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Iatrogenic nerve injury and foot drop: Surgical results in 28 patients

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ABSTRACT

Background: Most peroneal nerve injuries resulting in foot drop are secondary to trauma or iatrogenic. Foot drop can occur due to potential complications from the hip, lumbosacral spine, and knee surgeries, which are critical to diagnose and manage.

Methods: We reviewed our foot drop patients' data to determine the incidence and iatrogenic causes of the injury and managed surgically by neurolysis of the peroneal nerve and transfer of functional fascicles of either the superficial peroneal or the tibial nerve to the deep peroneal nerve.

Results: We found 28 iatrogenic foot drop patients who have had surgery and postoperative follow-up evaluations with us. Before the onset of foot drop, all except one (27 of 28) patient have had surgeries in other clinics before presenting to our institution. Foot drop in one patient was due to infection and hip wound after he was intubated and stayed in ICU for 4 weeks. Thirteen of the 28 patients have had lumbosacral (L3-4, L4-L5, and L5-S1) fusion or laminectomy, eight have had hip surgery, and five have had knee surgery. One patient had a fasciotomy due to compartment syndrome and another patient had two previous surgeries for posterior tibial entrapment and tarsal tunnel syndrome at other institutions. NCS and EMG reports showed that these patients had injuries to the peroneal or tibial nerve after their prior surgeries. One patient had a femoral nerve injury. Preoperatively, 10 patients had severe foot drop with muscle weakness and a functional grade of 0/5; 16 patients had grades ranging from 1 to 2/5; and two patients had 3/5. Overall, 23 of the 28 patients (83%) had improvement in their ankle dorsiflexion with anti-gravity and regained a healthier gait after the decompression, neurolysis, and nerve transfer at our clinic.

Conclusion: Twenty-three of the 28 (83%) iatrogenic foot drop patients in this report regained a healthier gait with improved ankle dorsiflexion and anti-gravity after the neurolysis, and nerve transfer of the peroneal or tibial nerve and transfer of functional fascicles of either the superficial peroneal or the tibial nerve to the deep peroneal nerve at our clinic.

Keywords: Decompression, Foot drop, Hip surgery, Iatrogenic nerve injury, Lower back spine surgery, Nerve transfer

INTRODUCTION

Most peroneal nerve injuries resulting in foot drop are secondary to trauma or iatrogenic.[13] Kretschmer *et al.* reported iatrogenic nerve lesions with an incidence rate as high as 17.4%.[12] Iatrogenic causes include mainly the lower back spine, hip, and knee surgeries.[1-6,8-13,16-19,21,22] Lumbosacral plexopathy can cause peroneal or tibial nerve pathology, weakening or loss of the foot and ankle dorsiflexors resulting in foot deformity, and functional gait impairment with characteristic foot slap during the heel strike and a steppage gait.[18,20] Lumbar spinal nerve root damage and peroneal nerve injury are the most frequent causes of foot drop.[4] Bakhsh *et al*.[2] reported that the long-term outcome of lumbar disk surgery was unsatisfactory, and new neurological deficits caused foot drop postoperatively in 8.8% of their patients. Failed back surgery syndrome due to postspinal surgical injury also causes foot drop.[2,6,21] Dellon[5] found that 58% of their postarthroplasty palsy patients had peroneal neuropathy and indicated surgical neurolysis of the common peroneal nerve.

Neurological deficit in the postsurgical period is under-recognized. Electrophysiological studies help diagnose the type and level of nerve injury.

Our study focuses on the surgical outcomes of iatrogenic foot drop resulting from potential complications of previous surgeries (lower back spine, hip, and knee surgeries) in other institutions before presenting to our clinic.

MATERIALS AND METHODS

We have reviewed our foot drop patients' data who consulted us over 17 years (07–2004 to current) to determine the iatrogenic causes and incidence of foot drop. EMG and NCS results were used for diagnosing nerve injuries in addition to clinical examinations of the involved foot. We successfully managed foot drop by neurolysis of the peroneal nerve and the nerve transfer[7] procedures described below.[14]

Surgical procedure

The involved leg was prepared and draped in a sterile fashion. A vertical midline incision was created in the distal posterior thigh, extended laterally along the posterior knee crease at the popliteal fossa, and then curved inferiorly along the course of the peroneal nerve over the fibular neck. The sciatic nerve was identified in the upper incision, which extended 6–8 cm above the popliteal fossa, and the terminal bifurcation of the nerve was traced. The superficial and deep peroneal nerve components were stimulated to identify or confirm conduction through the lateral and anterior muscle compartments. In those patients where the superficial peroneal nerve showed reasonable function, it was selected as the donor for the deep peroneal nerve. A partial transfer of one-third to the motor branch of the peroneal was feasible without clinical loss of eversion, as the superficial peroneal nerve is physically larger than the motor branch to the anterior tibialis muscle by about 3 times.

The motor branch to the anterior tibialis muscle was dissected several centimeters proximally within the common peroneal nerve so that coaptation was easily done without tension. If the lesion affected both superficial and deep branches, the tibial nerve was selected as a donor to the deep peroneal component of the common peroneal nerve or the deep peroneal nerve directly, if possible, by anatomy or by intraneural dissection. The incision created at the posterior knee and thigh allowed visualization of the sciatic bifurcation and dissection of the peroneal component to a distal level as possible to reduce regeneration time. The proximal tibial nerve was gently dissected intraneural to separate component fascicle groups. Typically, two large fascicle groups were then dissected out as suitable in diameter to fill the volume of the anterior and lateral part of the common peroneal nerve constituting the eventual deep peroneal motor branch. If intraneural dissection within the common peroneal nerve to isolate the deep peroneal nerve was feasible, then the tibial fascicle groups were coapted directly to the deep peroneal nerve fibers. Dissection was performed as distally as possible to reduce the length of regeneration to the anterior tibialis muscle. The deep peroneal nerve was sectioned with microsurgical technique and transposed to the area of the tibial nerve. The selected tibial nerve fascicles were then transected and placed in opposition to the peroneal nerve 2–4 cm distal to the bifurcation of the sciatic nerve and proximal to the popliteal crease area.

Approximately 25–30% of the overall volume of the tibial nerve was transferred. Neither the severed distal fascicles of the donor's nerve nor the transected proximal fibers of the recipient's deep peroneal nerve were managed specifically after being cut. The transfer site was secured with 9–0 nylon epineural stitches placed in a circumferential fashion around the peroneal-tibial or superficial peroneal-deep peroneal interface. The leg was then placed into a full range of motion to ascertain no tension at the repair site even with the knee was fully extended.

RESULTS

Before the onset of foot drop, all except one (27 of 28) patient have had surgeries in other clinics before presenting to our institution. Foot drop in one patient was due to infection and hip wound after he was intubated and stayed in ICU for weeks. Thirteen of the 28 patients have had lumbosacral (L3-4, L4-L5, and L5-S1) fusion or laminectomy, eight have had hip surgery, and five have had knee surgery. One patient had a fasciotomy due to compartment syndrome, and another patient had two previous surgeries for posterior tibial entrapment and tarsal tunnel syndrome at other institutions. NCS/EMG results showed that all except one patient had reduced peroneal nerve conduction velocity and amplitudes, and an absence or low sensory response of sural nerves. One patient had a femoral nerve injury and scarring and two patients also had tibial nerve injury.

Preoperatively, 10 patients had severe foot drop with muscle weakness and a functional grade of 0/5; 16 patients had grades ranging from 1 to 2/5; and two patients had 3/5 [Table 1] and [Videos 1A and 1B]. Overall, 23 of the 28 patients (83%) had

Table 1: Surgical improvements of foot drop in patients with iatrogenic nerve injury.

#	Gender/ Age	Preoperative history Type of injury	NCS/EMG Results	Preoperative Postoperative	Ankle dorsi-flexion	Follow-up months	Surgical outcomes
1	F/59	L3-L5 laminectomy	Abnormality was noted in both deep peroneal motor responses showing a significant axonal dropout and slowing in conduction velocities. Amplitude loss was present, but the sural sensory response was normal. EMG showed no recruitment and no voluntary motor units in the right tibialis anterior	Preoperative Postoperative	1 2+	15	Improvement in ankle dorsiflexion and extension
2	M/21	Fell at home, knocked himself out, mild strokes, infection, intubated in ICU for weeks, hip wound	There was no palpable and no electric responses in the left peroneal nerves	Preoperative Postoperative		32	Some improvements, still steppage gait present
3	F/69	Retroperitoneal hematoma, femoral palsy. Hip replacement	Femoral innervated muscles on the right demonstrated active denervation. F-waves, latencies, velocities, and conduction were normal in the right tibial, peroneal, and sural nerves. Femoral nerve palsy/scarring had microneurolysis of femoral nerve.	Preoperative Postoperative	3 4+/5	9	Gained 4+/5 MRC grade No steppage gait
4	F/53	Knee replacement: slow steps used a cane	The abnormal electrodiagnostic study report of the left lower extremity consistent with left peroneal neuropathy at or proximal to the fibular head, evidence of tibial neuropathy. Diffused sensorimotor polyneuropathy.	Preoperative Postoperative	0 2+	20	Significant improvement; was able to walk without a cane
5	F/39	Had tarsal tunnel and tibial nerve entrapment surgeries	The left peroneal motor nerve showed reduced amplitude (0.8mA). The left superficial peroneal sensory nerve showed no response.	Preoperative Postoperative	2 4+	2	Excellent outcome Achieved 4+ grade No steppage gait
6	M/60	Had fasciotomy due to compartment syndrome	Significant denervation to the left peroneus and longus anterior muscle.	Preoperative Postoperative	2 -R 3+ -R	15	Improvement in the right foot Developed left FD later due to compartment syndrome
7	F/48	Bilateral knee replacement; left FD	Acute denervation to the left peroneus and longus anterior muscle.	Preoperative Postoperative		17	Recommended for tendon transfer

(Contd...)

Table 1: *(Continued).*

#	Gender/ Age	Preoperative history Type of injury	NCS/EMG Results	Preoperative Postoperative	Ankle dorsi-flexion	Follow-up months	Surgical outcomes
8	M/48	Lumbar spine surgery	Denervation changes were seen bilaterally, left worse than the right.	Preoperative Postoperative		21	Not significant improvement
9	F/15	Had prior ligament reconstruction in the right knee	No nerve action potentials were recorded with the direct nerve to nerve stimulation of the peroneal nerve. cAMPS was recorded with stimulation of anterior tibialis and peroneus longus muscle with stimulus intensities 1.0 mA	Preoperative Postoperative	0 4	18	Great improvement No steppage gait
10	F/56	Lumbar spine surgery	Abnormal needle examination with severe denervation noted in the L5 innervated right leg muscles	Preoperative Postoperative	3 4+	10	Improved significantly
11	F/44	Hip replacement	Peroneal innervated muscles shared acute denervation changes and absent recruitment of MUP, indicating axonal disruptions. Continued acute denervation with no evidence of regenerating motor units in the common PN distribution	Preoperative Postoperative	0 4+	8 years	Excellent results: the patient sent us a photo wearing and able to walk in high heel
12	F/18	Femoral palsy; prior surgery for foot drop	Severe left sciatic neuropathy with more significant involvement of the PN division of the sciatic nerve	Preoperative Postoperative	1 3	8 an 13	No steppage gait
13	M/59	Laminectomy	Abnormal findings of left tibialis anterior and posterior, also, gastrocnemius; axonal sensory polyneuropathy.	Preoperative Postoperative	0 2	10	Some improvement in dorsiflexion but not yet achieved anti-gravity
14	F/64	Hip replacement	Peroneal neuropathy manifested by low motor CMAP amplitudes and slowing of conduction velocity of the peroneal around the fibular head	Preoperative Postoperative	1 4	17	Excellent surgical outcome Patient was able to walk normally
15	M/69	Laminectomy	Preneurolysis; peroneal to tib. anterior – no response at 10 mA	Preoperative Postoperative	0 2	1	Improvement in gait

(Contd...)

Table 1: *(Continued).*

#	Gender/ Age	Preoperative history Type of injury	NCS/EMG Results	Preoperative Postoperative	Ankle dorsi-flexion	Follow-up months	Surgical outcomes
			superficial peroneal to lateral compartment – no response at 10 mA				
16	F/60	Hip replacement	The left peroneal motor nerve showed no response (ankle) and (B-fibula); the peroneal motor nerve showed no response (fibula head). Superficial peroneal sensory nerve showed no response (14 cm), and sural sensory nerves showed no response (calf)		0 4	16	Significant improvement, no steppage gait
17	F/39	Laminectomy L5-S1 disk herniation	L5 radiculopathy; evidence of acute and chronic muscle denervation changes	Preoperative Postoperative	0 2	9	Some improvement in eversion and plantar flexion. Gait present.
18	M/59	L5-S1 microdiscectomy	Diffused diminished amplitudes throughout the left lower extremity	Preoperative Postoperative	1 3+	7	Excellent results of nerve transfer. Improvement in ankle dorsiflexion and eversion; stable ankle movements
19	F/59	Lumbar nerve injury Bunion removal	The right tibial and peroneal motor conduction studies revealed prolonged and markedly reduced CMAP amplitude and NCV	Preoperative Postoperative	0 3	30	An ongoing stable, excellent function of both ankles. No steppage gait
20	F/46	Lower Back surgery	L5 radiculopathy; superimposed peroneal neuropathy. The right peroneal motor nerve CMAP amplitude was diminished	Preoperative Postoperative		18	No notable functional improvement
21	F/44	L5 transforaminal epidural steroid injection, and surgery	NCSs of the lower left extremity revealed an absence of motor responses. absent peroneal sensory response and low sural sensory response		0 2	10	Steppage gait reduced
22	F/54	L5-S1 lumbar fusion	The right peroneal nerve CMAP was absent from the extensor digitorum brevis; the right peroneal F-waves were absent	Preoperative Postoperative	AG 4+	5	Continued improvement in dorsiflexion after nerve transfer. Excellent result of surgery. Steppage gait much reduced

(Contd...)

Table 1: *(Continued).*

#	Gender/ Age	Preoperative history Type of injury	NCS/EMG Results	Preoperative Postoperative	Ankle dorsi-flexion	Follow-up months	Surgical outcomes
23	F/41	Hip replacement	There was no elicitable response of peroneal motor nerve by stimulating the extensor digitorum brevis or tibialis anterior, left tibial motor nerve showed decreased amplitude with slow conduction. No elicitable response by stimulating the left peroneal sensory nerve; the left sural sensory nerve showed mild prolongation of the distal latency	Preoperative Postoperative	2 3	7	Improved gait
24	F/49	Hip replacement	Left peroneal distal latency and amplitude were absent, normal in the right, altered sensation in the left peroneal nerve distribution. Motor study: the left peroneal over EDB unobtainable. Left peroneus longus revealed absent motor unit activity	Preoperative Postoperative		14	No improvement yet
25	F/76	L4-5 spinal fusion, laminectomy	Distal peroneal and tibial latency was prolonged with markedly reduced amplitude. Sensory NCV was absent in peroneal and sural nerves	Preoperative Postoperative	0 2+	6	Improvement in ankle dorsiflexion Almost AG
26	M/23	Knee surgery	The right peroneal nerve conduction velocity was slowed; NCV slowing of conduction over fibular head. A conduction block was reported. No right F-wave response could be elicited—no activation of motor unit potential in the right peroneal innervated muscles	Preoperative Postoperative	0 4+	6	Excellent result of surgery Patient back to work
27	F/64	Hip replacement	The left peroneal motor (ankle) and sural sensory nerves (calf) showed no response	Preoperative Postoperative	2 3+	8	Gait improved
28	F/50	three prior surgeries for herniated disk L3-L4, L4-L5, and L5-S1		Preoperative Postoperative	1	9	The wound healed, no improvement yet

improvement in their ankle dorsiflexion with anti-gravity and gained a healthier gait after neurolysis and decompression of the peroneal nerve and transfer of functional fascicles of either the superficial peroneal or the tibial nerve to the deep peroneal nerve [Table 1] and [Videos 2A, 2B, and 2C]. The severity of the foot drop and the surgical improvements were not related to the type of patients' previous surgery. The severity of the foot drop and the surgical improvements were not related to the type of patients' previous surgery.

Video 1: A 39-year-old female patient with the left peroneal nerve palsy and foot drop after having two surgeries for posterior tibial entrapment and tarsal tunnel syndrome at other institution. Nerve conduction studies showed loss of conductivity through superficial and deep peroneal nerves below the knee. She had a steppage gait with 2/5 dorsiflexion before surgery [Video A]. A 64-year-old female patient with the left peroneal nerve palsy and foot drop after the hip replacement surgery. She had a steppage gait [Video B].

Video 2: This patient regained full ankle range of motion with 4+/5 dorsiflexion and normally walked 5 months after decompression and neurolysis of the affected superficial and deep peroneal nerves; transposition and transfer of superficial peroneal nerve fascicle group to the deep peroneal nerve [Video A]. This patient regained full ankle range of motion with 4/5 dorsiflexion after 6 months and walked without steppage gait 17 months after the neurolysis of the affected superficial and deep peroneal nerves: transposition and transfer of superficial peroneal nerve fascicle group to the deep peroneal nerve [Videos B and C].

DISCUSSION

Iatrogenic nerve injuries can occur during any surgical procedure. Kretschmer *et al.*[12] found 17.4% iatrogenic nerve injuries among 722 of their surgically treated cases of peripheral nerve trauma patients. Ghobrial *et al.*[8] reported an average of 9% postoperative neurologic complications (range 0.46–24%) in 2783 patients from 12 studies. About 18% of 1022 patients with foot complications who consulted our institution since 07–2004 had lower back/lumbosacral spine or hip or knee surgeries in other clinics before presenting to us. However, not all 18% of the patients have had foot drop.

In addition to peroneal nerve injury, sciatic nerve injuries[11] and major arterial injuries[9] during spine and acetabular surgical reconstruction were presented with symptoms ranging from radiculopathy to foot drop.[9-11] Bohrer *et al.*[3] found 1.8% postoperative neuropathy and foot drop in 14 (11 patients) of their 616 female patients who underwent elective gynecologic/pelvic surgery. Compression stretching of the superficial peroneal nerve causing numbness of the lower extremity, foot drop, and gait instability was reported after the laparoscopic gynecologic/pelvic surgery.[11]

Complete familiarity with the region's anatomy can significantly reduce the risk of nerve damage.[1] Issack and Helfet[10] recommended keeping the patient's hip extended and knee flexed during these surgeries to prevent the injury. About 82% of our patients improved dorsiflexion of the foot and ankle by direct nerve transfer rather than nerve grafting, as nerve grafts were shown to prevent neural regeneration.[15] Prasad *et al.*[15] further demonstrated that this is due to the stretch/traction injury zone extending into the myoneural junction. None of our 28 patients in this study reported postoperative complications or iatrogenic injury.

CONCLUSION

Twenty-three of the 28 (83%) iatrogenic foot drop patients in this report gained a healthier gait with improved ankle dorsiflexion and anti-gravity after neurolysis of the peroneal nerve and transfer of functional fascicles of either the superficial peroneal or the tibial nerve to the deep peroneal nerve at our clinic.

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Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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