Isolated Injury of the Posterior Interosseous Nerve Complicating a Deep Laceration of the Proximal Forearm Dorsolateral Muscles: A Case Report

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Isolated injuries of the posterior interosseous nerve (PIN) or its branches without additional damage of the superficial radial nerve are rare and are usually caused by penetrating injuries.[1–3] Injuries of the PIN caused by extensive proximal forearm lacerations without damage of the superficial sensory branch of the radial nerve have not been yet reported to the best of our knowledge. Although 12 cases of PIN palsies caused by forearm lacerations are mentioned in several articles in the English literature,[4–6] in none of them the above combination is described. In such a case, the intact sensation could mask the underlying motor neuronal damage, because the loss of both carpal and finger extension can be satisfactorily explained by the extensor muscles laceration.

The radial nerve divides into the PIN and the superficial radial nerve within an area 3 cm proximal or distal to the elbow joint. The PIN enters the radial tunnel and rests directly superficial and anterior to the radiocapitellar joint, before entering the supinator muscle through the Arcade of Frohse.[7] As the PIN exits the supinator, it divides into two major branches: the recurrent branch, supplying the superficial layer of extensor muscles (extensor digitorum communis, extensor digiti minimi, and extensor carpi ulnaris), and the descending branch for the deep extensors (abductor pollicis longus, extensor pollicis longus and brevis, and extensor indicis proprius).[8]

We report a case of wrist and all five fingers drop caused by an extensive forearm laceration at the level of the radial neck without any sensory loss of the hand. The main feature of the injury was the PIN damage before its division to its major branches, which was diagnosed by careful clinical examination on musculoskeletal and neurologic basis and treated immediately postinjury.

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CASE REPORT

A 55-year-old man who was carrying a 2 m × 2.5 m large, 4-mm thick glass plate, sustained an injury, while loading the plate on a truck and holding it above his head. The plate was cracked and a large fragment fell on the dorsolateral side of his right forearm, just below the elbow joint, causing an extensive laceration wound of 10 cm in length (Fig. 1). At admission, the patient was unable to extend the wrist and all five fingers, while sensation over the whole area of the radial nerve distribution was unaffected.

The clinical manifestation was primarily attributed to the muscle injury, and the patient was referred to the orthopaedic team for further treatment. Although the loss of carpal and finger extension could be explained by the extensor muscles laceration, it was the observed lack of thumb extension, which raised the suspicion of a possible neuronal involvement, because both extensor pollicis longus and extensor pollicis brevis muscles originate at the middle third of the dorsal side of the forearm, hence more distally to the injury site.[9]

The surgical exploration was performed by one (P.K.G.) of our two qualified upper limb surgeons trained in microvascular surgery. One of them is always available and in charge of dealing with such complicated neurovascular upper limb injuries. Intraoperatively, the wound was extended proximally and distally, and the extensor muscles of the posterior compartment (extensor digitorum, supinator, extensor digiti minimi, and extensor carpi ulnaris) as well as the muscles of the mobile wad (brachioradialis, extensor carpi radialis longus, and extensor carpi radialis brevis), were found to be totally severed through the muscle belly. The PIN was also identified to be completely crosscut, in contrast to the intact superficial, sensory branch of the radial nerve (Fig. 2, A).

After a thorough surgical preparation, the proximal and distal nerve endings were mobilized. The nerve injury was a "clear-cut" injury without significant neuronal tissue loss, and the nerve endings could be reapproximated without tension. Furthermore, the fascicular orientation could be easily identified. Taken these facts into consideration, epineurial suturing was chosen and was performed under 3.5× magnification without tension, using microsurgery instruments with 8-0 blue, monofilament, nonabsorbable polypropylene sutures (Medipac, Kilkis, Greece). The epineurial suturing consisted

Figure 1. An extensive laceration wound of 10 cm in length, caused by a glass plate that had fallen on the dorsolateral side of the right forearm, just below the elbow.

of four independent sutures, two on the front and two on the back nerve surface (Fig. 2, B). Subsequently, the injured muscles were sutured by end-to-end braided, violet, synthetic absorbable polyglycolic acid 2-0 sutures (Medipac).

Postoperatively, the arm was immobilized for 4 weeks in a "Sugar-Tong" splint with the wrist in extension and the fingers in the safe position. The removal of the splint was followed by supervised active mobilization. Almost full recovery of carpal extension was obtained at 6 weeks postoperatively, after muscle healing, whereas finger and thumb extension recovered gradually and was restored completely after 12 months, thus, being in accordance with the prerequisite axonal regeneration of the PIN.

Conduction studies performed at 3 months and 6 months postinjury suggested both a severe axonal damage of the PIN and that the nerve had entered a regeneration phase, while the radial sensory branch was found intact. Electromyographic examination at 1 year postinjury confirmed the successful reinnervation of the extensor muscles innervated by the PIN. The patient was able to return to his prior activities 14 months postoperatively and at the latest follow-up at 32 months, the hand function and strength had returned to normal level (Fig. 3, A and B).

DISCUSSION

Although injuries of the forearm are common, injuries to the PIN are relatively rare because of the deep course of the nerve in the forearm.[10] The median and the ulnar nerves are more commonly injured than the PIN.[10] However, it is quite frequent in PIN injuries that early diagnosis is missed, thus leading to a late, nonoptimal treatment.[6,11]

Traumatic PIN palsies have been categorized by Hirashi et al. into three types:

Type I—complete PIN palsy producing weak wrist extension with a radial drift, extension loss at the metacarpophalangeal joints of all fingers and the thumb, and weak abduction of the thumb.

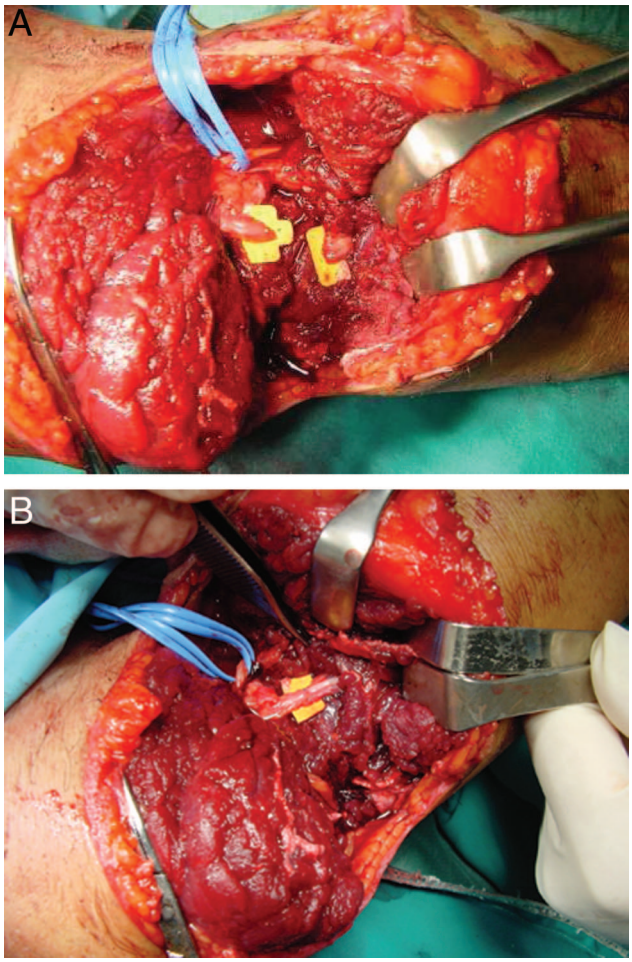

Figure 2. (*A*) Intraoperatively, the PIN was found to be completely dissected, whereas the sensory superficial branch (lassoed with the blue vessel loop) remained intact. (*B*) An epineurial repair of the PIN was performed under 3.5× magnification without tension, using 8-0 nonabsorbable polypropylene sutures.

Type II—loss of extension of the little and ring fingers, without loss of extension of the index, thumb, and middle fingers, resulting from injury of the recurrent branch.

Type III—loss of extension of the index and the thumb, and loss of abduction of the thumb without loss of extension of other fingers, resulting from injury to the PIN descending branch.[5]

In our case, which resembles a type I Hirashi traumatic PIN palsy, an additional damage of the extensor muscles not innervated by the PIN also occurred and further obscured the immediate postinjury manifestation. The loss of both carpal and finger extension could be satisfactorily explained by the extensor muscles laceration, but it was the observed lack of thumb extension that raised the suspicion of a possible neuronal involvement, based on the knowledge that both extensor pollicis longus and extensor pollicis brevis muscles originate more distally to the injury site. This "anatomically-based" suspicion of PIN injury was completely confirmed intraoperatively.

The almost full recovery of carpal extension after 6 weeks is explained by the healing of extensor carpi radialis

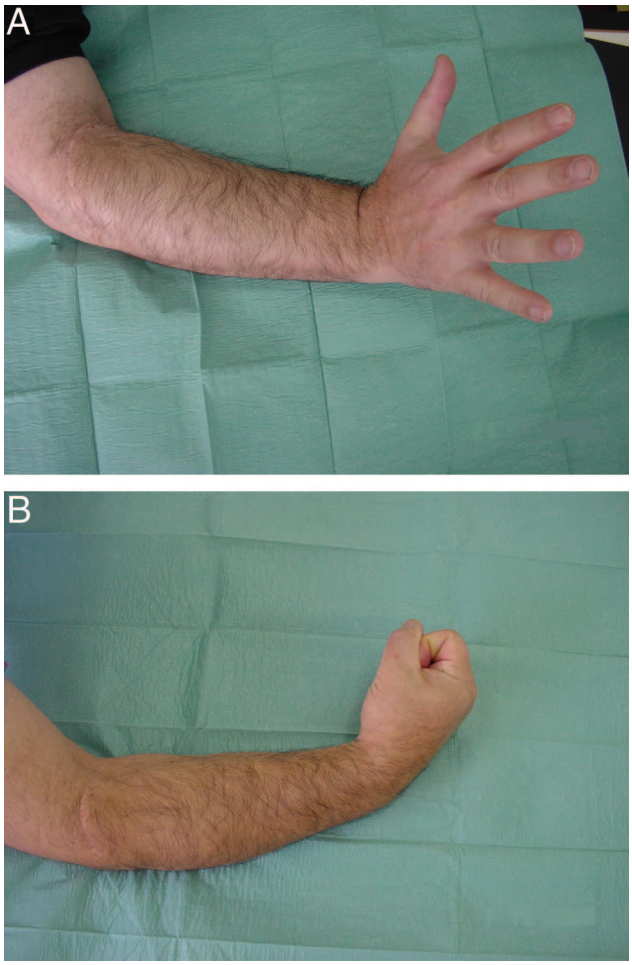

Figure 3. At 32 months postinjury, the functional result is excellent with normal wrist and finger extension (*A*) and flexion (*B*).

longus and extensor carpi radialis brevis, which are innervated by radial nerve branches arising well above the injury site.[9] Finger and thumb extension recovered gradually and was completely restored after 12 months after the prerequisite axonal regeneration of the PIN.

Emergency department physicians should be aware of the possibility of a PIN injury, when a patient presents with a penetrating or laceration wound of the extensor surface of the proximal forearm. It is imperative that the distal neurologic status of the involved limb is properly examined and recorded to reveal any underlying neurologic damage. In the case of a penetrating injury any loss of wrist and finger extension should alert the physician for a possible PIN injury. Moreover, an extensive laceration wound of the proximal forearm without sensory deficit is by far more complicated. The preservation of sensation due to the intact sensory branch can obscure the diagnosis of the underlying motor branch injury, as the clinical picture could be easily attributed solely to the more striking muscle trauma.

Although the paralysis due to a PIN injury can be treated satisfactorily by tendon transfers, there are numerous reports indicating that a reinnervated muscle is functionally and biomechanically superior over a tendon transfer,[12,13] and there is general agreement that exploration and repair of the PIN is preferable to tendon transfers as the gold standard of treatment.[2,6] In an acutely treated case, direct neurorrhaphy is preferable when there is no substantial gap, and the nerve ends can be adequately mobilized and reapproximated to allow end-to-end suturing without tension.

Muscles innervated by the PIN act as synergists, and the PIN contains almost exclusively motor neurons and has a simple funicular pattern. Because there is only a relatively short distance needed to be covered by the regenerating axons to reach the target muscles, functional recovery can be predicted to occur within a few months. Because of these anatomic features, the results of repairing this nerve are thought to be superior than those of other peripheral nerves.[2,5,14] Although it was reported that functional results may not be satisfactory if a PIN injury is associated with extensor muscle damage,[5] in our case, the coexistence of an extensive muscle laceration injury did not compromise the end result.

In conclusion, we think, that despite its rarity, emergency department physicians must always bear in mind the potential risk of a PIN injury complicating a forearm laceration. Normal sensation does not necessarily mean normal neuronal motor function. When the emergency physician detects a forearm laceration with a nerve injury, the patient should be referred to a surgeon skilled in microvascular surgery.

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