Work-Related Neurogenic Thoracic Outlet Syndrome

Diagnosis and Treatment

Gary M. Franklin, MD, MPH[a,b,c,d,*]

KEYWORDS

• Diagnosis • Practice guidelines • Thoracic outlet syndrome • Treatment
• Workers' compensation

KEY POINTS

- The diagnosis and treatment of neurogenic thoracic outlet syndrome (NTOS) are highly controversial and associated with surgical interventions based on no clear-cut evidence of presence of true thoracic outlet syndrome (TOS).
- Considering the poor outcomes reported from the surgical management of NTOS in most workers' compensation cases, this guideline requires objective evidence of brachial plexus disorder, including abnormal electrodiagnostic tests.
- In workers' compensation, a majority of patients have poor outcomes of surgery for NTOS 1 year after surgery.
- Approximately 20% of patients may have new adverse outcomes, primarily related to new neurologic complaints or lung pathology, the most serious of which is phrenic nerve dysfunction.

INTRODUCTION

This guideline is to be used by physicians, claim managers, occupational nurses, and utilization review staff. The emphasis is on accurate diagnosis and treatment that are curative or rehabilitative (see http://app.leg.wa.gov/WAC/default.aspx?cite=296-20-01002 for definitions). An electrodiagnostic worksheet and guideline summary are appended to the end of this document.

This guideline was developed in 2010 by the Washington State Industrial Insurance Medical Advisory Committee (IIMAC) and its subcommittee on Upper Extremity Entrapment Neuropathies. The subcommittee presented its work to the full IIMAC, and the IIMAC voted with full consensus advising the Washington State Department of Labor and Industries to adopt the guideline. This guideline was based on the weight of the best available clinical and scientific evidence from a systematic review of the literature

[a] Washington State Department of Labor and Industries, Olympia, WA 98501, USA; [b] University of Washington, Department of Environmental and Occupational Health Sciences; [c] Department of Neurology; [d] Department of Health Services
* Washington State Department of Labor and Industries, Olympia, WA 98501.
E-mail address: fral235@lni.wa.gov

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(evidence was classified using criteria defined by the American Academy of Neurology)[1] and a consensus of expert opinion. One of IIMAC's primary goals is to provide standards that ensure high quality of care for injured workers in Washington State.

TOS is characterized by pain, paresthesias, and weakness in the upper extremity, which may be exacerbated by elevation of the arms or by exaggerated movements of the head and neck. There are 3 categories of thoracic outlet syndrome: arterial, venous, and neurogenic. Arterial and venous thoracic outlet syndromes involve obstruction of the subclavian artery or vein, respectively, as they pass through the thoracic outlet. These vascular categories of TOS should include obvious clinical signs of vascular insufficiency: a cold, pale extremity in cases of arterial TOS, or a swollen, cyanotic extremity in cases of venous TOS. There is a separate surgical guideline for vascular TOS. This guideline focuses solely on nonacute NTOS.

Work-related NTOS occurs due to compression of the brachial plexus, predominantly affecting its lower trunk, at 1 of 3 potential sites. Compression can occur between the anterior scalene muscle (ASM) and middle scalene muscle (or sometimes through the ASM); beneath the clavicle in the costoclavicular space; or beneath the tendon of the pectoralis minor.[2]

The medical literature describes 2 categories of NTOS: true NTOS and disputed NTOS. A diagnosis of true NTOS requires electrodiagnostic study (EDS) abnormalities showing evidence of brachial plexus injury (discussed later). Disputed NTOS describes cases of NTOS for which EDS abnormalities have not been demonstrated. To avoid confusion that has arisen over these categories, this guideline does not use such terms. Rather, it provides guidance regarding treatment of cases of NTOS that have been confirmed by EDS abnormalities compared with those cases for which the provisional diagnosis has not been confirmed by such studies.

In general, work-relatedness and appropriate symptoms and objective signs must be present for the Washington State Department of Labor and Industries to accept NTOS on a claim. EDSs, including nerve conduction velocity studies and needle electromyography (EMG), should be scheduled immediately to confirm the clinical diagnosis. If time loss extends beyond 2 weeks or if surgery is requested, completion of EDSs is required and does not need prior authorization.

ESTABLISHING WORK-RELATEDNESS

Work-related activities may cause or contribute to the development of NTOS.[3,4] Because simply identifying an association with workplace activities is not, in itself, adequate evidence of a causal relationship, establishing work-relatedness requires all of the following:

1. Exposure: workplace activities that contribute to or cause NTOS
2. Outcome: a diagnosis of NTOS that meets the diagnostic criteria (discussed later)
3. Relationship: generally accepted scientific evidence, which establishes on a more probable than not basis (greater than 50%) that the workplace activities (exposure) in an individual case contributed to the development or worsening of the condition (outcome)

When the Washington State Department of Labor and Industries receives notification of an occupational disease, an occupational disease and employment history form is mailed to the worker, employer, or attending provider. The form should be completed and returned to the insurer as soon as possible. If a worker's attending provider completes the form, provides a detailed history in the chart note, and gives an opinion on causality, the provider may be paid for this (use billing code 1055M).

Additional billing information is available in the Attending Doctor's Handbook (Available at: http://www.lni.wa.gov/IPUB/252-004-000.pdf).

Symptoms of NTOS may be exacerbated by certain work-related activities, usually involving elevation or sustained use of the arms. Such activities may include but are not limited to the following[5]:

Lifting overhead
Reaching overhead
Holding tools or objects above shoulder level
Carrying heavy weights

Several occupations have been associated with NTOS. This is not an exhaustive list and is meant only as a guide in the consideration of work-relatedness:

Dry wall hanger or plasterer
Welder
Beautician
Assembly line inspector
Shelf stocker
Dental hygienist

MAKING THE DIAGNOSIS

Symptoms and Signs

A case definition of confirmed NTOS includes appropriate symptoms, objective physical findings (signs), and abnormal EDSs. A provisional diagnosis of NTOS may be made based on appropriate symptoms and objective signs, but confirmation of the diagnosis requires abnormal EDSs.

Classic symptoms of NTOS include pain, paresthesias, and weakness in the upper extremity. Paresthesias most commonly affect the ring and small fingers.[6] Symptom severity tends to increase after certain activities and worsens at the end of the day or during sleep.

Signs on examination may include tenderness to palpation over the brachial plexus, the scalene muscles, the trapezius muscles, or the anterior chest wall. Although tenderness may be a useful objective finding, it cannot support the diagnosis of NTOS alone. Advanced cases of NTOS are characterized by objective signs of weakness of the hand, loss of dexterity of the fingers, and atrophy of the affected muscles.

Provocative tests have been described that may help corroborate the diagnosis of NTOS. These tests are based on creating maximal tension on the anatomic sites of constriction. Studies have found a high false-positive rate for these tests in healthy subjects as well as patients with carpal tunnel syndrome.[7] Although they are described for completeness, the sensitivity and specificity of these tests for NTOS have not been established, and these tests cannot replace confirmatory EDS testing (discussed later).

Provocative tests include

- The elevated arm stress test (or Roos test)—patient places the affected arm in full abduction and external rotation and then opens and closes the hands slowly for 3 minutes. This test constricts the costoclavicular space. It is considered abnormal if typical symptoms are elicited and the patient cannot sustain this activity for the full 3 minutes.
- The Adson test—patient extends the neck and rotates the head toward the involved extremity, which is held extended at the side. This test constricts the interscalene triangle. It is considered abnormal if a change in the radial pulse is detected when the patients inhale deeply and hold their breath.

- The Wright test—patient sits or stands with the arm in full abduction and external rotation. This test constricts the costoclavicular space. It is considered abnormal if typical symptoms are elicited and a change in pulse is detected.
- The costoclavicular test—examiner depresses patient's shoulder. This test constricts the costoclavicular space and creates tension across the pectoralis minor. It is considered abnormal if typical symptoms are elicited.

Every effort should be made to objectively confirm the diagnosis of NTOS before considering surgery. A differential diagnosis for NTOS includes musculoskeletal disease (eg, arthritis or tendinitis) of the cervical spine, shoulder girdle, or arm; cervical radiculopathy or upper extremity nerve entrapment[8]; idiopathic inflammation of the brachial plexus (also known as Parsonage-Turner syndrome); and brachial plexus compression due to an infiltrative process or space-occupying mass (eg, Pancoast tumor of the lung apex).

Electrodiagnostic Studies

EDS abnormalities are required to objectively confirm the diagnosis of NTOS. Given the uncertainties in diagnostic assessment of NTOS, EDSs should be obtained as soon as the diagnosis is considered. EDSs may help gauge the severity of injury.[9–11] EDSs can help exclude conditions that may mimic NTOS, such as ulnar nerve entrapment or cervical radiculopathy.[12] EDS evidence that confirms a diagnosis of NTOS requires

1. Absent or reduced amplitude (<12 uV) of the ulnar antidromic sensory nerve action potential (SNAP) or absent or reduced amplitude (<10 uV) of the medial antebrachial cutaneous nerve (MABC) antidromic SNAP, with normal amplitude of the MABC SNAP in the contralateral (unaffected) extremity and
2. Absent or reduced amplitude (<5 mV) of the median nerve compound motor action potential (CMAP) or absent or prolonged minimum latency (>33 ms) of the ulnar F wave (with or without abnormalities of the median F wave) and with normal F waves in the contralateral (unaffected) upper extremity or needle EMG showing denervation (eg, fibrillation potentials, positive sharp waves) in at least 1 muscle supplied by each of 2 different nerves from the lower trunk of the brachial plexus, with normal EMG of the cervical paraspinal muscles and at least 1 muscle supplied by a nerve from the middle or upper trunk of the brachial plexus. And, to exclude the presence of other focal neuropathies or polyneuropathy as a cause for the abnormalities (described previously), the following must also be shown:
3. Normal amplitude ($\geq$15 uV) of the median nerve antidromic SNAP and
4. Normal conduction velocity ($\geq$50 m/s) of the ulnar motor nerve across the elbow

Other Diagnostic Tests

Arterial or venous vascular studies may be helpful in the diagnosis of suspected arterial or venous TOS. These tests have poor specificity, however, for NTOS, and there is no substantial evidence that vascular studies can reliably confirm the diagnosis of NTOS. Therefore, vascular studies conducted as a diagnostic tool for NTOS are not authorized.

Some investigators have suggested that MRI neurography may be helpful in the diagnosis of NTOS. This service is not authorized for this condition, however, because the clinical utility of these tests has not yet been proved. Although the IIMAC recognizes that this tests may be useful in unusual circumstances where EDS results are normal but there are appropriate clinical symptoms, the IIMAC believes that at this time the use of these tests is investigational and should be used only in a research setting.

ASM blocks have been used in the evaluation of suspected NTOS.[13,14] This test has poor specificity for NTOS, however, and there is no substantial evidence that ASM can reliably confirm the diagnosis of NTOS. Therefore, ASM blocks conducted as a diagnostic tool for NTOS are not authorized.

Radiographs of the chest may be useful to evaluate the possibility of an infiltrative process or space-occupying mass (eg, Pancoast tumor of the lung apex) compressing the brachial plexus.

TREATMENT

Nonsurgical therapy may be considered for cases in which a provisional diagnosis of NTOS has been made. Surgical treatment should be provided only for cases in which a diagnosis of NTOS has been confirmed by abnormal EDSs. Under these circumstances, the potential benefits of brachial plexus decompression may outweigh the risks of surgery.

Conservative Treatment

Conservative treatment of NTOS has been described in narrative reviews, case reports, and retrospective case series.[15–17] No randomized controlled trials have been conducted to measure the efficacy of conservative treatments for NTOS. No specific method of conservative treatment has proved most effective due to a lack of comparative studies.[15] An observational study (n = 50), however, showed that strengthening and stretching exercises reduced pain among 80% of patients after 3 months and among 94% of patients after 6 months,[16] and a 2007 systematic review of the available literature concluded that conservative treatment seems effective in reducing symptoms, improving function, and facilitating return to work (RTW).[15] Examples of conservative treatment include modification of activities that exacerbate symptoms, education, postural exercises, physical therapy, and antiinflammatory drug therapy.

Because surgical outcomes are poor in many situations, conservative interventions, such as stretching and strengthening exercises, should be considered first. If the initial response to conservative treatment is incomplete, modifying or changing the approach should be considered. If there is no response to conservative treatment within 6 weeks, or if time loss extends longer than 2 weeks, specialist consultation should be obtained.

Although botulinum toxin injections of the scalene muscles have been reported to relieve NTOS symptoms,[18] results of a high-quality randomized trial showed no clear clinical improvement related to this treatment.[19] In addition, it seems that there are substantial technical challenges and potentially severe adverse effects from this procedure. Therefore, Botox injections conducted as a diagnostic tool or for treatment of NTOS is not authorized.

When feasible, job modifications that reduce the intensity of manual tasks may prevent progression and promote recovery from NTOS.[17] If symptoms persist despite appropriate treatment, permanent job modifications may still allow patients to remain at work. Patients do not usually need time off from work activities prior to surgery, unless they present with objective weakness or sensory loss in the upper extremity that limits work activities or poses a substantial safety risk.

Surgical Treatment

Surgical treatment of NTOS has been described in narrative reviews, case reports, and retrospective case series.[5,20–35] A population-based study among injured workers in Washington State showed poor outcomes in the majority of cases and significant adverse events in up to 20% of cases.[35] More recent administrative data from Washington State showed similar poor outcomes and far greater expense and disability among TOS cases who received surgery.[36] TOS was on average the 10th diagnosis in cases, indicating that surgery is often requested late in the course of an injured

worker's condition, after many other often invasive treatments have failed. TOS surgery should include exploration of the brachial plexus throughout its course in the thoracic outlet to decompress it by resecting any compressive and/or constrictive structures. These may include any of the 3 sites of compression (discussed previously). No specific method of surgical treatment has proved most effective.

Surgical treatment should only be considered if

1. The patient has met the diagnostic criteria (discussed previously) and
2. The condition interferes with work or activities of daily living and
3. The condition does not improve despite conservative treatment

Without confirmation of NTOS by both objective clinical findings and abnormal EDSs, surgery is not authorized.

RETURN TO WORK

Early Assessment

Timeliness of the diagnosis can be a critical factor influencing RTW. Among workers with upper extremity disorders, 7% of workers account for 75% of the long-term disability.[37] A large prospective study in the Washington State workers' compensation system identified several important predictors of long-term disability: low expectations of RTW, no offer of a job accommodation, and high physical demands on the job.[38] Identifying and attending to these risk factors when patients have not returned to work within 2 to 3 weeks of the initial clinical presentation may improve their chances of RTW.

Washington State workers diagnosed accurately and early were far more likely to RTW than workers whose conditions were diagnosed weeks or months later. Early

Table 1
Occupational health quality indicators for neurogenic thoracic outlet syndrome

Clinical Care Action	Time Frame[a]
1. Identify physical stressors from both work and nonwork activities 2. Screen for presence of NTOS 3. Determine work-relatedness 4. Recommend ergonomic improvements or other appropriate job modifications	First health care visit
Communicate with employer regarding RTW using 1. Activity prescription form (or comparable RTW form) and/or 2. Phone call to employer	Each visit while work restrictions exist
1. Assess impediments for RTW 2. Request specialist consultation	If >2 wk of time loss occurs or if there is no clinical improvement within 6 wk of conservative treatment
Specialist consultation	Performed as soon as possible, within 3 wk of request
EDSs	If a diagnosis of NTOS is being considered, schedule studies immediately. These tests are required if time loss extends beyond 2 wk or if surgery is requested.
Surgical decompression	Performed as soon as possible, within 4–6 wk of determining need for surgery

[a] "Time frame" is anchored in time from first provider visit related to NTOS symptoms.

coordination of care with improved timeliness and effective communication with the workplace is also likely to help prevent long-term disability.

A recent quality improvement project in Washington State has demonstrated that delivering medical care according to occupational health best practices similar to those listed in **Table 1** can substantially prevent long-term disability. Findings can be viewed at http://www.lni.wa.gov/ClaimsIns/Providers/ProjResearchComm/OHS/default.asp.

Returning to Work After Surgery

How soon a patient can RTW depends on the type of surgery performed and when rehabilitation begins. Most patients can return to light duty work within 4 to 6 weeks and regular duty within 10 to 12 weeks of surgery.

ELECTRODIAGNOSTIC WORKSHEET

Claim Number: _____

Claimant Name: _____

PURPOSE AND INSTRUCTIONS

The purpose of this worksheet is to help interpret EDSs done for an injured worker. The worksheet should be used only when the main purpose of the study is to evaluate NTOS. It should accompany but not replace the detailed report normally submitted to the insurer.

Electrodiagnostic Worksheet for Work-Related Neurogenic Thoracic Outlet Syndrome

Electrodiagnostic Criteria for Work-Related NTOS Are Met if All Four Boxes Are "Yes"	**Check the Correct Box**	
	Yes	**No**
1. Ulnar SNAP[a] <12 uV or absent? OR MABC SNAP[a] amplitude <10 uV or absent, with normal amplitude of the MABC SNAP[a] in the contralateral (unaffected) extremity?		
AND		
2. Median nerve CMAP amplitude <5 mV or absent? OR Ulnar F wave (with or without abnormalities of the median F wave) minimum latency >33 ms or absent, with normal F waves in the contralateral (unaffected) upper extremity? OR Needle EMG showing denervation (eg, fibrillation potentials, positive sharp waves) in at least 1 muscle supplied by each of 2 different nerves from the lower trunk of the brachial plexus, with normal EMG of the cervical paraspinal muscles and at least 1 muscle supplied by a nerve from the middle or upper trunk of the brachial plexus?		
AND		
3. Normal amplitude (≥15 uV) of the median nerve SNAP[a]?		
AND		
4. Normal conduction velocity (≥50 m/s) of the ulnar motor nerve across the elbow?		

[a]Antidromic

Additional Comments:

_____

_____

_____ _____

Signed Date

GUIDELINE SUMMARY

Review Criteria for the Diagnosis and Treatment of Work-Related Neurogenic Thoracic Outlet Syndrome				
CLINICAL FINDINGS				
SUBJECTIVE (Symptoms)	**OBJECTIVE (Signs)**	**DIAGNOSTIC**	**CONSERVATIVE TREATMENT**	**SURGICAL TREATMENT**
AND		**AND**		
Pain, paresthesias, or weakness affecting the upper extremity (most commonly affecting the ring or small finger)	Tenderness Scalene Trapezius Anterior chest wall Brachial plexus Weakness Loss of finger dexterity Atrophy	EDSs are required to objectively confirm the diagnosis of NTOS. EDS criteria are as follows: 1. Absent or reduced amplitude (<12 uV) of the ulnar SNAP OR Absent or reduced amplitude (<10 uV) of the MABC SNAP with normal amplitude of the MABC SNAP in the contralateral (unaffected) extremity AND 2. Absent or reduced amplitude (<5 mV) of the median CMAP OR Absent or prolonged minimum latency (>33 ms) of the ulnar F wave (with or without abnormalities of the median F wave), and with normal F waves in the contralateral (unaffected) upper extremity OR Needle EMG showing denervation (eg, fibrillation potentials, positive sharp waves) in at least 1 muscle supplied by each of 2 different nerves from the lower trunk of the brachial plexus, with normal EMG of the cervical paraspinal muscles and at least 1 muscle supplied by a nerve from the middle or upper trunk of the brachial plexus AND 3. Normal amplitude (≥15 uV) of the median nerve SNAP AND 4. Normal conduction velocity (≥50 m/s) of the ulnar motor nerve across the elbow	Modify job activities that exacerbate symptoms AND/OR Physical therapy with strengthening and stretching, postural exercises AND/OR Antiinflammatory drug therapy	Surgical treatment should only be considered if 1. The patient has met the diagnostic criteria under the section making the diagnosis AND 2. The condition interferes with work or activities of daily living AND 3. The condition does not improve despite conservative treatment Without confirmation of brachial plexus compression **by both objective clinical findings and abnormal EDSs**, surgery is not authorized.

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