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The results of surgical repair of sciatic nerve injuries

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Objectives: The aim of this study was to evaluate surgical treatment and follow-up results of patients who presented to our department with sciatic nerve injuries.

Methods: The study included 13 patients (12 males, 1 female; mean age 23 years; range 11 to 35 years) who underwent surgical treatment for sciatic nerve injuries. The etiologies of sciatic nerve injuries were penetrating trauma in five patients, firearm injuries in four patients, and motor vehicle accidents in four patients. Injuries involved the knee level in five patients, and above-the-knee level in eight patients. Peroneal nerve involvement was seen in all the patients, and the tibial nerve was involved in 11 patients. Primary repair was performed in six patients, neurolysis in three patients, and nerve grafting in three patients. One patient underwent neurolysis for the peroneal portion, and nerve grafting for the tibial portion. Muscle strength and reflex changes were recorded at every stage of the treatment. Muscle strength was assessed according to the British Medical Research Council scale. The Semmes-Weinstein monofilament test was used for sensory evaluation. The mean follow-up period was 4 years (range 1 to 6 years).

Results: In 11 patients with tibial nerve injuries, the soleus/gastrocnemius strength was measured as follows: M1 in one patient, M3 in four patients, M4 in four patients, and M5 in two patients. Plantar sensation was absent in four patients, while seven patients had at least adequate protective sensation. In 13 patients with a peroneal nerve injury, the strength of the anterior tibial muscle was measured as follows: M0 in three patients, M2 in three patients, M3 in one patient, M4 in three patients, and M5 in three patients. Of these, four patients had persistent insensitivity in the dorsum of the foot, while six patients had protective sensation, and three patients had normal sensation. Two patients with inadequate anterior tibial muscle strength following nerve repair underwent posterior tibial tendon transfer for restoration of foot dorsiflexion. The greatest functional improvement was obtained in cases in which a neurolysis was performed; patients undergoing a primary repair had better outcomes compared to those where nerve grafts were used. The results were better in thigh level injuries than those in the gluteal region.

Conclusion: Low expectations after sciatic nerve repair in the past are now being rapidly replaced by a more optimistic approach. Advances in microsurgery and use of treatment algorithms based on scientific research account for this significant improvement in outcomes after sciatic nerve surgery. Tendon transfers can enhance the success rate and be combined with nerve repair in selected cases.

Key words: Nerve regeneration; peroneal nerve/injuries/surgery; sciatic nerve/injuries/surgery; tibial nerve/injuries/surgery.

The sciatic nerve is the longest and widest peripheral nerve in the human body. However, its injuries are much more uncommon compared to nerve injuries in the upper extremities. Common causes of sciatic nerve injuries are iatrogenic injuries caused by injection and hip surgery, penetrating trauma, and firearm injuries.[1,2]

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Sciatic nerve lesions in the upper thigh are associated with pain and paresthesia along the nerve territory and losses in knee flexion, foot dorsiflexion, and plantar flexion. Loss of sensation involves the posterior thigh, lateral aspect of the lower leg, and the entire foot. This may lead to pressure sores, infections, and claw foot deformity. Vasomotor alterations such as coldness, erythema, thinning of the skin, nail deformities, and edema may accompany these conditions. With appropriate treatment, it is possible to reduce pain, motor and sensory deficits resulting form sciatic nerve injuries.

The sciatic nerve is composed of two nerves coursing separately along its whole length. This dual structure is covered by a common sheath in the thigh region, but can easily be separated with dissection. The consequences of trauma and outcomes of surgery both differ for these two individual nerves and, therefore, should be addressed independently.[3]

The outcomes of sciatic nerve repairs, which were unsatisfactory until recently, have undergone significant improvements thanks to advances in microsurgery and its widespread use. This success has been displayed in large patient series published about the results of sciatic nerve repairs.

Sciatic nerve injuries can be seen with pelvic trauma and as a frequent complication of lower extremity surgery; therefore, physicians dealing with the surgery of this region should be familiar with the options and possible outcomes of sciatic nerve repair. The aim of this study was to evaluate surgical treatment and follow-up results of patients who presented to our department with sciatic nerve injuries.

Patients and methods

The study included 13 patients (12 males, 1 female; mean age 23 years; range 11 to 35 years) who presented to our department between 1999 and 2008 with sciatic nerve injuries and were treated surgically. The etiologies of sciatic nerve injuries were penetrating trauma (cuts caused by knife, glass, or scissors) in five patients, firearm injuries in four patients, and open or closed blunt trauma related to motor vehicle accidents in four patients. Injuries involved the knee level in five patients, and above-the-knee level in eight patients.

Evaluation of the patients

All patients were evaluated with detailed clinical examination and laboratory tests, muscle strength and reflex changes were recorded at every stage of the treatment. Muscle strength was assessed according to the MRC scale (British Medical Research Council). The Semmes-Weinstein monofilament test was used for sensory evaluation. Early electromyographic tests were not performed in the first 2-3 week period since it was too early for target muscles to show signs of innervation. Recovery was monitored by serial physical examinations and nerve conduction studies. The most distal point of axonal regeneration was determined by the observation of distally migrating Tinel-Hoffmann sign or nerve conduction response.

All patients were treated with vigorous physical therapy for the mobilization of the injured extremity. Intense pain unresponsive to medical treatment was considered an indication for surgical intervention. To prevent Achilles tendon shortening in patients with drop foot deformity, a drop foot splint was used and the patients were encouraged for walking.

Patients who presented to our clinic shortly after a penetrating injury were treated with early surgical repair. Patients with a delayed presentation and cases where a sciatic nerve injury was not manifest were followed-up for three months before a decision for surgery was made, to rule out neuropraxia caused by other causes such as hematoma. In cases sustaining a firearm injury or closed trauma, where one or both of the sciatic nerve divisions failed to recover after three months, the presence of a complete or advanced deficit and electromyographically documented permanent denervation were considered an indication for surgical treatment.

Surgical anatomy and dissection of the nerve

The sciatic nerve is derived from the lumbosacral plexus and provides sensation of the leg and also the motor innervation of the posterior thigh muscles and all the muscles of the leg and foot. It contains fibers from the anterior and posterior divisions of the L_4, L_5, S_1, and S_2 spinal roots and anterior division of the S3. Anterior and posterior divisions constitute the tibial and peroneal nerve branches, respectively. These two branches form the common peroneal nerve and tibial nerve at the distal third of thigh. The common peroneal nerve turns around the neck of the fibula and, in the anterior of the leg, gives off its deep and superficial branches. The tibial nerve runs through the posterior thigh and popliteal fossa and, in the popliteal fossa, it gives off branches to the gastrocnemius,

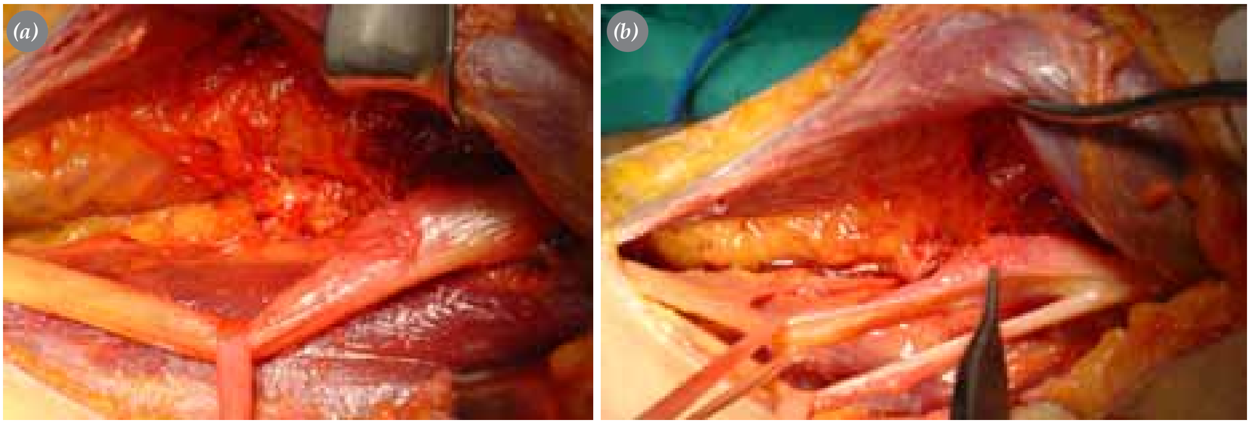

Fig. 1. **(a)** A case of traumatic neuroma and **(b)** separation of the sciatic nerve components (tibial and peroneal nerves).

popliteus, soleus, and plantaris muscles, and to the knee joint. A sensory branch also originates from this region to form the sural nerve.

The patients were placed in the prone position with a support beneath the pelvic region to provide flexion of the pelvis. If there was a possible need for a sural nerve graft, the contralateral lower extremity was also prepared for surgery. To expose the sciatic nerve, an incision was made starting from the lateral side of the posterior iliac spine. The incision was then curved to the iliac wing, and advanced along the superior border of the gluteus maximus muscle, extended along the greater trochanter and femoral shaft until the gluteal fold, where it reached the midline of the posterior thigh. In cases in which it was necessary to visualize the distal sciatic nerve, the incision was extended along the midline of the posterior thigh.[4]

The gluteus maximus muscle was exposed and released from the iliotibial tract laterally and superiorly. It was then incised leaving a 2-3 cm portion of muscle and tendon at its insertion to the greater trochanter to facilitate re-attachment during closure. The skin and muscle were retracted to the medial side and the sciatic nerve was found medially using first blunt and later sharp dissections. At this stage, neurolysis was performed, if necessary, superiorly towards the sciatic notch, preserving the hamstring, posterior femoral cutaneous branches, and gluteal vasculature. In some cases, the piriformis muscle was detached from the femur and retracted medially to gain a better view of the nerve around the sciatic notch.

If the injury was at the level of the thigh, a lazy S-shaped incision was made medial to the lateral hamstring muscles in the midline of the posterior thigh while the patient was in the prone position. The sciatic nerve was exposed after separating the biceps muscle from the semitendinosus muscle.

Evaluation and repair of the nerve

After exposure of the nerve, the affected part of the nerve was approached with sharp dissection from both the proximal uninjured end and the degenerated distal end. The tibial and peroneal parts of the nerve were separated from each other with dissection in the proximal and distal regions to determine which part was affected by the injury (Fig. 1). Each part was tested individually with a nerve stimulator (Stimuplex, B. Braun, Melsungen, Germany) for nerve conduction. Muscle contraction response was observed at 0.5, 1, and 2 mA electrical stimulations. In the presence of conduction, only neurolysis was performed.

If it was possible to repair the nerve without tension after the resection of the neuroma and mobilization of the nerve ends, an end-to-end epi-perineural and group fascicular repair was performed with non-absorbable 8-0 sutures. Sural nerve graft from the contralateral leg was used to bridge the gap when an end-to-end repair was not possible (Fig. 2). If the graft amount from the contralateral leg was inadequate, additional grafts from the ipsilateral leg were harvested. Fascicular groups were formed at both ends of the nerve and then were connected to each other with sural nerve grafts.

While peroneal nerve involvement was seen in all the patients, the tibial nerve was involved in 11 patients. The tibial and peroneal parts were handled independently. Primary repair was performed in six patients, neurolysis in three patients, and nerve grafting in three patients. One patient underwent neuroly-

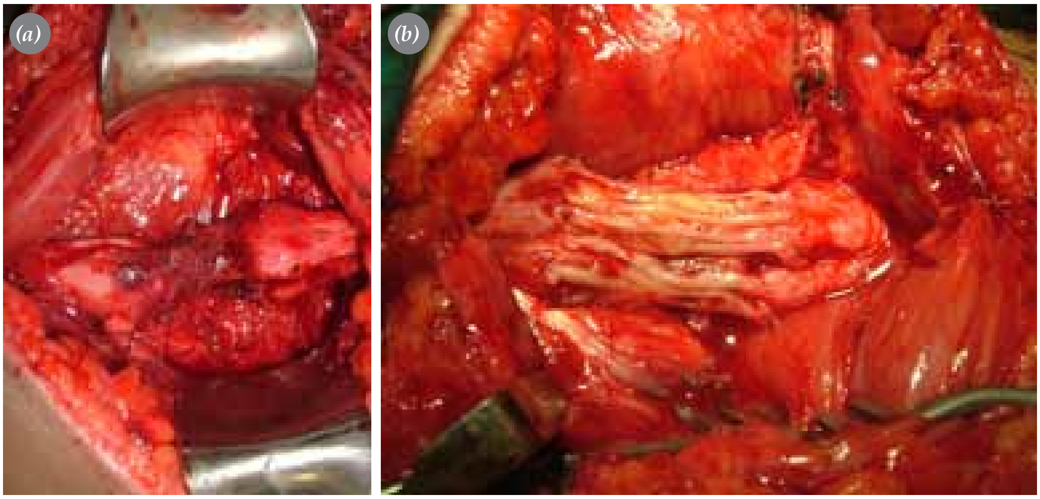

Fig. 2. (a) A case of total sciatic nerve laceration and **(b)** repair with nerve grafts.

sis for the peroneal portion, and nerve grafting for the tibial portion.

The operated lower extremities of the patients were stabilized in a drop foot splint for six weeks. In addition, the splint was used as long as the drop foot deformity persisted. The mean follow-up period was 4 years (range 1 to 6 years).

Results

In 11 patients with tibial nerve injuries, the soleus/gastrocnemius strength was measured as follows: M1 in one patient, M3 in four patients, M4 in four patients, and M5 in two patients. Plantar sensation was absent in four patients, while the remaining seven patients had adequate protective sensation (normal, diminished light touch, or diminished protective sensation according to the Semmes-Weinstein test). In 13 patients with a peroneal nerve injury, the strength of the anterior tibial muscle was measured as follows: M0 in three patients, M2 in three patients, M3 in one patient, M4 in three patients, and M5 in three patients. Of these, four patients had persistent insensitivity in the dorsum of the foot, while six patients had protective sensation, and three patients had normal sensation. Two patients with inadequate anterior tibial muscle strength following nerve repair underwent posterior tibial tendon transfer for restoration of foot dorsiflexion.

The results of muscle strength and sensation test obtained following each kind of surgical procedure are shown in Table 1. The greatest functional improvement was obtained in cases in which a neurolysis was performed; patients undergoing a primary

Table 1
Muscle strength and sensation test results obtained following each kind of surgical procedure

	Muscle strength*						Sensation test groups**				
	M0	M1	M2	M3	M4	M5	V	IV	III	II	I
Peroneal neurolysis	–	–	1	1	1	1	–	–	1	1	2
Peroneal primary repair	2	–	1	–	2	1	3	–	3	–	–
Peroneal nerve graft	2	–	1	–	–	–	1	1	1	–	–
Tibial neurolysis	–	1	–	–	1	–	1	–	1	–	–
Tibial primary repair	–	–	–	1	3	2	1	–	4	–	1
Tibial nerve graft	–	–	–	3	–	–	2	–	1	–	–

*Muscle strength according to the British Medical Research Council scale: M0: Total paralysis; M1: Flicker; M2: Movement with gravity eliminated; M3: Movement against gravity (no resistance); M4: Movement against gravity and resistance; M5: Normal power.

**Semmes-Weinstein monofilament test: Group I: Normal; Group II: Diminished light touch; Group III: Diminished protective sensation; Group IV: Loss of protective sensation; Group V: Not testable.

repair had better outcomes compared to those where nerve grafts were used. The results were better in thigh level injuries than those in the gluteal region.

Discussion

The outcomes of nerve repair in the lower extremity may vary highly due to the presence of multiple parameters affecting the treatment process. Nonetheless, in agreement with the relevant literature, our results show that adequate functional outcomes can be achieved, enabling the patients to pursue their daily activities.

The primary aim in treatment of sciatic nerve injuries is the restoration of plantar sensation. We observed that this could be achieved at a higher rate if a primary repair could be done.

The progress to better outcomes of sciatic nerve injuries over time can be observed in comparison of large series published previously. Two large series presenting sciatic nerve injuries in 1380 and 365 patients from World War II, respectively, concluded that the outcomes of sciatic nerve repair were unsatisfactory.[5]

Gousheh et al.[6] reported that 86.3% of 504 patients with sciatic nerve injuries affecting the tibial component regained adequate muscle power (M3 or higher) and were able to walk within two years, and that sensation in the sole was obtained in 73.4%. The rates of recovery in both motor and sensory functions were higher in cases in which repair was possible with direct coaptation. In contrast, the success rate was as low as 38.9% in injuries involving the peroneal component, being even lower in patients undergoing nerve graft repairs.

Kim et al.[7,8] reported the success rates of primary repair as 87% and 63% in injuries affecting the tibial and peroneal components, respectively. Similarly, the use of nerve grafts was associated with a lower success rate. Our outcomes were similar to these two large series. However, special attention should be paid to evaluate each case individually, as peroneal regeneration might be better in some cases undergoing repair of both peroneal and tibial components. Moreover, motor and sensory outcomes might not be in total concordance.

Inferior outcomes after repair of peroneal component injuries have been well documented in the literature and several explanations have been put forward, including increased vulnerability of the nerve to trauma due to its more lateral and superficial location, poor blood supply, the presence of less connective tissue between the fascicles, and the position of the motor fascicles within the nerve.[9-13]

Many types of ortheses have been proposed to prevent joint contractures caused by sciatic nerve injuries and to enhance mobilization. Most of them aim to solve problems associated with drop foot, but some problems may arise with their long-term use. Various tendon transfers can eliminate the need for the use of orthesis, the most common being the transfer of the posterior tibial tendon to the anterior tibial tendon.[14,15] This transfer provides support in terms of both walking and prevention of inversion and varus deformity. Transfer of the posterior tibial tendon can be performed simultaneously with the nerve repair or as a secondary procedure. Millesi[3] recommended the transfer of the posterior tibial tendon at the time of sciatic nerve repair in cases with poor prognostic factors. Wood[16] emphasized the need for tendon transfer in addition to nerve repair in cases with a nerve defect greater than 6-8 cm or in cases in which delay in nerve repair exceeded 6-9 months. Ferraresi et al.[17] reported that outcomes of nerve repair might improve with combination of tendon transfer. The mechanism of this improvement was proposed as the stimulation of nerve regeneration resulting from a continuous internal rehabilitation enabled by early correction of the flexion-dorsiflexion imbalance and early mobilization. Özkan et al.[18] concluded similarly that posterior tibial tendon transfer was beneficial in restoring active dorsiflexion of the foot and preventing flexion deformities of the toes. We prefer to reserve tendon transfer until the outcomes of nerve surgery becomes fully apparent, i.e., 1-1.5 years depending on the level of the lesion.

In conclusion, low expectations after sciatic nerve repair in the past are now being rapidly replaced by a more optimistic approach. Advances in microsurgery and use of treatment algorithms based on sound scientific research account for this significant improvement in outcomes after sciatic nerve surgery.

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