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Bilateral Radial Nerve Compression Syndrome in an Elite Swimmer

A Case Report

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Bilateral compression syndrome of the radial nerve at the lateral head of the triceps muscle is rare in athletes without trauma. This is a report of an elite female swimmer who complained of a strange repetitive weakness, without pain, in both forearms after swimming a few meters of the crawl. Isokinetic tests of the elbow joints were conducted to narrow the differential diagnosis and justify aggressive treatment consisting of a two-stage open release of the radial nerve. After surgery, the patient had full recovery and resumed her normal sports activity. She was reevaluated 9 years after surgery.

CASE REPORT

In 1990, a 15-year-old girl came to the outpatient department with severe weakness in both upper extremities after 50-meter crawl workouts or intensive weight training. She reported no problems at rest, but she was forced to discontinue practice after swimming a short distance because of the weakness in both forearms. She had point tenderness in both upper extremities on the posterolateral aspect of the humerus but otherwise was free of pain. She had no history of lateral epicondylitis or thoracic outlet syndrome. She was sent to various specialists, but the diagnosis remained unclear. The results of EMG and nerve conduction studies were normal and it was determined that she did not have radiculopathy.

The patient's symptoms led us to suspect that the problem was likely originating at the narrow space of the humerospiral groove of the radial nerve. We tested our theory by reproducing the extension movement of the crawl on a Cybex II dynamometer (Cybex International, Inc., Medway, Massachusetts) with the patient's upper arm stabilized.[16] Our intention was to activate the triceps muscle, reproducing its compression on the radial nerve throughout repetitive constrictions of the muscle in the humeral sulcus. The patient was tested at 240 deg/sec for 30 repetitions (less than maximum power) so that the swimming motion could be reproduced as closely as possible. This method of Cybex dynamometer testing of the upper extremity was the only possible method for reproducing the repetitive movements of the crawl in a standardized situation. Our primary aim was not to test the strength of the triceps muscle but to test the reaction of the patient on activation of the triceps muscle. During testing, the patient confirmed the same symptoms of forearm weakness that she was having during her athletic activities. The average of the first three repetitions was considered 100% and termed the initial peak torque value. These values were compared with the average of the last three repetitions to determine the decrease on each side. There was a demonstrated loss of 45% power in the left arm extensor muscles and 36% in the right arm extensor muscles (Fig. 1). This significant loss of strength was interpreted as functional entrapment of the radial nerve in the radial sulcus region of the humerus.

After thoroughly discussing the situation with the patient and her parents and obtaining appropriate consent, we performed an open release and decompression of the radial nerve through a posterolateral approach in a two-stage procedure, first on the left side and then on the right side. Intraoperative findings confirmed our diagnosis of entrapment of the radial nerve in the intramuscular septum at the lateral head of the triceps muscle (Fig. 2). No abnormalities or variations of the radial nerve were observed during surgery.

The patient underwent postoperative Cybex dynamometer testing 3 months after surgery to monitor the return of strength and function. She was able to resume her sporting activities after a short 10-week recovery. Six

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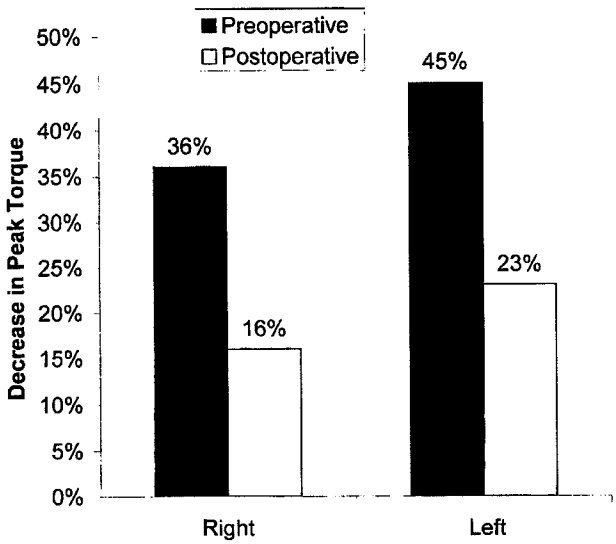

Figure 1. Isokinetic tests with a Cybex II dynamometer were performed pre- and postoperatively to compare strength of both elbows. The decreases in peak torques (degrees per second) are displayed as percentages.

months after surgery she won a silver medal in the 50-meter crawl at the Swiss National Championships.

Long-term follow-up in this case became available when, 9 years later, the patient was seen with hypertrophic and adhesive scar formation in her right arm. Her competitive swimming career continued until her retirement in 1993, but afterward she continued to participate in recreational sports activities such as weight training, swimming, and jogging. She had experienced no recurrence of her original symptoms since surgery. The Cybex dynamometer testing was repeated and results showed no significant loss of power in flexion or extension. There was an extension decrease of 19% on the right side and 10% on the left side. The hypertrophic scar was resected, the subcutaneous tissue was released, and an intracutaneous suture was made. The patient recovered uneventfully.

Figure 2. Intraoperative photograph of the radial nerve crossing the left humeral shaft (arrow denotes left radial nerve).

DISCUSSION

Compression syndromes are well known clinically. In the upper extremity, the most common type is carpal tunnel syndrome. Proximal compression neuropathy of the radial nerve is less common than carpal tunnel syndrome and often results after trauma (such as fracture), postfracture callus formation, or Saturday night palsy.[3,7,9,10,13,15,17,19,20] Radial nerve compression neuropathy caused by repetitive motion is very rare. There are a few reported unilateral cases in athletes[7,13,15,19]; no cases of atraumatic bilateral compression neuropathy at the radial nerve in athletes were found in the literature.

The radial nerve, which originates from the brachial plexus at C5-T1, is the major terminal branch of the posterior cord[1,4,10–12,15,17] (Fig. 3). The nerve travels anterior to the subscapularis, teres major, and latissimus dorsi muscles before passing deep to the long head of the triceps muscle. Passing between the medial and lateral heads of the triceps muscle, the nerve runs from the me-

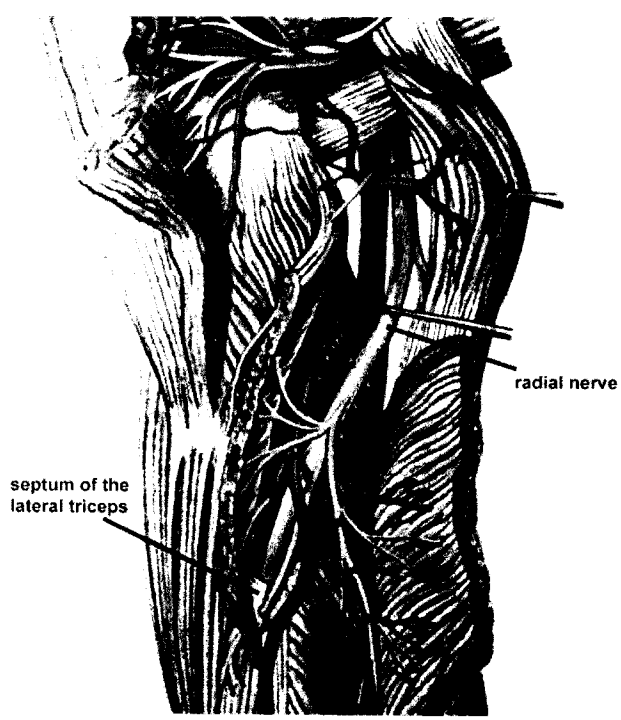

Figure 3. Anatomic rendering of the radial nerve entering the septum of the lateral triceps muscle (Reprinted with permission from Ferner H, Staubesand J [eds]: *Sobotta Atlas der Anatomie des Menschen.* Eighteenth edition. Munich, Urban & Schwarzenberg, 1982.)

dial to the posterior aspect of the humerus. It then turns toward the spiral groove of the humerus and pierces the lateral intermuscular septum about 15 cm proximal to the elbow joint. Before piercing the septum it splits up into the motor branches to the triceps muscle. The nerve then courses over the lateral border of the brachialis muscle and passes deep to the brachioradialis and extensor carpi radialis longus and brevis muscles, where it crosses the annular ligament of the radial head. Distal to the lateral epicondyle of the humerus, the nerve divides into the superficial radial and posterior interosseous nerves. After having passed the intermuscular septum, the nerve splits into the motor branches to the brachioradialis and extensor carpi radialis longus muscles, and, a little further along, into the branch to the extensor carpi radialis brevis muscle. The superficial branch of the radial nerve emerges from under the lateral border of the brachioradialis and then runs in a subcutaneous plane, providing sensation to the radial aspect of the dorsum of the hand. Soon after its origin, the interosseous nerve passes into a tunnel roofed by fibrous bands between the brachialis and brachioradialis muscles and the superficial head of the supinator muscle. The floor of the tunnel is composed of the anterior capsule of the elbow joint and the deep head of the supinator muscle. Then the nerve winds around the lateral aspect of the radius, passing below the supinator muscle between the extensor muscles of the forearm to the fourth extensor compartment. Here the nerve passes deep to the extensor retinaculum before ending at the level of the wrist joint. The radial nerve is the motor branch off the supinator as it travels close to that muscle. More distally it separates into branches of the extensor digitorum, the extensor digiti minimi, extensor carpi ulnaris, abductor pollicis longus, extensor pollicis longus, extensor pollicis brevis, and extensor indicis muscles.[10–12,16,19]

Nerve entrapment syndrome of the upper extremity is well known, although the radial nerve is the nerve least commonly involved. The median nerve and the ulnar nerve are more frequently involved, as reported by Wilhelm et al.[21] in their 13-year review of operated nerve entrapment syndromes. The proximal compression of the radial nerve is described as "Saturday night" or "honeymoon palsy." Wilhelm et al.[21] reported 20 cases of proximal radial nerve compression neuropathy among 1023 cases of entrapment syndrome of the upper extremity. In 1962, Kirchhof et al.[9] described a case of bilateral compression neuropathy of the radial nerve in a patient who, in his work, carried heavy boxes on his back with his arms extended, so that the boxes compressed the radial nerve. Fansa et al.[5] described a case of atraumatic bilateral compression of the radial nerve in the arcade of Frohse by the supinator muscle. Their patient was a 61-year-old woman who had diabetes and distal polyneuropathy.

Entrapment of the radial nerve is most commonly caused by trauma, such as fracture of the middle third of the humerus, postfracture hypertrophic bone formation, or iatrogenic surgical complications.[3,7,10] Less frequent causes include overuse symptoms, such as those described in this case report. In the absence of trauma, the mechanism of injury is nerve compression in the radial sulcus of the humerus where the nerve pierces the septum at the lateral head of the triceps muscle. Atraumatic cases of radial nerve entrapment involve repetitive movements of the elbow in which the intermuscular septum is compressed by the lateral head of the triceps muscle; this etiologic type is more often described in workers than in athletes.[14,20,21] The occurrence of chronic entrapment syndrome that manifests after repetitive movement appears to be a vascular problem that involves compression of the small nutrient vessels and not a demyelination process.[18]

Isokinetics

The concept of isokinetics was developed in the late 1960s. The isokinetic concept involves a constant, dynamic, preset, fixed speed with muscular resistance provided throughout the range of motion. It is widely accepted as a rehabilitation tool and less commonly as a diagnostic medium.[2,8] Different speeds are tested from 30 to 240 deg/sec, with different numbers of repetitions. Healthy volunteers show a 50% drop of peak torque after 40 to 60 seconds of maximum voluntary contraction.[16] Unilateral nerve palsy in an athlete is a rare but serious injury that may delay or preclude an athlete from return to sports. Unilateral radial nerve compression neuropathy makes up only 5.7% of all peripheral nerve injuries,[7] and athletes may obtain excellent results with appropriate treatment.

Our patient was tested at 240 deg/sec for 30 repetitions at less than maximum power so that the swimming movement could be reproduced. The results helped confirm the diagnosis of radial nerve entrapment in the radial sulcus of the humerus. The use of isokinetic testing as a diagnostic tool is uncommon, but in this case it supported the clinical suspicion of radial nerve compression neuropathy. Through isokinetic testing, we were able to rule out simple fatigue in this well-trained athlete; the testing clearly revealed the significant weakness that extended down both of her forearms.

Bilateral compression of the radial nerve is infrequently diagnosed. Because it is so uncommon, it may not be considered in the differential diagnosis. In competitive swimmers, success depends on muscle strengthening and hypertrophy of the muscle mass. The number of daily repetitions of specific movements is high and may result in compression of other anatomic structures, causing pain or weakness. Many physicians initially recommend nonoperative treatment, such as activity modification and antiinflammatory medications.[5,9,13] If no improvement is seen in the first 3 to 6 months, most physicians recommend decompression.[6,7,10–12,15,17,19,20] In this case, we report the result of taking a more aggressive approach initially and performing an open decompression of the nerve. A surgical release was the most effective mode of treatment in this elite athlete, as evidenced by her 9-year follow-up visit and successful outcome.

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