Outcome of repairing posterior interosseous nerve (PIN) injury

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Abstract

Introduction: The posterior interosseous nerve (PIN) is the terminal branch of the deep branch of the radial nerve. It providing movement for the posterior forearm, controlling extension of the wrist and fingers. PIN injury severely affects hand function so it should be diagnosed and repaired promptly. Microsurgical repair of the PIN will recover the best results. The purpose of this study: evaluate the efficient of repairing posterior interosseous nerve by microsurgery.

Patients and methods: Retrospective and prospective study base on 21 patients with PIN injury who was performed microsurgery repair from 2018 to 2022. Assessment of recovery outcomes by using The Louisiana State University Health Science grading system - 2020 (LSUHS) and classified into 3 groups: Good (grade 4, 5); Fair (grade 3. 2); Poor (grade 0. 1).

Results: There are 14 men and 7 women, aged from 6 to 47. Cause by wounds: 12/21 cases, after previous surgery: 7/21 cases, nerve compression: 2/21 cases. Direct repair (nerve grafting): 20/21 cases, end-to-end neurorrhaphy were performed in: 1/21 case. Time follow-up ranged from 3 months to 60 months. Results: Good: 17/21 (80.95%) cases; Fair: 5/21 (19.05%) cases; Poor: no cases.

Conclusion: As results: Good: 17/21 (80.95%) cases; Fair: 5/21 (19.05%) cases; Poor: no cases. PIN injury severely affects hand function, so it should be diagnosed and repaired promptly by microsurgery.

Keywords: Posterior Interosseous Nerve, Nerve injury, Microsurgical peripheral nerve

Introduction

The posterior interosseous nerve is the terminal branch of the deep branch of the radial nerve. This pure motor nerve branch governs the movement of the posterior forearm muscles of flexing the wrist and extending the fingers. Injury to the posterior interosseous nerve severely affects the function of the hand: inability to open the fingers and weak wrist extensor and rotator cuff tilt. Many pathologies damage the distal radial nerve, such as radial neural tube syndrome, posterior interosseous nerve syndrome, and Wartenberg syndrome [1]. The most common cause of posterior interosseous nerve injury, according to the literature, is compression [2], [3], [4]. However, the cause of injury or complications of routine surgery in the forearm is not lesions that are rare and easily missed. According to the literature, the ratio of posterior interosseous nerve damage in men/women is 2/1, in the right/left hand is 2/1 [5], and the degree of muscle paralysis depends on the severity of the nerve damage. For the right and timely interventions, the patient must diagnose injury to the posterior interosseous nerve early and accurately. Diagnosing posterior interosseous nerve injury is easily detected through clinical examination. In addition, the element in theevaluationof peripheral nervesasmagnetic resonance imaging 3.0, electromyography, and ultrasound, may disclose etiological information not available for clinical or neurophysiological assessment.

Treatment of posterior interosseous nerve injury, according to the literature, is mainly surgical decompression [2], [3], [4]. Posterior interosseous nerve injuries due to trauma or sharp objects require neurosurgery by microsurgery at the level of fiber sheath to provide the best recovery results. However, there are very few reported documents, and in Vietnam, there is currently no summary report on treating posterior interosseous nerve grafting with microsurgery. Therefore, we conducted this study with objectives: to evaluate the results of posterior interosseous nerve graft surgery by microsurgery.

Patients and methods

Subjects: A retrospective, cross-sectional study of 21 patients with interosseous nerve injury who underwent neurosurgery by microsurgery from 2018 to 2022 at the Department of Maxillofacial-Plastic Surgery, Viet Duc University Hospital with the following standards:

Patients with the time of PIN injury after < 6 months.

Patients operated by the same group of surgeons.

Exclusion: Patients with neurological damage > 6 months.

Methods:

Patients underwent clinical examination, electromyography, ultrasound, or MRI 3.0. Before surgery, the patient was photographed and taken clip with stretching postures, supine wrist, and fingers.

Surgical procedure:

The patient under general anesthesia without muscle relaxants

Re-operating the old wound, extending or entering the posterior part of the upper 1/3 and the middle 1/3 of the forearm.

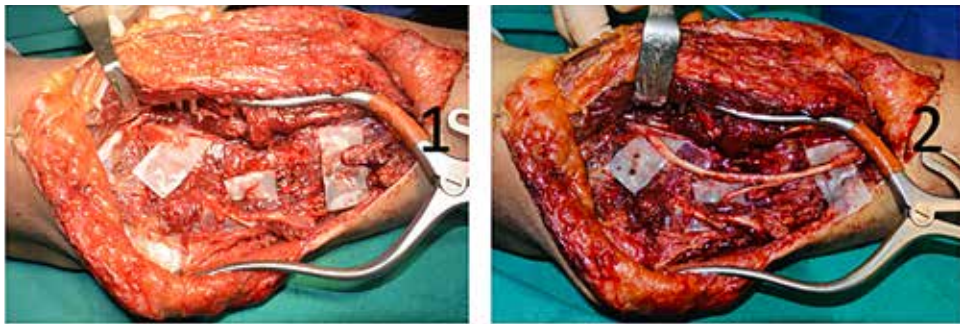
Dissect in the middle of 2 sets of supraclavicular muscles, and find the central head from the lateral biceps groove to the level of the elbow crease running around the top of the radial bone; the peripheral head divides into two motor branches for the muscles here.

Dissect the nerves under the microscope. Cut both ends of the damaged nerve to the healthy part; the nerve fiber bundles can be seen.

Measure the distance of the nerve defect.

Take the saphenous nerve segment for nerve graft.

Direct nerve anatomose (in early cases) or grafting the saphenous nerve segment by microsurgery technique under the surgical microscope with Nilon 10.0, 11.0 sutures.



Patient: Duy – V. TO 24 years old. Pic 1, 2: Before and after nerve graft by microsurgery

Rehabilitation exercise postoperative one week.

Examination and assessment outcome:

Post-operative follow-up milestones: 3 weeks, three months, six months, one year. Then every six months.

Evaluation criteria when re-examination:

Results 3 weeks early: assessment of wound healing, cast removal, and exercise instruction.

The following time points: assess the recovery of movement and strength of the muscles: ulnar wrist extensor, extensor finger.

Assessment of Individual muscle grades–distal RN lesion involving posterior interosseous nerve (PIN) base on The Louisiana State University Health Science grading system - 2020 (LSUHS) (Tab.1)

Table 1. Individual muscle grades–distal RN lesion involving posterior interosseous nerve (PIN)

Grade	Evaluation	Description
0	Absent	Absent extensor carpi ulnaris, extensor communis/extensor pollicis longus muscle function
1	Poor	Trace of contraction in the extensor carpi ulnaris muscle against gravity only; absent extensor communis and pollicis longus muscle function
2	Fair	Recovery of the extensor carpi ulnaris muscle; absence or trace of the extensor communis or the extensor pollicis longus muscle, or both
3	Moderate	Recovery of the extensor carpi ulnaris muscle, some extensor communis muscles, absence or trace of the extensor pollicis longus muscles
4	Good	Full strength of the extensor carpi ulnaris muscle, recovery of the moderate strength of extensor communis and the extensor pollicis longus muscles
5	Excellent	Full recovery of the extensor carpi ulnaris, extensor communis, and the extensor pollicis longus muscles

In this study, outcome classified into 3 groups: Excellent (grade 4, 5); Moderate (grade 3. 2); Poor (grade 0. 1).

Results

From 2018 to June 2022, 21 patients with PIN injuries were repaired nerve by microsurgery, including 14 males and seven females, aged 6 to 47 years, with a mean age of 30.8.

The majority of injuries caused by sharp wounds (cutting knives, falling glasses) in 12/21 cases, nerve injuries after previous surgery as cutting lesions and removing tumors in 7/21 cases, and in 2/21 cases is compression. The left hand is 12/21 cases, and the right hand is 9/21 cases.

20/21 patients were operated on in the second phase, and only one patient had surgery in the early period within 72 hours after the injury.

For patients undergoing surgery in the second trimester, the average time from injury to nerve transplantation surgery was 2.8 months, and the earliest was one month; the latest was seven months. 20/21 cases were operated on nerve transplantation by saphenous nerve, 1/21 cases of direct anastomosis, and this is the case in the early stage.

Table 2. Results of repairing PIN injury

Num	Age/Sex	Time from PIN injury to operative	Time onset of recovery (month)	Direct anatomes/ Nerve graft	Classification of LSUHS postoperative	Time of follow up (month)
1.	6/M	2	2	NG	5	38
2.	26/M	2	2	NG	5	34
3.	34/M	3	5	NG	4	35
4.	23/M	3	4	NG	5	27
5.	26/M	5	1	NG	4	26
6.	44/M	2	4	DA	5	16
7.	14/F	2	2	NG	5	13
8.	35/F	1	4	NG	5	48
9.	27/F	2	3	NG	5	40
10.	42/F	2	3	NG	4	34
11.	32/F	4	4	NG	4	12
12.	26/M	2	5	NG	5	22
13.	28/M	1	3	NG	4	22
14.	36/M	1	2	NG	5	21
15.	19/M	6	3	NG	4	13
16.	29/M	2	3	NG	4	12
17.	47/M	3	2	NG	3	5
18.	38/F	3	3	NG	3	4
19.	34/F	4	3	NG	2	3
20.	39/M	2	2	NG	2	3
21.	42/M	3	2	NG	3	4

The average postoperative follow-up time was 20.6 months, the longest was 48 months, and the shortest was three months. The average postoperative recovery time is 2.9 months; the earliest is one month after surgery, and the latest is five months after surgery.

Overall results of study: 17/21 (80.95%) achieved excellent recovery, 5/21 (19.05%) achieved moderate recovery, and no cases showed poor results.

Discussion

In 2006, Latimovic et al. reported that the incidence of radial nerve injury (including posterior intervertebral nerve) was 1.4 in women and 3.0 in men per 100,000 UK population, including traumatic injury and wound [5]. In our report, the male/female ratio is also 2/1, which can be explained by the fact that men participate in more activities and labor than women. Age is also one of the factors affecting the outcome of recovery; the younger the patient's age,

the higher the recovery outcome due to the better ability to regenerate and restore nerve distribution in younger patients. Twenty years old had significantly better recovery outcomes than older patients [6], [7], [8], [9]. In our study, most of them are of working age (average 30.8 years old), and there are only two patients under 18 years old.

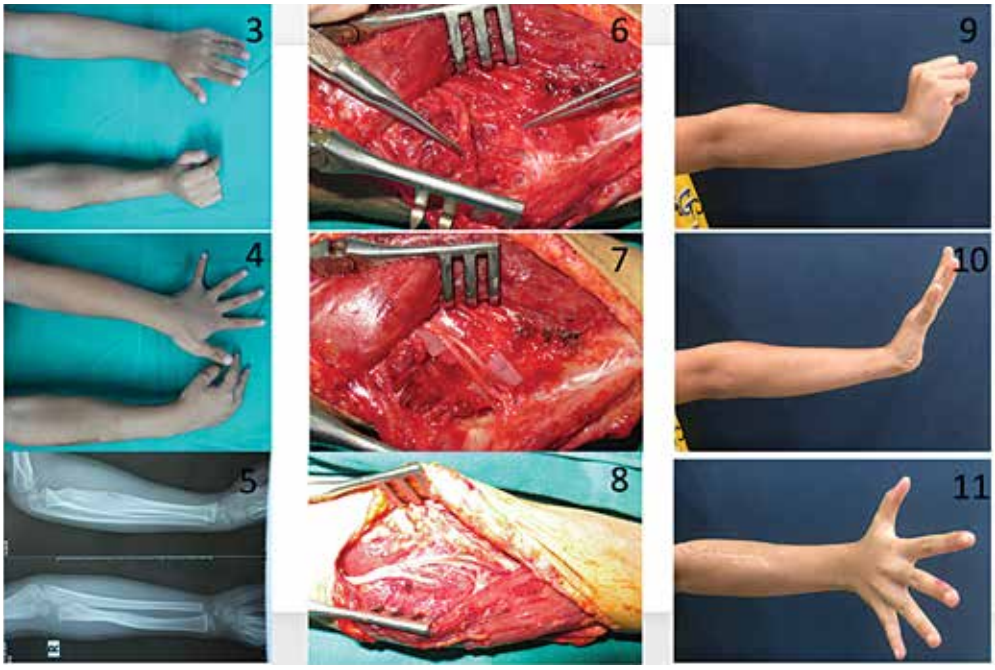
The literature reports that the most common cause of injury to the posterior interosseous nerve is compression after soft tissue trauma or inflammation, with very few cases due to injury [2], [3], [4]. In our study, the majority (19/21 cases) was nerve injury caused by trauma, such as sharp and pointed objects, or after a previous surgical operation, such as removing the plate - screw, bone grafting, or tumor removal. , only 2 cases were due to previous soft tissue injury causing nerve compression. In the cases of severe injuries caused by sharp objects, most of them are due to violent accidents being cut by others, followed by sharp objects such as falling glass and iron bars. With the cause of injury due to a violent accident, patients often put outside the forearm to protect themselves, so PIN is the most vulnerable. Another reason that should also be noted is that after conventional surgical operations such as surgery for radial lesions such as fusion of bones, the head tumor on the radial bone, bone grafting, especially surgery to remove the means of connection. These surgeries use incisions on the back of the forearm, so it is effortless to injure the posterior interosseous nerve. In addition, the scarring from the previous surgery makes it difficult for orthopedic surgeons to distinguish the structure of the nerve, sometimes unintentionally not thinking about this nerve. In our study, up to 7/21 cases of secondary injury after surgery.

Diagnosis of PIN injury by clinical examination is usually sufficient; functional investigations such as EMG, ultrasound, or magnetic resonance imaging are necessary in some cases to confirm the diagnosis [4]. One benefit of these investigations is that it helps the surgeon to locate the lesion, plan the surgical method and prepare the length of the graft. In addition, there is evidence to exchange preoperative explanations for the patient. In this study, 100% of the patients were assigned to do neuromuscular electrodiagnosis and ultrasound before surgery.

Nerve repair time is divided into the early, second, and late periods. Studies show that repair interventions should be performed in the first operation as early as three days after the injury or in the second period as early as the third to the fifth week for the best results [6] [7] [8] [9]. In our study, most of them were done in the second and late period in 20/21 cases as one month, six months after the injury, and only one case was operated on within the first three days after injury. The timing operation was late for the following reasons: firstly, patients with wounds that often receive first aid sutures at lower-level facilities missed the PIN injury. The second reason was after conventional surgery, which in PIN injury was not considered, and the final reason was the patient could not stretch the wrist and hand due to edema and pain, so detection was often tricky.

Reports show that the common cause of posterior interosseous nerve injury is compression or degeneration. Therefore, surgical repair is usually decompression and, in rare cases, nerve graft, in no case directly anastomosed [2], [3], [4]. In our study, 20/21 cases were nerve grafts by the sural nerve; only 1 case could be directly connected because the damage was detected early and repaired early. The cases requiring nerve graft were 18/20 cases of second-stage repair and 2 cases of decompression surgery. The PIN is often missed in first aid or during muscle dissection to place a plate to fix the forearm bones. The stump nerves must be dissected to maximize length before grafting. Another reason is that the distal and proximal stumps were contracted, even damaged over a long distance. Therefore, 100% of the repaired lesions in 2nd phase require the use of nerve grafts. In two cases of compression injury, the nerve degenerated and neuroma after examination; we had to cut all the damage to the healthy stumps to repair the nerve.

After nerve repair surgery, degeneration and regeneration in the peripheral segment coincide. Nerve regrowth from the axons across the lesion site will occur within hours to days. The axon will regenerate to the periphery at different rates from 1 to 1.4 mm/day [10], [11], [12]. The recovery time depends on the location of the injury. All cases in our study were injured from the flexor carpi ulnaris muscle level downward, which is the most commonly injured location of the posterior interosseous nerve. The average time from repair surgery to recovery was 2.9 months, the earliest was one month, and the latest was five months after surgery. The first is the rehabilitation of the flexor carpal ulnar muscle because it is the shortest branch of the posterior interosseous nerve with the sign of flexion of the wrist and no longer tilting of the rotator cuff. Afterward, the fingers and thumb extensor muscles and thumb extensor muscles recover. The muscle strength gradually recovered over time and the rehabilitation exercise. Our follow-up time averaged 20.6 months from three to 48 months, of which 16/21 cases followed up over 12 months, and 5/21 cases were 3 to 4 months.



Patient: Xuan – T. Nguyen 06 years old.

(Pic 3,4,5: Before operation; Pic 6,7,8: During operation; Pic 9,10,11: After nerve graft 38 months)

The characteristics of each nerve will give different recovery results; purely motor or sensory nerves will give the best recovery results after repair. Mixed nerves have poorer postoperative recovery outcomes because, during surgery, it is difficult to distinguish which fascicle is motor or sensory, so regeneration after repair may reach the wrong target muscle. Pure motor or sensory nerves have only one fascicle type, so regeneration always reaches the correct target organ [6], [7]. Our study on the PIN is purely motor nerve, so the recovery is quite good in 9/21 cases, reaching levels 5 and 8/21 cases and reaching levels 4 and 5/21 cases, reached levels 2, 3. 5/21 cases achieved recovery levels of 2, 3 were patients with not long postoperative follow-up time (3-4 months). The overall result was that 17/21 (80.95%) achieved good recovery, 5/21 (19.05%) achieved moderate recovery, and there were no poor cases.

Conclusion

PIN injury that severely affects hand function must be diagnosed and treated early. The study's initial results show the effectiveness of nerve repair by microsurgery.

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