What is the thoracic outlet?

Nerves and blood vessels travel from the neck to the upper limb through a series of three tunnels, known collectively as the thoracic outlet. (Picture 1)

![Diagram of the thoracic outlet.](image)

The nerves and blood vessels pass through three triangular channels which make up the thoracic outlet: (A) the triangular space between the scalene muscles; (B) the costoclavicular space; and (C) a space beneath the pectoralis minor muscle.

Obstruction to the electrical conduction down the nerves, or blood flow through the arteries, or veins can lead to symptoms in the arm and hand, known as the thoracic outlet syndrome (TOS). Most patients with the thoracic outlet syndrome have three features: numbness, weakness, and a sensation of swelling in the hand and arm. Most commonly, the complaints arise from altered posture that causes mild compression with intermittent symptoms and no alarming features. Depending upon the cause, and presentation, three types of TOS are recognized:

- **Neurogenic** - In about 90% of cases, nerve impingement occurs along the nerve’s path through the three tunnels; symptoms of numbness and tingling predominate. Neither swelling nor color change are evident. When a major nerve is blocked an added feature is persistent loss of sensation and visible loss of muscle tissue within the hand. This is rare.
- **Arterial** - In about 9% of cases, vascular impingement presents with sudden onset, often severe pain, and pale coloration of the forearm and hand.
- **Venous** - Rarely, in about 1% of cases, onset is less intense; swelling, and bluish discoloration is often present.

What are some of the causes of the obstruction?
Artery or vein obstruction can arise from blood clots, tumor, shoulder injury, and some quite rare deformities. Similarly, nerve obstruction can arise from abnormal muscle deformities resulting from birth defects to injury [1,2]. Depending on the site of obstruction other features can be identified by physical examination, nerve flow tests, or imaging studies performed with dye injected into the vessels [3,4]. But the vast majority of patients have either the droopy shoulder syndrome [5] or what has been called the “nonspecific neurogenic thoracic outlet syndrome” (NNTOS). Neither of these conditions requires imaging studies; treatment is usually successful, and the elimination of the complaints establishes the diagnosis. These patients do not have color changes, muscle atrophy, and their symptoms are intermittent, not constant. Numbness tends to occur along the side of the forearm leading toward the ring finger and little finger (the ulnar nerve area).

**What causes the droopy shoulder syndrome?**

The most common cause is sagging muscles related to aging, or obesity with heavy arms or heavy breasts. (Picture 2)

![Picture 2: Poorly fitted brassiere. Note thin tight straps, heavy breasts and arms.](image)

Other contributing factors include carrying a heavy backpack, a slouching sitting posture, and lack of brassiere support. Medical problems include weakness of the trapezius muscles either from aging or nerve damage. It can also occur from sleeping or working with arms overhead, or straining to reach overhead.

**What other conditions can cause similar complaints?**

Diabetes, the carpal tunnel syndrome, tumors near the tunnels or high in the lung, pinched nerves in the neck region, underactive thyroid, other causes of nerve damage, and blood clotting disorders are some of the diseases that must be ruled out.

**How is the diagnosis made?**
Thoracic outlet syndrome is seldom studied in randomized control fashion because the symptoms are usually temporary. Once aggravating factors are recognized and corrected the symptoms disappear. Simple diagnostic procedures can be performed in the doctor’s office. These maneuvers reproduce the symptoms or cause a diminution in the pulse wave. The Roos test (see picture 3) and the Adson maneuver (see picture 4)

Picture 3: The Roos test.

The patient repeatedly clenches and unclenches the fists while keeping the arms abducted and externally rotated (palms forward and upward). The elbows are braced slightly behind the frontal plane. The test is positive when symptoms are reproduced with this maneuver. A positive test is very suggestive of the thoracic outlet syndrome.

Picture 4. The Adson test.

With the patient seated, arms at the sides, the pulse is palpated at the wrist and the examiner listens to the sounds of blood flow above the collar bone while the patient takes a deep breath and performs the Valsalva maneuver. This is like blowing up a balloon with tight lips so no air can escape. During this test the neck is gradually tilted away and backward, the arm is elevated and the chin turned both toward and away from the involved side. This tenses the scalenus anterior muscle. A positive test results in diminished pulse, altered sounds, and numbness and tingling are increased.
Although these tests are helpful, they are by no means foolproof. Several small series of patients examined using these tests found the sensitivity and specificity to be relatively low (from 46-62%) [6-8.]

If the presentation includes constant symptoms, swelling, color change, or muscle atrophy, further investigation should be considered.

Imaging can be performed with ultrasound for vascular studies, x-rays may be taken of the chest and spine, or magnetic resonance imaging (MRI) performed for symptoms resulting from obstruction in one of the three tunnels. Bony obstruction from arthritis, fracture, or other bone deformities can be observed. However, many normal people have the same findings as those complaining of TOS, so that correction with surgery may not provide relief. A surgeon with a special interest in the disorder should be consulted. Often this is in the field of thoracic surgery. Special types of ultrasound, Doppler flow imaging, or intravascular ultrasonography are available but their benefit depends on the experience of the radiologist. The surgeon usually decides which of these procedures to order.

The other major diagnostic procedure is a nerve conduction study. This is an expensive and uncomfortable test; it is used to rule out other more serious disorders of the nervous system when conservative treatment has not been helpful. Blood tests can be used to identify diabetes, low thyroid, or inflammation that may cause similar symptoms. Carpal tunnel syndrome may coexist. The physical examination can pick this up.

**What is the treatment for thoracic outlet syndrome?**

The history and physical examination is the first step in conservative management. If pain is severe or there is notable color change or swelling the patient should be promptly referred to an experienced surgeon.

Conservative management begins with identifying improper postures and work habits that may be causing the symptoms. Aggravating factors include:

- Obesity with heavy arms and breasts
- Working overhead without adequate interruptions
- Sleeping with arms overhead
- Sleeping on several pillows or with the head on the arm of a sofa that thrusts the head forward
- Sitting slouched down in a chair
- Weight lifting that results in hypertrophy of neck and upper trunk muscles
- Ill-fitting brassiere; a proper brassiere may be suggested (Picture 5)
This is an example of a good brassiere. Note wide elastic straps and better support for the weight of the breasts.

Correcting these habits is important not only for symptom improvement but also to prevent recurrences. Posture correction, weight reduction, sleeping with arms down, and taking rest breaks when working with arms overhead may provide symptomatic improvement. Hikers using heavy backpacks may have to use a case on rollers that can be pulled, along at least some of the time.

Exercises to strengthen muscles surrounding the thoracic outlet may be helpful. (Pictures 6 and 7).

Neck erector exercises may be performed in standing, sitting, and backlying positions. In this example, the patient stands with back to the wall and feet six inches from the wall. The hands are placed behind the head and the head and shoulders pressed against the wall. This position is held for 5 to 10 seconds, and repeated five times at each session at least twice daily.
Shoulder shrugs are performed in a standing or sitting position with arms at each side and elbows straight. A two to five pound weight is held in each hand. The shoulders are pulled slowly toward the ears and backward. This position is held for five to ten seconds, relaxing completely between each shrug. This is repeated five times per session. The exercise can be done with both shoulders at once, or one at a time.

In most cases these measures provide benefit within 6 weeks [6,7,9,10]. No randomized controlled studies of conservative management have been published [11].

Surgery is considered when color change or swelling suggests circulatory system impingement or clots; when there are signs of muscle wasting or other features of more serious nerve flow obstruction; or if pain is unrelenting. Fewer than 5% of patients require surgical treatment [12]. The following checklist should be reviewed before considering surgery:

- Has carpal tunnel syndrome or a cervical disk problem been excluded?
- Has a nerve entrapment of the elbow region been ruled out?
- Has tumor been ruled out by use of chest x-ray or CT?
- Did the patient comply with avoiding aggravating factors?
- Were exercises performed; was a physical therapist involved?

 References

How is thoracic outlet syndrome treated?

The first step to beginning any treatment begins with a trip to the doctor. Make a list of all of the symptoms which seem to be present even if the sensations are vague. Make a note of what activities and positions produce or alleviate the symptoms and the time of day when symptoms are worst. Also, note when the symptoms first appeared. This list is important and should also include any questions one may have.

Due to overlapping in terms of symptoms it is difficult to make a definitive diagnosis; this is why a list is so important. Certain diagnostic tests have been designed which are very useful for examination. These tests involve maneuvers of the arms and head and can help the practitioner by providing information as to the cause of the symptoms and help in designing an approach to treatment. These tests, accompanied by a thorough history help in ruling out other causes which may produce similar symptoms. These include Pancoast tumor, neurofibromas, cervical spondylosis, cervical disk herniation, carpal tunnel syndrome and cubital tunnel syndrome. Don't forget to ask your practitioner about these conditions as well.

Here are a few more commonly applied provocation tests used in the diagnosis of thoracic outlet syndrome. These tests may or may not momentarily reproduce symptoms but as was mentioned earlier are important in ruling out other causes which may produce similar symptoms.
EAST Test or "Hands-up" Test
The patient brings their arms up as shown with elbows slightly behind the head. The patient then opens and closes their hands slowly for 3 minutes. A positive test is indicated by pain, heaviness or profound arm weakness or numbness and tingling of the hand.

Adson or Scalene Maneuver
The examiner locates the radial pulse. The patient rotates their head toward the tested arm and lets the head tilt backwards (extends the neck) while the examiner extends the arm. A positive test is indicated by a disappearance of the pulse.

Costoclavicular Maneuver
The examiner locates the radial pulse and draws the patient's shoulder down and back as the patient lifts their chest in an exaggerated "at attention" posture. A positive test is indicated by an absence of a pulse. This test is particularly effective in patients who complain of symptoms while wearing a back-pack or a heavy jacket.
Allen Test
The examiner flexes the patient's elbow to 90 degrees while the shoulder is extended horizontally and rotated laterally. The patient is asked to turn their head away from the tested arm. The radial pulse is palpated and if it disappears as the patient's head is rotated the test is considered positive.

Provocative Elevation Test
This test is used on patients who already present with symptoms. The patient sits and the examiner grasps the patient's arms as shown. The patient is passive as the shoulders are elevated forward and into full elevation. The position is held for 30 seconds or more. This activity is evidenced by increased pulse, skin color change (more pink) and increased hand temperature. Neurological signs go from numbness to pins and needles or tingling as well as some pain as blood flow to the nerve returns. Similar to what is felt after an arm "falls asleep" and circulation returns.