Journal of Peripheral Nerve Surgery (Volume 2, No. 1, July 2018) 55-61

ORIGINAL ARTICLE

Outcome of Lower Limb Nerve Repair in a Tertiary Care Hospital

Samiksha Mehare[1], S. Mehrotra[2], R. Kumar[3], Vikas[3], M. Alam Parwaz[4], Megha[5], Arjun[6]

Abstract

Background: Lower extremity nerve trauma is less common than upper extremity nerve injuries1. Limited experience, concerns of prolonged healing times and average outcomes historically resulted in many lower limb nerve injuries being managed conservatively. Better understanding of nerve repair physiology, evaluation methods and microsurgical techniques have led to a lower threshold for surgical intervention.

Materials & Methods: Thirteen patients of lower extremity nerve injuries were managed at our reconstructive centre in a tertiary care hospital over a period of 5 years from 2012 to 2017. Data was compiled retrospectively from patient records and reviews. Six patients reported to us more than 1.5 yrs after the trauma and were excluded. Seven patients who underwent surgical intervention were included in this study and followed up for variable period of eight to eighteen months

Results: All patients were male with an average age of 27.85 years (range 21 to 43 years). Four were injured due to gunshot wound (GSW) while the remaining three had injuries due to shell splinters, snake bite and road traffic accident . All except the snake bite case underwent exploration and debridement at local hospitals within hours of the trauma.In three cases the nerve injury was initially missed and detected subsequent to the acute event. Motor power examination as per Muscle Research Council (MRC) Grading System showed significant improvement in four cases. In one case of nerve graft there was no progression of Tinel's sign and no motor recovery even after 7 months. Functional recovery in the form of running was achieved in four patients. Two patients could achieve satisfactory walking after tendon transfer and another with foot drop orthosis.

Conclusion: Lower limb nerve injury management by surgery is a promising option looking at the current scenario. Polytrauma victims in a mass casualty scenario may result in low priority handling of some peripheral nerve injuries. After patient recovery, early neurologic evaluation and low threshold for exploration is likely to yield optimal outcomes.

Introduction

Lower extremity nerve trauma is less common than upper extremity nerve injuries[1]. Limited experience, concerns of prolonged healing times and average outcomes historically resulted in many lower limb nerve injuries being managed conservatively. Better understanding of nerve repair physiology, evaluation methods and microsurgical techniques have led to a lower threshold for surgical intervention. Military trauma due to gun shots or splinters from exploding shells infrequently result in such injuries. We present our data of six cases of lower extremity nerve injuries which were managed surgically. All underwent exploration few months after the initial insult and had established deficit.

Anatomy and Physiological Consideration

Lower limb penetrating nerve injuries are often seen in military service due to high velocity bullets and splinters. They constitute injury to sciatic, femoral, tibial, common peroneal and superficial peroneal nerves due to trauma over corresponding regions. Proximal injuries lead to severe functional deficit. Indian statistics on incidence of lower limb nerve injuries are limited and few studies mention outcome after surgical intervention.

Sciatic nerve is the largest peripheral nerve in both length and cross-sectional area and its size and depth presents anatomical challenges in repair. Furthermore, muscle and sensory targets are located at a considerable distance of up to 90cm from the site of injury[2]. As nerve regeneration progresses up to a rate of 1mm per day, successful nerve growth to distal target organ before its degeneration is one of the most demanding requirements in lower limb nerve repair.

✉ Samiksha Mehare
meharesamiksha@gmail.com

1,2,3,4,5,6 Dept of Reconstructive surgery, Army Hospital (R&R) Delhi Cantt, India

Transection of sciatic nerve occurring distal to innervation of hamstring muscles spares knee function so patient's ability to ambulate is often preserved. Ambulatory function in these cases is dependent on normally functioning quadriceps and ankle foot orthosis. However, the loss of sensory innervation to plantar aspect of the foot can lead to serious morbidity including pressure ulcers[3]. Transection of nerve in distal lower limb has less devastating effect with loss of sensation over dorsum and foot drop. This study was conducted to evaluate the types of injuries and outcome of surgical repair of lower limb nerve injuries.

Patient and Methods

Thirteen patients of lower extremity nerve injuries were managed at our reconstructive centre in a tertiary care hospital over a period of 5 years from 2012 to 2017. Data was compiled retrospectively from patient records and reviews. Six patients reported to us more than 1.5 yrs after the trauma and were excluded. Seven patients who underwent surgical intervention were included in this study and followed up for variable period of eight to eighteen months. Patient particulars were noted including date and mode of injury and any prior treatment. Clinical neurologic evaluation, electrophysiologic studies, surgical details and postoperative outcome were recorded. Sensory testing was done in form of light touch and pinprick sensation. Motor power was assessed according to Muscle Research Council (MRC) Grading System.

All seven patients reporting with less than 1.5 yrs of injury underwent exploration. Nerve exploration was done without tourniquet in high injuries but it was employed for all distal injuries. Based on findings, patients were subjected to neurolysis, nerve repair or grafting. We avoided nerve graft whenever possible by mobilization and knee flexion to approximate and suture nerve ends without tension. Up to 90 degree knee flexion was maintained for 4 weeks and the knee was gradually extended in increments over next 4 weeks till full extension was obtained at 2 months. Patient were evaluated immediate post operatively, at 8 weeks and intervals of 6 months till 1 year. Neurologic recovery and functional improvement were tabulated.

Results

All patients were male with an average age of 27.85 years (range 21 to 43 years). Four were injured due to gunshot wound (GSW) while the remaining three had injuries due to shell splinters, snake bite and road traffic accident (Table 1). All except the snake bite case underwent exploration and debridement at local hospitals within hours of the trauma.In three cases the nerve injury was initially missed and detected subsequent to the acute event.

Table 1: Patient details

S. no.	Age/Sex	Mode and site of injury	Nerve
1.	27/M	GSW Gluteal region	Sciatic
2.	32/M	GSW Popliteal fossa	CPN
3.	22/M	GSW Lower 1/3 thigh	Tibial & CPN
4.	24/M	Snake bite Popliteal fossa	CPN
5.	26/M	Grenade blast Upper 1/3 thigh (anterior)	Femoral
6.	43/M	GSW Lower 1/3 thigh	Sciatic
7.	21/M	RTA Knee lateral aspect	CPN

The average time of referral to our centre post injury was 4.71 months, maximum being 10 months and least 1 month following injury.

Sensory deficit was charted and motor power recorded. All underwent nerve conduction studies followed by surgical exploration. No conduction was present in 4 while it showed decrease in 3.

Sciatic nerve was damaged at the upper thigh in one patient, midthigh in one and lower thigh in two. Two patients had common peroneal nerve injury while another had femoral nerve injury at the groin. Upper sciatic and femoral nerve injury on exploration were found with intact trunks but enmeshed in fibrosis. Both underwent external and internal neurolysis.

Case 1

The patient had high sciatic gunshot injuryand underwent emergency debridement and closure. He was reviewed at our centre 10 months later with complains of significant pain over buttock with radiation to lower leg. On clinical examination there was evident muscle wasting with hamstring power of 4/5 while foot flexors, extensors and peroneal had power of 1/5. There were no active toe movements. On exploration he had a 4 cm neuroma in continuity and another 1cm lateral neuroma. Intraoperative nerve stimulation showed activity in innervated muscles and hence neurolysis was done. Post operative motor power of foot extensors improved to 3/5 at 2 months of follow up. Review at 10 months revealed 5/5 power of all muscle groups except for small muscles of foot. The patient was relieved of neurogenic pain postoperatively. With near normal walking, he was able to run satisfactorily on one year follow up (Fig. 1).

Fig. 1 Case of high sciatic GSW right side showing good result after neurolysis

Case 2

Following a gunshot wound over popliteal fossa, the patient had sustained injury to the common peroneal nerve. He presented 6 months after injury with wasting and grade 0 power in anterolateral compartments with sensory loss over dorsum of foot. NCS revealed no conduction beyond the injured segment. Exploration revealed a 3 cm neuroma with no conduction across. The neuroma was excised and resultant gap was bridged by direct coaptation of healthy nerve ends by mobilization and keeping the knee in flexion. After 4 weeks of immobilisation, the knee was gradually extended with weekly increments over another 4 weeks. The patient had good neurologic recovery with 5/5 power in foot extensors after 7 months of follow up. The patient could run comfortably on even terrain at one year (Fig. 2).

Case 3

This patient suffered a gunshot wound over lower thigh and underwent emergency debridement. He was referred to our centre after 5 months with complete wasting of affected leg. Evaluation gave evidence of complete tibio-peroneal denervation. Exploration revealed a transected tibial nerve and fibrous cord over injured segment of common peroneal nerve. He was managed with excision of affected nerve segment and direct coaptation with knee flexion. This was gradually extended over a period of 8 weeks. He showed good recovery in terms of tibial component with 4/5 grade power in plantar flexion. Peroneal component recovered to lesser extent with power of 3/5. Patient could achieve satisfactory running after 10 months (Fig. 3).

Fig. 2 Long term follow up of post GSW left CPN injury managed by direct coaptation with knee flexed, showing good recovery

Fig. 3 A case of left foot drop following GSW thigh managed with coaptation of tibial and CPN nerve with knee flexion, showing good recovery

Case 4

This patient of snake bite over popliteal region presented with foot drop after 4 months. Exploration revealed anecrotic Common Peroneal Nerve (CPN) of 6inch extent with necrosed cheesy anterolateral compartment muscles. He underwent a transmembranous tibialis transfer to TA with EHL hitch and fixation to intermediate cuneiform.This patient had a satisfactory outcome in terms of functional recovery. Tendon transfer enabled him to walk without orthosis (Fig. 4).

Fig. 4 Early and late post-operative result of tendon transfer in a case of snake bite with necrosis of CPN and peroneal muscles

Case 5

This 26-year serving soldier sustained grenade blast injury to right thigh while on duty. One month after initial debridement, he reported to our centre with weakness of knee extension with power of 1/5 on initial evaluation. He underwent exploration which revealed fibrosis around femoral nerve and encasement. External neurolysis was done. Over 5 months period he showed good recovery with gradual improvement and 5/5 power after 6 months postoperatively.

Case 6

This patient with mid tight grenade blast injury had suffered extensive soft tissue loss in addition to sciatic nerve injury. He had a grafted mid thigh wound with foot drop and 0/5 foot extensor power. Exploration revealed a 4-inch nerve defect which was bridged by sural cables to the tibioperoneal components and flap cover. After initial recovery the Tinel's sign was non-progressive at distal coaptation site. Follow up till 7 months did not reveal neurologic recovery. The patient was lost to follow up thereafter.

Case 7

21 year young serving soldier sustained blunt injury to right knee following road traffic injury. He presented very next day of injury. There was no spontaneous recovery over period of 6 months. Exploration revealed fibrosed nerve segment of 4cm which was excised and repaired with sural nerve graft. After follow up of 4 months he has shown sensory recovery and ankle stability.

Sensory recovery was evident in all 6 cases of nerve repair. The sensory recovery & motor recovery is shown in Table 2&3.

Table 2: Sensory Recovery

Patient	Surgery	Sensory Preoperative	Sensory Recovery
1	Neurolysis	Anaesthesia over dorsum, plantar aspect foot, posterolateral leg	protective sensation (+)
2	End to end repair	Anaesthesia over dorsum	Two-point discrimination (++)
3	End to end repair	Anaesthesia over dorsum, plantar aspect foot	protective sensation (+)
4	Tendon transfer	Anaesthesia over dorsum of foot	No (-)
5	Neurolysis	Hypoasthesia over medial aspect knee	Two-point discrimination (++)
6	Nerve graft	Anaesthesia over dorsum, plantar aspect foot, posterolateral leg	No (-)
7	Nerve graft and tendon transfer	Anaesthesia over dorsum, plantar aspect foot	Protective sensation (+)

Table 3: Motor recovery

Pt	Surgery	Power Preoperative	Power Postoperative	Functional Recovery
1	Neurolysis	Hamstring 4/5 Dorsiflex1/5, Plantarflex1/5	Hamstring 5/5, Dorsiflex 3/5 Plantarflex 3/5	Walking, Running
2	End to end repair	Dorsiflex 0/5, Plantarflex 0/5	Dorsiflex 5/5, Plantarflex 5/5	Walking, Running
3	End to end repair	Complete palsy0/5	Plantarflex 4/5, Dorsiflex 3/5	Walking, Running
4	Tendon transfer	Dorsiflexors 0/5	N A	Walking
5	Neurolysis	Knee extensors 1/5	Knee extensors 5/5	Walking, Running
6	Nerve graft	Foot dorsiflexion 0/5	Foot dorsiflexion 0/5	Walking with orthosis
7	Nerve graft with	Foot dorsiflexion 0/5	Foot dorsiflexion 3/5	Walking

Motor power examination as per Muscle Research Council (MRC) Grading System showed significant improvement in four cases. In one case of nerve graft there was no progression of Tinel's sign and no motor recovery even after 7 months. Functional recovery in the form of running was achieved in four patients. Two patients could achieve satisfactory walking after tendon transfer and another with foot drop orthosis.

Discussion

Primary or concomitant peripheral nerve injuries constitute 2-3% of Level I trauma centre admissions in the USA every year, with the incidence rising and approaching 5%[4]. Indian incidence data is still unclear. Review of literature with respect to lower limb nerve injury was not much encouraging in terms of outcome when managed surgically[5]. Recently many articles suggest good outcome and functional rehabilitation following surgical treatment of lower limb nerve injuries.

Kretschmer et al[6] studied 722 patients who underwent surgical exploration for peripheral nerve injury. It was a retrospective study to evaluate incidence of iatrogenic injury and showed 70% improvement in patients who were managed surgically over period of 10 years for iatrogenic injury.

Roganovic et al[7] performed a large volume study of missile-caused complete lesions of the peroneal nerve and peroneal division of the sciatic nerve. In this study outcome and factors affecting outcome were studied. Over 3-year period, 157 patients were treated surgically in the Belgrade Military Medical Academy. 4 years of follow-up showed a successful outcome in most low-level lesions (below the popliteal crease) repaired in the first 3 months after injury using grafts smaller than 4 cm. Conversely, high-level (above the middle of the thigh), repairs delayed for more than 7 months after injury and using grafts larger than 8 cm had poor outcomes andsurgery did not appearto be worthwhile.

A study was performed by *Roganovic et al*[8] to assess sensory and motor recovery potentials between different nerves. It was a prospective study of a homogenous group of 393 graft repairs of the median, ulnar, radial, tibial, peroneal, femoral, and musculocutaneous nerves. Sensory recovery potential was similar for all nerves tested ($P > 0.05$), but motor recovery potential differed significantly. After high-level repairs, motor recovery potential was significantly better for tibial nerves (useful recovery in 54.5% of patients), than for the peroneal nerves (useful recovery in 13.8% of patients). After intermediate-level repairs, motor recovery potential was better for femoral nerves than for the tibial. In addition, motor recovery potential was significantly the worst with peroneal nerve repairs.

After low-level repairs, motor recovery potential was similar for all nerves (useful recovery in the range of 88.9-100% of patients and in 56.3% of peroneal nerve repairs).

Matejcík et al[9] presented a retrospective study of 40 operations in 40 patients who were treated in the course of 15 years (from 1985-1999) for injury to common peroneal nerve, historically known as an injury difficult to treat. The mechanism of injury comprised injury caused by elongation with or without fracture, "sharp" or "blunt" injuries, shotgun injuries, compressions and iatrogenic injuries. Patients were operated if spontaneous repair did not occur within 2-6 months after injury. 20 external neurolysis, 8 nerve coaptations, and 12 nerve graftings were done in case of complete and persisting neurological deficiency and absence of action potentials on EMG. In 27 of 40 cases, motor improvement was achieved preventing instability of the foot and in 25 of 40 protective sensitivity developed. After neurolysis in 18 of 20 patients (90%) a useful grade of improvement was achieved despite severe preoperative motor deficiency. In 8 patients an "end to end" coaptation was made and 6 of these (75%) had motor restoration ofgrade 3 or more. 12 patients needed a reconstruction operation by means of nerve grafts, the length varying from 4 to 20 cm. With grafts shorter than 5 cm the function was restored to grade M4. In 20% patients with a graft of 6 to 12 cm and in none with grafts of 13 to 20 cm restoration grade 3 or more was achieved.

Sedel et al[10] to studied outcomes in patients treated with nerve graft for larger gapsranging between 7 to 20 cm. This study of 17 patients shows functionally satisfactory result in 37.5% patients of common peroneal nerve injury with large gap managed with nerve graft. Authors also suggest addition of a posterior tibialis tendon transfer to improve the result.

Ferraresi et al[11] performed a study to compare outcome of common peroneal nerve injury repair when performed as nerve repair alone and with tendon transfer. Patients with single stage nerve repair had poor outcome with motor recovery of only M1 M2 grade. Study suggests that association of microsurgical nerve repair and tendon transfer has improved the outcome of CPN injuries.

A war series of 55 cases operated for sciatic nerve injury was presented by *Samardziæ et al*[12]. Nerve continuity was preserved at least partially in 76.4% of cases, but only 13.3% of cases had preserved some nerve function. Surgical results were analysed in 45 cases followed for more than two years. The rates of useful functional recovery were 86.7% for tibial division, 53.3% for peroneal division and 86.7% for the sciatic nerve complex. On the basis of the obtained results he suggested following conclusions (1) missile injuries to the sciatic nerve are characterised by partially preserved nerve continuity and complete functional loss in the majority of cases, (2) surgery should be performed 3 to 6 months after injury, (3) reconstruction of tibial division is the major goal of surgical repair, (4) the extent and severity of nerve damage and the type of surgical procedure are the main prognostic factors and (5) failures of surgical repair are usually related to nerve grafting at gluteal level.

Gousheh et al[13]assessed the therapeutic results of sciatic nerve repair in Iran-Iraq war casualties in 2008.It was a retrospective study to evaluate the results of different therapeutic procedures for sciatic nerve injuries and conducting a comparative evaluation of peroneal and tibial nerve recovery. Study included 648 Iranian casualties of 1980 to 1988 Iran Iraq war with sciatic nerve injury were treated with nerve grafting, direct end to end coaptation, and neurolysis. It showed that 77.8% patients had tibial nerve injury and in 88.9%, the common peroneal nerve was injured. Protective sensory recovery of sole was evaluated as good in 69.1%, 74.4%, 89.3% of those with upper third, middle third, lower third thigh repair respectively. Overall motor recovery success rate after surgery was 86.3% and 38.9% for tibial and common peroneal nerve respectively. Motor deficit of common peroneal nerve needs to be overcome by tendon transfer or orthopaedic devices.

A study by Weil et al[14]on long-term functional outcome of penetrating sciatic nerve injurywas a retrospectively study of 29 patients with penetrating sciatic nerve injuries mostly resulting from GSW orblast, during the years 1990 to 2002, and compared those whowere treated operatively versus nonoperatively. It reiterated that functional neurologic recovery of the tibial divisionof the sciatic nerve was significantly better than the recovery of the peroneal division of the nerve.

Conclusion

Lower limb nerve injury management by surgery is a promising option looking at the current scenario. Polytrauma victims in a mass casualty scenario may result in low priority handling of some peripheral nerve injuries. After patient recovery, early neurologic evaluation and low threshold for exploration is likely to yield optimal outcomes. Lower limb nerve injury exploration in trained hands is a low risk surgery. Neurolysis has good outcomes and reflects less severe injuries. Nerve coaptation seems to yield better outcomes than grafting. We prefer direct nerve suture across the knee aided by flexion to grafting. Tendon transfer is a useful tool in CPN injuries and should be done in the same sitting as the nerve repair. Operating even up to a year after the injury we found benefits in terms of proximal muscle reinnervation and improvement.

References

1. Kouyoumdjian JA. Peripheral nerve injuries: a retrospective survey of 456 cases. Muscle and Nerve 2006;34:785-788.
2. Burks SS, Levi DJ, Hayes S, Levi AD. Challenges in sciatic nerve repair: anatomical considerations. J Neurosurg 2014;121:210-218.

3. Aydin A, Ozkan T, Aydin HU, et al. The results of surgical repair of sciatic nerve injuries. Acta Orthop Traumatol Turc 2010;44:48-53.
4. Ditty BJ, Omar NB, Rozzelle CJ. Surgery for Peripheral Nerve Trauma. In: Nerves and Nerve Injuries ; 2015.
5. Korompilias A V., Payatakes AH, Beris AE, Vekris MD, Afendras GD, Soucacos PN. Sciatic and peroneal nerve injuries. Microsurgery 2006;26:288-294.
6. Kretschmer T, Antoniadis G, Braun V, Rath S a, Richter HP. Evaluation of iatrogenic lesions in 722 surgically treated cases of peripheral nerve trauma. J Neurosurg 2001;94:905-912.
7. Roganovic Z. Missile-caused complete lesions of the peroneal nerve and peroneal division of the sciatic nerve: results of 157 repairs. Neurosurgery 2005;57:1201-12-12.
8. Roganovic Z, Pavlicevic G. Difference in recovery potential of peripheral nerves after graft repairs. Neurosurgery 2006;59:621-33-33.
9. Matejcík V. Surgical treatment of fibular nerve injury. Rozhl Chir 2001;80:397-401.
10. Sedel L, Nizard RS. Nerve grafting for traction injuries of the common peroneal nerve. A report of 17 cases. J Bone Joint Surg B. 1993;75:772-774.
11. Ferraresi S, Garozzo D, Buffatti P. Common peroneal nerve injuries: results with one-stage nerve repair and tendon transfer. Neurosurg Rev 2003;26:175-179.
12. Samardziæ MM, Rasuliæ LG, Vuckoviæ CD. Missile injuries of the sciatic nerve. Injury 1999;30:15-20.
13. Gousheh J, Arasteh E, Beikpour H. Therapeutic results of sciatic nerve repair in iran-iraq war casualties. Plast Reconstr Surg 2008;121:878-886.
14. Weil YA, Pearle AD, Palladas L, Liebergall M, Mosheiff R. Long-term functional outcome of penetrating sciatic nerve injury. J Trauma 2008;64:790-795.