Thoracic outlet syndrome (TOS) is a nonspecific label. When employing it, one should define the type of TOS as arterial TOS, venous TOS, or neurogenic TOS. Each type has different symptoms and physical findings by which the three types can easily be identified.

Neurogenic TOS (NTOS) is by far the most common, comprising well over 90% of all TOS patients.

Arterial TOS is the least common accounting for no more than 1%.

Many patients are erroneously diagnosed as “vascular” TOS, a nonspecific misnomer, whereas they really have NTOS.

The Adson Test of noting a radial pulse deficit in provocative positions has been shown to be of no clinical value and should not be relied upon to make the diagnosis of any of the three types. The test is normal in most patients with NTOS and at the same time can be positive in many control volunteers.

Arterial TOS is caused by emboli arising from subclavian artery stenosis or aneurysms. Symptoms are those of arterial ischemia and x-rays almost always disclose a cervical rib or anomalous first rib.

Venous TOS presents with arm swelling, cyanosis, and pain due to subclavian vein obstruction, with or without thrombosis.

Neurogenic TOS is due to brachial plexus compression usually from scarred scalene muscles secondary to neck trauma, whiplash injuries being the most common. Symptoms include extremity paresthesia, pain, and weakness as well as neck pain and occipital headache. Physical exam is most important and includes several provocative maneuvers including neck rotation and head tilting, which elicit symptoms in the contralateral extremity; the upper limb tension test, which is
comparable to straight leg raising; and abducting the arms to 90° in external rotation, which usually brings on symptoms within 60 seconds.

THESE AUTHORS ALSO NOTE:

Adson first described the Scalenus Anticus Syndrome in 1927 as an arterial problem caused by compression of the subclavian artery by the anterior scalene muscle (ASM).

In 1956, Scalenus Anticus Syndrome was changed to Thoracic Outlet Syndrome (TOS) in recognition that subclavian artery, the subclavian vein or brachial plexus can each be compressed, and the compression can be done by structures other than the anterior scalene muscle.

“TOS is a broad term whose definition is ‘upper extremity symptoms due to compression of the neurovascular bundle by various structures in the area just above the first rib and behind the clavicle’.”

The term TOS should be preceded by an appropriate modifier:

- Arterial TOS (ATOS) Less than 1% of cases
- Venous TOS (VTOS) About 3% of cases
- Neurogenic TOS (NTOS) Over 95% of cases

“NTOS comprises over 90% of all TOS cases seen today while ATOS is less than 1%.”

“Most patients with NTOS have a history of neck trauma preceding their symptoms, auto accidents being the most common and repetitive stress at work being next most common.”

VTOS may be preceded by excessive activity with the arms.

“Symptoms of ATOS usually develop spontaneously, unrelated to trauma or work. Arterial TOS is almost always associated with a cervical rib or an anomalous first rib and, thus, a normal neck x-ray is a good screening test to rule out ATOS.”

Cervical ribs occur in less than 1% of the population and most cervical ribs are asymptomatic. “However, the cervical rib is a predisposition to develop NTOS following neck trauma, most often whiplash injuries.”

“Symptomatic cervical ribs usually produce symptoms of NTOS, but a few will press against the subclavian artery and result in either stenosis or aneurysm formation. This is the etiology of ATOS.”

“The only patients we have seen develop ATOS had either a complete cervical rib or an anomalous first rib. Since ATOS is usually asymptomatic until arterial emboli occur, asymptomatic patients found to have one of these rib anomalies are
followed with duplex scans every few years to detect silent arterial abnormalities. If arterial abnormalities develop, surgical repair of the artery and excision of the rib should be performed before ATOS develops.” [Interesting]

**Arterial TOS Symptoms**

The symptoms of ATOS include digital ischemia, claudication, pallor, coldness, paresthesia, and pain in the hand but seldom in the shoulder or neck. These symptoms are the result of arterial emboli or from thrombus forming just distal to subclavian artery stenosis. The pallor and coldness are due to arterial ischemia.

**Venous TOS Symptoms**

“Swelling of the arm, plus cyanosis, is strong evidence of subclavian vein obstruction, either thrombotic or nonthrombotic. Pain or aching is often present, but may also be absent. The arm swelling seen in VTOS is not a feature of either ATOS or NTOS. Paresthesia in the fingers and hands is common in venous TOS and may be secondary to swelling in the hand rather than to nerve compression in the thoracic outlet area.”

**Neurogenic TOS Symptoms**

“Pain, paresthesia, and weakness in the hand, arm, and shoulder, plus neck pain and occipital headaches, are the classical symptoms of NTOS. Raynaud’s phenomenon, hand coldness and color changes, is also frequently seen.”

**Typical symptoms incidence in Thoracic Outlet Syndrome patients**

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paresthesia</td>
<td>98%</td>
</tr>
<tr>
<td>Trapezius pain</td>
<td>92%</td>
</tr>
<tr>
<td>Neck pain</td>
<td>88%</td>
</tr>
<tr>
<td>Shoulder pain</td>
<td>88%</td>
</tr>
<tr>
<td>Arm pain</td>
<td>88%</td>
</tr>
<tr>
<td>Occipital headache</td>
<td>76%</td>
</tr>
<tr>
<td>Supraclavicular pain</td>
<td>76%</td>
</tr>
<tr>
<td>Chest pain</td>
<td>72%</td>
</tr>
<tr>
<td>Paresthesia in all 5 fingers</td>
<td>58%</td>
</tr>
<tr>
<td>Paresthesia in 4th and 5th fingers</td>
<td>26%</td>
</tr>
<tr>
<td>Paresthesia in 1st- 3rd fingers</td>
<td>14%</td>
</tr>
<tr>
<td>No Paresthesia</td>
<td>2%</td>
</tr>
</tbody>
</table>

In NTOS, the coldness and color changes are due to an “overactive sympathetic nervous system whose fibers run on the circumference of the nerve roots of C8, T1, and the lower trunk of the brachial plexus.”
“When the nerves are irritated or compressed, the sympathetic fibers are activated, producing Raynaud’s phenomenon. This explains how the coldness and color changes are frequently seen with NTOS.” Importantly, the same coldness and color changes also occur in ATOS.

“VTOS is easily identified on physical exam by arm swelling, cyanosis, and distended superficial veins over the shoulder and chest wall.”

“NTOS usually demonstrates tenderness over the scalene muscles and duplication of symptoms by the following provocative maneuvers:

1) Neck rotation and head tilting (ear to shoulder), which elicit symptoms of pain and paresthesia down the contralateral side.

2) Abducting the arms to 90° in external rotation with 90° elbow flexion (90° AER), which brings on symptoms within 60 seconds and often, in less than 30 seconds. (the arms in a “stick-em-up” position)

3) Modified upper limb tension test of Elvey (ULTT). The later test is comparable to straight leg raising in the lower extremity."

**Typical positive exam findings in Thoracic Outlet Syndrome patients**

<table>
<thead>
<tr>
<th>Test</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>90° Abduction in external rotation</td>
<td>100%</td>
</tr>
<tr>
<td>Upper Limb Tension Test (ULTT)</td>
<td>98%</td>
</tr>
<tr>
<td>Scalene muscle tenderness</td>
<td>94%</td>
</tr>
<tr>
<td>Scalene pressure yields radiating symptoms</td>
<td>92%</td>
</tr>
<tr>
<td>Neck rotation to opposite side</td>
<td>90%</td>
</tr>
<tr>
<td>Head tilt to opposite side</td>
<td>90%</td>
</tr>
<tr>
<td>Sensation to light touch</td>
<td>68%</td>
</tr>
</tbody>
</table>

These authors have modified the Upper Limb Tension Test of Elvey (ULTT), as follows:

1) This patient sits up, and both arms are tested simultaneously.

2) The patient actively abducts the arms to 90° with elbows extended.

3) The patient actively dorsiflexes the wrists.

4) The patient tilts the head to one side, increasing the stretch on the brachial plexus on the opposite side.

5) The head is then tilted to the other side to test the opposite brachial plexus.

“Pain down the arm, especially around the elbow, and/or paresthesia in the hand is a positive response.”
A positive ULTT indicates compression against the nerve roots or the branches of the brachial plexus in the thoracic outlet space, or in the pectoralis minor space, or in the cervical spine.

In ATOS, there usually is no scalene muscle tenderness; neck rotation and head tilt elicit no symptoms; and the ULTT may be normal. “In ATOS, most of the symptoms are in the hand and forearm, fewer in the shoulder girdle and neck.”

An x-ray will easily detect a cervical or anomalous first rib. “If there is none, this essentially eliminates ATOS.” “Even if there is a cervical rib, most symptomatic cervical ribs cause symptoms of neurogenic, not arterial, TOS.”

The Ninety-degree abduction in external rotation stress test (90° AER) was fist described in 1963, and is very helpful in the diagnosis of neurogenic TOS. This test is also known as the elevated arm stress test (EAST test of Roos, after Dr. David Roos, a pioneering thoracic outlet surgeon). The patient elevates the arms in a “stick-em-up” position. 94% of NTOS patients will have a reproduction of the symptoms of pain and paresthesia within 60 seconds of holding the arms in this position.

Arteriography should be used only when a patient has signs and symptoms suggestive of arterial insufficiency or ischemia and surgery is being considered. Magnetic resonance arteriography (MRA) is similarly indicated, and has fewer risks than transfemoral arteriography.

“Electromyography (EMG) and nerve conduction velocity (NCV) tests are normal in the large majority of patients with clinical signs of NTOS.”

NCV of the sensory medial antebrachial cutaneous nerve revealed abnormalities in clinical NTOS patients in whom all other electrodiagnostic studies were normal.

CONCLUSIONS

“Adson test is not reliable to either rule in or rule out a diagnosis of neurogenic TOS. It is employing a vascular sign to diagnose a neurologic condition, which frequently is misleading.”

“The upper limb tension test (ULTT) is comparable to straight leg raising in the lower extremity and is very helpful in the diagnosis of neurogenic TOS.”

The purpose of arteriography and MRA is to assist the surgeon in planning arterial reconstruction, not to establish a diagnosis.
KEY POINTS FROM DAN MURPHY

1) There are 3 types of thoracic outlet syndrome:

   Arterial TOS (ATOS) Less than 1% of cases
   Venous TOS (VTOS) About 3% of cases
   Neurogenic TOS (NTOS) Over 95% of cases

2) The Adson Test of noting a radial pulse deficit in provocative positions has been shown to be of no clinical value and should not be relied upon to make the diagnosis of any of the three types.

3) Arterial TOS is caused by emboli arising from subclavian artery stenosis or aneurysms. Symptoms are those of arterial ischemia and x-rays almost always disclose a cervical rib or anomalous first rib.

4) If there is no cervical or anomalous first rib, this essentially eliminates ATOS. “Even if there is a cervical rib, most symptomatic cervical ribs cause symptoms of neurogenic, not arterial, TOS.”

5) “Symptoms of ATOS usually develop spontaneously, unrelated to trauma or work. Arterial TOS is almost always associated with a cervical rib or an anomalous first rib and, thus, a normal neck x-ray is a good screening test to rule out ATOS.”

6) Venous TOS presents with arm swelling, cyanosis, and pain due to subclavian vein obstruction, with or without thrombosis. VTOS may be preceded by excessive activity with the arms.

7) “VTOS is easily identified on physical exam by arm swelling, cyanosis, and distended superficial veins over the shoulder and chest wall.”

8) Neurogenic TOS is due to brachial plexus compression usually from scarred scalene muscles secondary to neck trauma, whiplash injuries being the most common. Symptoms include extremity paresthesia, pain, and weakness as well as neck pain and occipital headache. Physical exam is most important and includes several provocative maneuvers including neck rotation and head tilting, which elicit symptoms in the contralateral extremity; the upper limb tension test, which is comparable to straight leg raising; and abducting the arms to 90° in external rotation, which usually brings on symptoms within 60 seconds.

9) “Most patients with NTOS have a history of neck trauma preceding their symptoms, auto accidents being the most common and repetitive stress at work being next most common.”

10) Cervical ribs occur in less than 1% of the population and most cervical ribs are asymptomatic. “However, the cervical rib is a predisposition to develop NTOS following neck trauma, most often whiplash injuries.”
11) "Pain, paresthesia, and weakness in the hand, arm, and shoulder, plus neck pain and occipital headaches, are the classical symptoms of NTOS. Raynaud’s phenomenon, hand coldness and color changes, is also frequently seen."

12) In NTOS, the coldness and color changes are due to an “overactive sympathetic nervous system whose fibers run on the circumference of the nerve roots of C8, T1, and the lower trunk of the brachial plexus.”

13) The most common symptom of NTOS is paresthesia that affects all 5 fingers.

14) Nearly all patients with NTOS will have symptoms within 60 seconds and often, in less than 30 seconds, when abducting the arms to 90° in external rotation (90° AER) (the arms in a “stick-em-up” position). This test is also known as the elevated arm stress test (EAST test of Roos).

15) Nearly all patients with NTOS will have pain down the arm, especially around the elbow, and/or paresthesia in the hand, when performing the modified upper limb tension test of Elvey (ULTT), as follows:

A)) This patient sits up, and both arms are tested simultaneously.

B)) The patient actively abducts the arms to 90° with elbows extended.

C)) The patient actively dorsiflexes the wrists.

D)) The patient tilts the head to one side, increasing the stretch on the brachial plexus on the opposite side.

E)) The head is then tilted to the other side to test the opposite brachial plexus.

16) Electromyography (EMG) and nerve conduction velocity (NCV) tests are normal in most patients with clinical signs of NTOS, with the exception of NCV of the sensory medial antebrachial cutaneous nerve.