Management and outcomes in 353 surgically treated sciatic nerve lesions

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Object. This is a retrospective analysis of 353 surgically treated sciatic nerve lesions in which injury mechanisms, location, time to surgical repair, surgical techniques, and functional outcomes are reported. Results are presented to provide guidelines for management of these injuries.

Methods. One hundred seventy-five patients with buttock-level and 178 with thigh-level sciatic nerve injury were surgically treated at the Louisiana State University Health Sciences Center between 1968 and 1999. Buttock-level injury mechanisms included injection in 64 patients, hip fracture/dislocation in 26, contusion in 22, compression in 19, gunshot wound (GSW) in 17, hip arthroplasty in 15, and laceration in 12; at the thigh level, GSW was the cause in 62 patients, femoral fracture in 34, laceration in 32, contusion in 28, compression in 12, and iatrogenic injury in 10. Patients with sciatic nerve divisions in which positive intraoperative nerve action potentials (NAPs) were found underwent neurolysis and attained at least Grade 3 functional outcomes in 108 (87%) of 124 and in 91 (96%) of 95 buttock- and thigh-level tibial divisions, respectively, compared with 84 (71%) of 119 and 75 (79%) of 95, respectively, in the peroneal divisions. For suture repair, recovery to at least Grade 3 occurred in eight (73%) of 11 buttock-level and in 27 (93%) of 29 thigh-level tibial division injuries, and in three (30%) of 10 buttock-level and 20 (69%) of 29 thigh-level peroneal division lesions. For graft repair, good recovery occurred in 21 (62%) of 34 and in 43 (80%) of 54 buttock- and thigh-level tibial divisions, respectively, even in proximal repairs requiring long grafts, and in only nine (24%) of 37 and 22 (45%) of 49 buttock- and thigh-level peroneal division lesions, respectively.

Conclusions. Surgical exploration and neurolysis after positive NAP readings, or repair with sutures or grafts after negative NAP results are worthwhile in selected cases.

KEY WORDS • sciatic nerve • neurolysis • nerve repair • nerve graft

In this retrospective study from the LSUHSC we review 353 surgically treated buttock- and thigh-level traumatic injuries of the sciatic nerve with regard to the injury mechanism, location, time to surgical repair, and surgical procedures to determine which of these factors had an impact on postoperative functional outcomes. The results of this review are also presented to provide guidelines for the management of these injuries.

The proper management of sciatic nerve injuries can diminish pain and motor and sensory deficits, all of which can be severe. At worst, as in the case of a complete sciatic nerve lesion proximal to the hamstring branch, the patient presents with sciatic distribution pain and paresthesias, difficulty with knee flexion, and a flail foot caused by loss of dorsiflexion and plantar flexion. There is also loss of function of the posterior tibialis foot invertors and the peroneus longus and brevis foot evertors. Sensory loss involves the posterior thigh, lower lateral leg, and the entire foot; this may lead to pressure sores, infections, claw toes, and in some instances to eventual limb amputation. There are also delayed vasomotor changes in the involved limb that encompass sensations of coldness, skin erythema and thinness, nail changes, and edema. At best, if the sciatic nerve is injured below the hamstring branches and the femoral complex remains functional, the patient can extend, lock, and flex the leg, but a “kick-up” foot brace is required to substitute for the lost foot dorsiflexion, to bear weight, and to walk with an improved gait. The correct care of sciatic nerve lesions is thus vital to avoid severe deficits and to maximize recovery from less profound injuries.

In this paper we illustrate the injury mechanisms, the location of injury with respect to the buttock or thigh level, division and distal end point for nerve regrowth, and surgical techniques, that is, the types of repairs used to deal properly with these potentially devastating injuries. Timing of surgical intervention is also crucial to an advantageous outcome. Based on data obtained in patients with missile injuries to the sciatic nerve, Taha and Taha recommended repair within 3 months because all neurapraxias and some of the axonotmetic injuries would have at least early evidence of recovery by this time. Other authors also recommend a 3- to 4-month waiting period for a complete sciatic nerve injury due to fracture/dislocation. The timing of surgery for different injury mechanisms and grades of injury will be addressed in this retrospective clinical study.

Abbreviations used in this paper: GSW = gunshot wound; LSUHSC = Louisiana State University Health Sciences Center; NAP = nerve action potential.
Management and outcomes in 353 sciatic nerve lesions

Each of these factors, including injury mechanism, location of injury, time to surgical repair, type of surgical repair, and postoperative functional outcomes will be reviewed to provide guidelines for the management of these injuries. Additionally, it should be noted that this paper is an extension of previously published work.11

Clinical Material and Methods

Patient Population

On the basis of preoperative clinical, electrophysiologic, and radiologic assessments, 353 patients with traumatic buttock- and thigh-level sciatic nerve lesions that were not recovering or who had severe pain underwent surgery at the LSUHSC and were evaluated postoperatively. The charts for patients treated at this institution between 1968 and 1999 were reviewed retrospectively to determine the injury mechanism, type of lesion, level of injury, surgical techniques used, and functional outcomes.

Patients’ ages ranged from 8 to 68 years. Follow-up periods extended from 1.5 to 3 years. Among the patients who underwent surgery and who were included in the study group, 175 sustained buttock-level and 178 had thigh-level traumatic injuries. Traumatic buttock-level injury mechanisms in descending order of frequency were injection, hip fracture/dislocation, contusion, compression, GSW, hip arthroplasty, and laceration (Fig. 1 upper). At the thigh level, traumatic injury mechanisms were slightly different from those at the buttock level, as was the incidence. Injuries at the thigh level (in descending order of frequency) included GSW, femoral fracture, laceration, contusion, compression, and iatrogenic injury (Fig. 1 lower). The LSUHSC grading system, which is described in Tables 1 and 2, was used for pre- and postoperative clinical evaluations. Motor and sensory functions in the distributions of the tibial and peroneal divisions of the sciatic nerve were graded according to a standardized scheme,10 with recovery of a Grade 3 or better level constituting a favorable functional outcome.

Surgical Anatomy

The sciatic nerve is formed from the anterior and posterior divisions of the L-4, L-5, S-1, and S-2 spinal roots, and the anterior division of S-3. The anterior and posterior divisions comprise the tibial and peroneal divisions of the sciatic nerve, respectively. In most instances the two divisions join to form the sciatic nerve in the pelvis. The nerve then exits the sciatic notch along with gluteal branches to supply the gluteal muscles. The inferior gluteal nerve passes beneath the pyriformis muscle to supply the gluteus maximus, whereas the superior gluteal nerve branch passes above it (Fig. 2). The superior gluteal nerve innervates the gluteus medius and minimus and then continues forward to innervate the tensor fascia lata.

| TABLE 1 | The LSUHSC grading system for buttock- or thigh-level tibial division lesions*
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Grade</td>
<td>Criteria</td>
</tr>
<tr>
<td>-------</td>
<td>---------</td>
</tr>
<tr>
<td>0</td>
<td>no gastrocnemius–soleus function; no inversion; no toe flexion; little or no sensation on the plantar surface of the foot</td>
</tr>
<tr>
<td>1</td>
<td>trace gastrocnemius, but no other tibially innervated muscle function; trace-to-poor plantar sensation</td>
</tr>
<tr>
<td>2</td>
<td>gastrocnemius contracts vs gravity only; plantar surface sensation usually ≤ Grade 2</td>
</tr>
<tr>
<td>3</td>
<td>gastrocnemius–soleus contracts vs gravity &amp; some force; trace or better inversion; plantar sensation ≥ Grade 3</td>
</tr>
<tr>
<td>4</td>
<td>either a trace or no toe flexion; sensation ≥ Grade 4</td>
</tr>
<tr>
<td>5</td>
<td>gastrocnemius has full function; inversion ≥ Grade 4; toe flexion present; plantar sensation ≥ Grade 4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TABLE 2</th>
<th>The LSUHSC grading system for buttock- or thigh-level peroneal division lesions*</th>
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</thead>
<tbody>
<tr>
<td>Grade</td>
<td>Criteria</td>
</tr>
<tr>
<td>-------</td>
<td>---------</td>
</tr>
<tr>
<td>0</td>
<td>no or little function in short head of biceps; no peroneally innervated muscle function; no AT, EHL, or ED function</td>
</tr>
<tr>
<td>1</td>
<td>short head of biceps contracts; no distal peroneally innervated muscle function</td>
</tr>
<tr>
<td>2</td>
<td>short head of biceps contracts; peroneally innervated muscles contract vs gravity or better; no trace of AT; no other distal motor function</td>
</tr>
<tr>
<td>3</td>
<td>short head of biceps contracts; peroneally innervated muscles ≥ Grade 3; AT contracts vs gravity, but function of EHL &amp; ED for toes usually absent</td>
</tr>
<tr>
<td>4</td>
<td>short head of biceps &amp; peroneally innervated muscles contract, as does AT, which is ≥ Grade 3; EHL &amp; ED may have trace function</td>
</tr>
<tr>
<td>5</td>
<td>short head of biceps &amp; peroneally innervated muscles contract; AT ≥ Grade 4; EHL &amp; ED contract at least vs gravity</td>
</tr>
</tbody>
</table>

* AT = anterior tibialis; ED = extensor digitorum; EHL = extensor hallucis longus.
At the buttock level, the sciatic nerve lies dorsal to the superior gemellus, the obturator internus, the inferior gemellus, the quadratus femoris, and the adductor magnus muscles. It enters the thigh somewhat deep and between the medial and lateral masses of the hamstring muscles.

On reaching the upper thigh, the tibial division branches to supply the long head of the biceps femoris, the semitendinosus, the semimembranosus, and the ischial portion of the adductor magnus muscles (Fig. 3). The short head of the biceps is supplied by a peroneal division branch, which also originates in the proximal thigh. As the sciatic nerve proceeds distally, deep to the hamstrings, it bifurcates into the tibial and peroneal nerves, usually at the junction of the middle and lower third of the thigh (Fig. 4). Injury at or close to these levels can involve the tibial or peroneal nerve or both, rather than the sciatic nerve as a whole.

Surgical Treatment

A sciatic nerve operation was indicated for a serious or complete functional deficit in the distribution of one or both divisions if the deficit failed to improve over a few months, and in patients with severe pain that was not responsive to conservative measures, even if there was only a partial deficit.

**Buttock-Level Injury.** The patient was placed prone, with elevation of the ipsilateral anterior iliac crest, knees slightly bent, and feet padded. The buttock and proximal thigh, and also the lower leg(s) if sural nerve grafting was anticipated, were shaved, prepared, and draped. The buttock incision started below the posterior inferior iliac spine, curved around the buttock mass to the midline of the buttock crease, and continued lower in the midline, ending at the posterior upper thigh. The glutei were exposed and the lateral gluteus maximus muscle was incised 2 to 3 cm from its greater trochanter insertion, leaving a tagged cuff of muscle and tendon to be reattached to the opposite cut edge at closure. The gluteus medius muscle was reflected and retracted medially by using large rake retractors, and after blunt then sharp dissection the sciatic nerve was exposed medially. The nerve next underwent neurolysis superiorly toward the sciatic notch, preserving the hamstring and posterior femoral cutaneous branches and gluteal nerves and vessels. The piriformis muscle was often sectioned or a segment was removed to facilitate exposure in the sciatic notch region.

**Thigh-Level Injury.** With the patient placed prone, an undulating incision was made in the posterior midline thigh along the lateral hamstring tendon’s medial border and was extended curvilinearly as needed, either into the lateral but-
tock crease or toward the popliteal fossa. The long head of the biceps, which angled across the upper thigh, was encircled by one or two Penrose drains and retracted superiorly or inferiorly for exposure of the proximal thigh-level sciatic nerve. Exposure of the gluteus maximus muscle’s inferior border was helpful to visualize the sciatic nerve at the buttock crease. The gluteus could be undermined and retracted superiorly by using a medium-sized Richardson retractor, thus preserving the branches to the lateral short head of the biceps femoris that arise from the peroneal division distal to the buttock crease. At the thigh level the sciatic nerve was found by separating the biceps from the semitendinosus musculature.

**Sciatic Dissection and Evaluation.** A No. 15 blade on a long-handled knife or a Metzenbaum scissors was used for sharp dissection of the sciatic nerve. The presumed lesion site was approached in a circumferential manner, alternating from the superiorly more normal proximal nerve toward the lesion and distally from the degenerated intact nerve and again toward the lesion. For a sciatic nerve lesion in continuity, if an NAP was recorded at a location distal to the neuroma, the peroneal and tibial divisions proximal and distal to the lesion were isolated and each division was stimulated proximally and monitored for an NAP distal to the lesion. A recordable NAP indicated significant sparing of function or adequate regeneration, and in either case it meant that neurolysis alone was usually adequate. Occasionally, an NAP transmitted across a lesion in continuity, but one part of the cross-section appeared worse. This portion was split away using internal neurolysis and was assessed separately. If it did not transmit, it was resected and a split repair was performed. Absence of an NAP several months postinjury signified a neurotmetic injury in which the chance of recovery was minimal without lesion resection and repair.

**Nerve Repair.** An end-to-end epineurial suture repair was performed if the gap was relatively short after resection of the lesion and if it could be bridged tension free by nerve mobilization. Long gaps were frequent and in those cases sural nerve grafts were harvested from the opposite leg and interposed between the prepared proximal and distal stumps. An interfascicular procedure was used in which groups of fasciculi were created on both stumps and these groups were joined by the sural grafts. The treated legs were not placed in a cast or immobilized, and patients were required to ambulate soon after surgery.

**Results**

The 353 traumatic injuries of the sciatic nerve were divided into 175 buttock- and 178 thigh-level lesions because mechanisms of injury and surgical exposures were different for each level. There were differences in both the number and type of lesion for each level. At the buttock level, there were 64 injection lesions, which constituted the majority, whereas the hip fracture/dislocation category included 26 patients, 22 had blunt contusion, and there were 19 compression injuries. Seventeen patients sustained GSWs at the buttock level of the sciatic nerve, hip arthroscopy procedures resulted in 15 lesions, and 12 lacerations caused sciatic nerve pareses or paralyses (Table 3). At the thigh level, mechanisms of injury consisted of 62 GSWs, which was the most frequent lesion, followed by 34 femoral fractures, 32 lacerations, 28 contusions, 12 compressions, and 10 iatrogenic injuries (Table 4). Outcomes varied not only by mechanism and level of injury, but also by surgical technique. The time to surgical intervention was kept consistent for each mechanism of injury as outlined in Fig. 5. There were exceptions, however, due to referral factors.

![Fig. 4. Photograph of a microdissection in a cadaver showing the bifurcation of the sciatic nerve into the tibial and peroneal nerves, which usually occurs at the junction of the middle and lower third of the thigh.](image-url)
Buttock-Level Sciatic Nerve Traumatic Lesions

Injection Injury. This lesion was usually due to a needle injection into an area outside the upper outer quadrant of the gluteus muscle in patients 65 years of age or older. Immediately after the injections, patients reported radicular pain and paresthesias and had variable motor and/or sensory deficits. A subset of injection injury patients (10%) experienced a delayed onset of pain and paresthesias and progressive loss of motor function minutes to hours after the injection. The most common agents injected intramuscularly were analgesic and antiemetic drugs in combination, whereas sole agents were antibiotic or local anesthetic drugs, vitamins, vaccines, and steroid medications.

Because many cases of injection injury were treated conservatively, the clinical presentations of both nonsurgically and surgically treated patients with injection injury were evaluated for this category. The presentations consisted of four main types, each with decreasing degrees of neurological deficits. The first type, which occurred in 18 (11%) of 164 nonsurgically and surgically treated patients with injection injury, was a severe sciatic nerve paralysis that combined a moderate lateral hamstring weakness with complete peroneal and tibial deficits. The second presentation was an isolated but complete peroneal or tibial division paralysis, which was found in 39 (24%) and five (3%) patients, respectively, with injection injury. On neurological examination, most of the patients with injection injury (72 [44%]) had the third finding, which was an incomplete deficit involving the peroneal more often than the tibial division. The fourth category included those whose chief symptom was severe neuritic pain (most likely caused by the actual injection) but with normal motor strength on examination; there were 30 patients (18%) in this subgroup.

Of the 164 nonsurgically and surgically treated patients with injection injury, 72 patients (44%) in the third category who had a partial injury that spared some function in both peroneal and tibial divisions were treated conservatively. Two nonsurgically treated patients from the third category who had mild partial deficits suffered persistent severe neuritic pain that was unresponsive to drugs, and these two underwent surgery. The remaining 70 third-category patients ultimately were treated without surgical intervention. The 30 patients (18%) in the fourth category were also treated conservatively. The first and second categories (complete or severe deficits in both peroneal and tibial distributions or in either division alone, respectively, with no evidence of recovery over time) were the usual indications for surgical exploration. Thus, there were 18 patients (11%) with complete tibial and peroneal loss of function, 39 (24%) with complete isolated peroneal division functional loss, and five (3%) with complete tibial functional loss alone who underwent surgery. Surgery was therefore performed in 64 (39%) of 164 injection injury lesions and the time frame for surgical intervention was between 3 and 8 months after the occurrence.

Of 64 surgically treated patients, 50 (78%) exhibited transmittable NAPs across each tibial and peroneal division of a nerve segment presumed to have been injected, indicating initial partial sparing of function or significant ongoing regeneration through the lesion site. In these cases, treatment with neurolysis was performed and in 42 (84%) of the 50 tibial divisions that underwent neurolysis there was at least Grade 3 recovery of tibial function, whereas in 34 (68%) of the 50 peroneal divisions the same result was achieved.

In a minority of cases there were no transmitted NAPs across the lesion; in these patients the affected segment of nerve was resected and an end-to-end suture repair was performed. Despite the proximal buttock level of repair, three of four patients treated with end-to-end suture repair of the tibial division recovered to at least Grade 3, compared with one of three patients with suture repair of the peroneal division at that level. Grafts 5 to 8.5 cm in length were used in 15 patients, of whom four (57%) of seven with graft repair of the tibial division attained functional recovery, compared with only two of eight patients who underwent graft repairs of the peroneal division; both of the latter two patients with recovery were younger than 9 years of age.

Stretch Injury Associated With Fracture. Buttock-level sciatic nerve palsy in 26 patients with persistent severe distributional loss in one or both divisions related to hip fractures and/or dislocations necessitated surgical exploration. Most lesions caused by stretch and contusion injuries to the nerve were in continuity, and 12 (86%) of 14 patients with tibial division injuries treated with neurolysis recovered useful function, compared with six (67%) of nine with peroneal division lesions. Grafts varying between 6 and 10 cm in length were used for nine tibial and 11 peroneal division injuries, with six (67%) of the former and only three (27%) of the latter recovering useful function. The mean time before

<table>
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<tr>
<th>Type of Injury</th>
<th>No. of Patients</th>
<th>Neurolysis</th>
<th>Suture</th>
<th>Graft</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Tibial †</td>
<td>Peroneal</td>
<td>Tibial</td>
</tr>
<tr>
<td>GSW</td>
<td>62</td>
<td>27/27</td>
<td>27/24</td>
<td>14/14</td>
</tr>
<tr>
<td>femoral fracture</td>
<td>34</td>
<td>17/15</td>
<td>17/11</td>
<td>1/1</td>
</tr>
<tr>
<td>laceration</td>
<td>32</td>
<td>6/6</td>
<td>6/5</td>
<td>14/12</td>
</tr>
<tr>
<td>contusion</td>
<td>28</td>
<td>23/21</td>
<td>23/16</td>
<td>0/0</td>
</tr>
<tr>
<td>compression</td>
<td>12</td>
<td>12/12</td>
<td>12/10</td>
<td>0/0</td>
</tr>
<tr>
<td>iatrogenic</td>
<td>10</td>
<td>10/10</td>
<td>10/9</td>
<td>0/0</td>
</tr>
<tr>
<td>total</td>
<td>178</td>
<td>95/91</td>
<td>95/75</td>
<td>29/27</td>
</tr>
</tbody>
</table>

* Values are expressed as the number of cases managed surgically per number of cases with recovery to at least Grade 3. Both divisions were not necessarily tabulated for a given case, unless there was a deficit or severe pain at the start in that distribution.
† Values for this column and those to the right of it refer to nerve divisions.
some recovery was evident was 10 to 14 months for tibial division injuries and more than 16 months for the peroneal division.

**Contusion Injury.** The clinical presentation in this subgroup consisted of pain and paresthesias in the sciatic nerve distribution with incomplete motor and sensory deficits. Twenty-two patients underwent surgical exploration because of persistent pain, and neurolysis without suture or graft repair was performed in all 22. The majority of the patients who underwent surgical intervention experienced relief of pain after the operation; however, two patients required internal neurolysis during surgery due to significant interfascicular scarring in painful neuromas. Patients in the contusion injury category had an excellent prognosis: 20 (91%) of 22 and 18 (82%) of 22 achieved at least Grade 3 functional recoveries for the tibial and peroneal divisions, respectively.

**Compression Injury.** Compression injury may be caused by pressure on the sciatic nerve if the patient falls asleep while seated. It may follow surgery performed with the patient placed in the lithotomy position and in a state of general anesthesia or it may occur in someone having piriform muscle entrapment, and so forth. In this series, in 19 patients who underwent surgical intervention for this injury only neurolysis was performed, because intraoperative recordings demonstrated an NAP in each case. Of the 19 patients with tibial division lesions, 18 (95%) had good functional recovery compared with the 19 with peroneal division lesions, of whom 15 (79%) had at least Grade 3 recovery.

**Gunshot Wound.** The sciatic nerve complex at the buttock level sustained injury from GSWs in 17 patients who required surgery because of continued severe functional loss or in a few because of severe neuritic pain. Eight needed neurolysis, four underwent suture repair, and five received graft repair with grafts between 7.5 and 12.5 cm long. For each of the three surgical methods the tibial division, with 88, 75, and 60% good outcomes after neurolysis, suture, and graft repair, respectively, had a better recovery rate than did the peroneal division, with 75, 25, and 20% good recoveries for each of the three techniques.

**Hip Arthroplasty.** Fifteen patients with sciatic nerve dysfunction after hip arthroplasty performed at another institution underwent surgery because of severe persistent functional loss and/or pain. Of these, neurolysis was performed in eight because the injured segment conducted an NAP. Recovery of tibial division function occurred in six patients (75%); however, peroneal division functional recovery was attained in only two (25%). When grafts were required, four (57%) of seven patients with tibial division graft repairs recovered, but only one (14%) of seven patients with peroneal division graft repairs regained useful motor function.

**Laceration.** Twelve patients with sciatic nerve lacerations at the buttock level underwent surgery. Neurolysis was performed in three patients for incomplete lesions that were in continuity, because there was early evidence of regeneration on NAP readings recorded during surgery. All three of these patients had Grade 3 or better functional recoveries in both divisions. Three patients sustained sharp transections and underwent end-to-end suture repairs. In two of three tibial division repairs the patients had a Grade 3 or better functional outcome, whereas only one of three with peroneal division repairs attained this outcome. Four of six patients undergoing graft repair in which grafts 6 to 10 cm in length were used achieved functional recoveries for the tibial division; however, only two of six in this category achieved similar functional recoveries for the peroneal division. In each of three patients with laceration, the injuries were caused by a boat propeller, which resulted in blunt and thus contusive transection requiring a delayed repair as well as a long graft passing from the buttock to the upper thigh levels in each case. Another patient had retracted nerve ends, which, despite mobilization of proximal and distal stumps, required a graft. As in the other categories, suture or graft repair of the tibial division was superior to peroneal division repair. The recovery after end-to-end repair of laceration injuries was slightly longer than 12 months for the tibial division and at least 18 months for peroneal division muscles. There was a further delay in the recovery when grafts were necessary.

**Thigh-Level Sciatic Nerve Traumatic Lesions**

**Gunshot Wound.** Gunshot wound was the most common mechanism of injury to the sciatic nerve at the thigh level, with 62 surgical cases. Complete paralysis of both divisions

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**FIG. 5.** Algorithm for surgical management of a sciatic nerve injury.
was the neurological deficit found preoperatively in the majority of patients who underwent surgery for this injury. The peroneal division usually sustained complete or very severe functional loss, whereas the tibial division usually exhibited incomplete loss. Close-range shotgun injuries often caused femoral fractures and vascular injuries in addition to the primary nerve lesion. Sometimes shotgun pellets became embedded in the nerve, creating severe neuritic pain as well as a considerable degree of functional loss. The pain and deficit mandated removal of the pellets and careful internal neurolysis or a split-graft repair guided by intraoperative NAP monitoring.

The majority of patients with thigh-level sciatic nerve injuries from GSWs did not recover spontaneously over a 3- to 4-month follow-up period, and thus 62 patients required surgery. Intraoperative recordings were made in these patients and neurolysis was performed after a positive NAP was obtained or repair with suture or graft was undertaken when no NAP was present (Fig. 6). All 27 patients undergoing neurolysis of the thigh-level tibial division and 24 (89%) of 27 with peroneal division injuries recovered to at least Grade 3 functional level. After resection of a focal injury, when the nerve gap was smaller than 3 cm end-to-end suture repair was possible after mobilization of both proximal and distal ends. The results were excellent in this subset, with all 14 patients with tibial division suture repairs achieving a functional outcome of at least Grade 3, whereas 10 (71%) of 14 with peroneal division suture repairs attained the same outcome. Recovery was less dramatic but still good after graft repair, with 18 (86%) of 21 patients with tibial division and nine (50%) of 18 with peroneal division graft repairs regaining useful function.

**Stretch Injury Associated With Fracture.** Femoral shaft fractures due to high-speed motor vehicle accidents that caused extensive skeletal trauma were commonly associated with stretch injuries of the thigh-level sciatic nerve in this series. Many of these femoral shaft fractures required open reduction and internal fixation.1,9,25 Thirty-four patients required surgical exploration because their injuries failed to improve spontaneously. Seventeen underwent neurolysis, and only one was eligible for end-to-end suture repair of a focal injury created by a fracture, whereas 16 received graft repairs because stretch damage usually involved a considerable length of nerve. Graft length varied from 5 to 14 cm with a mean of 8.5 cm. Repairs in the tibial division resulted in better outcomes than those in the peroneal division, that is, 15 (88%) of 17 compared with 11 (65%) of 17 for the neurolysis group, and 12 (75%) of 16 compared with four (25%) of 16 for the graft group. The only patient who underwent suture repair recovered tibial but not peroneal function.

**Laceration.** Glass and propellers caused most of the sharp lacerations to the posterior thigh and were frequent causes of sciatic nerve damage. Surgical intervention was performed in 32 patients, and in a few of these cases the sciatic laceration was associated with complete transection or “guillotine” injury of the hamstring muscles. Six patients underwent neurolysis and in all six the tibial divisions had good functional outcomes, as did five (83%) of six peroneal divisions. Fourteen patients with focal injuries involving mainly the sciatic nerve underwent end-to-end suture repair. Patients with tibial division injuries recovered to a Grade 3 or better in 12 (86%) of 14 cases, compared with 10 (71%) of 14 with peroneal division injuries. Twelve patients needed graft repair because of a delay in referral that resulted in nerve end retraction, or because of extensive injury. Ten (83%) of 12 with tibial division injuries and eight (67%)}
of 12 with peroneal injuries made a useful recovery. As a group, patients with lacerations at the thigh level had good outcomes after appropriate repair.

Contusion. Twenty-eight patients with contusion injuries required surgical intervention and 23 of them underwent neurolysis because a lesion in continuity conducted an NAP. Neurolysis resulted in good outcomes in 21 (91%) of 23 with tibial division injuries and in 16 (70%) of 23 with peroneal injuries. There were five tibial division contusion injuries requiring grafts and three (60%) of these five patients attained good outcomes, whereas in one (33%) of three cases of peroneal contusion injuries requiring grafts the patient had a good functional recovery.

Other causes of thigh-level sciatic neuropathy included 12 cases of compression injury and 10 of iatrogenic injury. Only neurolysis was required for both types of cases. For compression injuries all 12 patients with lesions in the tibial division had good functional recovery and 10 (83%) of the 12 with peroneal division lesions had a good functional outcome. For iatrogenic injury, the majority achieved excellent recovery for both the tibial and peroneal divisions, that is, 10 of 10 and 9 (90%) of 10, respectively.

Discussion

Traumatic injuries to the sciatic nerve were analyzed with regard to mechanisms of injury at the buttoc compared with thigh level and whether they involved peroneal or tibial divisions. These injury mechanism categories were also evaluated for time to surgical repair, surgical techniques, and postoperative functional outcomes for both the buttock and thigh levels.

There were different mechanisms for buttock- compared with thigh-level injury, and injection injury for buttock-level and GSW for thigh-level lesions were the most common mechanisms. A traumatic lesion in the thigh exhibited consistently better functional outcomes than one in the buttock because there was a shorter regeneration distance in the thigh injury. Tibial division injuries had a better recovery than those involving the peroneal division for each injury mechanism and for each type of surgical procedure at both the buttock and thigh levels. There was one exception to this finding in the buttock-level laceration category, in which patients with peroneal neurolysis repairs did as well as those with tibial repairs; however, there were only three patients in this group. Reasons for the more favorable results in the tibial division injuries are that the peroneal division, because of its location, has a greater tendency to be injured and for those injuries to occur with more force than in the tibial nerve, and the peroneal division also has less chance of regenerating than the tibial one.

Factors that underlie the peroneal division’s proclivity toward both injury and a more severe injury are multiple. At the hip and proximal thigh, the peroneal lies lateral to the tibial division and therefore is in a more susceptible location to a lesioning force. The tibial division is relatively fixed only at the sciatic notch; whereas the peroneal is relatively fixed not only at the sciatic notch but also as it passes over and somewhat around the surgical neck of the fibula; it is thus less resilient at impact.18 There is a smaller blood supply to the peroneal compared with the tibial division, which may result in less regeneration for the peroneal division.

The peroneal division has fewer and larger fascicles that are separated by less connective tissue than the tibial division, and thus more injury force is presumably absorbed by the fascicles than by the connective tissue.24 Peroneally rather than tibially innervated muscles may be stretched in addition to the nerve and thus may be injured as well. Also, the deep peroneal branches innervate the long, relatively thin extensor muscles of the anterior compartment at multiple sites, requiring a coordinated nerve input for successful and effective muscle contraction. Uncoordinated input from disordered reinnervation may thus be insufficient to generate enough force to permit useful dorsiflexion of the foot and/or toes.11 Compare this to the tibially innervated gastrocnemius–soleus, a relatively bulky muscle similar to the biceps femoris, in which only a little reinnervation is needed to produce functional contraction.

After an injury at the buttoc or thigh level resulting in tibial distribution palsy, recovery was first observed in the gastrocnemius–soleus muscle group in the earlier series of sciatic nerve injuries.11 This occurred in part because tibial nerve branches enter this muscle group proximally in the leg and in addition, as stated earlier, only a relatively small number of fibers are needed to reinnervate the gastrocnemius–soleus muscle for function to occur. Plantar flexion is first evident in most cases 6 to 12 months after a midthigh lesion and 12 to 18 months after buttoc-level lesions.

We also analyzed the time to surgical repair summarized in the algorithm, which is displayed in Fig. 5. Most sciatic nerve fracture- and contusion-associated lesions and GSWs were followed and evaluated periodically for 2 to 5 months before exploration, intraoperative NAP recordings, and repair. For sharp transections of the sciatic nerve an attempt was made to repair these as acutely as possible; when this could be achieved the results were excellent.

The three surgical techniques, including neurolysis after a positive NAP on intraoperative testing, suture repair, or graft repair (with split-graft repairs when needed) were used in the treatment of the various lesions. Traumatic injury resulting in a lesion in continuity for which neurolysis was performed after a positive NAP was found on intraoperative testing of each tibial and peroneal division yielded the best mean percentages of good functional recovery. The percentages were 80 and 88%, respectively, for buttock- and thigh-level lesions combined, as defined by at least a Grade 3 on the LSUHSC grading scale. This was followed by suture repair, which yielded mean results of 51 and 71% good recovery for buttock- and thigh-level lesions, respectively, and then graft repair with 43 and 60%, respectively. This reproduces our conclusions in an earlier review from this institution, in which 231 surgical buttock- and thigh-level sciatic nerve cases were summarized.11

Management of Specific Injuries

Injection Injury. Elderly patients had a predisposition to this injury because they were thin as a result of age and/or debilitating disease and had less gluteal soft-tissue covering. Intraneural injection into the sciatic nerve is the usual cause of the immediate onset of pain, paresthesias, and/or deficits. The less frequent pattern is a delayed onset, ranging from minutes to hours, of the same symptomatology and findings, which may be related to placement of the injection adjacent to the nerve or into the epineurium. Drug
combinations such as Demerol with Vistaril or Phenergan were commonly implicated in these injuries. Injection injuries resulting in partial function in both divisions were treated conservatively with pain medication, physical therapy, and time. A painful neuropathy with a partial or mild functional deficit was sometimes but not always helped by neurolysis. This was the case, however, in only 50 of the 64 surgically treated patients with injection palsies. Those with worse deficits and no NAP transmissions across their lesions in continuity underwent resection and repair. Exploration is recommended in patients who do not demonstrate spontaneous recovery on clinical or electromyographic examination by 4 to 5 months after the onset of the injection palsy.

**Stretch Injury Associated With Fracture.** The frequency of injury of the sciatic nerve associated with an acetabular fracture or fracture/dislocation of the hip has been reported to be 10 to 19%1,4,5,10,20 and these injuries occur most commonly when the femoral head is dislocated posteriorly.6 Patients with buttck-level sciatic palsy related to hip fracture and/or dislocation can also suffer pelvic fractures and lumbosacral plexus damage proximal to the femoral as well as sciatic outflows. It is important to differentiate these patients from those with more distal buttck-level sciatic injuries.6

Femoral shaft fractures predominated at the thigh level. Outcomes of injuries at this level were similar to those at the buttck level. Thus, in the neurolysis category the results were 88 and 86% good recovery for the buttck and thigh tibial divisions, respectively, and 67 and 65% for the peroneal divisions. For suture repair, there were no buttck-level sutures with which to compare thigh-level ones. For the graft repairs, however, tibial procedures yielded 67 and 75% good recoveries and peroneal procedures yielded good recoveries in 27 and 25% of patients with buttck- and thigh-level injuries, respectively.

**Gunshot Wound.** Missiles can injure the sciatic nerve by direct hit and shock waves or by causing an associated injury such as a femur fracture, and can result in neuroparaxic, axonotmetic, or neurotmetic injuries to the peripheral nerves.21 Peroneal nerves in which neurolysis was performed based on NAP recordings had better motor recovery at the thigh compared with the buttck level (89% compared with 75%, respectively) because there was a shorter distance at the thigh level over which to regenerate. Motor recovery after neurolysis was better in the tibial than in the peroneal nerve for both thigh (100%) and buttck (88%) levels. In adults, peroneal nerves sutured at the thigh level had significantly better motor recovery than those at the buttck level, that is, 71 and 25%, respectively, whereas the tibial nerve achieved an even higher percentage of at least Grade 3 functional recovery for the thigh compared with the buttck level, that is, 100 and 75%, respectively. The better outcomes for the tibial compared with the peroneal nerve,21,26 and also for thigh-level compared with buttck-level injuries for both peroneal and tibial nerves26 have been reported by others. Surgical exploration is recommended for patients in whom no spontaneous recovery of function had occurred by 3 to 5 months postinjury.

**Contusion.** Falls from a height or blunt local trauma caused by industrial accidents were the usual causes of buttck-level sciatic nerve contusion injury without fracture or dislocation. Contusions in thigh-level sciatic nerves were caused by automobile, motorcycle, and industrial accidents. Patients with this category of injury at both the buttck and thigh levels usually underwent neurolysis only and attained excellent recoveries at both levels for the tibial division, that is, 91% at both levels, and slightly worse but still good results for the peroneal division, that is, 82% compared with 70% for the buttck and thigh levels.

**Laceration.** The three patients with laceration mechanisms that left the nerve in continuity and who underwent neurolysis all had Grade 3 recovery or better in both peroneal and tibial divisions at the buttck level. This was one of the most favorable injuries to manage because even when repair was needed, recovery for tibial division injury, whether at the buttck or thigh level, was quite acceptable; surprisingly, so was that for the peroneal division.

**Compression.** Compression lesions at both the buttck and thigh levels underwent only neurolysis procedures at both levels and both divisions did very well. There were more of this type of injury at the buttck level, that is, 19 compared with 12 at the thigh level. For the tibial division, the rate of compression injuries recovering to Grade 3 or better at the buttck compared with the thigh level was 95% compared with 100%, respectively, and for the peroneal divisions the recovery was 79% at the buttck level compared with 83% for the thigh level.

**Hip Arthroplasty.** Hip arthroplasties can be associated with iatrogenic injury at the buttck level. The incidence of sciatic nerve palsy associated with hip arthroplasty ranges from 0.6 to 3% depending on the series cited.14,15,19 Sciatic nerve injury is most common in patients who need acetabular reconstruction for dysplasia and in those undergoing revision arthroplasty,4 and can also be caused by direct trauma from surgical instruments such as retractors, by penetrating injury from fixation screws, or from excessive tension caused by nerve lengthening. Ischemic damage, intra- neural hemorrhage, thermal damage from extruded methyl methacrylate as it polymerizes, or compression from a bone or prosthetic prominence can also occur. Intraoperative real-time nerve monitoring during acetabular fracture and complex total hip repairs has been advocated to prevent iatrogenic sciatic nerve injury.1,2,16 In surgically treated cases of sciatic nerve injury caused by hip arthroplasties in patients referred from other institutions, the nerve was first freed circumferentially from fibrous scar. Tibial and peroneal divisions were then split apart with the aid of magnification provided by surgical loupes or a microscope, and NAP recordings were used to determine the need for resection. If the NAPs were positive, external neurolysis was extended proximally and distally to release tension on the nerve. This extensive dissection increased the nerves’ mobility when the hip or knee was moved.

Complications of surgical treatment for this series in general included wound hematoma or infection, failure of the nerve to regenerate, graft-donor site breakdown, or systemic infection, which was usually pulmonary, urinary tract, and so forth, in origin.

**Conclusions**

Sciatic nerve injuries can cause significant disability if they are not treated in a timely manner and if the correct sur-
Management and outcomes in 353 sciatic nerve lesions

gical techniques are not used. In this retrospective study we examined outcomes in 353 patients with traumatic lesions of the sciatic nerve at the buttocck and thigh levels that were treated surgically at the LSUHSC during a 32-year period. We conclude that traumatic lesions in the thigh recovered better than those in the buttock because there was a shorter regeneration distance in the thigh injuries, and that tibial functional outcome was consistently better than peroneal outcome at both levels for each traumatic injury mechanism and for each surgical technique used. The time to surgical repair for each lesion is summarized in the algorithm shown in Fig. 5. Traumatic injuries resulting in a lesion in continuity and a positive NAP recording had the most favorable outcome (Grade 3 or better) after neurolysis. This was followed by suture repair; graft repair resulted in the lowest number of Grade 3 outcomes, although it was still worthwhile. The results of this review provide guidelines for the management of sciatic nerve injuries.

References

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