

Prospective evaluation of lateral femoral cutaneous nerve injuries during periacetabular osteotomy

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ABSTRACT

Periacetabular osteotomies (PAOs) are used to treat acetabular dysplasia in younger patients, but are not without morbidity. Lateral femoral cutaneous nerve (LFCN) injuries are commonly associated with the approach for PAOs, but the true incidence and rate of resolution is not known. The purpose of this prospective study was to determine the incidence of LFCN injuries after PAO using an innovative nerve conduction study (NCS) and to report the patient-reported outcomes. We prospectively enrolled 23 patients (24 hips) undergoing PAOs to have pre- and post-operative NCSs at a mean of 12 weeks post-operative. Patients were followed prospectively. Patients were contacted 3 years post-operatively via phone to determine the presence and severity of symptoms. Patient-reported outcome scores were also correlated with patient symptoms. Patients (91%) reported one or more LFCN symptoms post-operatively. The most common symptoms were numbness (91%), tingling (36%), pain (18%) and burning (9%). Patients (67%) had evidence of LFCN injury based on NCSs. Symptoms (40%) resolved 4 months post-operatively. Two-thirds of patients had continued symptoms at 3 years. Only 1 patient required treatment. The incidence of LFCN injury after PAO is 90%, two-thirds of which can be identified objectively by NCS. Numbness is the most common symptom. LFCN symptoms (40%) resolve by 4 months, but two-thirds of patients may continue to have thigh numbness up to 3 years after surgery. Fortunately, symptoms are not clearly associated with outcome score and treatment for this complication is rare.

INTRODUCTION

Acetabular dysplasia is a condition that affects between 3.6% and 12.8% of adults [1, 2]. It has been associated with early onset osteoarthritis of the hip and need for total hip arthroplasty (THA) [3]. The Bernese periacetabular osteotomy (PAO) was first described by Ganz *et al.* [4] as a means of correcting acetabular dysplasia. The procedure has become the preferred treatment option in younger patients with acetabular dysplasia in hopes of preserving the native hip joint and preventing and/or delaying THA. The procedure is complex, has a long learning curve, and is not without morbidity. Several recent studies have shown that likely the most common complication after PAO is lateral femoral cutaneous nerve (LFCN) injury [5, 6]. The incidence of this injury has been reported between 1.5%

and 100% [6–11]. All but one of these studies is retrospective and most minimized the significance of these injuries. The true prevalence and severity of these injuries at the time of PAO is therefore not known.

While clinical exam and subjective patient evaluation are often utilized to identify LFCN injuries, nerve conduction studies (NCSs) can objectively diagnose the injury and help determine prognosis and/or treatment [12]. A recent NCS protocol developed at our institution, utilizing ultrasound guidance and based on the anatomic variability of the LFCN, has shown less inter-side variability and has a higher rate of responses compared with previous protocols [13, 14].

To our knowledge, no study has objectively and prospectively identified the incidence of LFCN injuries following PAOs at greater than 1 year post-operatively. The

purpose of this study, therefore, is to determine the incidence of LFCN injury after PAO using NCSs and patient-reported symptoms 3 years post-operatively, as well as whether there was any correlation between the presence of symptoms and patient-reported outcome scores.

MATERIALS AND METHODS

Patient selection

Following institutional review board approval, we prospectively enrolled patients undergoing a PAO by RJS and RTT from 17 December 2012 to 16 December 2013. There were 19 female and 4 male patients with a mean age of 24.7 years (range: 15–41 years). There were 15 right hips and 9 left hips (one male had bilateral PAOs). The mean body mass index (BMI) was 24.9 kg/m² (range: 17.7–40.7 kg/m²) (Table 1). All patients with a PAO were included regardless of prior surgery, trauma or pre-operative diagnosis. The pre-operative diagnoses were developmental dysplasia in 17 (71%) patients and acetabular retroversion in 7 (29%) patients. Three (13%) patients had a previous hip arthroscopy on the ipsilateral side. Interestingly, 3 (13%) patients had LFCN symptoms prior to surgery: one was from a previous hip arthroscopy, one was from a motorcycle injury 1 year prior, and the other was likely related to lumbar pathology. Concomitant procedures included a femoral head–neck osteochondroplasty in 15 (63%), anterior inferior iliac spine (AIIS) trimming in 9 (38%), labral debridement in 5 (21%), labral repair in 2 (8%) and a surgical hip dislocation in one patient (4%).

Nerve conduction studies

Patients that agreed to participate in the study had pre- and post-operative NCSs performed on the operated side, specifically evaluating the LFCN. Baseline testing was performed pre-operatively, and then again at the time of any routine post-operative surgical follow up visits. As described by Boon *et al.* [13], the NCSs were carried out using a Nicolet select electromyograph (Viasys Biomedical, Madison, WI, USA) with the following settings: sensitivity 5–10 μ V/cm; sweep speed 1 ms/cm and filter bandwidth 20–3000 Hz. Electrical stimuli were 0.1 ms in duration and were administered at a rate of 0.5–1 Hz. The anode was rotated when necessary to minimize shock artifact, and at least five responses were averaged once supramaximal stimulation was achieved. Negative peak latency and baseline to peak amplitude of the sensory nerve action potential (SNAP) were recorded. Ultrasound was performed with a Logiq E portable machine (GE Healthcare, Milwaukee, WI, USA), using a 38-mm footprint linear-array transducer (7–13 MHz). Ultrasound settings were

optimized for nerve imaging—i.e. the highest frequency available, given the superficial nature of the target, with adjustment of depth, focal zone, gain and time gain/depth gain compensation to optimize LFCN visibility.

At the stimulation site, the cathode was placed 1 cm medial to the anterior superior iliac spine (ASIS) (with the anode positioned cephalad to the cathode). Current was applied at 0.1-ms duration with increasing intensity until the subject felt paresthesias in the lateral thigh in the distribution of the LFCN. If no response was perceived with a stimulus intensity of 20 mA, the cathode was relocated more laterally (over the ASIS) or medially along the inguinal ligament until paresthesias was felt in the LFCN distribution. The recording site was a point approximately 10 cm along a line extending from the ASIS to the lateral border of the patella. Ultrasound was used to visualize and localize the LFCN, exploring up to 4 cm medial and lateral to the initial reference point.

LFCN injuries were defined as a decrease by 50% or more in amplitude post-operatively (compared with the amplitude elicited with pre-operative testing) or a lack of response (i.e. no response).

Surgical procedure

General anesthesia was administered in 21/24 patients. Three patients underwent spinal anesthesia. All patients received an epidural catheter pre-operatively and, unless contraindicated, were administered a multimodal, pre-emptive, pre-operative pain regimen including oxycodone, celecoxib and gabapentin. Intraoperative neuromonitoring was utilized for all surgeries (monitoring free run EMG from sciatic and femoral innervated muscles in the ipsilateral limb). As described by Ganz *et al.* [4], an anterior approach to the hip was utilized. The incision was centered over the ASIS starting on the iliac wing and extending distally between the tensor fascia lata and sartorius. A Heuter approach was performed, entering the interval between the tensor fascia lata and sartorius, through the tensor fascia lata laterally. The interval is exposed bluntly being careful to avoid the LFCN but in the majority of instances the LFCN is not seen or exposed. The hip was flexed when possible, especially during ischial and pubic osteotomies, and any retraction around the nerve was limited as much as possible. The fascia on the medial side was tagged and retracted medially. The anterior pelvic brim was exposed. The sartorius was taken off the ASIS directly from bone and the rectus from the AIIS. An ASIS osteotomy was not performed. Once the hip capsule was exposed, an osteotomy was placed anteriorly and the ischial osteotomy was performed under fluoroscopic control. Subsequently, the pubic osteotomy was performed in an oblique fashion. The

Table I. Patient demographics

Patient	Age (years)	Side	Sex	BMI (kg/m ²)	Concomitant procedure	Pre-existing injury	Pre-operative diagnosis
1	25	R	F	20.1	None		Dysplasia
2	29	R	F	22.6	a,b	Yes, previous hip arthroscopy	Dysplasia, s/p hip scope
3	23	R	F	34.6	a,b,c		Dysplasia
4	28	R	F	27.4	None		Dysplasia
5	24	L	F	40.7	a,c		Acetabular retroversion
6	15	R	F	23.0	None		Dysplasia
7	25	L	M	22.5	a,b		Dysplasia
7	25	R	M	22.5	a,b		Dysplasia
8	36	R	F	29.2	a,b,c		Dysplasia
9	34	R	F	21.2	a		Dysplasia, s/p hip scope
10	17	R	M	22.3	a,c		Acetabular retroversion
11	20	R	F	25.9	c		Dysplasia
12	26	L	F	19.7	c		Dysplasia, s/p hip scope
13	26	R	F	30.2	a	Yes, motorcycle accident	Acetabular retroversion, s/p trauma
14	41	L	F	23.2	a		Dysplasia
15	20	L	F	17.7	a,d,e	Yes, lumbar etiology	Acetabular retroversion
16	19	L	M	24.4	a,b,c		Acetabular retroversion
17	36	L	F	32.1	d		Dysplasia
18	16	R	F	23.1	c		Dysplasia
19	25	R	F	20.2	b		Dysplasia
20	18	L	F	28.1	None		Dysplasia
21	21	L	F	20.4	a		Acetabular retroversion
22	22	R	M	29.3	a,c		Dysplasia
23	19	R	F	18.4	a		Acetabular retroversion
Mean	24.7	15	9	4	19		
SD	6.78						

^aOsteochondroplasty.^blabral debridement.^canterior inferior iliac spine trimming.^dlabral repair.^esurgical hip dislocation.

iliac osteotomy was done at the level of the ASIS. At the pelvic brim, the surgeon then turned 120 degrees and connected the iliac and ischial osteotomies. The fragment was then mobilized. Intraoperative fluoroscopy confirmed correct position of the fragment, and it was fixed with two or three screws from the pelvic brim down to the osteotomized fragment. A capsulotomy was performed and the labrum was inspected in 21/24 hips (88%). If torn and irreparable, a debridement was performed. If torn and repairable, then the labrum was repaired. Otherwise, the labrum was left alone. A head–neck osteochondroplasty was performed to improve motion if needed. The capsule was then closed loosely with absorbable braided suture. The rectus and sartorius were then placed back into their native locations with non-absorbable braided suture. The rest of the wound was closed in a routine fashion over one drain. Post-operatively, all patients utilized a continuous passive motion device and were allowed hip range of motion as tolerated.

Data collection

Patient demographics were obtained at the time of surgery. The primary outcome measure was the presence or absence of LFCN injury objectively identified by NCSs or based on the subjective presence of numbness, tingling, burning and/or pain in the LFCN distribution. This information was obtained from the NCS reports in our institution's electronic medical record and via telephone questionnaire (Appendix). Additional information obtained included severity of the symptoms, on a scale from 0 to 10, both at the peak of symptoms and at last follow-up, and whether or not the symptoms resolved. Treatment information, including nerve stabilizing medications (gabapentin, pregabalin, amitriptyline, etc.), nerve blocks and/or neurolysis, specifically to treat the LFCN injury, was also obtained.

Surgical variables, including anesthetic type, operative time and blood loss were also obtained from the intraoperative electronic medical record. Intraoperative findings and concomitant procedures were obtained from the operative notes of RJS and RTT.

Patient symptoms were correlated with outcomes scores from the Academic Network of Conservational Hip Outcomes Research (ANCHOR) database. Scores were obtained at 1, 2 and 3 years post-operatively and included the UCLA Activity Score, Harris Hip Score (HHS), Hip Disability and Osteoarthritis Outcome Score (HOOS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) and SF-12 Physical and Mental Health Summary Scales (SF-12).

Statistics

Data was analyzed and reported using mean (standard deviation) for continuous variables and count (percentage) for categorical variables. Logistic regression was used to analyze the association between patient demographics, baseline clinical characteristics, surgical factors and outcome scores with the occurrence of nerve injury based on NCS and subjective reporting. The sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of the NCS were calculated using the presence of symptoms (numbness, tingling, burning and pain) as the gold standard; these values were reported with 95% confidence intervals. Statistical significance was set at a P -value ≤ 0.05 . All analyses were conducted using SAS version 9.4 (SAS Institute, Inc., Cary, NC, USA) and R version 3.1.1 (R Core Team, R Foundation for Statistical Computing, Vienna, Austria, 2014).

RESULTS

Nerve conduction studies

All patients had pre- and post-operative NCSs performed on the LFCN on the operated side. Amplitude, latency and absent responses (NR) were noted (Table II). The mean pre-operative time from NCS to surgery was 1.8 days (range: 0–5 days) and the mean post-operative time to NCS was 12 weeks (range: 6–49 weeks). Two patients had NR on their pre-operative NCSs (neither patient had pre-operative LFCN symptoms) and 12/24 (50%) hips had NR on their post-operative NCS. The mean pre- and post-operative amplitudes were 13 microvolts and 6 microvolts, respectively. The mean pre- and post-operative latencies were 2 ms and 2 ms, respectively. The mean absolute percent change in amplitude and latency was 35% and 6%, respectively. Sixteen hips (67%) had objective evidence of a LFCN injury, with a mean change in amplitude and latency of 59% and 3%, respectively. NCS sensitivity, specificity, PPV and NPD were 0.70, 0.50, 0.93 and 0.14, respectively. No statistically significant risk factors were identified as being predictive of detecting an injury based on NCSs, however there was a trend toward lower BMI being a risk factor (odds ratio 0.93; 95% confidence interval 0.79–1.10). The mean (SD) BMI for patients with and without an injury based on NCS was 24.0 (5.6) and 26.8 (5.4), respectively.

Three patients (4 hips) had a second NCS performed on the operative side at a mean post-operative time of 10 months (range: 7–12 months). Two patients had no change in response. The other patient, who had bilateral PAOs and bilateral LFCN injuries, showed interval improvement bilaterally.

Table II. Nerve conduction studies

Patient	Pre-operative NCS		Post-operative NCS		NCS follow-up (weeks)	Amp change (%)	Lat change (%)	LFCN injury	
	Amp (μ V)	Lat (ms)	Amp (μ V)	Lat (ms)					
1	12.0	2.10	NR	NR	13	—	—	Yes	
2	21	2.0	NR	NR	12	—	—	Yes	
3	3	2.3	4	2.0	8	33.3	-13.0	No	
4	3	2.5	2	2.8	10	-33.3	12.0	No	
5	9	1.6	NR	NR	9	—	—	Yes	
6	6	2.7	4	2.4	8	-33.3	-11.1	Yes	
7	18	1.8	9	2.1	6	-50.0	16.7	Yes	
7	22	2.1	NR	NR	25	—	—	Yes	
8	9	2.0	NR	NR	9	—	—	Yes	
9	7	2.1	3	2.0	8	-57.1	-4.8	Yes	
10	26	2.2	NR	NR	9	—	—	Yes	
11	19	1.8	11	1.8	10	-42.1	0.0	No	
12	11	2.2	NR	NR	11	—	—	Yes	
13	5	1.8	NR	NR	13	—	—	Yes	
14	9	1.8	NR	NR	10	—	—	Yes	
15	15	2.3	11	2.5	13	-26.7	8.7	No	
16	21	1.8	9	2.3	11	-57.1	27.8	No	
17	NR	NR	5	2.8	49	—	—	No	
18	11	1.8	11	2.0	7	0.0	11.1	No	
19	7	2.2	NR	NR	12	—	—	Yes	
20	46	2.0	2	2.2	13	-95.7	10.0	Yes	
21	4	2.5	NR	NR	11	—	—	Yes	
22	4	2.2	3	2.4	9	-25.0	9.1	No	
23	12	1.6	NR	NR	6	—	—	Yes	
Mean	13	2.1	6.2	2.3	12.02			16	8
SD	9.86	0.29	3.71	0.32	8.75				

NCS, nerve conduction study; NR, no response; Lat, latency; Amp, amplitude.

Patient phone-call interviews

Twenty-one of 23 hips (22 patients) were reached by phone at a mean follow-up of 34 months (range: 29–39 months) (Table III). Each patient answered the questions set forth in the questionnaire (Appendix). A 19/21 (91%)

patients reported one or more LFCN symptoms post-operatively. The most common symptom was numbness (20/22 hips, 91%), followed by tingling (8/22 hips, 36%), pain (4/22 hips, 18%) and burning (2/22 hips, 9%). A 7/19 (37%) patients went on to have complete resolution of

symptoms without intervention at a mean 4 months (range: 1.5–12 months) post-operatively. The mean worst severity of the symptom(s) was 6/10 (range: 1–10). Three years post-operatively, 12/19 (63%), patients continued to have symptoms with a mean severity of 2/10 (range: 1–10). Persistent symptoms included burning in 1/2 hips (50%), numbness in 11/20 hips (55%), tingling in 5/8 hips (63%) and pain in 3/4 hips (75%). Only 1 patient tried using a nerve inhibiting medication, nerve block and a neurolysis to treat his symptoms, all of which were unsuccessful. This patient also had an associated femoral nerve injury. No statistically significant risk factors were identified as being predictive of symptom presence, severity or resolution. A sub-group analysis was performed in the four patients that reported pain, but no statistically significant risk factors were identified.

Outcome scores

No statistically significant associations between burning, pain, tingling and outcome score were identified at any time point ($P > 0.05$). Patients that reported numbness (19/22) had better UCLA and total WOMAC scores 1 year post-operatively (8.3 versus 6.0, $P = 0.001$ and 97.5 versus 100.0, $P = 0.045$, respectively). The same patients had worse Harris Hip, HOOS (pain) and HOOS (function, sports and recreation) scores 1 year post-operatively (93.7 versus 100.1, $P = 0.024$, 95.0 versus 100.0, $P = 0.013$ and 88.1 versus 100.0, $P = 0.012$, respectively).

DISCUSSION

The PAO is not without morbidity as multiple studies have shown [5–9, 11, 15–20]. A recent review by Swarup and colleagues found that the most common complication after PAO was a LFCN injury at 14.8% [6]. Even Ganz *et al.*, in their original 1988 report, saw ‘relatively frequent’ dysesthesias in the LFCN after PAO, though offered no additional commentary [4]. Biedermann and colleagues [11] reviewed 60 patients after PAO and found a 30% incidence of LFCN dysesthesia, on par with many other studies. Unlike other studies, at the time of last follow-up (mean 7.4 years), 24/42 (57%) patients complained of dysesthesias in the LFCN distribution and had significantly worse WOMAC scores ($P < 0.05$).

In our study, we identified 67% of patients with objective evidence of a LFCN injury on post-operative NCSs and 91% with subjective LFCN symptoms (numbness, tingling, burning and/or pain). These values suggest that LFCN injuries are on average at least 30% greater than that of previous reports. In addition, 60% of our patients continued to have mild symptoms, mostly numbness, 3 years post-operatively. This is much higher than most

previous reports where the symptoms either resolved or remained ‘trivial’ in less than 20% of patients.

Given the high percentage of persistent symptoms, we further investigated whether there was an association with outcome. Fortunately, pain, burning and tingling did not have any statistically significant association with outcome score. Numbness was the only symptom that correlated significantly with outcome score. Patients reporting numbness had better UCLA and total WOMAC scores 1 year post-operatively, but worse Harris Hip, HOOS (pain) and HOOS (function, sports and recreation) scores at the same time post-operatively. The clinical significance of these findings is guarded given the mixed results and the fact that the differences were less than the minimal clinical important difference for each score.

Injury to the LFCN is likely due to a combination of stretch/compression leading to neural ischemia, direct injury and/or inflammatory neuropathy [7, 9, 19, 21, 22]. The LFCN most commonly exits the pelvis medial to the ASIS, therefore making a c-shaped skin incision closer to the ASIS and using blunt dissection should minimize nerve injury [18, 23–28]. Some authors have advised making the fascial incision more lateral, or over the belly of TFL, as a means of reducing injury to the LFCN, but this does not protect against the superior/posterior branch crossing the TFL which is often sacrificed [6, 7, 9, 15, 18, 23]. The authors currently use electrocautery to take down the sartorius, however, this may lead to thermal injury if the nerve is close to the ASIS. Flexing the hip and/or osteotomizing the ASIS takes tension off the LFCN and can minimize thermal injury, respectively [18, 28]. However, risks of ASIS non-union, delayed union or pull-off the sartorius must be weighed. In our exposure, the sartorius and abdominal musculature is taken down as a continuous sleeve, from the inner table to the Smith Petersen interval, allowing easy side-to-side healing without compromise of muscle function.

While NCSs remain the most sensitive test in evaluating LFCN injuries, this study has shown that nearly 25% of LFCN injuries in patients with subjective complaints may be missed with NCSs. Furthermore, the utility in determining severity and/or prognosis was not established in this study and remains to be determined. Sensory NCSs can be normal in a symptomatic patient when there is nerve irritation without axonal loss, or where the nerve is compressed proximal to the site of stimulation and recording [29]. We suggest that in the current era of cost containment, clinical examination and subjective patient evaluation are as good a test as any, unless objective evidence of nerve injury is necessary for documentation purposes or the diagnosis of LFCN injury is in question.

Table III. Patient phone-call follow-up

Patient	F/U months	Initial symptoms	Remaining symptoms	Resolved symptoms	Time (months)	Worst severity	Severity at F/U	Treatment
1	30.5	a	a			–	2	
2	36.4	a	a			4	1	
3	33.3	a	a			8	2	
4	35.5	a	None	a	3.5	2	0	
5	35.4	a	None	a	6	5	0	
6	38.7	a	b	a		5	2	
7	35.0	a,b	None	a,b	2	1	0	
7	33.6	a,b,c,d, Femoral nerve injury	a,b,c,d			10	10	Yes ^e
8	35.4	a,c	a,c			8	2	
9	35.7	None	None					
10	36.5	a,b	a,b			3	1	
11	33.4	a	None	a	2	7	0	
12	36.3	a,b,c	a,b,c			8	3	
13	36.3	a	a			7	4	
14	29.3	a	a			10	4	
15	33.7	None						
16	33.8	a	None	a	1.5	3	0	
17	28.9	a,b	b	a		7	1	
18	32.0	a,b,c	a	b,c		8	1	
19	30.9	a,d	a	d		3	1	
20	37.9	a,b	None	a,b	1.5	5	0	
21	39.2	a,b	None	a,b	12	4	0	
Mean	34.4				4.1	5.68	1.7	
SD	2.83				3.85	2.67	2.34	

^a Numbness.^b tingling.^c pain.^d burning.^e gabapentin, neurolysis, pain pump, acupuncture, manipulation, injections.

Limitations of this study include small patient numbers. The inability to identify any statistically significant risk factors and the mixed relationship with outcome score is likely a result of our study being underpowered. Recall bias may have affected the accuracy of the symptom duration

and/or resolution. Strengths of the study include the prospective nature, use of objective data and duration of follow-up.

In conclusion, we have shown that 9/10 patients sustain an injury to the LFCN injury after PAO where an ASIS

osteotomy is not performed. The most common symptom is numbness. Symptoms (40%) resolve by 4 months, but 60% of patients remain mildly symptomatic 3 years after surgery. NCSs have a low sensitivity and specificity. Outcome scores are not clearly associated with symptom(s) and need for treatment is rare. This information allows surgeons to better inform their patients of surgical risks and prognosis should an injury occur.

CONFLICT OF INTEREST STATEMENT

None declared.

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Appendix

1. Did you have any pain, numbness, tingling or burning in your [operated side] leg BEFORE your surgery? YES NO

a. If yes, NOT a study candidate.

2. Did you have any pain, numbness, tingling or burning in your [operated side] leg AFTER your surgery? YES NO

a. If yes,

i. Do you still have any symptom(s)?

YES NO

1. If yes,

a. What are they (pain, numbness, tingling, burning)?

b. What is the severity now (0–10)?

c. What was the worst severity (0–10)?

d. Where are they located (dermatomal)?

e. ARE/WERE you taking any nerve medication(s) such as Neurontin, Gabapentin, Lyrica, Pregabalin, Amitriptyline or Cymbalta for your symptoms?

YES NO

i. If yes, what medication(s) ARE/WERE you taking?

f. Did you have any injections/nerve blocks to help with the symptom(s)?

YES NO

i. If yes,

1. What type of injection was it (local, local with corticosteroid, corticosteroid)?

2. Where was the needle inserted?

3. Did it help your symptoms? YES NO

a. If yes,

i. What percentage relief did you get?

ii. How long did symptoms abate for?

4. How many total injections/blocks did you receive?

g. Did you have any surgery to help with the symptom(s)?

YES NO

i. If yes,

1. When was it?

2. What was done?

3. Did it help?

YES NO

a. If yes,

i. What percentage improvement did you have?

ii. How long did symptoms abate for?

2. If no,

a. When did the symptoms abate?

b. What were they (pain, numbness, tingling, burning)?

c. What was the worst severity (0–10)?

d. Where were they located (dermatomal)?

e. ARE/WERE you taking any nerve medication(s) such as Neurontin, Gabapentin, Lyrica, Pregabalin, Amitriptyline or Cymbalta for your symptoms?

YES NO

i. If yes, what medication(s) ARE/WERE you taking?

f. Did you have any injections/nerve blocks to help with the symptom(s)? YES NO

i. If yes,

1. What type of injection was it (local, local with corticosteroid, corticosteroid)?

2. Where was the needle inserted?

3. Did it help your symptoms? YES NO

a. If yes,

i. What percentage relief did you get?

ii. How long did symptoms abate for?

4. How many total injections/blocks did you receive?

g. Did you have any surgery to help with the symptom(s)?

YES NO

i. If yes,

1. When was it?

2. What was done?

3. Did it help?

YES NO

a. If yes,

i. What percentage improvement did you have?

ii. How long did symptoms abate for?

3. Are you willing to come back for repeat nerve conduction study(s)?