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Case Report

Neglected posterior interosseous nerve injury

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ABSTRACT

Posterior interosseous nerve (PIN) injury is uncommon due to its anatomically deep location. We report a neglected, rare case of PIN injury presenting the loss of extension of thumb, index, and small fingers with weakness of thumb abduction in a 49-year-old male patient. The patient sustained a penetrating injury to his right forearm caused by a kitchen knife that was repaired primarily through an emergency surgery under general anesthesia. During the regular follow-up on the 52nd postoperative day, the patient presented 20° of extension lags in the right thumb and index finger and 30° in the small finger. Wrist extension was intact, and there was no sensory deficit. We explored the wound and traced the PIN completely, identifying a club-shaped neuroma formation at the proximal cut end of the PIN. Delayed nerve repair was performed with a double-strip cable graft. Hand surgeons should be aware of the probable PIN injury in certain situations of forearm-penetrating injury and perform proper preoperative physical examination to rule out neurovascular deficits. Careful exploration and immediate repair of severe PIN are mandatory, even in emergency situations.

Introduction

Direct injuries to the posterior interosseous nerve (PIN) are relatively rare due to its deep anatomical position in the forearm. PIN injuries can be induced by trauma, such as laceration wound [1], penetrating injury [2], iatrogenic causes [3,4], open fracture [5], and palsies due to soft tissue masses [6]. However, there are very few case reports of PIN injury resulting from laceration and penetrating wounds of the forearm [2]. The intact sensation might mask the underlying motor neuronal damage because the loss of both carpal and finger extension can be satisfactorily explained by extensor muscle laceration in such cases. Subtle clinical signs tend to be missed at the initial presentation and are only detected during follow-up. PIN injuries have been reported to produce various clinical manifestations, including weak wrist extension with radial drift, extension loss at the metacarpophalangeal joints of all fingers and the thumb, and weak abduction of the thumb [7]. Here, we report a rare case of delayed repair of neglected PIN injury presenting the loss of extension of thumb, index, and small fingers with weakness of thumb abduction along with a review of literature.

Case

A 49-year-old man sustained a penetrating injury to his right forearm caused by a kitchen knife (Fig. 1). The dorsal–ulnar laceration wound was 10 cm long and the volar-radial laceration wound was 5 cm long, externally. The patient presented with no sensory deficits,

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Fig. 1. A 49-year-old man sustained a severe penetrating injury to his right forearm caused by a kitchen knife. Dorsal-ulnar laceration wound was 10 cm long, and volar-radial laceration wound was 5 cm long. Physical examination in the emergency room revealed right thumb's flexion and extension loss, with extension loss of other four fingers.

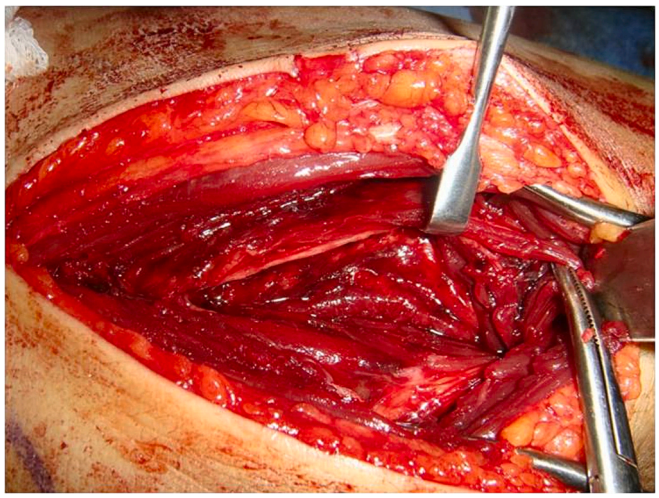

Fig. 2. Immediate myorrhapy was performed during emergency surgery. Extensor carpi radialis longus, extensor carpi radialis brevis, extensor digitorum communis, extensor digiti minimi, and extensor carpi ulnaris were repaired at the superficial layer. Abductor pollicis longus, extensor pollicis brevis, and extensor pollicis longus were repaired at the deep layer.

and physical examination in the emergency room revealed weakened flexion and extension of the right thumb, with extension loss of the other four fingers. Under general anesthesia, emergency exploration was performed, and ruptures of the muscle bundles of mobile wad including extensor carpi radialis longus (ECRL), extensor carpi radialis brevis (ECRB), and the extensor muscles of the posterior compartment including extensor digitorum communis (EDC), extensor digiti minimi (EDM), and extensor carpi ulnaris (ECU), abductor pollicis longus (APL), extensor pollicis brevis (EPB), and extensor pollicis longus (EPL) were repaired primarily (Fig. 2). The patient was discharged without any surgical complications on seventh postoperative day.

However, during outpatient follow-up on the 52nd postoperative day, the patient presented with extension lags of 20° of the right thumb, 20° of the index finger, and 30° of the little finger (Fig. 3). Extensions of the middle finger, ring finger, and wrist were intact. No sensory deficits were observed. Functional loss of the APL, EPL, EPB, EDM, and extensor indicis proprius (EIP) innervated by the descending branch of the PIN was suspected. Assuming a neglected neurovascular bundle injury of the PIN, we immediately performed a delayed exploration through the previous surgical scar. Intraoperatively, the wound extended both proximally and distally. After dissection of the intermuscular septum between the EDC muscle and the muscle bundles of the ECRB and ECRL, the proximal cutting end of the PIN was traced along the posterior interosseous artery (PIA) using handheld Doppler. The PIN running along the PIA was completely crosscut at the site of the crosscut, which was 11 cm distal from the elbow and 16 cm proximal to the wrist (Fig. 4). The cut ends of the PIN with 0.4 cm × 0.3 cm-sized ball-shaped neuroma formation at the proximal end were observed. The proximal and distal

Fig. 3. On the 52nd postoperative day during outpatient follow-up, the patient presented delayed symptoms of the right thumb drop with weakness, index finger's extension lag of 20°, and little finger's extension lag of 30°. Extensions of the middle and ring fingers were intact. Wrist extension was intact and there was no sensory deficit.

nerve endings were released from the severely adhesive fibrotic scar tissues. After resection of the neuroma, the nerve gap between the proximal and distal end was 2.5 cm in length (Fig. 5A).

The distribution of the distal end of the descending branch of the PIN into the EPL and APL muscles at the dorsal-ulnar aspect of the forearm was identified (Fig. 5A), which presented an extension lag and loss of abduction of the thumb on physical examination. The intactness of the third and fourth finger extensions can be attributed to the intact distal recurrent branch of the PIN between the interval of the ECRB and the EDC, as the severed level was more distally located (Fig. 4).

We harvested 5 cm of posterior antebrachial cutaneous nerve. For delayed tensionless nerve repair of PIN (motor nerve), the sensory nerve direction was reversed and utilized as a double-strip cable graft (Fig. 5B, C). Epineurial suturing of the strips using a 9–0 Ethilon were performed. The patient was discharged without surgical complications. However, the patient was lost to follow-up in the third postoperative month.

Discussion

Neglected nerve injuries may have severe and detrimental consequences for patients, particularly when proper motor nerve reconstruction is lacking. Injuries to the median and ulnar nerves are more frequently encountered in hand and forearm injuries than in the PIN [1–5], and these injuries can be effectively repaired. However, because of their deep anatomical course, PIN injuries are often overlooked during the initial diagnosis, resulting in delayed and suboptimal treatment, as reported in the literature [7–9]. PIN injuries mostly occur as a complication of Moteggia fracture [1], direct injuries such as lacerations to the radial side of the volar aspect of the proximal forearm [2], or even indirect compressions [6]. Neuropathy of the PIN is caused by compression lesions such as thrombosed vessels compressing the PIN after posterior elbow dislocation [5], or bleeding into the superior radioulnar joint following Thompson's approach [4].

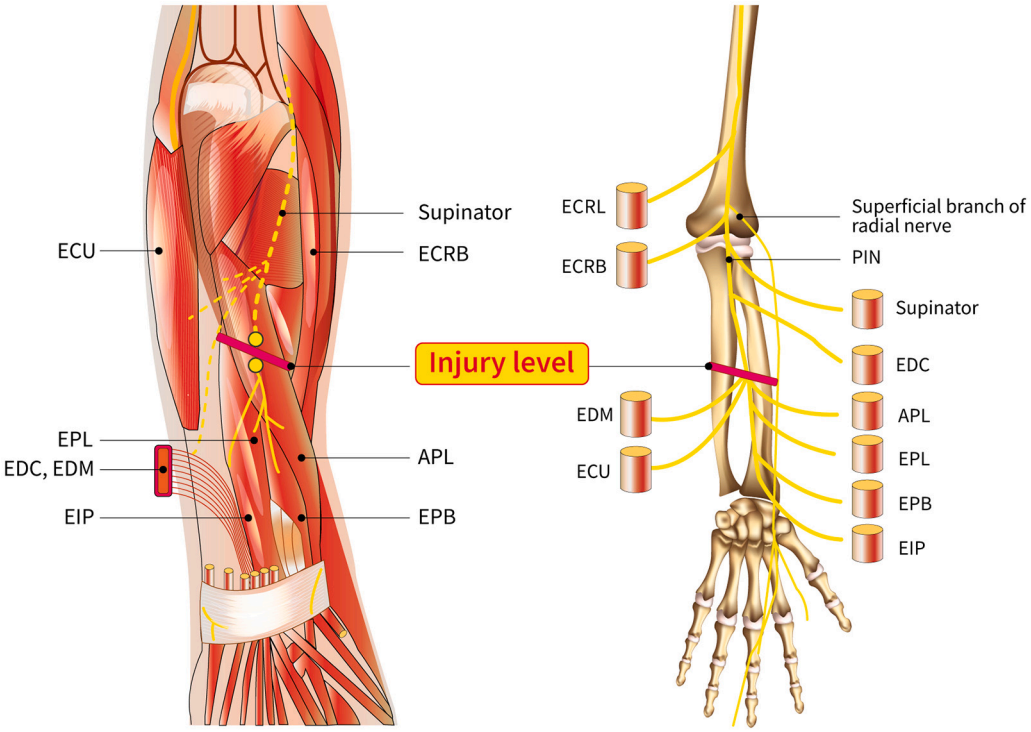

Fig. 4. Illustration of the posterior interosseous nerve (PIN) anatomy and innervation with injury level at the forearm (red line).
ECRB, Extensor carpi radialis brevis; ED, extensor digitorum; EDC, extensor digitorum communis; EDM, extensor digiti minimi; EIP, extensor indicis proprius; ECU, extensor carpi ulnaris; APL, abductor pollicis longus; EPB, extensor pollicis brevis; EPL, extensor pollicis longus.

PIN compression typically results in weakness of the extensor muscles without accompanying pain. It can manifest as a reduction in grip strength, which may progressively affect the fingers, thumb, and wrist, accompanied by deep pain in the extensor region of the forearm. Clinical signs such as radial deviation and dropping of the ulnar fingers are indicative of isolated damage to the distal recurrent branch of the PIN, occurring between the supinator muscle within the interval of the ECRB and EDC [8]. Hirachi et al. [7] conducted a study on traumatic PIN injuries and categorized them into three types based on their underlying mechanisms. Type I represents complete PIN palsy characterized by weak wrist extension, radial drift, and loss of extension at the metacarpophalangeal joint of all fingers and the thumb. Type II involves injury to the recurrent branch of the PIN, resulting in loss of extension, specifically in the little and ring fingers, whereas the extension of the thumb, index finger, and middle finger remains intact. Type III corresponds to an injury to the descending branch of the PIN, which leads to loss of extension of the index finger and thumb, accompanied by loss of thumb abduction. The extension of the other fingers remains unaffected. As described in the literature, the clinical presentation of PIN injuries can vary according to the level of nerve severance.

In our case, the clinical manifestation indicated a type III PIN palsy, which was accompanied by symptoms suggesting involvement of the branch in the EDM. However, our patient had a level of severance compared just to the distal level of that of a type I palsy. The PIN was cut at a level proximal to the descending branch running into the APL, EPB, EPL, and EIP muscles at the dorsal-ulnar aspect of the forearm (Fig. 5A). Functional loss of the APL, EPB, and EPL innervated by the descending branch of the PIN was suspected to be the reason for the extension lag with loss of thumb abduction, while the extension lag in the index and little fingers was related to the EIP and EDM muscles, respectively. The preservation of the third and fourth finger extensions can be attributed to the severance level immediately before branching to the EPL and APL (Fig. 5B).

In cases of non-traumatic PIN palsy, significant improvements in motor function can be achieved by removing space-occupying lesions or addressing factors causing compression of the PIN. Conversely, in direct traumatic injury leading to nerve severance, nerve repair can be pursued through two available options [9]. First, neurorrhaphy can be performed within a few days after injury. Second, autologous nerve grafting can be employed when the nerve gap is shorter than 5 cm, allowing for potential implementation even up to seven months following the injury. We applied delayed nerve graft on the 52nd day after the injury. On the other hand, tendon transfer is considered when the nerve gap exceeds 4 cm [10]. Surgeons typically wait for a period of four to six months before attempting tendon transfer due to the elevated risk of severe complications, such as extensive scarring and skin loss [9,10].

It is worth noting that the PIN is primarily responsible for motor function, with the exception of providing sensory innervation to the wrist, as it also innervates the periosteum of the radius, interosseous membrane, and dorsal capsule of the wrist [7,8]. Even though easily neglected, early identification of PIN palsy has been associated with significantly better outcomes relative to other nerve injuries, and even delayed repair should be attempted. One suspected cause is the largely homogenous motor fiber composition of the

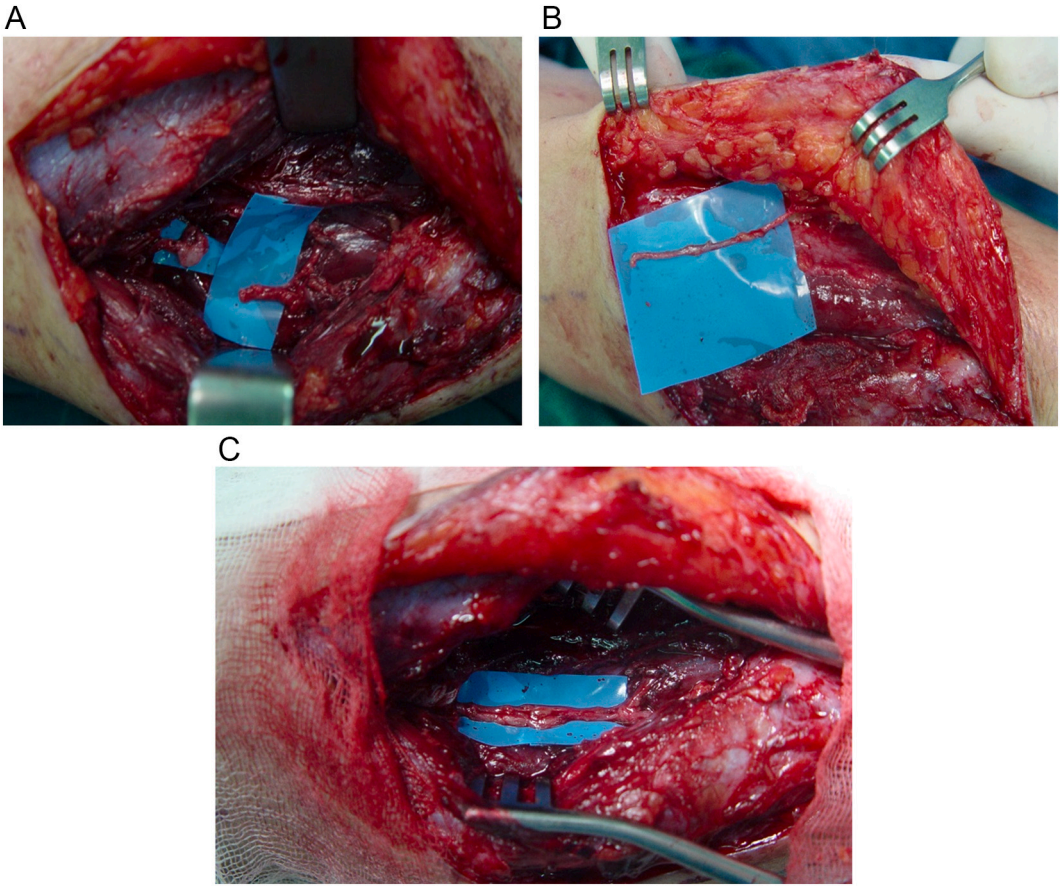

Fig. 5. (A) Assuming a possible neurovascular bundle injury, we performed delayed exploration and found transected posterior interosseous nerve (PIN) in the wound. There was a neuroma formation at the proximal end of PIN. After resection of the neuroma, nerve gap between the proximal and distal end was 2.5 cm. (B) Posterior antebrachial cutaneous nerve was harvested for delayed nerve repair. (C) Cable grafting was performed using the harvested posterior antebrachial cutaneous nerve.

PIN, which tends to regenerate more completely following epineurial suturing [9] and early mobilization of the volar and dorsal musculature compared to primarily mixed-type or sensory nerve fibers [7–9].

In conclusion, this case demonstrates that clinical presentation can vary depending on the level of PIN severance following trauma or inadvertently during surgery. As evaluating such injuries during the initial examination can be challenging, hand surgeons must exercise extreme caution in accurately diagnosing and defining the probable level of PIN involvement. Even if initially overlooked, delayed repair should be performed immediately after the correct detection.

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Informed consent

Written informed consent was obtained from the patient for their anonymized information to be published in this article.

Declaration of competing interest

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Statement of animal and human rights

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008 (5). Informed consent was obtained from all patients for being included in the study.

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