5

Chapter Five
Thoracic Outlet Syndrome

"I cannot control my shoulder. I cannot hold my right arm over my head. My fingers now go numb, and my shoulder aches."

Winging It

Bruce (not his real name) is a strong man, with serious, piercing eyes. He is tall and handsome. Bruce has been working as a lineman for the telephone company for ten years. He likes to climb telephone poles and fix the overhead wires. Today, as he speaks to me, he is intense, and frustrated.

"Doctor Dellon", Bruce explains, "that is exactly my problem. I cannot control my shoulder. I cannot hold my right arm over my head. My fingers now go numb, and my shoulder aches. The last doctor looked at my back and told me that my shoulder blade was sticking out. He said I have a 'winged scapula' and that I am becoming paralyzed! Can you help me?"

"Yes Bruce, I can help you," I said. "Tell me how this began. Did you injure yourself somehow?"

"Yes, Doctor Dellon, I did. I was pulling broken tree branches away from a telephone pole after a storm, trying to restore power. I was dragging the tree limb behind me, when I felt a sudden tearing pain in the right side of my neck and pain went into my shoulder. I dropped the large tree branch, and the pain slowly went away. But I could not use my arm properly. I went right in to the company doctor that day. He took x-rays and examined my arm, but found nothing wrong. The next day I went back to work. I could work, but the aching in my shoulder and problems with the use of my right arm have never gone away. And they have gotten worse."

"How long ago was that injury," I asked.

"More than two years ago. For the past year I can only work in doors. I cannot do my regular job. I have had lots of therapy. The Orthopedic Surgeon says my rotator cuff is fine and so are the discs in my neck. They did all those special MRI x-rays. When the last doctor found my shoulder blade sticking out, he sent me for one of those EMG tests, where they stick you with needles. You have the report. It shows my muscle is dying, the one that controls my shoulder blade. Can you help me?"

"Yes Bruce," I reassured him, "this is a very unusual problem, but I can fix it for you. It is called, as you have said, a winged scapula. The shoulder blade sticks out because the nerve to the muscle that controls the shoulder blade

had been injured. That nerve is part of the brachial plexus, a collection of nerves that controls all upper extremity movement, including the shoulder. You have brachial plexus compression, but before I discus this with you further, Let me show you a picture in the anatomy book to explain this complex area better to you." (See Figures 5-1 and 5-2.)

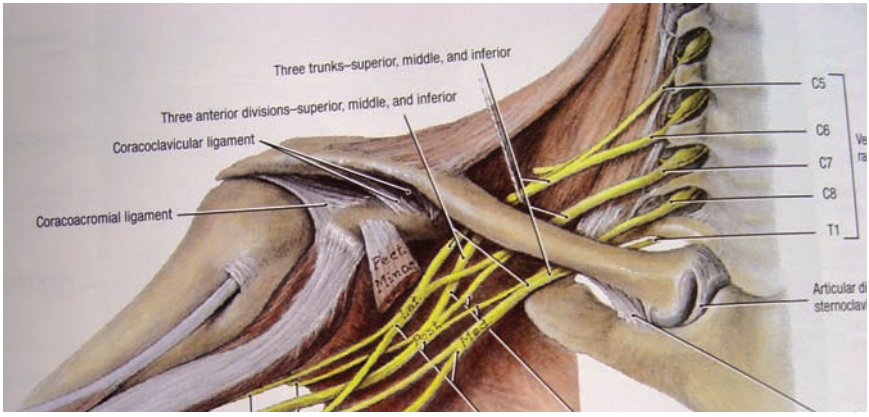

Figure 5-1. Traditional anatomy drawing of the right brachial plexus. The five cervical nerve roots (C5,C6,C7,C8, and T1, shown in yellow) are depicted without a muscle covering and the long thoracic nerve, responsible for winging of the scapula is not shown.

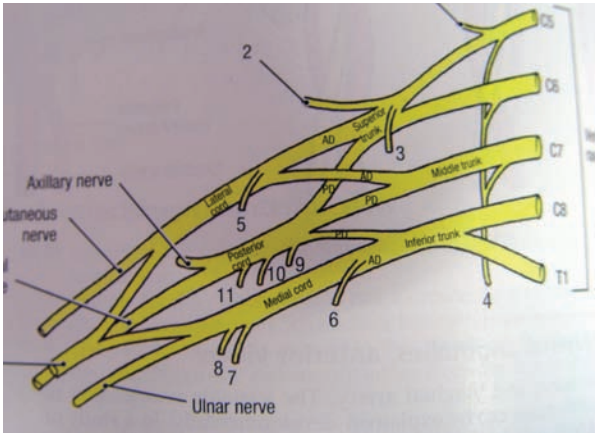

Figure 5-2. Traditional schematic of the brachial plexus which shows the nerves intertwining without showing the muscles or bones. This schematic shows the long thoracic nerve as nerve number 4, going downwards and into the region of the chest cavity, which is NOT where this nerve actually goes.

I explained that in many forms of injury, the small muscles that help in turning the head and protruding the chin, such as when you are working at the computer or after a "whiplash" injury from a car accident, become trapped by the scarring or spasm of these muscles. As can be seen in Figures 5-1 and 5-2, this small region contains all the nerves to the neck, shoulder, part of the chest, and the entire arm. Therefore the symptoms that a patient can have range from just the winging of the scapula to numbness and weakness of the entire arm, chest or breast pain, neck pain, and headaches that are in the back of the head on the same side as the shoulder pain. The symptoms are all made worse when the arm is held in the air, over the head.

This entire collection of symptoms can be so vague as to make the doctor think that there cannot be a single cause for it. Unfortunately, the degree of compression is often mild enough that the traditional evaluation

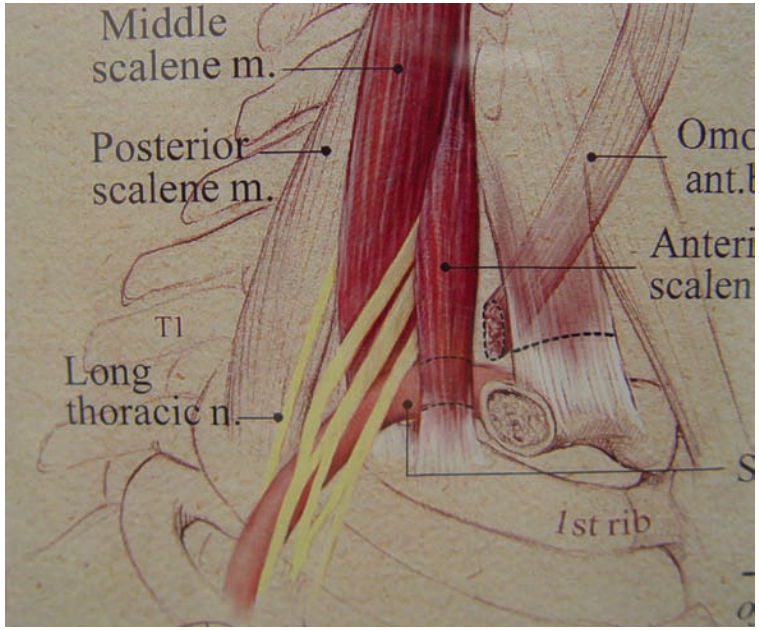

Figure 5-3. Illustration that depicts the true location of the long thoracic nerve exiting either beneath or between the scalene muscles. In this location, the nerve can become stuck by a torn, injured muscle. In this location the nerve can be identified and reconstructed. (With permission http://www.dellon.com)

by the neurologist and orthopedic surgeon do not find anything wrong. Because this symptom complex occurs frequently in the setting of a car accident or workmen's compensation, the patient often is not believed, and thought to be malingering.

About 50 years ago, this symptom complex was called "Scalenus Anticus Syndrome," and when doctors thought of this diagnosis, they understood that this muscle, the anterior scalene, needed to be removed.

In Figure 5-3, you can see the long thoracic nerve, and you can see how spasm and scarring of the anterior scalene muscle can compress this group of large important nerves to create all of these symptoms. In 1956, a Physical Therapist from the Mayo Clinic devised exercises to stretch this tight muscle, and strengthen other shoulder muscles like the trapezius and rhomboids, so pressure is lifted from the compressed nerves. In 1956 the name Thoracic Outlet Syndrome was created for this syndrome. While this is a "nice name" it is anatomically incorrect (the thoracic outlet is the diaphragm and this region is properly called the thoracic inlet) and this name thoracic outlet syndrome diverted doctors' attention away from the scalene muscles.

The good news is that 90% of patients will have their symptoms improve with 6 months of therapy described above. If the symptoms do not go away, then surgery can be done to remove the pressure from the brachial plexus.

I believe the correct name for this symptom complex should be "Compression of the Brachial Plexus in the Thoracic Inlet," and while that is a lot of words for a name, it describes the pathology so that a proper operation can be designed to decompress the nerves. I created this name in 1993.* Many doctors believe you should remove the first rib through the armpit (axilla) to correct this problem, but in my experience, the rib does not need to be removed. My approach is located just above the collar bone.

*Dellon AL: "Brachial plexus compression" (not "thoracic outlet syndrome"): Treatment by supraclavicular plexus neurolysis. J Reconstr Microsurg 9:11-18, 1993.

Removing the first rib through the armpit has many complications associated with it such as collapse of the lung, injury to the major artery and vein to the arm, and injury to the nerves to the skin of the armpit, creating more pain whenever the arm is elevated. Figure 5-4 shows an example of this complication. Furthermore, often a small piece of rib is left that still causes compression, and the scalene muscle is still stuck to the nerves.

Figure 5-4. This man is two years after having his "thoracic outlet" (really his thoracic inlet) decompressed by removing his first rib through his armpit. This surgery failed to help him, and left him with the area under his arm and on his chest that is painful to touch (shown in blue dots); a neuroma of the second intercosto-brachial nerve. I can still help him by removing this damaged nerve, and then operating along the blue line near his collar bone to remove his anterior scalene muscle and decompress his brachial plexus.

The surgical approach that I favor requires an incision in the neck near the collar bone. The surgery is done under general anesthesia. Because my surgery is done with microsurgical technique, and because the rib is left in place, I have excellent control over the nerves, blood vessels, and lungs. This surgery is successful in 80% of patients, relieving pain and permitting them to use the hand and arm in the overhead position again, as is demonstrated in Figure 5-5.

Figure 5-5. Top: Woman who is one year after my supraclavicular brachial plexus neurolysis. She is smiling as her symptoms are relieved, and demonstrates holding her hands overhead. Bottom: Note appearance of the scar at one year.

"Thank you Dr. Dellon for explaining that to me." It is very complicated. But do you have any pictures you can show to me of someone with my degree of muscle paralysis who is better?"

"Bruce," I replied, "yes, I do. And there is hope for you too." (See Figure 5-6.)

Figure 5-6. A young woman injured left shoulder while being twirled by her dancing partner 6 months ago. The winging of the right scapula is present (top) even without trying to lift her right arm. She can elevate her right arm (bottom) in the recovery room following the surgical procedure.

I described the entrapment for the long thoracic nerve in the year 1999, and reported my first five cases of successful surgery with two of our Johns Hopkins Plastic Surgery residents in 2001.*

"I am ready for the surgery Doctor Dellon," said Bruce. "Are there any more tests you need to do for me?" (See Figure 5-7.)

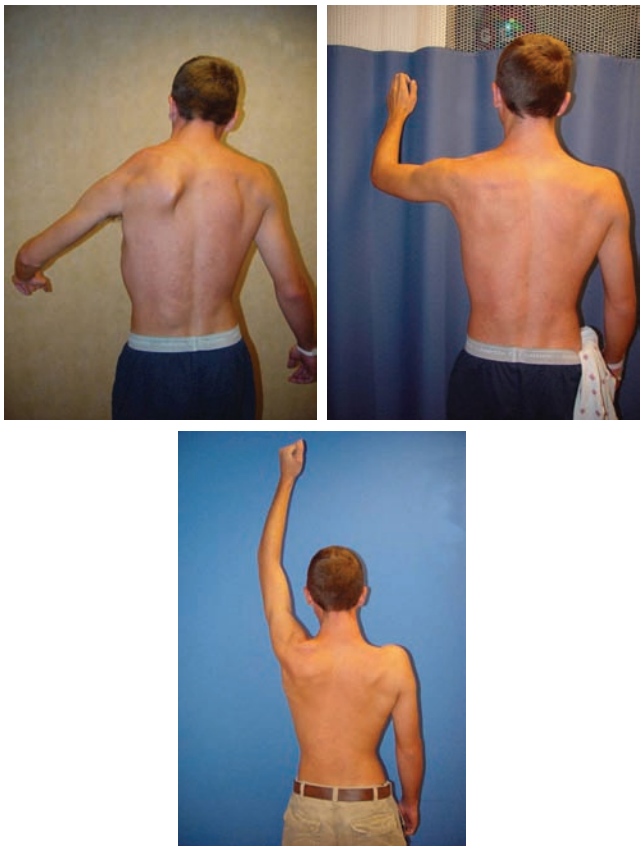

Figure 5-7. Top Left: The young man, injured wrestling 6 months before, was unable to lift his right arm higher than shown. The "chicken bone" or winged scapula is clearly seen protruding from his back. Top Right: He is shown still in the hospital the day after surgery. He can now lift his arm higher and already the serratus anterior muscle is pulling the scapula back against the rib cage, correcting the winging. Bottom: Three weeks after surgery.

*Disa J, Wang B, Dellon AL: Correction of scapular winging by neurolysis of the long thoracic nerve. J Reconstructive Microsurgery, 17: 79-84, 2001.

"Bruce, not for you. Most people with symptoms of 'thoracic outlet syndrome' do not have winging. They have a lot of complaints in their hands. For those people I do a neurosensory test with the Pressure-Specified Sensory Device™, which documents abnormal sensory nerve function when the hand is at rest, and then after the hand has been held elevated for 3 minutes. This type of testing puts additional compression on the brachial plexus, and helps us determine whether the patient will benefit from more therapy, whether they need a neurolysis of their brachial plexus (an anterior scalenectomy), or whether they have some other problem with their arm like compression of the ulnar nerve at the elbow, called 'cubital tunnel syndrome' This is compression of the ulnar nerve at the site where you strike your 'funny bone and feel it shoot into your little finger." (See Figure 5-8.)

Figure 5-8. Entrapment of peripheral nerves, like the median nerve at the wrist(left), causing carpal tunnel syndrome, or ulnar nerve entrapment at the elbow (right), causing cubital tunnel syndrome, demonstrated here, can refer symptoms to the neck and shoulder and give symptoms similar to those of brachial plexus compression. If these peripheral nerve are compressed, they should be treated surgically first, as the more proximal neck and shoulder symptoms may also go away. Compression of the ulnar nerve at the elbow can give symptoms of coldness in the hand, but so can compression of the main artery to the arm (see Figure 5-3). If vascular compression is present, it should be decompressed before decompressing the peripheral nerves (see Figure 5-9).

More typical are the complaints of Leslie (not her real name), a 40 year old waitress. "Doctor Dellon", said Leslie, "I can no longer carry trays with my right hand. Not only do all my fingers go numb, but the side of jaw hurts and I have horrible headaches. My dentist told me I have 'TMJ' but my teeth are lined up well. This is getting worse and worse. I now even have trouble just trying to dry my hair. Can you help me?"

"Yes Leslie, I can help you," I said. "In many people, an injury has not occurred. Instead, you most likely were born with either extra muscles that press upon your nerves, or the complicated pattern of the brachial plexus (see Figure 5-1 and 5-2) did not form normally. The muscles pull on the back of your head, where they arise from the first few cervical vertebra, and this causes those headaches. Nerves to the skin at the side of your face come through these muscles too, get compressed, and give facial pain, that is often said to be due to the temporomandibular joint (TMJ). The operation that I do, removal of the extra muscles and the anterior scalene muscle, and removal of scar tissue from the nerves, neurolysis of the brachial plexus, can relieve your symptoms," I said.*

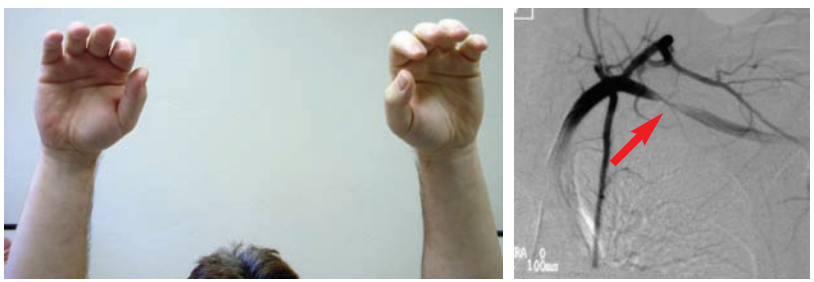

Figure 5-9. Left: Note the left hand is white when elevated compared to the right hand which is more pink. Right: Note the black dye coming from the heart is blocked (arrow) as it tries to flow into the subclavian artery to the right arm while the arm is elevated. This documents vascular compression which can be present in addition to compression of the nerves of the brachial plexus.

*Howard M, Lee C, Dellon AL: Documentation of Brachial Plexus Compression in the thoracic inlet utilizing provocation with Neurosensory and Motor Testing. J Reconstr Microsurg, 19:303-312, 2003.

"You need to have painless neurosensory testing to document the brachial plexus compression" (see Figure 5-10A).

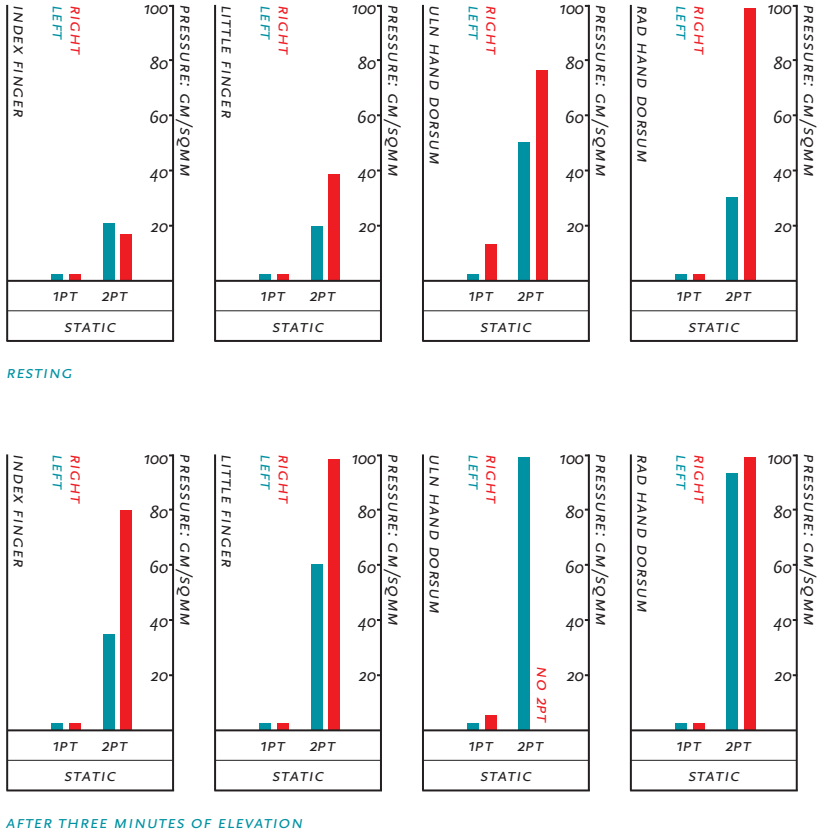

Figure 5-10A. Neurosensory with the Pressure-Specified Sensory Device™ done on Leslie prior to surgery. The red bars are the right hand and the blue bars are the left hand. **Higher numbers mean the nerve is not normal.** In the top row, the measurements are taken when the hand is at rest. On the bottom row, the measurements are repeated after the hand has been held up in the air for 3 minutes. Note that on the bottom row, all red bars have gotten higher, and one red bar has disappeared. This documents severe compression of the right brachial plexus, and supports the recommendation for brachial plexus decompression. Note that even the blue bars in the bottom row have become elevated, demonstrating that this waitress is now beginning to have this problem in her left hand too.

Leslie's post-operative neurosensory testing results are shown below (see Figure 5-10B).

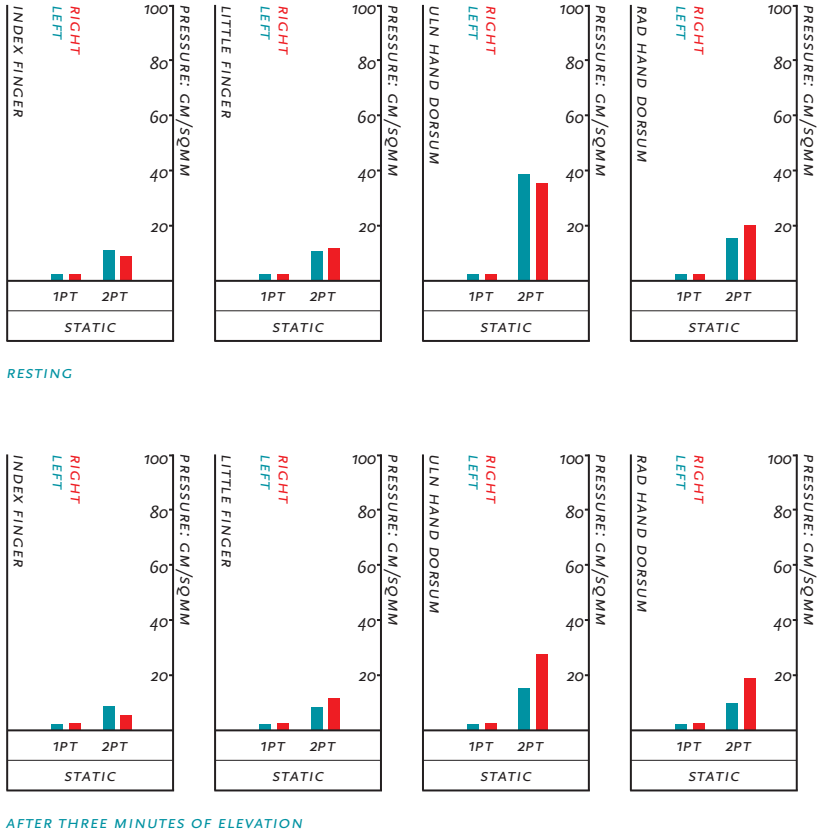

Figure 5-10B. The neurosensory testing results after decompressing Leslie's right brachial plexus and removing her anterior scalene muscle, and allowing her left side to rest during the three weeks she was off work. Note that even at rest, both the blue and red **bars are lower than they were before surgery.** Note that on the bottom row, that now, even with her hand elevated, the blue and red bars no longer increase in height. This documents that pressure has been relieved from the brachial plexus. Her symptoms also were relieved.

After operating on Leslie, I drew a picture of what I found for her parents, who accompanied her to surgery (see Figure 5-11).

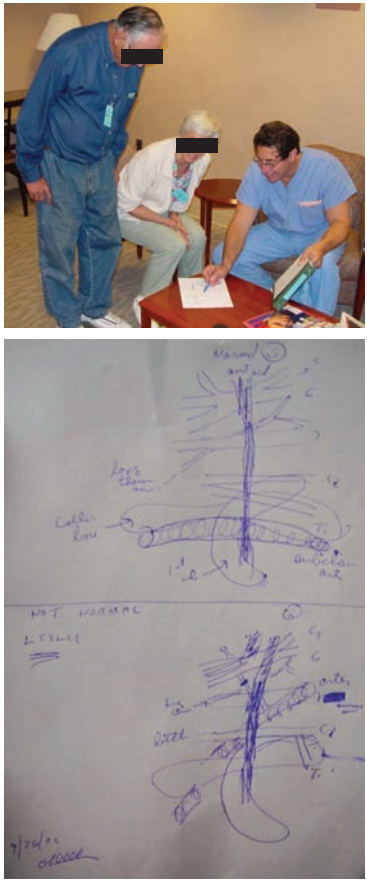

Figure 5-11. Top: After Leslie's operation, Doctor Dellon went out to talk to her parents. Here he is explaining the intra-operative findings to the Leslie's parents. Bottom: Below, is a close-up view of the drawing which shows the normal and the Leslie's anatomical findings. The dark blue is the anterior scalene muscle which was removed. The compressed long thoracic nerve is saved and is shown. The tubular structure is the subclavian artery, which in Leslie was located above the clavicle. The curved structure is the first rib below the clavicle. *The first rib was NOT removed.*

An example of the actual surgery is shown in Figure 5-12.

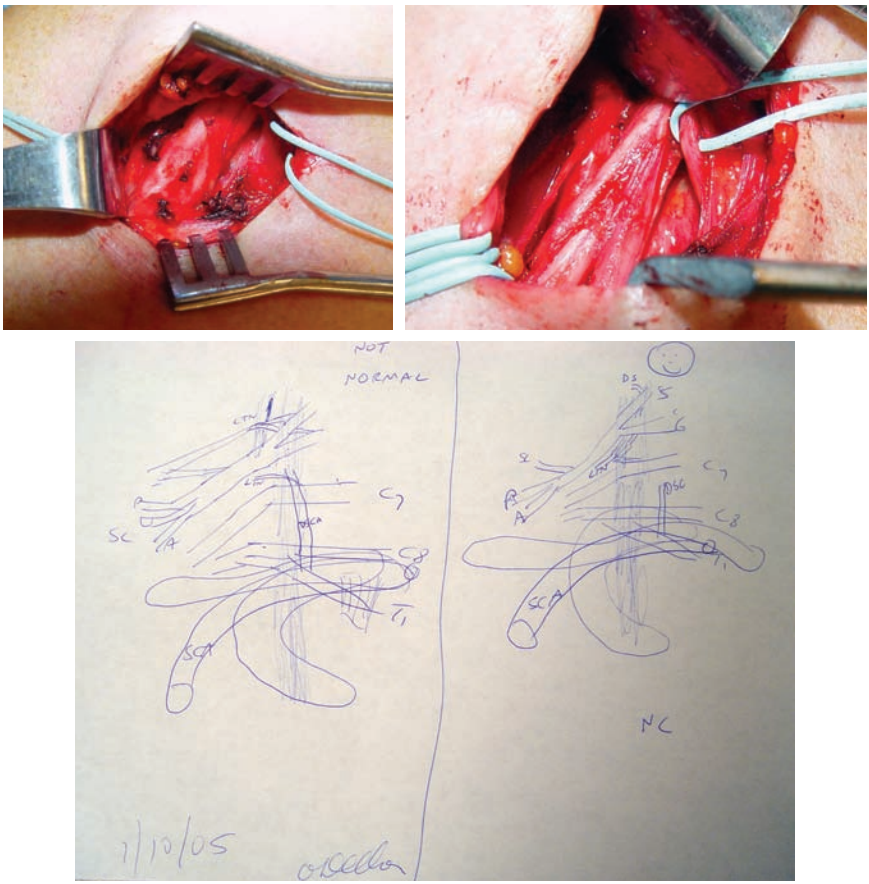

Figure 5-12. Intra-operative photographs of the brachial plexus, with (top left) demonstrating the right scarred upper trunk and suprascapular nerve, which is the source of the shoulder pain and some of the shoulder weakness, and numbness in the thumb and index fingers. The neurolysis of these nerves (top right) has been completed, and the long thoracic nerve has been identified just above and behind this upper trunk. This is the nerve responsible for the scapular winging. The abnormal findings in this patient (bottom), on the left side of the drawing, are contrasted to the normal anatomy on the right. The circular subclavian artery is located in the normal relationship to the clavicle and the curved first rib. The long thoracic nerve (LTN) is drawn in at the top, and may be seen in this location (center) above.

There are those patients who are born with an extra "first rib" , which is called a cervical rib, demonstrated in Figure 5-13.

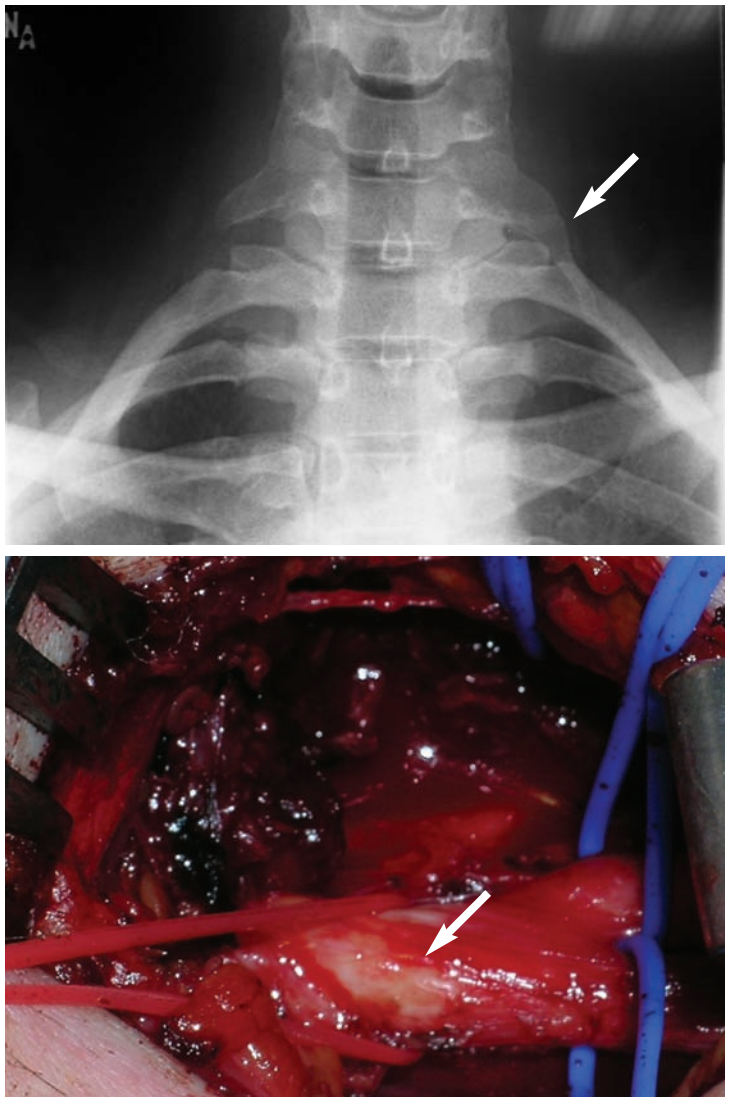

Figure 5-13. The x-ray (top) demonstrates a cervical rib, an extra rib, on the left side. This can cause compression of the brachial plexus and give thoracic outlet symptoms. In this case, that extra rib must be removed. This is shown in surgery (bottom).

Pain Solutions Summary

Five nerves that exit the spine in the neck region combine to form the brachial plexus, the source of all sensory and motor function for the shoulder and hand. If the muscles or other structures in this small region, called the thoracic inlet, become injured, or compressed, the function of the shoulder and hand and the blood vessels that supply them will be changed. This can cause face, neck, shoulder, chest and hand numbness, weakness, and pain, and coldness or swelling in the hand. If the shoulder muscles that hold the scapula to the ribs become weak, this bone sticks out in the back; this is called "winging". Headaches are common.

Most people with these symptoms can be helped by therapy that stretches the tight neck muscle, called the anterior scalene, and strengthens the trapezius and rhomboids that support the shoulder and take pressure away from the brachial plexus. If symptoms persist after 6 months of dedicated therapy, then surgical decompression of the brachial plexus is indicated. My approach for this surgery is through the area just above the collar bone. I remove the tight anterior scalene muscle. I leave the first rib. The relief of upper extremity symptoms and headaches can be dramatic.

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