Superficial surgical landmarks for identifying the posterior interosseous nerve

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Object. There is a paucity of information in the neurosurgical literature regarding the surgical anatomy surrounding the posterior interosseous nerve (PIN). The goal of the current study was to provide easily recognizable superficial bone landmarks for identification of the PIN.

Methods. Thirty-four cadaveric upper extremities obtained from adults were subjected to dissection of the PINs, and measurements were made between this nerve and surrounding superficial bone landmarks.

In all specimens the main radial trunk was found to branch into its superficial branch and PIN at the level of the lateral epicondyle of the humerus. Proximally, the PIN was best identified following dissection between the brachioradialis and extensor carpi radialis longus and brevis muscles. At its exit site from the supinator muscle, the PIN was best identified after retraction between the extensor carpi radialis longus and brevis and extensor digitorum communis muscles. This site was a mean distance of 6 cm distal to the lateral epicondyle of the humerus. No compression of the PIN by the tendon of origin of the extensor carpi radialis brevis muscle was seen. One specimen was found to have a proximally split PIN that provided a previously undefined articular branch to the elbow joint. The mean diameter of the PIN proximal to the supinator muscle was 4.5 mm. The leash of Henry crossed the PIN in all but one specimen and was found at a mean distance of 5 cm inferior to the lateral epicondyle. The PIN exited the distal edge of the supinator muscle at a mean distance of 4 mm. The exit site from the distal edge of the supinator was found to be at a mean distance of 18 cm proximal to the styloid process of the ulna. This exit site for the PIN was best identified following dissection between the extensor carpi radialis longus and brevis and extensor digitorum communis muscles. The distal articular branch of the PIN was found to have a mean length of 13 cm and the proximal portion of this terminal segment was located at a mean distance of 7.5 cm proximal to the Lister tubercle.

Conclusions. The addition of more anatomical landmarks can help the neurosurgeon to be more precise in identifying the PIN and in avoiding complications during surgery in this region.

Key Words • peripheral nerve • radial nerve • anatomy • surgery • anatomical landmark

There is a paucity of information in the neurosurgical literature regarding the surgical anatomy of the PIN. In the distal lateral arm, the radial nerve pierces the lateral intermuscular septum passing from the posterior to the anterior compartment of the arm. Here the nerve divides into two terminal branches: the cutaneous superficial radial nerve, which supplies the skin of the radial dorsal aspect of the hand and distal forearm, and the primarily motor PIN. Close to its origin, the PIN is crossed by lateral branches of the recurrent radial artery and vein, the so-called leash of Henry (Fig. 1). The PIN descends, passing over the anterior aspect of the radiohumeral joint, and travels deep with respect to the superficial lamina of the supinator muscle, the most proximal edge of which is known as the arcade of Frohse. The PIN then travels to the posterior aspect of the forearm, around the lateral side of the radius and exiting between the fibers of the supinator muscle, and is prolonged distally to the middle of the forearm. After traveling through the supinator muscle (~ 4 cm), the PIN divides and typically produces six branches to the extensor carpi ulnaris, extensor digiti minimi, extensor digitorum communis, extensor pollicis brevis and longus, abductor pollicis longus, and extensor indicis muscles. In some cases, the PIN also produces branches to both radial extensors of the wrist before it enters the supinator muscle. Considerably diminished in size, the PIN travels posterior to the interosseous membrane and anterior to the extensor pollicis longus muscle onto the dorsum of the carpus, where it sends filaments to the ligaments and articulations of the dorsal carpus (Figs. 2 and 3). Additionally, this distal articular segment may supply the periosteum of the radius and the interosseous membrane.

Materials and Methods

Ten male and seven female adult formalin-fixed cadavers (range in age 50–89 years at the time of death [mean 70 years]) were subjected to dissection of their PIN on each side (a total of 34 nerves), and measurements were made between this nerve and sur-

**Abbreviation used in this paper:** PIN = posterior interosseous nerve.
rounding superficial bone landmarks. All measurements were made using calipers. Measurements included the diameters of the distal radial nerve trunk just proximal to the site where it branches into the superficial radial nerve and PIN, the proximal PIN, and the distal PIN, as well as the distance from the lateral epicondyle of the humerus to the leash of Henry (Fig. 1), the distance from the lateral epicondyle of the humerus to the PIN as it enters the supinator muscle (Fig. 1), and the distance from the lateral epicondyle of the humerus to the PIN as it exits the supinator muscle (Fig. 2). Other measurements included the distance from the styloid process of the ulna to the exit site of the PIN from the distal border of the supinator muscle (Fig. 2) and the distance from the Lister tubercle (dorsal radial tubercle) to the PIN as it branches into its last muscular branch in the forearm (Fig. 2).

Statistical analyses were made between the left and right sides of the cadavers and between the sexes by using Student t-tests.

Results

All specimens were found to have a PIN and, on both sides of the cadavers, this nerve began laterally and traveled medially from its approximate origin off the main radial nerve trunk at the level of the lateral epicondyle of the hu-
The radial nerve trunk just prior to its branching into the PIN and superficial branch was found to have a diameter ranging from 5.5 to 9 mm (mean 7 mm). The diameter of the PIN at this proximal site ranged from 3 to 5.5 mm (mean 4.5 mm). Proximally (that is, prior to its entrance into the supinator muscle) and in a neutral and partially flexed position, the PIN was best identified after dissection and retraction between the muscle bellies of the brachioradialis and extensor carpi radialis longus and brevis muscles. The leash of Henry crossed the PIN in all but one specimen; it was found to lie 3.5 to 6 cm (mean 5 cm) inferior to the lateral epicondyle of the humerus. The diameter of the PIN at this location was found to be 4.5 to 7.5 cm (mean 6 cm) distal to the lateral epicondyle of the humerus. The PIN then exited the distal edge of the supinator muscle 10 to 15 cm (mean 12 cm) distal to the lateral epicondyle of the humerus. The diameter of the PIN at this location was 3.5 to 5 mm (mean 4 mm). The exit site from the distal edge of the supinator muscle was also found to be 15 to 21 cm (mean 18 cm) proximal to the styloid process of the ulna. Again with the forearm in a neutral and partially flexed position, this exit site for the PIN was best identified following dissection and retraction between the extensor carpi radialis longus and brevis and extensor digitorum communis muscles. This nerve in its descent into the forearm traveled first along the radius; when it reached the approximate midpoint of the forearm, the nerve traveled between the ulna and radius, much of the time just posterior to the interosseous membrane. After providing innervation to the extensor pollicis longus muscle, the remaining articular branch of the PIN was found to be 9 to 16 cm in length (mean 13 cm), and the proximal portion of this terminal segment was found to be 7 to 9 cm (mean 7.5 cm) proximal to the Lister tubercle. No anomalies were noted in the forearm of our specimens, with the exception of one PIN that was duplicated at its origin from the radial nerve trunk. In this right-sided specimen, two equally sized branches appeared to arise from the distal radial nerve trunk proximal to the supinator muscle. The medial branch entered but did not leave the supinator muscle, whereas the lateral branch entered the supinator muscle and then exited it to continue along the distal forearm. Another right-sided specimen was found to have an articular branch from the proximal PIN that supplied the elbow joint. No significant differences were found between the left and right sides of the cadavers or between their sexes (p > 0.05, Student t-test).

Discussion

The most common site of PIN compression is at the arcade of Frohse—that is, the site at which the nerve enters into the supinator muscle. Other causes of compression may lie in the tendinous origin of the extensor carpi radialis brevis or the leash of Henry. However, we were unable to find any compression of the PIN by the tendinous origin of the extensor carpi radialis brevis muscle, although the PIN did move laterally toward this tendon with pronation of the forearm. All but one specimen were found to have a leash of Henry that crossed anterior to the proximal PIN. A tardy PIN palsy may develop after an unreduced radial head dislocation, in association with proximal ulnar fractures, and with anterolateral dislocation of the radial head. Neurofibromas, schwannomas, traumatic aneurysms of the posterior interosseous artery, neurofibromas, ganglion cysts, and myxomas have also been reported as causes of paralysis of the PIN. Trauma may cause paralysis of this nerve; however, many cases of PIN entrapment have no history of antecedent trauma.

Posterior interosseous nerve entrapment syndrome, which is more common in tennis players, is primarily a motor syndrome characterized by a reduction or loss of extension of all digits and atrophy of the posterior forearm muscles with the exclusion of the brachioradialis and extensor carpi radialis longus. Because the extensor carpi radialis longus muscle is usually innervated by the radial nerve trunk, there is usually no wrist drop. However, the wrist deviates radially when wrist extension is examined because of contraction of the extensor carpi radialis longus muscle. A dull, aching pain is a common presenting symptom that is usually localized to the lateral aspect of the elbow and proximal lateral forearm.

Incomplete neuropathy of the PIN may involve only the fourth and fifth digits, in which there is lack of extension. A patient’s hand may resemble a claw without extension at the metacarpophalangeal joints. This type of claw hand has been described as a pseudoulnar claw hand.

There is a pain syndrome involving the distal PIN that is often caused by perineural fibrosis distal to the fourth dorsal compartment, intracapsular ganglia superior to the scapholunate ligament, or osteophytes on the dorsal aspect of the lunate bone. Transection of the distal PIN is indicated in these cases to treat the pain, which often occurs during wrist extension.

Surgical therapy for an entrapped PIN is indicated after 3 months of conservative therapy if functional recovery is absent or if symptoms worsen. As found in our study, the proximal PIN can be isolated from its origin off the main radial trunk more or less at the level of the lateral epicondyle of the humerus. This site was best observed with dissection.
and retraction between the muscle bellies of the brachioradialis and extensor carpi radialis longus and brevis muscles. Low, et al.,17 have described this branching as originating an average of 1.8 cm distal to the lateral epicondyle. This branching site has been stated to be 8 to 9 cm inferior to the lateral intermuscular septum.18,22 One should also remember that the PIN moves medially as much as 1 cm with pronation of the forearm.8 The proximal PIN is decompressed by dividing the arcade of Frohse. The posterolateral approach to the forearm allows for good visualization of the PIN course via retraction between the extensor carpi radialis longus and brevis and extensor digitorum communis muscles. Operative release of the PIN is generally successful.18,19 Parenthetically and in cadavers, Üstün, et al.,21 have found that median nerve branches to the pronator teres, flexor pollicis longus, and pronator quadratus muscles might be suitable for neurotization of the injured PIN with the hope of restoring wrist extension.

Interestingly, in one of our specimens the right PIN was split into two equal components before it entered the fibers of the supinator muscle. Seradge and colleagues20 have reported a similar case in which the PIN split, with one half of its fibers exiting inferior to the distal edge of the supinator muscle and the other one half piercing through the supinator muscle. These authors proposed that this variation of the PIN could provide an additional compression site for this nerve, which is responsible for some atypical presentations of symptoms and for partial recovery following surgical decompression.

We found that the PIN provided its most distal muscular branch into the extensor pollicis longus muscle at a mean distance of 7.5 cm proximal to the Lister tubercle. This corresponds to the findings of Elgafy and associates,9 who stated that in their series this distance was approximately 8 cm. Similarly, Abrams, et al.,1 found that the distance from the radial styloid process to the last muscular branch of the PIN was approximately 11 cm. Of note, we found that the mean length of the distal PIN following its last muscular branch was 13 cm. This terminal segment could be used for neurotization procedures without cutaneous denervation because this last part of the PIN is an articular branch.

Conclusions

Our findings have documented many potentially useful superficial bone landmarks for locating the PIN. It is our hope that these data will aid the neurosurgeon in avoiding complications during surgery and in more easily identifying this nerve when attempting to decompress it in patients with PIN compression. Additionally, our data may prove useful in identifying the distal articular branch of the PIN, which may be harvested simultaneously for more proximal PIN or other nerve repair.

References


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