach. Most importantly, the subclavian vein can be directly visualized, facilitating venolysis and, if surgical venous reconstruction is needed, proximal exposure of the central veins can be gained by transmanubrial extension of the infraclavicular incision. For these reasons, we have found the infraclavicular approach to be an excellent choice for treatment of VTOS. Limited utilization of the infraclavicular approach is most likely due to lack of familiarity with the technique, which is actually quite straightforward.

65.2 Technique

General endotracheal anesthesia is provided. The patient is positioned supine with a shoulder roll with the entire affected arm prepped into the field. The extremity is encircled with a sterile sling to allow mobility of the shoulder, which is key to facilitate exposure, particularly during dissection along the posterior aspect of the rib.

A transverse incision is made below the clavicle, overlying the first rib (Fig. 65.1). The incision extends from the lateral border of the manubrium to the deltopectoral groove. After dividing the platysma muscle and deep pectoral fascia a plane is developed between the fibers of the pectoralis major muscle using a muscle-sparing approach without division of the muscle fibers. The anterior surface of the first rib is identified deep to the pectoralis major muscle and it may be necessary to divide some of the central attachments of the pectoralis major muscle to the manubrium and medial aspect of the first rib (Fig. 65.2). The subclavius muscle is divided from its insertion onto the superior edge of the first rib. Continuing dissection posteriorly and directly along the superior aspect of the first rib, the attachments of the anterior and middle scalene muscles are divided with electrocautery. Along the inferior aspect of the rib the intercostal muscles are divided. A hand-held small Deever retractor is used to aide visulatization of the lateral and posterior portions of the first rib while also protecting the superiorly located neurovascular structures. Superior and anterior movements of the shoulder are also extremely

Fig. 65.1 A transverse incision is made overlying the first rib

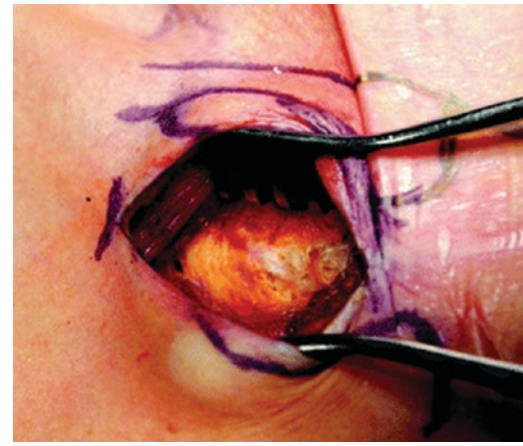

Fig. 65.2 After muscle-sparing division of the pectoralis fibers, the anterior surface of the first rib is encountered

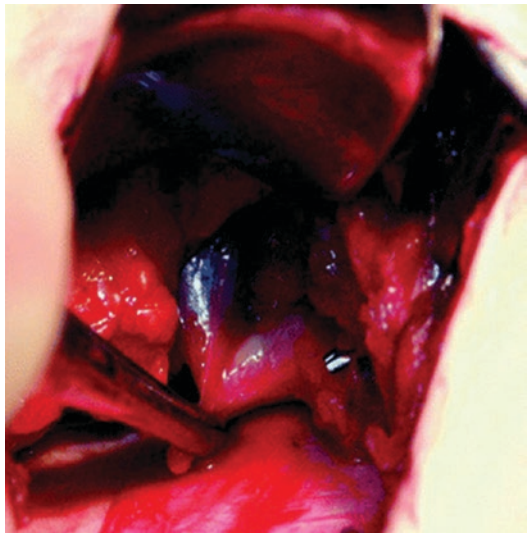

Fig. 65.3 Exposure facilitates an extensive subclavian venolysis

useful to open the costoclavicular space, thereby facilitating exposure as the first rib is freed posteriorly. Using a periosteal elevator, the pleura is cleared from the deep surface of the rib. The first rib is then divided using either Kerrison rongeurs or a rib cutter at the costomanubrial junction, and as far posteriorly as feasible, to complete excision of the first rib. If necessary, residual fragments of the posterior rib can be removed using rongeurs. It is important to remove as much of the rib as possible since removal of just a small anterior segment, leaving behind a large posterior rib remnan, may predispose to the pateint to the later development of neurogenic TOS.

A venolysis of the subclavian vein is then performed using sharp scissors dissection to remove any residual fibrous tissue surrounding the vein. Careful attention is paid to freeing the vein anteriorly as it courses behind the costoclavicular ligament, the head of the clavicle, and the manubrium (Fig. 65.3). Although others have reported routine patch angioplasty to treat venous stenoses [2], our preferred method is to perform intraoperative venography and treat residual subclavian vein stenoses using balloon angioplasty (Fig. 65.4). In our experience about two-thirds of pateints have a residual subclavian vein stenosis and most can be

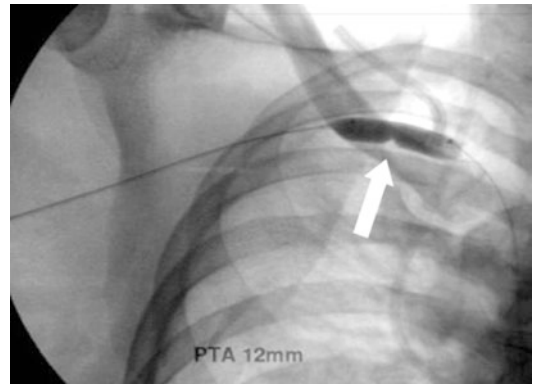

Fig. 65.4 Residual stenosis (*arrow*) is treated with balloon angioplasty

effectively treated with intraoperative balloon angioplasty without stent placement [3]. Although surgical reconstruction with patch angioplasty or replacement of the subclavian vein is usually not needed, it can also be performed via the infraclavicular approach using transmanubrial extension of the incision to elevate the clavicle and to expose the innominate vein.

The first rib resection is performed extrapleurally, and while it is not uncommon to create a rent in the pleura, a thoracostomy tube is generally not needed. A closed suction drain is routinely placed in the bed of the resected rib.

65.3 Postoperative Management

Intravenous ketorolac, standing acetaminophen and as-needed narcotics are used for postoperative analgesia. Immobilization in an arm sling is unnecessary and gradual return to normal use of the upper extremity is encouraged. The drain is removed after the output is less than 30 ml for a 24-h period. Postoperative anticoagulation is selectively used only for patients with residual non-occlusive chronic thrombus observed by intraoperative venography and is generally started at least 48 h post-operatively to avoid bleeding complications. When used, postoperative anticoagulation is continued for 30 days unless the patient requires prolonged anticoagulation for a documented hypercoaguable condition. Surveillance duplex ultrasonography is

performed within 2 weeks and at 3 and 12 months postoperatively.

65.4 Outcomes

Molina was the first to describe use of the infraclavicular approach for treatment of VTOS [2]. Using an approach that consisted of immediate thrombolysis and urgent decompression via the infraclavicular technique, 100% procedural success was achieved. Of 97 patients treated for VTOS and acute subclavian vein thrombosis, there was only one bleeding complication and two pneurmothoraces that required tube thoracostomy. At short-term and long-term follow-up (Mean = 5.2 years, range 2–21 years) duplex assessed subclavian vein patency was 100%. Arm function was noted to be normal in all patients [4].

Siracuse et al. reported a 91% primary patency and 100% secondary patency in 33 patients treated for VTOS and acute subclavian vein thrombosis using the infraclavicular approach for rib resection and venolysis followed by intraoperative subclavian vein angioplasty to treat residual stenosis [5]. It should be noted that poorer outcomes are typical for patients with chronic subclavian thrombosis, especially when surgical reconstruction or replacement of the subclavian vein is needed, emphasizing the need for early identification and treatment of patients with effort thrombosis with catheter-directed thrombolysis and thrombectomy [6].

65.5 Summary

The infraclavicular approach allows exposure of the vein from mid-clavicle to sternum, and can easily be converted ("Molina exposure") to allow exposure of the brachiocephalic vein and superior vena cava. As such, it is an excellent technique for not only thoracic outlet decompression, but also for the external venolysis that is almost always required (and reconstruction, if needed, as well).

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