ORIGINAL ARTICLE

Acta Orthop Traumatol Turc 2012;46(6):438-442
doi:10.3944/AOTT.2012.2900

Peroneal nerve injury surgical treatment results

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Objective: The purpose of this study was to retrospectively evaluate the clinical and functional results of nerve grafting and end-to-end peroneal nerve repair between sciatic bifurcation and distal branching.

Methods: The study included 26 patients (22 men, 4 women; mean age: 19.9 years; range: 5 to 46 years) who underwent peroneal nerve repair between 1992 and 2009. Open nerve injuries were seen in 21 patients and closed injuries in 5. Surgical repair was performed with sural nerve grafting in 19 patients and end-to-end in 7. Mean nerve graft length was 5.42 (range: 2 to 15) cm with a mean 3.1 (range: 2 to 4) nerve cables used. Mean follow-up was 33 (range: 13 to 96) months. The British Medical Research Council (BMRC) scale was used for the evaluation of the tibialis anterior and peroneal muscles and Semmes-Weinstein monofilaments were used for protective sensation evaluation.

Results: Adequate and full recovery was observed in 19 patients (73%). Mean follow-up time was 39.3 months in patients undergoing nerve grafting and 30.1 months in end-to-end nerve repair. Fifteen of 19 patients with nerve grafting and 4 of 7 patients with end-to-end nerve repair had an adequate or full recovery. Posterior tibial tendon transfer to dorsal foot was applied in 3 of 7 patients without recovery. Protective sensory recovery was determined in 16 of 22 patients.

Conclusion: Good results in both end-to-end repair and in repair with grafting is possible in peroneal nerve repair.

Key words: Nerve graft repair; peroneal nerve surgery; peroneal nerve injury.

Peroneal nerve injuries are most commonly found in the lower extremity.[1] Etiology varies greatly, from penetrating injuries, gunshot wounds and knee traumas to iatrogenic injuries.[1-4] The tibialis anterior (TA), peroneus longus (PL), peroneus brevis (PB), peroneus tertius (PT), extensor hallucis longus (EHL) and extensor digitorum longus (EDL) muscles, innervated by the peroneal nerve, are generally affected following injury. Due to severely limited post-injury ankle dorsiflexion, drop foot deformity commonly occurs and, in turn, affects a patient's ability to walk. Additionally, dorsal foot sensation is also impaired.

After peroneal nerve injuries, the aim of treatment is to recover ankle dorsiflexion. However, there is currently no consensus on recovery following nerve repair in the literature. Some studies have reported poor recovery results and the posterior tibial tendon (PTT) transfer is recommended with or without nerve repair.[5-7] Roganovic reported that the recovery potential of the peroneal nerve is worse than the other peripheral nerves.[8] On the other hand, a large series from Louisiana State University has shown that good repair results can be achieved.[9]

The aim of this study was to retrospectively evaluate the results of sural nerve grafting and end-to-end

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Submitted: April 30, 2012 **Accepted:** October 8, 2012

Available online at
www.aott.org.tr
doi:10.3944/AOTT.2012.2900
QR (Quick Response) Code:

repair after peroneal nerve injuries from the sciatic nerve bifurcation throughout the common peroneal nerve (CPN) and its branches.

Patients and methods

Twenty-six patients (22 men, 4 women; mean age: 19.9 years; range: 5 to 46 years) who underwent peroneal nerve repair between 1992 and 2009 were retrospectively evaluated. End-to-end epiperineural nerve repair was performed in 7 patients and repair with sural nerve graft in 19.

Open nerve injuries occurred in 21 patients (81%) and closed nerve injuries in 5 (19%). Injury was caused by; penetrating injury in 16 patients, gunshot wound in 3, work accident in 2, and traffic accident in 5. Nerve injuries were also accompanied by knee dislocation in 1 patient, fibular head avulsion fracture in 1 patient and lateral collateral ligament (LCL) injury in one patient.

Patients were placed in prone position and both lower extremities were prepared under tourniquet control. The first part of the vertical incision was a broad S-shape and began in the short head of the biceps muscle. A broad portion of the incision crossed the fibular neck so that it could be better explored. The short head of the biceps muscle was elevated and moved laterally away from the CPN, giving a much clearer visual inspection. The dissection was continued to the lateral popliteal space where the nerve passed under the fibula. The nerve dissection was continued by cutting the lateral gastrocnemius fascial extension and soleus muscle. Whether the CPN branched into deep and superficial branches or not was recorded. The injuries in all our patients were above this level. The posterior edges of muscles and peroneal fascia were explored by sharp dissection.

The peroneal muscles were retracted laterally and inferiorly to provide better visualization of the superficial peroneal nerve. A Penrose drain was placed around the superficial CPN and the deep branch was reached. During dissection, small vessels were sealed by bipolar cautery.

The nerve was dissected proximally and distally until healthy nerve endings in the injured area were located. End-to-end epiperineural nerve repair was performed in 7 patients with 8/0 non-absorbable sutures where there was no tension between healthy proximal and distal nerve endings. In 19 patients where end-to-end repair was not possible, group fascicular nerve repair was performed with 8/0 non-absorbable sutures by placing an interpositional sural nerve graft taken from the opposite leg into the defect. The sural nerve graft averaged 5.42 (range: 3 to 15) cm. The average number of cables used was 3.1 (range: 2 to 4).

The average duration between injury and surgical intervention was 28.9 (range: 1 to 180) days. Primary (first 3 days) or delayed (4 to 7 days) nerve repair was performed on 12 patients and secondary (after the 7th day) nerve repair was performed on 14. A long leg splint with the knee flexed at 30 degrees was used for 3 weeks in patients without extra injuries (93%). Following splint removal, a peroneal paralysis orthosis was applied until active ankle extension began.

The British Medical Research Council (BMRC) scale was used to evaluate peroneal nerve repair.[2] Recovery of TA and peroneal muscles was determined as full in patients with M4-M5 muscle strength classification, satisfactory in patients with M3, fair in M1-M2 patients, and poor in M0 patients. The Semmes-Weinstein monofilament test was used to evaluate recovery of sensation for the first dorsal web space. Patients scoring a minimum of 4.56 were considered to have a recovered sense of protection (Table 1).[10]

Results

The muscle strength obtained from TA and PB-PL at the end of surgical treatment are presented in Table 2. Adequate and full recovery occurred in 19 (73%)

Table 1. The British Medical Research Council and Semmes-Weinstein sensation test criteria.

The British Medical Research Council scale for muscle strength		Semmes-Weinstein monofilament test scale	
M5	Normal power	Group 1 (2.83-3.61)	Normal
M4	Movement against gravity and resistance	Group 2 (4.31)	Diminished light touch
M3	Movement against gravity (no resistance)	Group 3 (4.56)	Diminished protective sensation
M2	Movement with gravity eliminated	Group 4 (5.07)	Loss of protective sensation
M1	Flicker	Group 5 (6.65)	Not testable
M0	Total paralysis		

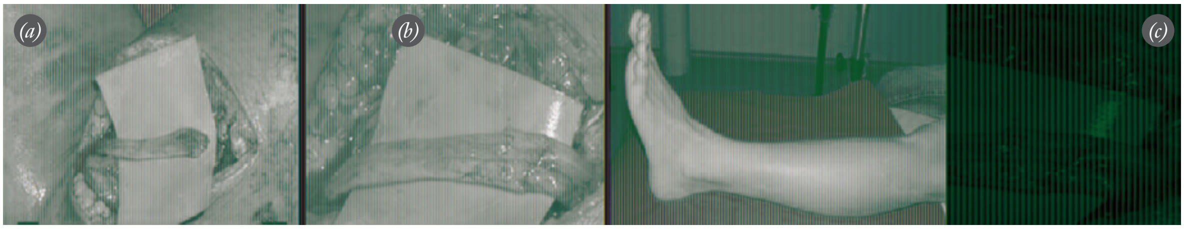

Fig. 1. **(a)** Preoperative, **(b)** perioperative, and **(c)** postoperative 19th month images of a 17-year-old patient who underwent end-to-end nerve repair. [Color figure can be viewed in the online issue, which is available at www.aott.org.tr]

Fig. 2. **(a)** Preoperative, **(b)** perioperative, and **(c)** postoperative 23rd month images of a 29-year-old patient who underwent nerve repair with autologous grafting. [Color figure can be viewed in the online issue, which is available at www.aott.org.tr]

patients. M2 muscle strength was seen in 3 patients, M1 in 2 and M0 in 2.

Adequate and full recovery was observed in 15 of 19 patients with grafted nerve repair at the end of an average 39.3 months of follow-up (Fig. 1). Of these patients, two patients had M2 muscle strength and two had M0. In the 7 patients who underwent end-to-end nerve repair, adequate and full recovery was seen in 4 patients after an average follow-up of 30.1 months (Fig. 2). Of these, one patient had M2 muscle strength and 2 had M0 and one patient underwent reoperation since no recovery was determined in the 20th month.

Functional restoration was performed in 3 patients who still presented inadequate ankle dorsiflexion strength by transferring PTT to the dorsum of the foot after a minimum of 2 postoperative years.

In the sensorial evaluation, protective sensation was regained in 16 of 22 patients on the dorsal area of the first web space. Protective sensation was regained in 12 of the patients with grafted nerve repair and 4 with end-to-end nerve repair (Table 2).

Discussion

Fewer studies regarding the treatment of lower extremity nerve injuries have been reported than those regarding upper extremity injuries. Although easy to clinically diagnose, the published results for surgical treatment of peroneal nerve injuries vary.[3,5-8]

Clawson and Seddon reported 36% motor recovery in 72 patients with peroneal nerve repair.[5] Millesi[2] performed neurolysis on 13 of 44 patients and observed full recovery. On the other hand, poor functional results were observed in 2 patients with end-to-end nerve repair. Kim and Kline, in their series of 218 CPN injuries, obtained good results in 16 of 19 patients who underwent end-to-end nerve repair.[3] In our study, 4 of 7 end-to-end nerve repair patients obtained muscle strength scores of M3 or above. One patient showing no recovery after end-to-end nerve repair underwent PTT transfer.

The mobility and elasticity of the peroneal nerve is lower than in other peripheral nerves. Therefore, nerve grafting is often preferred, with the sural nerve

Table 2. Muscle strength results of surgical treatment methods.

	M5	M4	M3	M2	M1	M0	Total	G1	G2	G3	G4	G5	Total
Graft repair	6	6	3	2	2	-	**19**	3	5	4	2	1	**15**
End-to-end repair	2	2	-	1	-	2	**7**	-	-	4	1	2	**7**
Total	8	8	3	3	2	2	**26**	3	5	8	3	3	**22**

most commonly used as donor. Wood noted that the ipsilateral sural nerve should be removed only if sensory function is damaged and the sural nerve graft taken from the opposite leg if sensory function ipsilaterally is saved.[7] Many studies have reported poorer clinical recovery post grafting than following end-to-end repair. Millesi determined functional recovery in 16 of 29 patients undergoing repair with nerve grafting and suggested direct PTT transfer with grafted nerve repair or without any nerve repairs in the selected patients.[2] Matejcík[11] performed operations on 40 patients and obtained functional recovery in 3 of 12 patients who underwent nerve grafting. It was noted by Matejcík that the longer a nerve graft is, the worse the clinical results were. However, there is still no consensus on critical length affecting nerve repair results. Kim and Kline[3] reported recovery rates following nerve grafting 50% worse than end-to-end nerve repair rates. They determined motor recovery rates of 75%, 38% and 16% in the patient undergoing nerve repairs were performed with grafts of lengths shorter than 6 cm, 6 to 12 cm, and 13 to 20 cm, respectively. In a 157 patient group with sciatic and peroneal nerve injury caused by gunshot wounds, Roganovic noted success rates of 57%, 22.4% and 40% using nerve grafts of lengths 4 cm or shorter, 4 to 8 cm, and longer than 8 cm, respectively.[12] On the other hand, Durandeau et al. obtained good results with nerve grafts shorter than 5 cm and between 5 and 8 cm performed for peroneal nerve traction at the knee level.[13] We determined full and adequate recovery in 78% of patients with grafted nerve repair shorter than 6 cm. Although few patients had long graft nerve repair, the results obtained are comparable to those of Kim and Kline[3] and Durandeau et al.[13] Additionally, 3 of 4 patients with 6 cm or larger grafts achieved full or adequate recovery.

The cause of nerve injury is among the principle factors affecting recovery. End-to-end nerve repair is the first option in peripheral nerve injuries caused by sharp cuts. Compared to grafted nerve repair, the result of end-to-end nerve repair appears less problematic.[14,15] In our study, 11 of the 16 patients injured by sharp cuts underwent end-to-end nerve repair and satisfactory to full recovery was observed in 13 of these patients. However, extreme distension caused by high-energy traumas (such as gunshot wounds and traction type injuries with or without fracture) leads to intraneural and extraneural scarring and affects a larger nerve segment than the primary nerve injury area. Therefore, high energy nerve injuries are often repaired by nerve grafting. Sedel and Nizard[16] performed CPN grafting on 16 patients with peroneal nerve injuries caused by traction. Five of 9 patients recovered free from any significant walking or running problems without performing PTT transfer. In our study, nerve graft repair was performed on 7 patients with high-energy trauma, 5 of which achieved a muscle strength of M3 or above.

The main aim of surgical treatment in peroneal nerve repair is to restore function in patients with drop foot deformity. Although orthosis is recommended, long-term problems can occur when there is no reinnervation. PTT transfer can be performed on patients presenting bad prognoses or patients who cannot be accommodated through less intrusive means. Millesi recommends primary tendon transfer in elderly patients with nerve defects or those who have delayed repair for 3 months.[2] Wood recommend direct tendon transfer in patients with nerve defects over 6 to 8 cm or in the 6 to 9th month of injury.[17] Some studies state that tendon transfer accelerates nerve recovery due to the internal rehabilitation effect.[18] Sedel and Nizard[16] and Aydin et al.[19] recommend tendon transfer 2 years and 1 to 1.5 years after nerve repair, respectively. Our opinion is to perform tendon transfer one year after end-to-end repair or 2 years after grafted nerve repair. In our study, functional restoration with PTT transfer was performed on 3 patients.

When a peroneal nerve function disorder occurs in an open injury, the nerve needs to be revealed by early surgery. When this occurs in blunt traumas or sutured laceration, it is recommended to wait 2 to 8 months before surgically exploring the nerve.[7,11,17] However, some authors recommend tendon transfer after 6 to 8 months.[2,20] These situations greatly affect the decision making of the surgeon with regard to surgical timing. Ultrasound can be used in peripheral nerve continuity and to aid clinical diagnosis.[21,22] We recommend exploring the nerve surgically in closed or sutured laceration when the coherence of ultrasound and the nerve cannot be determined.

In conclusion, good results from end-to-end repair and small grafts shorter than 6 cm can be obtained in the treatment of peroneal nerve injury between the sciatic bifurcation and distal branching. PTT transfer on patients without any nerve recovery in order to recover ankle dorsiflexion at the end of a 2-year observation period can be recommended.

Conflicts of Interest: No conflicts declared.

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