

## THORACIC OUTLET SYNDROME

### The Problem

The term “thoracic outlet syndrome” is used to describe a condition of compression of the nerves and/or blood vessels in the region around the neck and collarbone, called the thoracic outlet.

Thoracic outlet syndrome is very controversial in the medical literature. The diagnosis and treatment of patients with thoracic outlet syndrome has been variable, particularly in patients who have complaints of tingling, numbness and pain in the arm and hand. More recently it has been recognized that patients with thoracic outlet syndrome can be divided into patients with compression of the blood vessels (subclavian vein and artery) and patients with nerve compression (brachial plexus). Symptoms that are related to nerve compression are more common than symptoms related to compression of the blood vessels. However, most of the controversy involves patients with compression of the brachial plexus.

### Symptoms

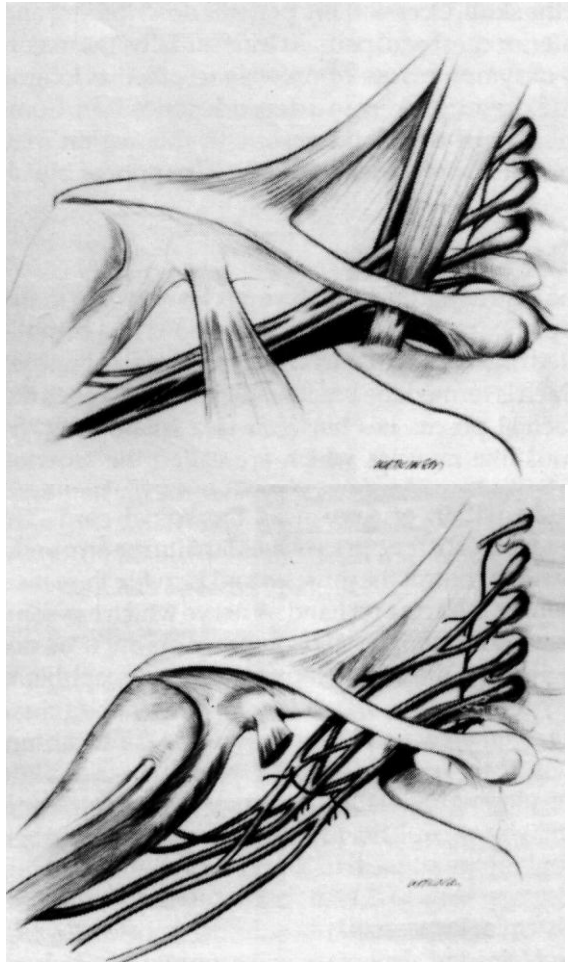
Patients with thoracic outlet syndrome (compression of the brachial plexus) usually complain of a “pins and needles” feeling and/or numbness in the arm, forearm or hand. Many patients also have complaints of pain and aching in the shoulder neck or shoulder blade region. These symptoms are usually made worse with activities that require the arms positioned overhead. For women, some common activities include applying makeup or doing their hair. Patients may describe headaches at the back of the head or around the eyes. Occasionally, patients may describe face and chest pain but these types of complaints are less common. Pressure on the blood vessels in the region of the thoracic outlet may cause the hand to

feel cooler, swollen or the hand may appear white or blue in color. In the beginning, the symptoms may only occur with the arms in an overhead position and go away with the arms down by the side. As the time of compression goes on, the symptoms will often occur more often and with less time in irritating positions.

### Anatomy

The nerves, that leave the spinal cord at the neck and connect into nerve roots and bundles forming the brachial plexus, go to the muscles of the arm and hand and give feeling to the skin in the arm and hand. The five nerve roots at the neck (C-5, C-6, C-7, C-8 and T-1) leave the spinal cord and form the upper, middle and lower trunks of the brachial plexus. These trunks then divide and form the medial, lateral, and posterior cords. Finally these further divide into branches called the median, radial and ulnar nerves. In the neck region, the brachial plexus lies between two muscles called the anterior and middle scalene muscles and the first rib. The scalene muscles go from fifth, sixth, and seventh cervical vertebrae at the side of the neck and attach to the first rib. If the scalenes muscles get short and tight, they can put pressure on the brachial plexus in the region of the neck between the anterior and middle scalene muscles and the first rib. The C-8 and T-1 nerve roots form the lower trunk of the brachial plexus and the lower trunk lies on the first rib. When the scalene muscles get tight and pull up on the first rib, the lower trunk is more likely to be compressed. This area is often called the “thoracic outlet” however the correct anatomical name for this area is actually the “thoracic inlet”. Pressure on the brachial plexus in the thoracic inlet area and also pressure from the pectoralis minor muscle in

front of the shoulder can cause the symptoms related to thoracic outlet syndrome.



Some people are born with an extra rib and it is called a cervical rib. The cervical rib may be connected to the first rib with bone or fibrous tissue. The cervical rib can also place increased pressure on the nerves of the brachial plexus because of the small, tight space where it is located. Other soft tissue bands, ligaments and small muscles that you may have been born with can put more pressure on the nerves of the brachial plexus. It is important to know that not all patients with thoracic outlet syndrome have cervical ribs and not all patients with cervical ribs have thoracic outlet syndrome.

### **How Does it Happen**

The cause of thoracic outlet syndrome is

thought to be a combination of factors and the exact cause remains uncertain. Nerve compression in other parts of the body like the carpal tunnel syndrome is better understood. This information about nerve compression can be related to pressure on the brachial plexus in the thoracic outlet.

There are areas in the extremities where the nerves can be “pinched” and other places where the nerve is not under any risk of pressure. In general, when nerves cross a joint, they are more susceptible to compression or stretching. In some places in the arm there are tight spaces made by bones, ligaments or muscles and if the nerve travels through one of these “tunnels”, then the nerve may be more at risk to pressure. For example with carpal tunnel syndrome, there is more pressure on the median nerve when the wrist is bent or extended than when the wrist is in a straight position. Increased pressure in the carpal canal can put increased pressure on the median nerve causing tingling and numbness to the thumb, index and middle finger. Another example, of nerve compression, is at the elbow with pressure on the ulnar nerve. The ulnar nerve runs behind the elbow and that area is called the cubital tunnel. When the elbow is bent, there is increased pressure and tension on the nerve. If the position is held for a long period of time, there will be a tingling or numbing feeling to the small and ring fingers. With thoracic outlet syndrome, it appears that arm overhead positions and downward pulling (like carrying a heavy bag) increases pressure on the brachial plexus. Symptoms of nerve compression take many months and likely years to progress and worsen. It is easy to hold your elbow or wrist bent for a long time (especially at night) and therefore symptoms caused by carpal tunnel or cubital tunnel syndrome are more likely to progress more quickly. Because pressure on the brachial plexus is irritated with arm overhead positions and these positions often cause significant discomfort; the progression of nerve compression will be much slower because you will be uncomfortable in these provocative positions and quickly learn to avoid them. This protective habit may however limit your range of movement and make certain muscles very tight.

The onset of thoracic outlet syndrome is

usually the result of many factors. Some patients may recall an accident that occurred before their symptoms started while other people may not remember a particular incident when their symptoms started. Patients with an extra cervical rib, tight soft tissue bands or other usual anatomy that could press on the brachial plexus are more likely to develop symptoms. In these patients, it will take less pressure and strain to develop symptoms from pressure on the brachial plexus. People who are overweight or women with large breasts will have extra pressure placed on the nerves and muscles in the thoracic outlet region due to the extra weight pressing down on the brachial plexus and are also more likely to have poor posture with associated muscle imbalance.

The symptoms related to thoracic outlet syndrome are likely coming from nerve compression (pressure on the brachial plexus) and from irritation of the muscles in the neck and shoulder region. Many people spend a lot of time in bad postures like head forward and round shoulder positions. This will cause some muscles to be placed in shortened positions and over time they will get tighter. Other muscles may be placed in long positions and this will cause these muscles to be weaker. The shorter muscles can become painful and if they are stretched too far can produce more pain in the neck and shoulder region. Because some muscles are weaker, other muscles will have to do more work to compensate for the weaker muscles and they may become more painful from overuse. Therefore the symptoms in the neck and shoulder region may be more related to the muscle imbalance in this region and the tingling and numbness in the hand may be more related to the pressure on the brachial plexus.

Certain activities that require long periods of time with arms overhead may cause symptoms of tingling and numbness to the arms within a very short period of time. Arm positions that are a little lower (like driving a car) may also cause symptoms but it will take a longer period of time to develop the symptoms. A strain to the muscles around the neck or shoulder blade can cause the muscles to tighten and go into spasm. If the pectoralis minor and/or scalene muscles are irritated, then more pressure may be placed on the brachial plexus. In

general, the cause of thoracic outlet syndrome is thought to be the result of a number of factors, including activities at home and work, sleep postures, trauma, anatomy and other diseases.

### **Double Crush Syndrome**

Patients with thoracic outlet syndrome usually have symptoms of tingling and numbness in the hand. These types of hand symptoms are similar to the symptoms that patients with carpal and cubital tunnel syndrome describe. The “double crush” mechanism may play a role in the development of symptoms in patients with thoracic outlet syndrome. The nerve fiber begins in or near the spinal cord and then goes all the way to the hand to give sensation and movement to the arm and hand. If the nerve is pinched at one place, then it is less likely to tolerate any more pressure along the nerve. Therefore other tight places like at the wrist (carpal tunnel) or elbow (cubital tunnel) are more likely to produce symptoms with very little added pressure. The idea of the “double or multiple crush” is that patients with nerve compression at one site are more likely to develop nerve compression at another site. There are some diseases that can be the first “crush”; for example patients with diabetes, hypothyroidism, rheumatoid arthritis or alcoholism are more susceptible to developing symptoms from nerve compression. Some people have a hereditary susceptibility to develop nerve compression.

### **Evaluation**

A complete history and physical examination is necessary to identify all sites of nerve compression or other musculoskeletal problems that may be causing your symptoms. Nerve conduction studies assessing thoracic outlet and the brachial plexus are usually normal. These studies however are useful in identifying an associated carpal and cubital tunnel syndrome. An X-ray of the neck and chest may be done to identify a cervical rib or other problems in the neck that are not related to thoracic outlet syndrome, that may be causing your symptoms. If your symptoms are related more specifically to your cervical spine or shoulder joint then a consultation by another specialist may be indicated. If you have

a shoulder problem, it will be difficult for you to get your brachial plexus nerves to glide or your muscles to stretch out until the shoulder problem is solved. Studies to assess the blood vessels in your neck and hand may be necessary in some patients.

Patients with thoracic outlet syndrome usually have very few complaints when their arms are at rest. Therefore some testing with your arms in an elevated position may be necessary to provoke your symptoms. Because pain is often a significant part of the symptoms related to thoracic outlet syndrome, this pain may have an effect on your overall function. You may also be asked to have a psychological test to see how much the pain has affected your life.

### **Non-operative Management**

In the vast majority of patients, non-operative treatment is successful in relieving the symptoms related to thoracic outlet syndrome. This should begin by modifying your activities to decrease the time that you spend in positions that are irritating your symptoms (usually arm overhead positions). Physical therapy is recommended to instruct you in exercises to initially stretch soft tissues that are too tight and then to strengthen weak muscles. Physical therapy programs with stretching and strengthening that is too aggressive will likely flare your symptoms and make you worse. Patients with thoracic outlet syndrome are often very comfortable in head forward and round shoulder positions. This type of posture can lead to brachial plexus nerve compression and muscle imbalance in the neck and shoulder blade region.

Physical therapy exercises will first begin to stretch the muscles and nerves in the neck and shoulder region. If the physical therapy is not specific and if the exercises that you do are too forceful, you may increase the discomfort in the neck, shoulder and arm. Exercises should begin at a level that is just enough to stretch the muscles and nerves but not too strong to irritate your symptoms. Once you have regained good range of motion and control of your symptoms, then you can begin strengthening exercises. These exercises will be specific to muscles that are weak in your neck and shoulder blade region. It is important for you to do these exercises throughout the day to

control your symptoms. In addition, changes in your posture at home, work and during sleep to a more upright position (avoiding head forward, round shoulder and arm overhead positions) will help to decrease your symptoms.

A soft neck roll may help to support your neck at night to help rest the muscles in this area. Rolled composite padding inserted into 2 inch stockinette makes a very comfortable neck roll (1 or 2 rolls can be used). If you have carpal tunnel syndrome or cubital tunnel syndrome, you may be given a wrist splint or elbow pad to wear at night. You should try to sleep with your arms down by your side as much as possible.

These exercises and postural changes will not give you immediate relief. It usually takes several weeks before you stretch out the muscles and relieve pressure on the nerves and feel relief of your symptoms. However, to have total relief of your symptoms, you may need to do the exercises for many months and incorporate them into your daily regime indefinitely.

Symptoms thought to be from “thoracic outlet syndrome” may include some symptoms from other problems (like carpal tunnel syndrome, cubital tunnel syndrome, cervical disc disease, rotator cuff tendinitis, large breasts). If conservative management does not get rid of your symptoms, then surgery to address the other problems may be suggested before surgery for thoracic outlet syndrome.

### **Surgical Management**

Surgery for thoracic outlet syndrome is very controversial and it has been associated with many complications. Therefore if at all possible, surgery should be avoided. However in some cases, non-operative treatment including physical therapy, job change, activity modification, will not relieve your symptoms and surgery to release the structures in the thoracic outlet will be discussed. Surgical management may involve release of the scalene muscles and/or removal of the first rib. This operation is frequently done with a supraclavicular incision (above the collarbone). Your surgeon may however recommend a surgical approach through the armpit. In general, the results with either approach for a first rib resection

or release of the scalene muscles alone give the same long term results.

After surgery you will have only a small dressing over your incision. A drain may be placed in the incision to reduce the amount of blood that may collect around the surgical site. If a drain is used, it will be removed within 2 to 3 days. The stitches used are usually absorbable and then steri strips are also used. If non-dissolving stitches are used they will be removed 7-10 days after surgery. In the early the post-operative period, a soft neck roll may be used at night to support your neck and to provide a more restful sleep. Even on the first day after surgery, you will begin range of motion exercises to the neck and arm. It is important to regain movement in this area so that you do not become more stiff and tight with scar. Desensitization of the incision may require light massage of the incision. Physical therapy, if needed, may begin several weeks after your surgery for strengthening exercises.

## **Complications**

One of the reasons that surgical management of thoracic outlet syndrome is controversial is because of the complications that have been reported following surgery. The most significant complication is injury to the major blood vessels or nerves in the region of the brachial plexus. *It is important to stress that there is a risk of complications with this surgery.*

The brachial plexus (C-8, T-1) is located on either side of the first rib and therefore these nerves are very vulnerable to injury with excision of the rib. The C-8/T-1 nerve roots provide motor and sensory function to the hand and arm. Therefore injury to these nerve roots can affect the muscle function in the hand and sensation to the medial border of the forearm and to the ring and small finger. The stellate ganglion is a nerve bundle also located near the C-8/T-1 nerve root. Injury to the stellate ganglion may cause a Horner's syndrome (droopy eyelid and uneven pupil size). The long thoracic nerve is located by the middle scalene muscle and therefore is at risk during retraction of the nerve or surgical injury in its location. Injury to this nerve will cause "winging" of the shoulder blade. The phrenic

nerve that innervates the diaphragm is located on the anterior scalene muscle. Injury to this nerve will affect the movement of your diaphragm and may cause shortness of breath. Sensory nerves in the area of the incision can be injured or irritated causing decreased sensation or hypersensitivity in the region around the collarbone.

There are other complications related to bleeding and fluid collection and if these occur they may require drainage. Blood, fluid or air may collect around the lung and cause temporary breathing problems and may require a chest tube for drainage. *Even when great care is taken during this surgery, these known and recognized complications can occur with this surgery.*

## **Recovery After Surgery**

After surgery, it is anticipated that patients will notice an improvement of their arm symptoms. Many of the symptoms to the neck and shoulder region are related the muscle imbalance in the neck and shoulder region. The solution to relieving these symptoms is to correct the problem of muscle imbalance. Therefore further physical therapy and exercises are necessary to build up the strength in the shoulder blade muscles (middle and lower trapezius and serratus anterior). Although many symptoms may be relieved, it may still be necessary to modify your activities, like avoiding overhead arm positions. The results of surgery are not guaranteed, although in our experience about 75 percent of patients achieve a good to excellent result and 25 percent reporting fair or poor relief of symptoms.

## **Conclusion**

Thoracic outlet syndrome involves compression of the brachial plexus and/or subclavian vein and artery and involves muscle imbalance in the neck and shoulder region. In the majority of patients, this problem is best treated without surgery with modification of activities (home, work, sleep postures) and specific exercises. Surgery for thoracic outlet syndrome carries significant risks and potential complications. This surgery should only be performed on the rare patient who has not been able to control their symptoms despite compliance

to a correct program of exercises and behavior  
modification at home, work and sleep.

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