# Thoracic Outlet Syndrome

## CASE SCENARIO

A 44-year-old woman presents with a chief complaint of neck pain with radiation of paresthesias into her left medial forearm, and fourth and fifth digits. She was involved in a rear end motor vehicle collision 2 years prior. Her symptoms are exacerbated by work (eg, typing, mousing), and combing her hair, and have remained relatively constant at 3 of 10 average, and 8 of 10 at its worst by visual analogue scale (VAS) scale.

Her current physical examination reveals a moderate cervicothoracic kyphosis, head forward, rounded shoulder posture. She has a normal neurologic examination with absence of extremity edema, normal pulses, and no bruits with auscultation over the supraclavicular fossae. Spurling maneuver recreates local pain into the upper trapezius only. Roos, Wright, and Adson tests are positive bilaterally for reproduction of her medial forearm and digit paresthesias without diminished pulses. Cervical radiographs reveal elongated C7 transverse processes bilaterally without cervical ribs and magnetic resonance imaging 6 months after the injury showed mild to moderate spondylosis at C5-6 and C6-7 without central or foraminal stenosis. A Doppler ultrasound study performed 8 months after the injury was negative for upper extremity deep vein thrombosis and an electrodiagnostic test 8 months after the injury was negative for radiculopathy, plexopathy, or ulnar entrapment neuropathy. Treatment has included 3 months of chiropractic and 12 visits of physical therapy immediately after the accident including ultrasound, massage, electricl stimulation, and cervical traction, with each treatment offering only mild temporary relief.

In total, her presentation is suggestive for thoracic outlet syndrome, but there is no distinct evidence for neurological or vascular impairments. Her primary care provider has suggested that this problem may be "in her head." What is your clinical impression and what further assessment and treatment do you recommend?


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## Jason Lee, MD, Responds

This case describes a typical patient often encountered several months or even years after blunt trauma to the cervicobrachial region and presents both a diagnostic and treatment dilemma for practitioners. As a vascular surgeon with a clinical research interest in the treatment of athletic vascular injuries, I am faced with these types of posttraumatic cases, as well as work-related overuse injury and repetitive motion athletic injury. These patients often are referred with the request to "rule out thoracic outlet syndrome." Thoracic outlet syndrome (TOS) is a poorly characterized disease entity with a wide differential diagnosis. First coined in 1956 by Peet et al [1], TOS can be categorized as vascular (arterial or venous) or neurogenic (NTOS). Although vascular-related TOS pathology is intuitively easier to understand and document because of more definitive imaging findings and symptoms, there remains significant controversy as to even the existence of NTOS [2,3].

The anatomic issue in TOS occurs as the result of compression of the neurovascular bundle (brachial plexus, subclavian artery, and subclavian vein) at the transition between the neck and axilla just above the first rib. Neurogenic TOS is much more common than vascular TOS, with most single-center series reporting ratios of 20 to 1. Symptoms of NTOS referable to the upper extremity occur because of compression of the lower trunk of the brachial plexus caused by a cervical rib or band and enlarged scalene muscles.

Classically described or "true" NTOS with strict diagnostic criteria was outlined by Gilliatt et al in 1970 [4], but unfortunately, most reported series of NTOS to date rarely meet these criteria. Symptoms typically include arm discomfort,

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paresthesias of the inner surface of the hand and forearm, and weakness and atrophy of the thenar and intrinsic hand muscles of the affected side. Distinct anatomic and electrophysiologic findings include low compound muscle action potentials in the thenar and intrinsic muscles, abnormal sensory conduction of the ulnar nerve, prolonged F-wave latency of the ulnar nerve, and abnormal sensory conduction of the medial antebrachial cutaneous nerve.

Because these criteria rarely are documented in most patients referred for NTOS, Wilbourn [3] introduced the phrase "disputed" or nonspecific NTOS (NNTOS), which I believe our patient in this discussion falls under. I submit that surgical treatment of vascular TOS and "true" NTOS via thoracic outlet decompression is generally well accepted and indicated, but what remains controversial is the 90% of cases that are TOS.

The controversy in the diagnostic workup for patients with suspected NNTOS emanates from the fact that the presentation can be varied and overlaps with many other musculoskeletal issues of the upper extremities. Patients will typically have a history of a hyperextension neck injury, such as whiplash from an automobile accident or a fall to the floor. Also very common is a work-related injury caused by repetitive movements [5]. Predisposing anatomic factors to NNTOS include cervical ribs, anomalous first ribs, and congenitally narrowed scalene triangles. Another common presentation is athletes with repetitive upper limb movements, including swimmers, divers, water polo players, rowers, baseball pitchers, and football quarterbacks [6]. Certainly, this very heterogeneous group of presenting patients will have a wide differential diagnosis, including and not limited to cubital and carpal tunnel syndromes, myofascial pain syndromes, and spinal stenosis [7].

The evaluation when considering NNTOS begins with a thorough history and physical examination, with the clinician attempting to elicit the exact nature of discomfort, paresthesias, and disability in the patient. An accurate physical examination documents whether certain nerves or nerve roots are involved. I find the Roos and Adson tests particularly helpful because the provocative positioning eliciting symptomatology or a change in the pulse can be quite reproducible. The combination of any of the maneuvers that bring about symptoms or pulse dropouts are not very sensitive but can be quite specific in that not having any positive signs makes it unlikely that NNTOS is the correct diagnosis. For our patient in question, she fits the typical profile, having experienced a whiplash injury several years ago and now has had years of vague upper extremity symptoms. Her physical examination showed some reproduction of symptoms with provocative maneuvers and no other obvious physical abnormalities.

Often overlooked and poorly documented in the literature is how these types of diseases disable people from activities of daily living. Although we may ask and even write in the chart spontaneous comments about patients' limitations, the lack of a validated and objective measure makes follow-up and comparisons difficult. Some very promising work uses standardized quality-of-life questionnaires, notably the QuickDASH (Disabilities of the Arm, Shoulder, and Hand) outcome measure, which generates a score that ranges from 0 to 100, with 100 indicating maximal disability, and that was initially developed and ultimately validated for upper extremity orthopedic pathologies and their surgical treatments [8]. The Johns Hopkins vascular group has applied this outcome measure to their large series of patients after thoracic outlet decompression of all types and found that the score correlates well with Short Form-36 surveys (which measure general health-related quality of life) and documents significant improvement after surgery [9]. I have been prospectively collecting QuickDASH data on all patients with NTOS during the past 4 years on more than 100 patients, with approximately one half of the patients undergoing surgery mostly for neurogenic reasons. Our long-term goal with this project is to identify predictors of a positive response to surgery.

After the initial consultation, inventory of symptoms, accurate physical examination, and completion of the baseline QuickDASH survey, a multitude of radiographic tests can be ordered. Many patients in a referral practice have already had magnetic resonance imaging or computed tomography-angiography of the shoulder because these patients are seen first to rule out musculoskeletal tears or neck pathology. Again, to reiterate the lack of sensitive radiographic findings for NNTOS, the findings often are negative, as in this example. Duplex imaging of the upper extremity is useful in assuring there is no venous component present and is quite sensitive and specific for arterial or venous involvement. Our patient in question here had normal results of a duplex ultrasound. I order for all TOS patients arterial digit plethysmography, which can document with provocative maneuvers the obliteration of waveforms suggestive of a narrowed thoracic outlet. This information can be useful when taken in the context of the entire diagnostic evaluation.

At this point in our case, I would consider that conservative management is a safe and appropriate approach. In fact, Landry et al [10] described no significant symptom difference at 4 years after evaluation for NTOS in patients undergoing surgical treatment versus observational therapy. The University of California, Los Angeles vascular surgery group, who has taken an aggressive approach to surgical management, has documented somewhat high long-term failure rates with surgery for NTOS, with only about one half of patients after surgery who showed sustained improvement 18 months postoperatively [7]. Subset analysis in these series and others have found poor predictors of long-term success to include worker's compensation cases [11], duration of symptoms $>2$ years, and previous operations.

Given the unknown long-term issues with such a surgical approach, I concede that initially this patient should undergo a 2- to 3-month trial of conservative management on the basis