Ultrasonographic Appearance of Idiopathic Radial Nerve Constriction Proximal to the Elbow

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Ultrasonography not only permits a detailed assessment of peripheral nerves but also is useful for intrinsic nerve abnormality detection, as in peripheral nerve enlargement (eg, in trauma, peripheral nerve sheath tumors, and nerve compression). Ultrasonography can also be used to locate nerve compression due to an extrinsic factor (eg, compression of the posteri- or interosseous nerve by the arcade of Frohse, ganglionic cysts, vessels, rheumatoid nodules, lipoma, or hemangioma).

We report a case of a closed radial nerve injury at the distal part of the humerus in which ultrasonography was instrumental in revealing a severe injury without a definite cause. Ultrasonography also allows specification of the nature of a radial nerve impediment and identification of its exact location. These elements were very useful in deciding on surgical treatment. We compare this recently observed radial nerve palsy with other intermediate injuries of the radial nerve previously described in the literature. Finally, we emphasize the role of ultrasonography in the treatment of radial nerve palsies.

Case Report

A 46-year-old left-handed solderer came to the radiology department for a left motor deficit of wrist and finger extension. The patient had no medical history, and the clinical examination did not reveal any triggering factor. A few days before admission, the patient had only weakness in his wrist. His paralysis was evident on awakening, with complete radial nerve palsy distal to the triceps.

Physical Examination

A physical examination showed that the triceps strength grade was 5/5 according to the Medical Research Council scale, but brachial radialis, supinator, extensor, carpal radialis, extensor digitorum communis, extensor carpi ulnaris, extensor pollicis longus, and abductor pollicis longus grades were all 0/5. We also observed a sensory...
deficit, which included the dorsal surface of the proximal half of the thumb and index and middle fingers and a small area on the dorsum of the first and second metacarpal web spaces. Electrodiagnostic studies and physical examination allowed us to determine the level of radial nerve injury between the sensitive branch and the tricipital branch of the radial nerve. The patient was followed closely for 6 months and had no clinical evidence of spontaneous recovery.

An experienced radiologist (J.S.) performed ultrasonography. An Ultramark HDI 5000 ultrasound system (Philips Medical Systems, Bothell, WA) and a 12-MHz broadband linear array probe were used for ultrasonographic examination. Normal peripheral nerves on ultrasonography revealed hypoechoic nerve fascicles and hyperechoic connective tissue. In the transverse plane, the peripheral nerve is relatively hyperechoic compared with surrounding muscle. In the longitudinal plane, a peripheral nerve exhibits a linear fascicular appearance of approximately 2 mm in diameter.

In our case, the radial nerve was initially detected in the radial groove at the distal part of the humerus and then followed along its longitudinal axis on a longitudinal and transverse scan. In addition, color Doppler ultrasonography was performed to assess vascularization of the nerve. However, at the distal part of the humerus, after its crossing in the lateral intermuscular septum, the radial nerve had an hourglass-shaped appearance: we noted first a thickening (≥3 mm), then a stricture, and, again, a very limited thickening (between 2 and 2.5 mm) (Figures 1 and 2).

We also observed abnormal hypoechochogenicity and loss of neuronal fascicle distinction. On a transverse scan, in the area of the stricture, the nerve appeared blurred and measured 1 mm. No neovascularization was observed on color Doppler ultrasonography.

Surgery
Our patient underwent surgery 10 months after the onset of the symptoms and 1 month after the ultrasonographic examination. At surgery, the portion of the radial nerve located after the tricipital branch had an hourglass-shaped appearance after its crossing in the lateral intermuscular septum (Figure 3). Resection of this nerve portion and a direct nerve suture were performed. Histologic examination of the resected tissue revealed a stenosis of the nerve with interruption of the neurofilaments (Figures 4 and 5); however, no etiology was determined. Six months after surgery, there was no improvement.

Second Examination
Nine months after surgery, a physical examination confirmed that the brachioradialis and the extensor carpi radialis grades were 3/5. Fifteen months after surgery, the brachioradialis and extensor carpi radialis grades were 4/5, the supinator grade was 3/5, and the extensor carpi ulnaris grade was 1/5. Electrodiagnostic tests showed no sensitive potentials. A palliative nerve transfer was planned after a 6-month delay.

Discussion

Radial Nerve Injuries
As reported by Lowe et al., one can define 3 levels of radial nerve injuries: a high injury (above the level of insertion of the pectoralis major muscle), an intermediate injury (between the insertion of the pectoralis muscle and the posterior interosseous nerve), and a low injury (posterior interosseous nerve or radial sensory nerve). At the distal part of the humerus, intermediate radial nerve palsy is frequent in either traumatic or nontraumatic injury. The radial nerve pierces the lateral intermuscular septum; in this instance, the nerve is close to the humerus, and its mobility decreases. There is a lack of epineurial tissue at the site where the radial nerve passes the spiral groove of the humerus; the nerve is also less
protected. However, in our patient, the nerve injury was located after its crossing in the lateral intermuscular septum.

Furthermore, there was no improvement within 10 months after the onset of the symptoms. In most cases, intermediate nontraumatic injuries have a good prognosis. Various cases of nontraumatic radial nerve palsies have been reported in the literature; however, to our knowledge, no case similar to ours has been reported. In fact, radial nerve compression can occur secondary to muscular overexertion through a fibrous arch coming from the lateral head of the triceps. However, the manifestations are progressive and become more pronounced with the duration of muscle effort. The prognosis is usually good, with complete spontaneous recovery. In addition, radial nerve palsy has also been reported after muscular overexertion as a result of compression by a fibrous arch coming from the long head of the triceps or from compression of the triceps in the absence of any defined fibrous arch. During military rifle training, because of kneeling, radial nerve palsy has also been reported at the lateral border of the humerus, where the radial nerve pierces the lateral intermuscular septum.

Nerve compression is moderate when histopathologic studies report local demyelination with an intact axon. The nerve compression is more serious when epineurial fibrosis occurs with axonal damage. Two mechanisms can be involved in nerve compression: first, ischemia is implicated; and second, application of differential pressure along the nerve trunks causes invagination of the nodes of Ranvier. This mechanism is a critical factor in compressive neuropathies. Radial nerve compression also occurs with prolonged use of axillary crutches due to the fact that the radial nerve is close to the humerus. Complete recovery should occur within 2 months. Other authors have also reported radial nerve palsy after the use of crutches. The nerve was compressed at the edge of the latissimus dorsi tendon and at the long head of the triceps.

Radial nerve torsion has been described previously in an 18-year-old man. At surgery, the nerve had an hourglass-shaped appearance before crossing the lateral intermuscular septum. The patient had complete recovery after surgery. Furthermore, the onset of our patient's symptoms was very sudden, with no clearly evident traumatic etiology. Severe onset has also
been reported with “Saturday-night palsy.” During deep sleep, after alcohol or drug ingestion, compression of the radial nerve against the humerus can occur because of the position of the arm. This paralysis is nonprogressive and is evident on awakening. However, this injury is simple neuropraxia, and recovery is complete within 6 to 12 months. Finally, idiopathic causes of radial nerve palsy have also been reported. In our case, ultrasonographic examination showed radial nerve constriction proximal to the elbow after its crossing in the lateral intermuscular septum. The radial nerve had an hourglass-shaped appearance with abnormal hypoechoicinity and loss of distinction of the neuronal fascicles. The surgical correlation was excellent. We suggest that a plausible etiology of the radial nerve constriction in our case could be chronic microtraumas related to the patient’s job, but it was not possible to establish the exact etiology.

Ultrasonography in Nerve Examinations
The normal ultrasonographic appearance of nerves is one of hypoechoic nerve fasciculi surrounded by a hyperechoic structure representing the nerve sheath. The normal diameter of the radial nerve measures 2 mm. On transverse scans, the nerve appears rounded at the proximal third of the humerus, oval at the middle third, and rounded again at the distal third of the humerus. Ultrasonography is a useful diagnostic tool in evaluation of patients with traumatic radial nerve palsy. Moreover, ultrasonography enables detection of severe nerve damage that requires surgical repair and also fascicular hematoma without severe nerve damage.

Ultrasonography allows specification of the nature of the nerve injury and can be considered a useful tool for deciding surgical or conservative treatment. Ultrasonography also permits detection of radial nerve entrapment within a humerus fracture. At the fractured area, ultrasonography shows an abrupt change in the course of the radial nerve.

Furthermore, a study of 4 patients with supinator syndrome (compression of the deep branch of the radial nerve located near or beneath the supinator muscle) has been reported. These patients underwent ultrasonographic examination. The deep branch of the radial nerve appeared hypoechoic and edematous. Color Doppler ultrasonography was able to locate an associated neovascularization. Ultrasonography can also be useful for determining the cause of nerve compression, for example, in tumors.

Magnetic resonance imaging has been used to diagnose peripheral nerve sheath tumors, lipomas, and ganglionic cysts. However, ultrasonography allows detailed assessment of peripheral nerve continuity with a mass, which can show an intrinsic nerve abnormality versus an adjacent extrinsic mass.

Scope and Limitations
Limiting factors of ultrasonography of the radial nerve are that it requires high-quality ultrasonographic equipment and an experienced operator with a profound knowledge of the ultrasonographic appearances of different soft tissue structures, as well as a sound knowledge of peripheral nerve anatomy. Advantages are that ultrasonography is noninvasive and can be performed repeatedly at low cost.

Conclusions
Our case shows the decisive role of ultrasonography in intermediate radial nerve palsy at the distal part of the humerus after the crossing of the nerve in the lateral intermuscular septum. The paralysis was evident on awakening; there was no triggering factor; and the patient did not have spontaneous recovery. In this case, ultrasonography was basically instrumental in follow-up treatment: it permitted specification of the nature of the radial nerve impedance and it enabled identification of the exact location of the radial nerve injury for the surgeon.
On ultrasonography, the radial nerve had an hourglass-shaped appearance, and the surgical correlation was excellent. To our knowledge, a similar case has not been reported in the literature. We suggest that ultrasonography can be a useful tool for treatment of peripheral radial nerve palsies.

References