

From the Society for Vascular Surgery

## Transaxillary decompression of thoracic outlet syndrome patients presenting with cervical ribs

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### ABSTRACT

**Objective:** The transaxillary approach to thoracic outlet decompression in the presence of cervical ribs offers the advantage of less manipulation of the brachial plexus and associated nerves. This may result in reduced incidence of perioperative complications, such as nerve injuries. Our objective was to report contemporary data for a series of patients with thoracic outlet syndrome (TOS) and cervical ribs managed through a transaxillary approach.

**Methods:** We reviewed a prospectively maintained database for all consecutive patients who underwent surgery for TOS and who had a cervical rib. Symptoms, preoperative evaluation, surgical details, complications, and postoperative outcomes form the basis of this report.

**Results:** Between 1997 and 2016, there were 818 patients who underwent 1154 procedures for TOS, including 873 rib resections. Of these, 56 patients underwent 70 resections for first and cervical ribs. Cervical ribs were classified according to the Society for Vascular Surgery reporting standards: 25 class 1, 17 class 2, 5 class 3, and 23 class 4. Presentations included neurogenic TOS in 49 patients and arterial TOS in 7. Operative time averaged 141 minutes, blood loss was 47 mL, and hospital stay averaged 2 days. No injuries to the brachial plexus, long thoracic, or thoracodorsal nerves were identified. One patient had partial phrenic nerve dysfunction that resolved. No hematomas, lymph leak, or early rehospitalizations occurred. Average follow-up was 591 days. Complete resolution or minimal symptoms were noted in 52 (92.8%) patients postoperatively. Significant residual symptoms requiring ongoing evaluation or pain management were noted in four (7.1%) at last follow-up. Somatic pain scores were reduced from 6.9 (preoperatively) to 1.3 (at last visit). Standardized evaluation using shortened Disabilities of the Arm, Shoulder, and Hand scores indicated improvement from 60.4 (preoperatively) to 31.3 (at last visit).

**Conclusions:** This series of transaxillary cervical and first rib resections demonstrates excellent clinical outcomes with minimal morbidity. The presence of cervical ribs, a positive response to scalene muscle block, and abnormalities on electrodiagnostic testing are reliable indicators for surgery. A cervical rib in a patient with TOS suggests that there is excellent potential for improvement after first and cervical rib excision. (*J Vasc Surg* 2018;■:1-7.)

**Keywords:** Thoracic outlet syndrome; Cervical ribs; Transaxillary resection; Outcomes

Cervical ribs are a prominent anatomic variant associated with thoracic outlet syndrome (TOS). They are infrequent and are present in about 0.05% to 3% of the general population and are more commonly found in women.<sup>1</sup> When it is identified in patients with upper extremity pain and paresthesia, a cervical rib will frequently lead to the diagnosis of TOS. Resection of cervical ribs may be accomplished through supraclavicular or transaxillary incisions. The supraclavicular approaches

are favored by many authors and have formed the bulk of reported cases.<sup>2,3</sup> Furthermore, the transaxillary approach is less familiar to many surgeons and may present technical challenges to those lacking training or appropriate equipment. Advocates of transaxillary rib resection have proposed a lower aggregate risk of peripheral nerve injuries.<sup>4</sup> Proponents of the supraclavicular approach have disputed this theory.<sup>5,6</sup> However, a lack of rigor in reporting has made it difficult to resolve this debate. The recently published TOS reporting standards of the Society for Vascular Surgery seek to address these issues.<sup>7</sup> We have adopted a transaxillary approach as our primary modality for TOS decompression and have used it for the resection of cervical ribs associated with TOS. In this article, we have reviewed our experience using a primary transaxillary approach for cervical rib resection. The primary analysis reports outcomes as measured by standardized instruments (somatic pain score and shortened Disabilities of the Arm, Shoulder, and Hand [QuickDASH] questionnaire). A secondary analysis is directed at comparing results among cervical rib types, presentations, genders, and types of operations employed.

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## METHODS

Using a prospectively maintained database of TOS patients and medical records, we abstracted clinically relevant data: symptoms, preoperative evaluation, surgical details, complications, and postoperative outcomes. The protocol and informed consent were approved by our Institutional Review Board (protocol No. 13-000624), and all patients gave informed consent. Neurogenic TOS (nTOS) and arterial TOS (aTOS) are in compliance with definitions outlined in the Society for Vascular Surgery TOS reporting standards.<sup>7</sup> The patients with nTOS and aTOS were managed by protocol.<sup>8,9</sup> A clinical diagnosis of TOS was based on standardized history and examination data collection. All patients presenting for evaluation of TOS underwent assessment of symptom severity and functional evaluation using standardized measures. Symptom severity was assessed with a somatic pain scale (pain score). Functional assessment was documented using the standardized QuickDASH score (DASH score).<sup>10</sup> Chest radiographs or cervical spine radiographs were obtained for evaluation of possible cervical ribs. Additional testing was directed toward identifying other potential sources for upper extremity symptoms; cervical spine magnetic resonance imaging, upper extremity electromyography (EMG), and nerve conduction velocity (NCV) were used when clinically indicated (for cervical magnetic resonance imaging: presence of focal pain in neck, history of cervical spine problems, positive Spurling test result; for EMG/NCV: focal pain in elbow or wrist, presence of Tinel sign at those points, presence of Phalen sign).

Anterior scalene muscle blocks (ASMBs) were performed routinely to support the diagnosis of nTOS. Somatosensory evoked potential (SSEP) testing was used as another means to confirm the diagnosis of nTOS. Surgery was considered for patients with a diagnosis of nTOS after failure of an attempt at management with TOS-specific physical therapy for at least 6 weeks, failure of management with medication, and symptom severity causing significant impairment with activities of daily living and work.

Surgery was considered for all patients presenting with arterial thrombosis, embolization, preocclusive stenosis, or aneurysmal degeneration of the subclavian artery associated with extrinsic arterial compression at the thoracic outlet. The patients with aTOS presenting with acute upper extremity ischemia were initially managed with thrombectomy or thrombolysis for relief of acute ischemia. Imaging (arteriography or computed tomography angiography) was used to define arterial anatomy, the presence of extrinsic compression, or aneurysmal degeneration. Anticoagulation was used until arterial decompression and reconstruction were completed. Surgical decompression was performed through a transaxillary approach and cervical rib resection.

## ARTICLE HIGHLIGHTS

- **Type of Research:** Single-center retrospective cohort study
- **Take Home Message:** This series of 70 transaxillary cervical and first rib resections that included 49 neurogenic thoracic outlet syndrome patients demonstrated excellent clinical outcomes with minimal morbidity. Cervical ribs, a positive response to scalene muscle block, and abnormalities on electrodiagnostic testing were reliable indicators for surgery.
- **Recommendation:** Data suggest that a cervical rib in a patient with thoracic outlet syndrome predicts excellent improvement after first and cervical rib excision.

Reconstruction was reserved for aneurysms >2 cm in diameter. Smaller aneurysms were observed with yearly ultrasound.

A standard transaxillary incision was employed with the patient in lateral position and the arm distracted with a specialized arm holder. Our technique was to resect the entire first and full cervical rib from the costochondral junction to the articular junction with the transverse process. Technical enhancements included use of table-mounted arm retraction, fiberoptic lighted wound retractors, and high-definition video endoscopy.<sup>11</sup>

Data for this report were organized according to recent Society for Vascular Surgery Reporting Standards regarding TOS.<sup>7</sup> Cervical ribs were subdivided into classes 1 to 4. Class 1 cervical ribs were incomplete ribs measuring <2 cm. Class 2 cervical ribs were incomplete ribs measuring >2 cm. Class 3 cervical ribs were full ribs with fibrous band junctions onto the first rib. Class 4 cervical ribs were full ribs with a synovial articulation to the first rib.

Transaxillary operations were grouped into three types. Patients presenting with small (class 1 and class 2) cervical ribs were managed by resection of the first rib and the attached cervical rib band (FR-band). Patients presenting with longer cervical ribs (class 2, class 3, and class 4) were managed by resection of the first rib and the cervical rib (FR-CR). In selected patients, the cervical rib was resected alone and the first rib was left in place. These were instances in which after resection of a cervical rib, we measured a distance >2 cm between the first rib and the lower trunk of the brachial plexus.

Perioperative data points included duration of surgery, blood loss, and intraoperative surgical complications. Specific complications identified included hemothorax, need for reoperation, lymphatic leak, length of stay, cause for prolonged (>4 days) hospitalization, and 30-day readmission to the hospital. Specific neurologic

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