Sonographic Detection of Radial Nerve Entrapment Within a Humerus Fracture

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Radial neuropathy is frequently associated with fracture of the middle third of the humerus owing to the course of the nerve adjacent to the humeral shaft. The prevalence varies from 2 to 18% of humeral fractures.1–8 The therapeutic management is still controversial. Some authors recommend initial surgical exploration,2,6 whereas others prefer observation and intervention only if the injured nerve failed to recover after a period of more than 4 months.1,4

According to the literature, verification of an entrapped radial nerve in a fracture gap requires surgical exploration,1,6 but diagnostic tools to verify the existence of a pathologic condition are limited. We describe the sonographic findings of an entrapped radial nerve and review the literature regarding diagnosis and treatment of entrapped radial nerve in cases of humeral fracture.

CASE REPORT

A 26 year old man was admitted to our traumatology department suffering from a closed fragmented fracture at the middle third of the right humerus (Fig. 1). He reported a weakness in his arm and loss of sensitivity. Neurologic and electromyographic examinations 5 weeks after the injury verified a complete motor and sensory axonal lesion of the radial nerve. Six weeks after injury MR imaging and ultrasonographic examinations were performed to assess the amount of hematoma and, if possible, the condition of the radial nerve. Owing to the extension of a seroma surrounding the fractured bone, the continuity of the radial nerve could not be followed by means of MR imaging. On B-mode sonography, using a 5-12 MHz broadband linear array on a HDI 5000 unit (Advanced Technology Laboratories, Bothell, WA), the radial nerve at the distal part of the humerus was first detected in the radial groove in a transverse scan and followed along its longitudinal axis proximally in a transverse and longitudinal scan. The radial nerve showed an abrupt change of its course at the fractured area, suggesting nerve entrapment (Fig. 2). The nerve itself appeared narrowed but not disrupted. Proximal to the fracture the nerve showed a normal

ABBREVIATIONS

MR, Magnetic resonance
appearance. A fluid collection representing the seroma as seen on MR images was noted adjacent to the fracture. Persistence of radial neuropathy and the clear sonographic results mandated immediate surgical intervention. Surgical findings confirmed the existence of nerve entrapment in the fractured fragments with narrowing of the nerve (Fig. 3) and presence of surrounding pannus and callus. The nerve was released from entrapment and embedded into the surrounding triceps muscle; and the fracture gap was then treated with compression plates. The patient’s neurologic deficit disappeared spontaneously within 2 months, and sonographic follow-up studies showed correct alignment of the nerve.

**DISCUSSION**

Fracture of the humeral shaft is a rare injury and sometimes associated to radial nerve palsy. Primary radial nerve lesions after fracture of the humerus are a consequence of the close relationship of these two structures. Nerve damage may be caused by direct laceration from the fractured fragment, by forced traction on the nerve, or by hematoma within the nerve sheath. Other causes of radial neuropathy are nerve entrapment in the fractured fragments and interposition of muscle secondary to a humerus fracture, as described by Nakamichi and Tachibana. Secondary radial nerve lesions may develop operative fixation, forced iatrogenic axial reposition, or entrapment in growing callus. Spontaneous recovery of nerve injury occurs only when damaged nerve is affected by neurapraxia or axonotmesis, whereas when affected by neurotmesis the nerve shows no signs of recovery.

There is general agreement that patients with radial nerve injury in humeral fracture without clear signs of disruption should not be operated on immediately since radial nerve palsy can recover spontaneously. Early surgical exploration and repair should be performed only in open fractures, which require debridement, and in association to vascular injuries. However, therapeutic management of radial nerve injury in cases of humeral fracture is still controversial when spontaneous recovery of radial nerve palsy fails to occur within months. Different groups of investigators suggest exploration only when periods varying from 6 weeks to 6 months have elapsed without recovery of nerve function; some authorities prefer early surgical intervention when radical neuropathy is diagnosed by electromyography and electrophysiologic studies. According to Pollock and coworkers, a vast majority of patients with fractures at the distal third of the humerus are at risk for radial nerve injury, and delayed repair can still lead to a good result. The radial nerve should be explored only if signs of recovery fail in a range of several weeks to months.

In a study conducted by Fenyö and coworkers, 55 patients with radial injury underwent immediate nerve exploration, but in the majority of the cases the nerve was found to have only minor contusion. Only in one case was impingement of the nerve in the fracture fragment present. Holstein and Lewis also described an entrapment of the radial nerve in an oblique distal fracture. Similar rare findings of an interpositioned nerve within a fracture were found by Böstman and colleagues and Kwasny and associates.

To our knowledge no diagnostic modality is currently used to detect pathologic conditions of the radial nerve associated with fractures of the humerus, although in the past years musculoskeletal sonography gained wide acceptance in the fields of traumatology and orthopedics. Improved equipment permits greater nearfield clarity, which allows the viewer to
differentiate soft tissue structures, such as muscles, tendons, small vessels, joints, and nerves.\textsuperscript{11–16} Although tendons, ligaments, and nerves appear hyperechoic, these structures have enough differences in their sonographic appearances to allow them to be distinguished. In comparison to tendons, ligaments demonstrate a fine fibrillar appearance. Peripheral nerves are coarser, with alternating hyperechoic and hypoechoic bundles than the fibrillar pattern of tendons. The sonographic appearance of nerves is one of hypoechoic nerve fasciculi surrounded by an hyperechoic structure representing the nerve sheath. The fasciculi are best seen in a transverse scan, as demonstrated by Silvestri and coworkers.\textsuperscript{11} Sonographic studies have been performed in several pathologic nerve conditions, such as carpal tunnel syndrome or cubital tunnel syndrome,\textsuperscript{12,13} in which structural changes of the nerve could be detected with high sensitivity.

In our case sonography was of great value in the early decision on whether or not nerve exploration should be performed. As a consequence of early surgical repair, the time to complete recovery was less than 4 months after nerve injury, thus significantly decreasing the amount of muscle atrophy and peripheral degeneration and allowing faster return to normal activity.

In this report we demonstrate the feasibility of sonography for detecting an impinged radial nerve, and we conclude that the ability to assess the position and course of the radial nerve might be an important aid in the adequate management of humeral fractures with radial lesions, shortening the recovery time.

**REFERENCES**


