

Neurogenic Thoracic Outlet Syndrome in Whiplash Injury

J Spinal Disord 2001 December;14(6)487-493.

Yukihiro Kai; Masanobu Oyama; Shinnosuke Kurose; Tatsuro Inadome; Yutaka Oketani; Yoshitake Masuda

FROM ABSTRACT:

NTOS = neurogenic thoracic outlet syndrome

A prospective study of 110 patients was carried out to determine the pathogenic significance of trauma to the upper body in the development of neural compressive irritation at the thoracic outlet.

Twenty-nine patients were reviewed as cervical strain injuries (N group), 25 patients as probable neurogenic thoracic outlet syndrome (NTOS) (PT group), 39 patients as definite NTOS (T group), and 17 patients as NTOS associated with cervical disc disease (CD-T group).

29 had cervical strain	N group
25 had probable neurogenic thoracic outlet syndrome (NTOS)	PT group
39 had definite neurogenic thoracic outlet syndrome	T group
17 had NTOS associated with cervical disc disease	CD-T group

The time lapse between accident and diagnosis and the duration of treatment were significantly longer in T patients or CD-T patients than those in the N group.

Radiography of NTOS patients also showed a higher percentage of cervical spine-length/height ratio. [ie., longer neck].

Traumatic NTOS would suggest two types related to direct damage of scalene muscles that included some physical aspects of cervical disc disease.

Pathogenesis provided a key to the resolution of more complex posttraumatic problems of whiplash injury.

THESE AUTHORS ALSO NOTE:

Whiplash injury patients occasionally do not respond to conventional treatment, and become worse.

“Severe symptoms such as aching pain, arm ‘heaviness,’ easy fatigability of the arm, tingling and numbness in the ulnar aspect of the hand, and headache may appear in whiplash patients.”

“In our clinical experiences of the past 10 years, we have noted that these neck–shoulder–arm symptoms represent the classic features of thoracic outlet syndrome (TOS).”

TOS symptoms can be neurogenic and /or vascular, and the vascular type occurs less frequent than the neurogenic type.

Vascular type TOS is mainly due to the congenital anomalies of the scalenus muscle insertion to the first rib, or from osseous anomalies.

Neurogenic type TOS may arise from edema or spasm of the anterior scalenus muscle or from postural abnormalities.

Whiplash trauma will most likely cause a narrowing of the scalene triangle by spasm of the scalene muscles, and/or cause a compromise to the tight costoclavicular space.

A whiplash origin of TOS has been documented, but not widely appreciated.

Whiplash traumatic TOS can cause long-term disabling symptoms following rear-end auto accidents.

“Neural irritation of the TOS elicited by cervical injuries has emerged as a principal cause of chronic shoulder–arm symptoms in these patients.”

PATIENTS AND METHODS

In this study, 110 patients with a history of cervical trauma and no symptoms before injury were used.

None of these patients had neuropathy of the ulnar or median nerve, thromboangiitis obliterans of the upper extremity, shoulder lesions (impingement, acromioclavicular joint disease, etc.), osseous anomalies (cervical rib, enlarged C7 transverse process), cervical ossification of the posterior longitudinal ligament, neoplasm, inflammatory disease, or known traumatic bone deformity.

The following tests were used to make the diagnosis:

(1) Morley test:

Brachial plexus compression test in the supraclavicular area from the scalene triangle. A positive response was the reproduction of an aching sensation and typical localized paresthesia, and not mere tenderness of the area.

(2) One-minute Roos test:

A thoracic outlet shoulder girdle stress test that consists of the shoulder braced and arms in a 90° abducted and externally rotated position; the patient was required to repetitively clench and relax fists for 60 seconds. A positive test was one that reproduced the symptom.

(3) Wright test:

In the above-mentioned stress position, a positive test produced discoloration of the hand and one or more symptoms, which did not always correlate with a diminution or absence of radial pulse.

29 had cervical strain
No positive tests.

N group

25 had probable neurogenic thoracic outlet syndrome (NTOS)
Only one positive test.

PT group

39 had definite neurogenic thoracic outlet syndrome
Two or three positive tests.

T group

17 had NTOS associated with cervical disc disease
Positive cervical compression test and positive Spurling's maneuver in a sitting position, abnormal cervical MRI findings, associated with neurologic problems of the upper extremity.

CD-T group

All patients underwent radiologic evaluations of the cervical spine in neutral, flexion, and extension at standing to bilateral upper limbs dropped distally. The following measurements were obtained.

(1) The lowest level of cervical spine identified as superior, middle, or inferior margin of vertebra in neutral-lateral radiograph position.

(2) The length of cervical spine (LCS) was measured from the tip of the superior margin at C1 to the lowest level of cervical spine in neutral-lateral view. %LCS was expressed as a percentage of LCS divided by patient's body height. The length on plain radiographs was multiplied by 0.9 to show length.

(3) Cervical lordosis: the angle measured from a straight line at the posterior margin of C2 and C7 with neutral-lateral radiograph.

(4) Range of cervical motion was accomplished by the C2-C7 angle examined with measurement at flexion-extension lateral radiographs.

(5) Anterior-posterior diameter of C5-C6 canal at lateral radiographs.

RESULTS

Predominant symptoms comparison by percentage:

	N	PT	T	CD-T
Headache	28	37	43	47
Neck Pain	55	70	63	59
Neck Stiffness	10	24	56	41
Scapular Pain	31	30	46	35
Arm Ache	10	20	24	41
Arm Numbness	10	40	36	71
Lumbago	10	24	26	24
Dizziness	0	3	8	6
Nausea	6	7	12	12
Treatment Duration (days)	18	64	127	409
Time To Correct Dx (days)	50	118	203	128

“The average duration for treatment was significantly longer in the PT, T, and CD-T groups than that of the N group.”

The authors note that there is a possibility of secondary NTOS associated with cervical disc injuries. [This is consistent with the Double Crush Syndrome].

Six patients with CD-T had anterior cervical fusion. The clinical results were effective only for diminishing discogenic pain or numbness in four of six patients, leaving residual headache or shoulder–arm symptom along with a positive brachial plexus compression or shoulder girdle stress test.

Two of the cervical fusion surgical procedures failed to improve the patients. The duration of treatment in these patients extended over an average of 548 days (range: 150 to >1,000 days).

Satellite ganglion block or epidural injection were performed for all six surgical cases, but only produced symptomatic relief for a few days.

Radiographs of T patients revealed significantly longer %LCS than for those of the N group; for instance, this 0.41% longer LCS suggests that a T-patient with a height of 170 cm had a cervical spine that was approximately 7 mm longer. [Findings suggest that a longer neck is associated with increased probability of whiplash NTOS].

The ranges of motion in the cervical spine in the CD-T group were significantly smaller than that of the N, PT, and T groups.

“Mean cervical lordotic angle also revealed no significant differences between each group, but the ratio of patients who had cervical kyphotic malalignment was higher in both the PT and T groups (44% and 46.2%, respectively) than that in the N and CD-T groups (24.1% and 11.7%, respectively).”

DISCUSSION

There is no epidemiologic or scientific basis to suggest that:

- (1) Whiplash injuries are impossible at [low] collision speeds.
- (2) That the whiplash problem is psychological.
- (3) Whiplash injury is feigned as a mean to obtain secondary financial gain.

“Late whiplash injury is defined as whiplash syndrome persisting for longer than 6 months.”

“We suspected that many of these patients with symptoms persisting more than a couple of months after injury might have the shoulder–arm symptoms of TOS.”

TRAUMATIC NTOS

The authors cite 3 studies that associate trauma and TOS:

- (1) Capistrant TD. Thoracic outlet syndrome in cervical strain injury. *Minn Med* 1986; 69: 13– 7.
- (2) Capistrant TD. Thoracic outlet syndrome in whiplash injury. *Ann Surg* 1977; 185: 175– 8.
- (3) Martinez NS. Traumatic thoracic outlet syndrome. *Contemp Surg* 1982; 21: 29– 38.

One study notes “that 36% of cervical strain injuries were complicated by TOS.” (Capistrant, 1986).

The authors note that whiplash NTOS is:

- (1) Probably a compression neuropathy
- (2) Has a significant longer time lapse between the accident and diagnosis.
- (3) Is probably not the result of vascular compression.

“The compression of the subclavian artery is less frequent than the compression of the brachial plexus.”

“The majority of TOS cases after trauma may be due to neurogenic injury.”

"Some of the specific symptoms of traumatic NTOS include disorientation and incapacitating headache, stiffness, numbness, nausea, and dizziness."

A difficulty in diagnosis of TOS is associated with cervical disc injury involvement. [again, a Double Crush Syndrome issue].

"The poor outcome for six CD-T patients who expected shoulder–arm symptom relief after a surgical procedure also indicate a complicated pathogenesis."

PROBABLE OR DEFINITE NTOS

"The physique of classic TOS patients is that of a long neck with sloping shoulders."

"Radiological findings in the neutral position–lateral view of the cervical spine of PT and T patients of the current study showed a longer %LCS and the midline–inferior margin of T1 at the lowest level, when compared with those of N group as controls."

This reduces the space for the neurovascular bundle located at the scalene triangle, clavicle, and first rib.

"Trauma in whiplash-injured patients with this postural factor will most likely affect the narrowing of the costoclavicular space by muscle spasm and produce compressive irritation of the brachial plexus in the tight thoracic outlet space."

Whiplash accidents "may potentially produce a histochemical change at the cellular level or abnormal fibrotic pattern of the scalene muscles in these patients." [The Fibrosis Of Repair].

Minor trauma from rear-end collision auto accidents will not usually produce chronic symptoms in the average person, but can in these susceptible persons.

[VERY IMPORTANT !]

"Reproducibility of the Roos test [positive] with negative Wright test may also suggest a traumatic onset of NTOS."

"The Morley or Roos maneuver appears to have a significant value in the diagnosis, because the development of NTOS after cervical trauma may be caused solely by pressure on the brachial plexus by the overlying scalenus muscle."

"The acceptance of a traumatic mechanism in thoracic outlet syndrome can improve significantly the treatment of the patients referred to as having late whiplash injury."

“The higher ratio of females in traumatic NTOS may also suggest sagging of the upper body as a possible precipitating factor.”

“The PT and T patients had a tendency for kyphotic malalignment of the cervical spine when compared with the N group, although whole alignments of each group showed cervical lordosis on average.”

“We suspect that this cervical kyphosis will lead to total spinal malalignment or rounded shoulders, generally recognized in TOS.”

“In addition, this malalignment will result in headache, neck pain, scapular pain, and low back pain with postural sway or continuous contraction of trunk muscles.”

Incredibly, the authors note that “the mainstays of nonoperative treatments that include the use of medication, the modification of activities, the use of a neck collar, and some injections,” will not result in the needed changes in spinal alignment, noting:

“Changes in the muscles and spinal alignment, standard treatments may be beneficial for short-term relief of painful symptoms, but will not be effective or essential for long-term relief.”

The authors do not advocate the application of cervical traction because of the possibility of the deterioration of symptoms by stretching muscles or nerves.

The authors do advocate shoulder girdle muscle-toning exercises.

“Early mobilization after a whiplash injury may decrease neck–shoulder pain more than a standard program using a soft collar or initial rest.”

CLASSIFICATION OF TRAUMATIC NTOS

Traumatic NTOS includes two types:

(1) NTOS directly caused by trauma:

These patients have fibrous bands, weak muscles, or abnormal physique.

“The patient with tight costoclavicular space of sloping shoulders or round shoulders will experience localized compression or neuritis on the brachial plexus from minimal trauma.” **[IMPORTANT!]**

“Even patients with no primary factors may experience the onset of chronic symptoms caused by scalene muscle edema or spasm.”

(2) NTOS associated with cervical disc injury by trauma. These patients have damage or injury at the C5–C7 roots.

“Based on the assessment of patients described herein, we have to consider the onset of NTOS related to cervical radiculopathy.” [Double Crush Syndrome].

Six cases of NTOS with disc injury displayed chronic residual symptoms after anterior fusion, suggesting that NTOS may be combined with cervical disc disease rather than caused by disc injury. [Double Crush Syndrome].

Also, there is the possibility that NTOS is associated with cervical spondylosis. [Double Crush Syndrome].

“Because the more complex problems of traumatic NTOS involve the physique, muscle damage, or disc injury, the symptoms are more variable, and the treatments more uncertain.”

“The frequency of occurrence, the long period of convalescence, the financial loss through disability, and the inevitable medical–legal complications all make NTOS one of the most prevalent and important posttraumatic problems faced by the medical profession.”

KEY POINTS FROM DAN MURPHY

(1) It is documented that whiplash trauma can cause TOS.

(2) Whiplash caused TOS can cause long-term disabling symptom.

(3) Common whiplash TOS symptoms include:

nausea

dizziness

numbness

aching pain

disorientation

neck stiffness

arm heaviness

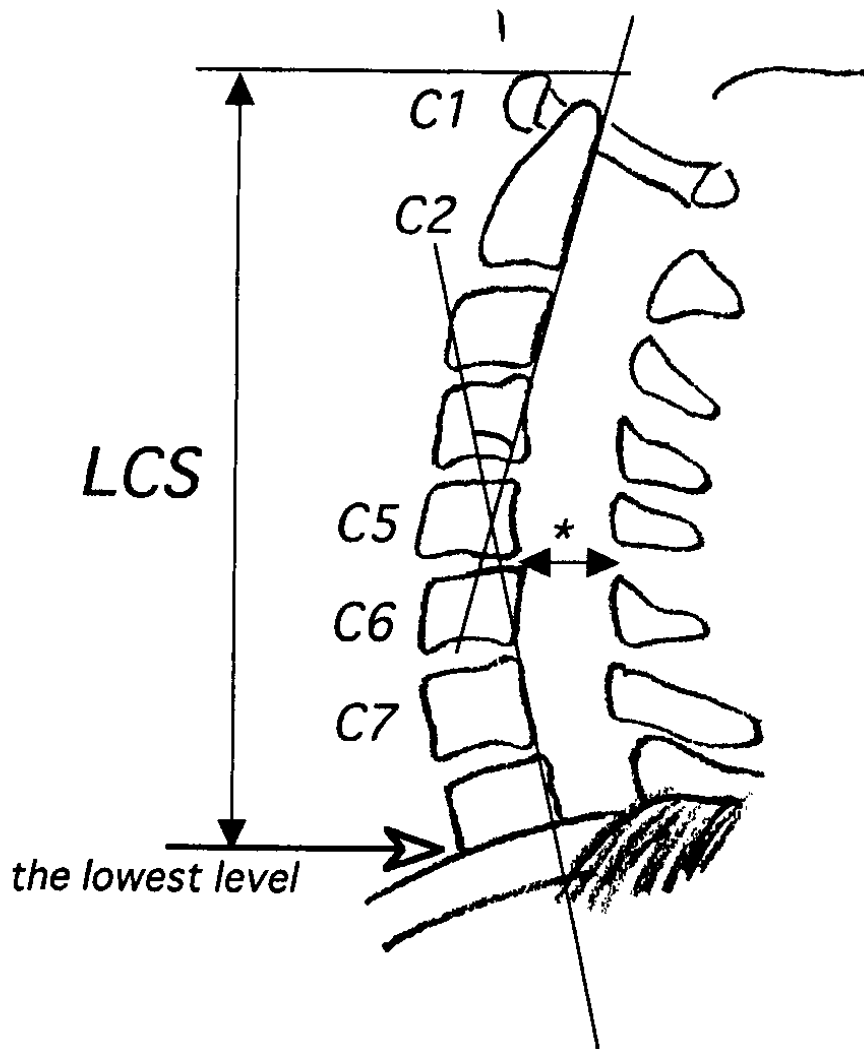
incapacitating headache

easy fatigability of the arm

tingling and numbness in the ulnar aspect of the hand

(4) Neural irritation of the TOS elicited by cervical injuries is the principal cause of chronic shoulder–arm symptoms in whiplash patients.

- (5) Neurogenic TOS is the rule, and vascular TOS is the exception.
- (6) Correctly identifying the patient's chronic symptoms as being caused by TOS can be delayed for between 4- 7 months.
- (7) Treatment duration for patients with traumatic NTOS can exceed 4 months, and exceed 1 year if the cervical discs are involved.
- (8) The authors present compelling evidence and argument for a discogenic Double Crush Syndrome component for some traumatic NTOS patients.
- (9) Cervical fusions, satellite ganglion blocks, and epidural injections were not associated with acceptable clinical outcomes in this study.
- (10) Risk factors for traumatic NTOS include:
 - a longer neck
 - cervical kyphotic malalignment
 - sloping shoulders
- (11) Post traumatic "Fibrosis Of Repair" can cause whiplash NTOS.
- (12) Minor trauma from rear-end collision auto accidents can cause chronic TOS symptoms in susceptible persons.
- (13) Cervical kyphosis will lead to total spinal malalignment, increasing whole body stress and symptoms.
- (14) Medical care will not improve the spinal alignment and therefore will not be effective for long-term relief. **[WOW!]**



The radiographic measurements of neutral lateral view included:

- (1) The lowest level of vertebral body.
- (2) LCS (length of cervical spine) measured from the tip of the superior margin at C1 to the lowest level.
- (3) Anterior-posterior canal diameter of C5-C6 (*).
- (4) Cervical lordotic angle formed by straight line at posterior margin of C2 and C7.