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# Sonographic evaluation of dynamic posterior interosseous nerve compression secondary to radial fracture fixation

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## Abstract

Posterior interosseous nerve injury is a rare complication of the radial bone fracture or its surgical treatment. We report a rare case where compression of the nerve was dynamic with supination of the wrist and rotation of the screw towards the overlaying nerve. These types of compression are difficult to localize as x-rays do not depict the nerve, and MRI imaging is static. We describe a technique of dynamic sonographic examination of the posterior interosseous nerve that allowed localization of the site of the compression and a particular faulty hardware piece. Awareness of this complication is important for early detection and the use of diagnostic capabilities of dynamic sonographic evaluation for surgical decision-making.

***Keywords:*** Posterior interosseous nerve injury; Iatrogenic nerve injury; Sonography of the nerve.

## Introduction

Proximal radial fractures account for up to 5% of all fractures. On average, one in three patients will present with associated injuries, though up to 80% of cases document damage to surrounding tissues in displaced, fragmented fractures. Yet, despite the prevalence of such tissue injury, there are only rare reports of the Posterior Interosseous Nerve (PIN) injury following such fractures, suggesting the protected position of the nerve. Primary PIN injuries can occur following anteriorly deviated fractures, Monteggia fracture dislocations, and penetrating traumatic injuries [1,2].

However, because the PIN is very sensitive to even slight traction, secondary or delayed palsies are more common. These injuries result from fracture manipulation during intraoperative nerve exploration or surgical repair of the radius. In such cases, exploration of the nerve prior to manipulations usually documents the initial intact state of the nerve by visual inspection. During surgery, the PIN can be unknowingly entrapped or damaged between the bone and an installed plate, during nailing of the bone, or when repositioning bone fragments. It is difficult to distinguish in such posttraumatic nerve palsies if the lesion was due to trauma itself, result of manipulation as single initial event, or ongoing nerve irritation or damage by hardware, bony fragments or scar tissue. Although the mechanism of immediate traction induced injury is generally understood, when nerve damage does not improve, surgical re-exploration has historically been indicated because the cause of persistent dysfunction has not been identifiable without direct visualization of the dynamically moving PIN in relation to surrounding structures. Nerve conduction studies and electromyography allow to evaluate severity of nerve injury, but do not assess the cause or mechanism.

## Case report

15 years of teenage girl sustained a fall on her outstretched arm, resulting in a right comminuted proximal radius shaft fracture and Distal Radio-Ulnar Joint (DRUJ) dislocation (Essex-Lopresti fracture-dislocation). She underwent surgical treatment with Open Reduction and Internal Fixation (ORIF) right proximal radius shaft fracture and closed reduction of DRUJ dislocation. During exploration, the PIN was intact and located

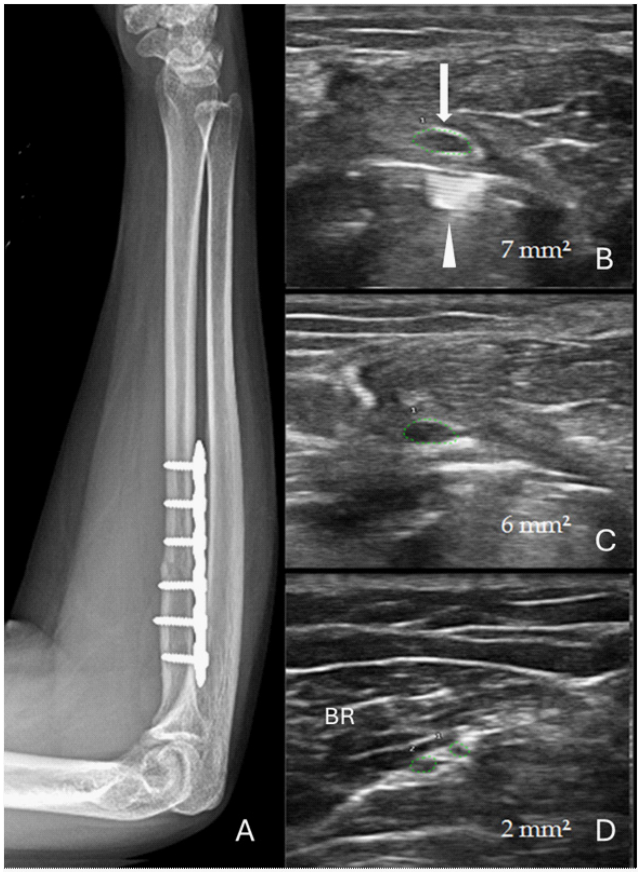


**Figure 1: (A)** X-ray of ORIF of proximal radial shaft fracture. **(B-D)** Ultrasound images illustrating change in caliber of the posterior interosseous nerve (arrowheads) from 2 mm (normal) at the elbow to 7 mm (enlarged) at the site of the faulty screw. The screw (arrow) appears as a hyperechoic structure with multiple parallel lines related to the threads.
BR: Brachioradialis Muscle.

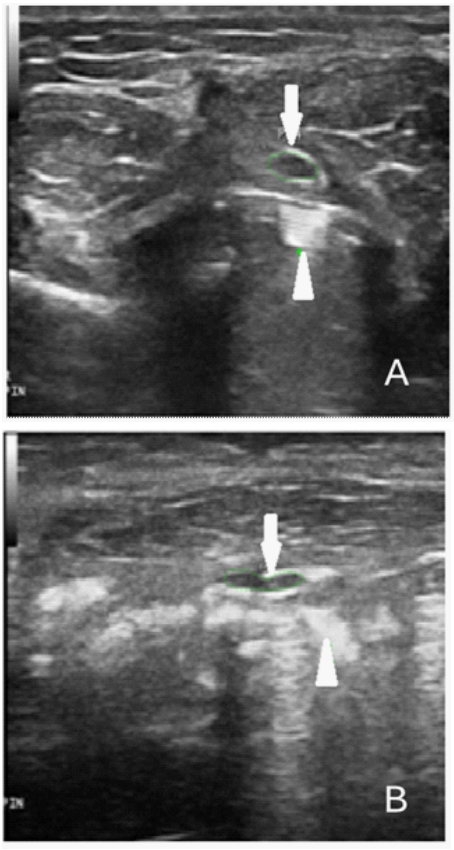


**Figure 2:** Sonogram of the posterior interosseous nerve (arrowhead) in transverse view at the level of screw (arrow) in pronation **(A)** and supination **(B)** positions shows deformation of the nerve with supination and decreased nerve gliding mobility caused by protruding screw.

directly onto the dorsal aspect of the bone and the fracture was directly deep to the PIN. The fracture ends were reduced, and a 6-hole DCP plate was placed onto the radius and using standard technique. After reduction of the DRUJ patient splinting of the wrist in supination position was used to protect reduction. After the surgery patient noted weakness of her hand, she was not able to extend her wrist and move her fingers. Gradually within following 3-4 weeks she noted improvement of her wrist movements, but had severe finger drop with no sensory changes. EMG confirmed PIN palsy. At that point PIN neuropathy was attributed to the mechanism of trauma when PIN becomes vulnerable. At 3 months after surgery, there was no improvement in strength, and the patient noted worsening of index finger extension. Repeated EMG again showed severe PIN injury with axonal loss and only minimal signs of reinnervation. She underwent sonographic evaluation of the posterior interosseous nerve, which demonstrated the nerve in continuity. Metal plate and all six screws were easily visualized sonographically (Figure 1) and at the proximal site of the hardware PIN was significantly focally enlarged up to 7 mm² in cross-sectional area (NL- 1- 2 mm²). More importantly, dynamic test with wrist supination/pronation showed direct compression of the nerve by the hardware in the supinated position, with deformation and flattening of the nerve, while pronation caused increased space between PIN and radius with hardware (Figure 2). The patient underwent repeated surgery with hardware removal. During exploration, PIN was found to be edematous with signs of vascular congestion along the proximal aspect of the plate where the nerve was lying directly over the plate. Hardware was carefully removed, and the PIN was freed up to allow easy excursion. The postoperative course was uneventful. The patient showed steady improvement throughout the following 5 months with complete regain of hand function.

## Discussion

To our knowledge, this is the first description of non-invasive ultrasonographic examination used to identify both focal deformation and edema with dynamic limitation of PIN movement during supination and pronation. These observations localized the site of ongoing PIN injury for subsequent surgical intervention. Sonographic evaluation of the nerves is a relatively new technique, with the benefits of excellent resolution and real-time assessment with different dynamic maneuvers. Detection of the hardware in relation to muscles, tendons, and fine structures like small caliber nerves and vessels allows obtaining important additional information to explain patient symptoms and guide clinical decisions in management. Causes of immediate PIN injury during surgery have been previously described [2-4], and include positioning of the patient during general

anesthesia, inadvertent traction of the nerve against a repositioned bone fragment, and nerve stretch injury during bone nailing or plating. The dynamic plate osteosynthesis approach to radial bone stabilization has been linked to subsequent radial nerve palsy in almost 80% of reported cases, probably because it requires placing a long plate for bone fixation. Manipulation of the plate into the appropriate position, whether fixation is tight or is left as dynamic, is thought to be the cause of immediate stretch injury. As noted previously, neuropraxia of the PIN has been reported in fractures of the proximal third of the radius, fracture dislocation syndromes (Montego, Essex-Lopresti), gunshot wound-associated injuries, compression at the arcade of Frohse, iatrogenic surgical approach injuries as noted above, and as a complication of elbow arthroscopy [3]. The very nature of neuropraxic injuries is that the associated focal demyelination eventually improves, and without significant nerve axonal injury, recovery of function ensues. However, when there is no intraoperative evidence for severe nerve crush injury, evulsion, or transection, the causes for persistent PIN muscle denervation are less well described. Persistent PIN injury has been observed in patients with persistent joint swelling following fracture, from bone callus formation with nerve dislocation, and from residual bone fragment-mediated nerve compression [5]. In iatrogenic radial nerve plating-associated injuries, persistent nerve dysfunction has been thought to result from compression or entrapment of the nerve by the plate itself. Dynamic studies to assess lesions for the cause of nerve injury have not been possible using standard X-rays, which do not visualize soft tissues, or with MRI, which cannot assess dynamic function, and which is often affected by metal, producing significant magnetic field artifacts, even in non-ferrous metals. As observed in this case, ultrasound offers a technology that can non-invasively identify dynamic nerve compressions, when structures are sufficiently near the surface to be visualized. This technique can reduce the uncertainty surrounding persistent muscle denervation after initial surgical intervention, and more accurately plan therapeutic interventions without exploratory surgery.

## Conclusion

This case demonstrates the importance of considering the dynamic effect of the hardware on the nerve, which requires additional investigations to prevent permanent loss of the nerve fibers. In a complex trauma situation, when the mechanism of trauma itself can cause typical nerve injuries, there should be a level of suspicion, and careful longitudinal assessment of the function is needed. High resolution ultrasound is a non-invasive technique that has become more readily available and allows assessment of not only nerve integrity but also reveals dynamic compression of the nerve by tissues or hardware, differentiating traumatic from iatrogenic causes of nerve injury.

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