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Abstract

Removal of the clavicle yields superb exposure of the entire axillary-subclavian-inominate vein complex, and leads to the most complete exposure possible for venous reconstruction, bypass, or replacement. At least two-thirds of the clavicle should be resected to avoid problems from the residual lateral segment; if this is done, long-term functional outcome is excellent.

Introduction

While supraclavicular exposure provides excellent access to the middle and posterior part of the first rib and transaxillary exposure to the anterior part, neither provides exposure to the subclavian vein itself. Various techniques have been described, including Molina's "sternal flap" (essentially disarticulating the clavicle, but leaving the junction intact) [1] and infra/supraclavicular ("paraclavicular") exposure popularized by Thompson [2], but neither provide consistent, continuous exposure to the vein itself with room to perform any intervention needed. Claviclectomy opens this area in its entirety, is surprisingly well tolerated, and

should be considered for patients in whom complex venous resection is required.

Technique

Claviclectomy itself is relatively straightforward. An incision is made over the clavicle, and cautery is used to expose the bone itself. The operation is classically described as a "medial claviclectomy," but we and others stress that at least two-thirds of the clavicle needs to be removed [3, 4]. Leaving too much clavicle in place produces a very mobile bone, which can either stick up and be cosmetically unattractive and painful, or worse, can be forced downward, creating a secondary thoracic outlet syndrome of any variety. Resecting as much of the bone as possible eliminates this problem.

Once the bone is identified, it is cleaned using a periosteal elevator. A large right-angle clamp can be used to get around the midportion of the bone circumferentially, and this can then be moved medially and laterally to divest the bone from the

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underlying subclavius muscle. There is fear sometimes at this point that the vein is close enough to be injured, but in actuality the subclavian muscle and a significant amount of soft tissue remains, and the vein is quite safe with this maneuver.

At this point, an oscillating saw is used to divide the bone at least two-thirds of the way toward the shoulder. The bone is then elevated and dissection continued toward the costoclavicular junction. Especially inferiorly and medially, attachments can be tight, and this can be a surprisingly difficult part of the operation. Perseverance is the best tool. The goal is to formally disarticulate the clavicle from the sternum itself; no clavicle should be left behind medially but articular cartilage does not need to be removed.

At this point the bed of the clavicle is exposed. As described above, the vein is still deep to this. The subclavius muscle is the main structure remaining, although it is often indistinguishable from the surrounding tissue. The muscle and associated soft tissue should be resected, with attention paid to the vein at this point. The vein can be surprisingly hard to find, especially if obliterated in a patient with chronic stenosis or occlusion. A useful technique is to find a tributary vein (such as the cephalic) and follow it deeply until the main vein can be found. Large collateral veins can, at times, be mistaken for the subclavian vein, and dissection should be thorough enough to clearly identify normal axillary-subclavian vein peripherally and normal innominate vein centrally. Obviously, enough vein should be cleared at both locations for adequate clamping. If jugular transposition/turndown is contemplated, a separate incision is required as significant length of vein is needed.

Using this technique, superb exposure of as much of the axillary-subclavian-innominate vein family as is needed can be obtained. Reconstruction, covered elsewhere, may include patch venoplasty with internal venolysis, jugular vein turndown, or even interposition grafting with paneled saphenous vein, femoral vein, or, occa-

sionally, prosthetic. The clavicle should be discarded; trying to reattach this risks chronic malunion and long-term pain. It should be noted that the first rib can easily be resected once the clavicle is out, but this is not needed as the thoracic outlet is fully decompressed already (we have one patient with staged first rib and clavicle excisions who is symptom free several years after his last procedure).

Results

Clavicular resection is surprisingly well tolerated, even in healthy, competitive athletes. We have performed approximately 20 medial claviclectomies over the past two decades. Green reported our first decade's experience in 2000 [3]. Eleven patients were operated on, all for venous TOS, and followup occurred (in all 11) at a mean of 6 years (range 3–9 years). All patients (all young) returned to their preoperative vocation, four of which involve heavy labor. No patient describes any limitation of shoulder function, all 11 consider their operation "completely successful" from a functional standpoint, and only two are bothered by the cosmetic results. All reconstructed veins were patent, and only one patient had slight swelling with exertion.

An illustrative case is a patient with highly symptomatic VTOS who was operated on at our institution approximately 7 or 8 years ago. After clavicular resection (and jugular transposition), he went on to be Captain of his Ski Team at his Ivy League college and was named a Division I All-American. Currently a vascular surgery resident, he remains quite physically active and reports absolutely no functional problems from the claviclectomy.

As described above, at least two-thirds of the clavicle must be removed, as an overly-long lateral segment can be cosmetically unsightly (Fig. 64.1) at best, and protrude downward into the thoracic outlet, creating secondary problems, at worst. There are several reports of total

Fig. 64.1 A patient with a residual, lateral mobile clavicular segment illustrating the drawbacks of leaving too much clavicle in place (Reprinted from Green et al. [3] with permission from Elsevier)



claviclectomy in the orthopedic literature, and, although a bit dated, show that function is excellent [5, 6]. Patients, for example, can play golf, swim, and hunt. A 1947 paper, in fact, describes a family with 9 members who were born without clavicles and perform manual labor (farming) without problems [7].

Summary

While clavicular resection is not the first choice in dealing with VTOS, it provides superb exposure of as much vein as needed for reconstruction and is quite well tolerated. It should be stressed that at least two-thirds of the clavicle should be resected to avoid problems from the residual lateral segment; if this is done, long-term functional outcome is excellent.

Conflicts of Interest None

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