

Chronic Nerve Injuries and Delays in Surgical Treatment Negatively Impact Patient-reported Quality of Life

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Background: Little emphasis has been paid to characterize quality of life (QoL) burdens experienced by patients seeking surgical treatment for nerve injuries and neuropathic pain.

Methods: A cross-sectional survey was distributed to all patients (N = 767) from a single nerve surgeon's practice between 2014 and 2019. Data collected included demographics, specifics of the injury and symptoms, time to referral, and effects of the injury, surgery, and timing of surgery on QoL.

Results: Of the 767 patients, 209 (27.2%) completed the survey. Average age was 48.8 years; 68.9% of patients were women and 31.1% men. At presentation, 68% had experienced symptoms for more than 1 year; 86.1% reported severity as being profound; 97.6% reported QoL was at least moderately negatively impacted by nerve injury; 70% felt they should have been referred earlier for surgical evaluation; 51.2% were not told that nerve surgery was an option for their problem; 83.1% felt that earlier referral would have improved their QoL. After surgery, symptoms were significantly mitigated in 55.5% of the patients, moderately mitigated in 21.5%. Patients reported QoL was significantly (59.8%) or at least moderately (76.6%) improved by nerve surgery.

Conclusions: The majority of patients reported that nerve injuries imparted a moderate to severe impact on QoL, and that surgical treatment improved QoL. Most patients felt that earlier referral for surgical intervention would have led to better outcome and positively impacted QoL. Interdisciplinary treatment algorithms, including a role for surgical intervention, may be helpful in facilitating timely diagnosis, referral, and thus improved outcomes. (*Plast Reconstr Surg Glob Open* 2021;9:e3570; doi: 10.1097/GOX.0000000000003570; Published online 21 May 2021.)

INTRODUCTION

As peripheral nerves generate the signals that govern both pain and peripheral motor function, dysfunction of peripheral nerves is inherently debilitating. Chronic nerve injuries may be considered those injuries that manifest in patients seeking outpatient care. These may result from an untreated acute injury to a nerve, or may result from a progressive chronic process, such as untreated compression neuropathy.

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Nerve injuries often present with an obvious loss of function that may impart substantial disability and impair activities of daily living, ability to work, or to pursue recreation.¹⁻⁴ Untreated chronic neuropathic pain due to nerve injury, although impossible to define objectively by an examiner, may have a multitude of equally disabling effects on an individual's quality of life (QoL). Chronic pain may induce or exacerbate psychological stress and depression,⁵ and may result in chronic emotional, behavioral, and even personality changes.¹ Furthermore, chronic pain may interfere with ability to work, sleep, engage in social activities, and ability to pursue leisure or hobbies.¹ Pain has been demonstrated to be specifically predictive of negative changes in QoL and mood,⁶ and the reported intensity of a patient's pain has been shown to be predictive of the level of disability imparted by the nerve injury.^{2,3}

Time since injury is also predictive of the level of disability,² and this time may be increased by delays in referral, treatment and attempted treatment with ineffective modalities, whether medical or interventional.

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Table 1. Patient Demographics

	Avg 48.8	SD 19.1
Age	No. of Patients	Percentage of Patients
Survey respondents	209	27.2
Gender		
Men	65	31.1
Women	144	68.9
Comorbidities		
No major comorbidities	77	36.8
Anxiety	65	31.1
Depression	59	28.2
Peripheral vascular disease	31	14.8
Thyroid disorders	23	11
Autoimmune diseases	18	8.6
Diabetes	13	6.2
Cancer	10	4.8
Presenting symptoms		
Pain	192	91.9
Numbness	82	39.2
Tingling/burning	129	61.7
Muscle weakness	45	21.5
Difficulty using arm or leg	46	22
Headaches/migraines	111	53.1
QoL variables affected		
Sleep	164	78.5
Ambulation/use of extremity	92	44
Personal/social life	183	87.6
Professional activities	150	71.8
Mood/spirits	175	83.7

Medications (opioids, neuroleptics, and antidepressants) used chronically for pain related to nerve injuries may themselves lead to further undesirable effects.⁷

Although neuropathic pain has been repeatedly demonstrated to represent a negative burden on QoL in patients treated pharmacologically,^{7,8} there is surprisingly little information available in the literature examining QoL burdens reported by patients seeking nerve surgery, or examining the effect of nerve surgery on QoL. We therefore sought to characterize the burden of nerve injuries on QoL in patients seeking surgery for these conditions. The objectives of this study were (i) to characterize patient-reported effects of chronic nerve injuries on quality of life, across a broad range of conditions presenting for ambulatory treatment; (ii) to examine the effect of nerve surgery on patient-reported QoL, and (iii) to

characterize patients' feelings about timing of referral to a surgeon and delays in treatment.

METHODS

An institutional review board (IRB)-approved retrospective cross-sectional survey was distributed to all patients (N = 767) from a single nerve surgeon's (ID) ambulatory referral-based practice between 2014 and 2019. Minimum follow up was 1 year. Data collected included demographics, reason of injury, concurrent clinical conditions, specifics of nerve injury/disorder type, symptom of the injury and the severity, time to referral, severity of the symptoms, how the QoL was affected, feelings regarding the process of finding treatment, post-surgery impacts on symptoms and QoL, and complications of surgery.

RESULTS

Characteristics of the Patient Group

Of the 767 patients, 209 (27.2%) completed the survey. Average age was 48.8 (SD = 19.1) years; 68.9% were women and 31.1% men. Notable comorbidities included anxiety (31.1%), depression (28.2%), and thyroid disorders (11.0%) (Table 1). The composition of the response group versus non-responders to the survey is characterized in Table 2.

Presenting symptoms included: pain 192 (91.9%), numbness 82 (39.2%), tingling/burning 129 (61.7%), muscle weakness 45 (21.5%), difficulty using arm or leg 46 (22%), headaches /migraines 111 (53.1%), and others < 10% (Table 1).

Specifically, the symptoms affecting quality of life included: sleep pattern in 78.5% of the patients, social life in 87.5%, extremity function in 44.0%, personal/social life in 87.6%, professional activities in 71.8%, and mood/spirits in 83.7% (Table 1).

The duration of symptom before presentation is distributed as: <3 months (3.8%), 3–6 months (8.1%), 6–12 months (20.1%), 1–2 years (25.8%), 3–5 years (21.1%), 5–10 years (10.0%), and >10 years (11.0%). An estimated 68% (95% confidence interval [CI] = [61.2%, 74.2%]) of the patients had symptoms for more than 1 year before surgery (Figs. 1, 2).

Table 2. Characteristics of Response Group versus Non-responders

	All (N = 767)	Responded (N = 209)	Did Not Respond (N = 558)	Responded versus Did Not Respond
Age				
Mean ± SD	43.71 ± 18.52	48.80 ± 19.07		
Gender				
Women	503 (65.58%)	144 (68.90%)	359 (64.33%)	P = 0.267
WC versus insurance				
WC	110 (14.34%)	28 (13.40%)	82 (14.70%)	P = 0.729
Surgery type				
Neurolysis	455 (59.32%)	108 (51.67%)	347 (62.18%)	P = 0.011
Neuroma excision + implantation to muscle	42 (5.48%)	7 (3.33%)	35 (6.27%)	P = 0.153
Excision and reconstruction	256 (33.38%)	90 (42.86%)	166 (29.74%)	P = 0.001
Nerve tumor	14 (1.83%)	4 (1.90%)	10 (1.79%)	P = 1.000
Anatomical area				
Head & neck	484 (63.10%)	118 (56.46%)	366 (65.59%)	P = 0.023
Breast/chest	4 (0.52%)	2 (0.96%)	2 (0.36%)	P = 0.300
Upper extremity	71 (9.26%)	20 (9.57%)	51 (9.14%)	P = 0.889
Lower extremity	163 (21.25%)	62 (29.67%)	101 (18.10%)	P = 0.001
Trunk/groin	45 (5.87%)	6 (2.87%)	38 (6.99%)	P = 0.037

WC, worker's compensation.

Symptom Frequency & Duration

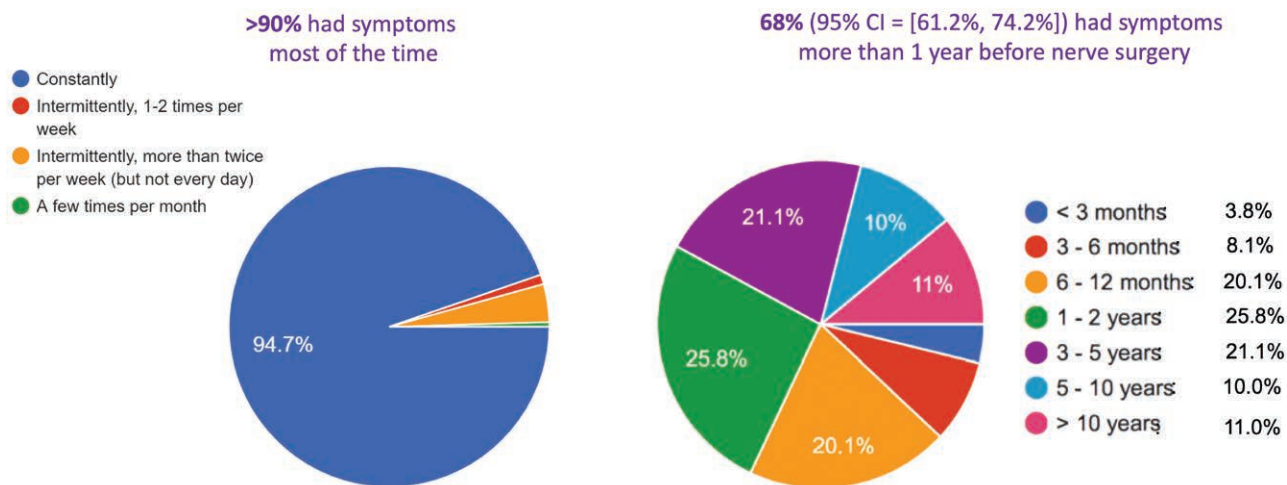


Fig. 1. Symptom frequency and duration.

Anatomical Areas Affected

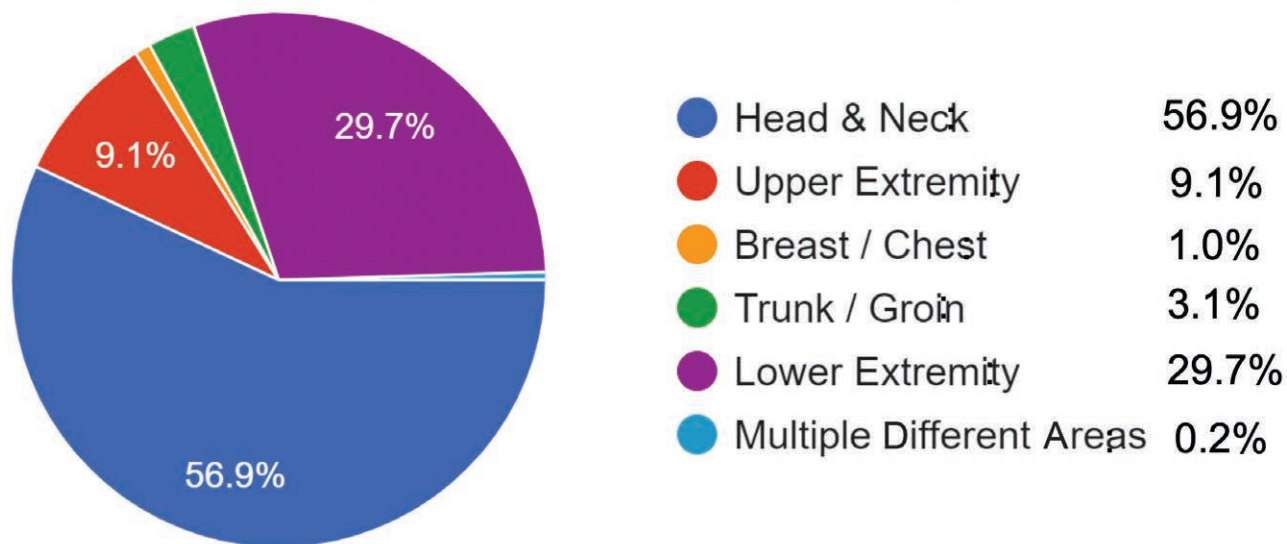


Fig. 2. Anatomical areas affected.

Anatomical areas affected included: head and neck in 119 patients (56.9%), lower extremity in 62 (29.7%), upper extremity in 19 (9.1%), trunk/groin in 6 (2.9%), breast in 2 (1%), and multiple areas in 1 (0.5%) (Table 1). An estimated 16.3% had spontaneous onset, 53.1% had suffered a physical trauma, and 30.6% were precipitated by previous surgery.

Surgery types included neurolysis in 108 (51.67%) patients, neuroma excision with implantation to muscle in 7 (3.33%), neuroma excision and nerve reconstruction in 90 (42.86%), and excision of nerve tumor in 4 (1.90%) (Table 2).

Severity of Symptoms before and after Surgery

86.1% (95% CI = [80.7%, 90.5%]) of the patients reported the severity of symptoms at presentation being profound, with a mean \pm SD preoperative Likert scale pain score of 8.1 ± 2 (median 9) (Fig. 3). After the surgery, 9.1% (95% CI = [5.6%, 13.8%]) reported that the severity of symptoms was profound, a 77% reduction from pre-surgery symptoms ($P < 0.001$ by McNemar's test). The mean \pm SD Likert scale (0–10) pain severity score was 3.2 ± 3.0 (median=2). The change (reduction mean \pm SD = 4.9 ± 3.6 ; median = 5) was statistically significant ($P < 0.001$ by the Wilcoxon Rank Sum test) (Fig. 4).

Symptom Severity at the Time of Initial Presentation

86.1% (95% CI = [80.7%, 90.5%]) reported the severity of symptoms at presentation being profound

At the time of presentation, the mean ± SD Likert scale (0 - 10) pain severity score was **8.1 ± 2.0** (median = 9)

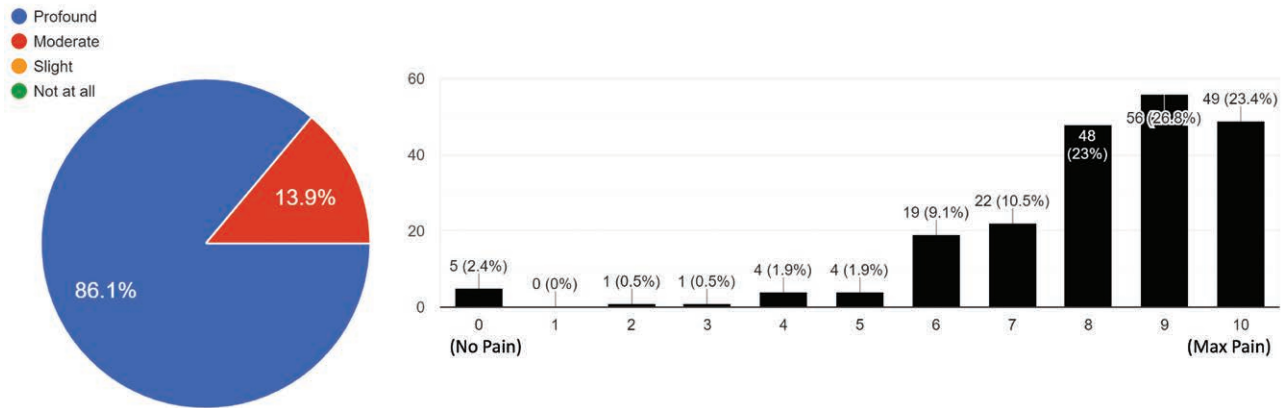


Fig. 3. Symptom severity at time of presentation.

The Effect of Nerve Surgery on Reduction of Nerve Symptom Severity

Only **9.1%** (95% CI = [5.6%, 13.8%]) reported that the severity of symptoms was **profound**, a **77%** reduction from pre-surgery symptoms ($p < 0.001$ by McNemar's test)

28.7% (95% CI = [22.7%, 35.4%]) reported the severity of symptoms was **at least moderate**, a **71.3%** reduction from pre-surgery symptoms ($p < 0.001$ by McNemar's test)

The mean ± SD Likert scale (0-10) pain severity score was **3.2 ± 3.0** (median = 2)

The change (reduction mean ± SD = **4.9 ± 3.6**; median = 5), was statistically significant ($p < 0.001$ by Wilcoxon Rank Sum test)

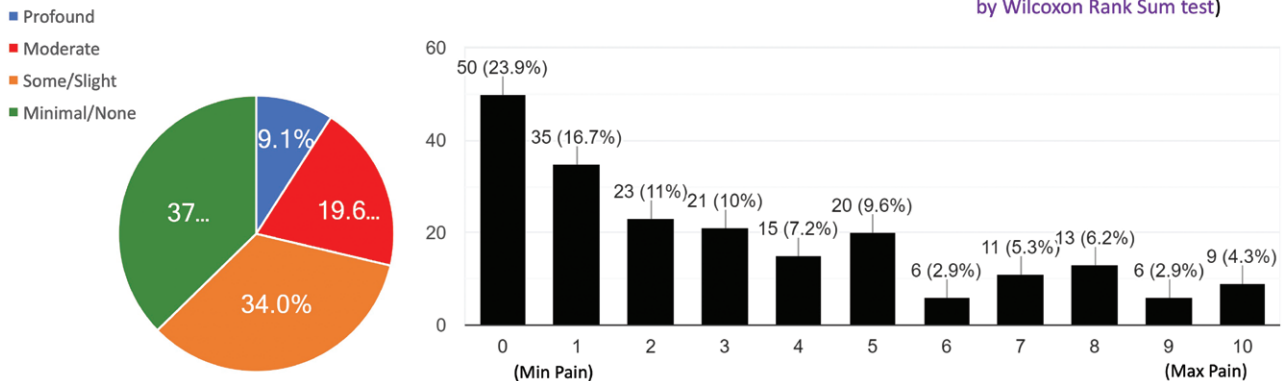


Fig. 4. The effect of nerve surgery on reduction of nerve symptom severity.

Patients reported that symptoms were significantly mitigated in 55.5% of the patients, moderately mitigated in 21.5%, somewhat mitigated in 10.0%, and 12.9% felt that surgery was not helpful (Fig. 5).

Quality of Life before and after Surgery

84.7% (95% CI = [79.1%, 89.3%]) reported their QoL was significantly negatively impacted by their nerve injury, and 97.6% (95% CI = [94.5%, 99.2%]) reported their QoL was at least moderately negatively impacted by their nerve injury, which suggests with 95% statistical confidence that

more than 79.1% of the patients' QoL was significantly negatively impacted by their nerve injury (Fig. 6). 59.8% (95% CI = [52.8%, 66.5%]) reported their QoL was significantly improved by their nerve surgery treatment; and 76.6% (95% CI = [70.2%, 82.1%]) reported their QoL was at least moderately improved by their nerve surgery treatment (Fig. 7).

The surgery positively affected: 68.3% of those whose sleep pattern was affected by the symptom; 75.0% of those whose extremity function was affected by the symptom; 74.9% of those whose personal/social life was

Nerve Surgery Helped Resolve Nerve Symptoms

77% (95% CI = [70.7%, 82.6%]) reported meaningful (significant/moderate) severity of symptoms reduction following nerve surgery

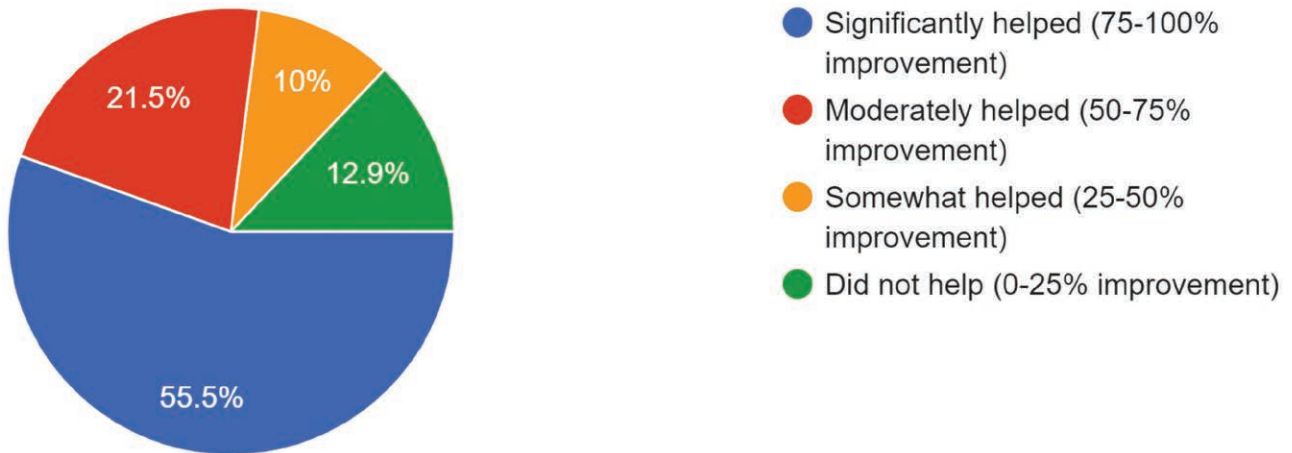


Fig. 5. The degree to which nerve surgery helped resolve nerve symptoms.

How Nerve Injuries (Negatively) Affect QOL

Patients reporting **significant (84.7%; 95% CI = [79.1%, 89.3%])** or **at least moderate (97.6%, 95% CI = [94.5%, 99.2%])** negative impact on QOL by nerve injuries (significance level = 0.05)*, stated the following variables were most affected:

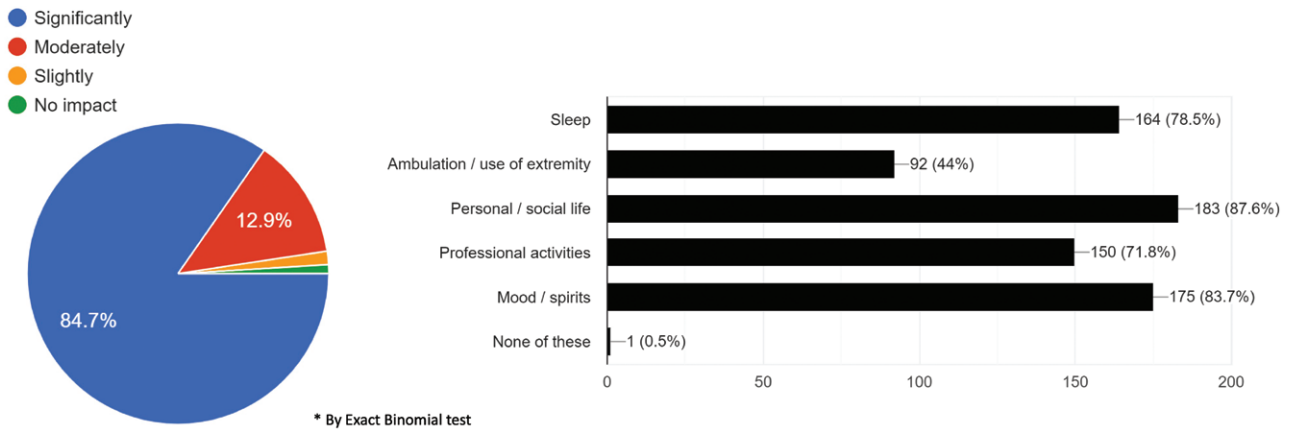


Fig. 6. Impact of nerve injuries on quality of life at presentation.

affected by the symptom; 66.0% of those whose professional productivity was affected by the symptom; and 76.6% of those whose mood/spirits was affected by the symptom (Fig. 7).

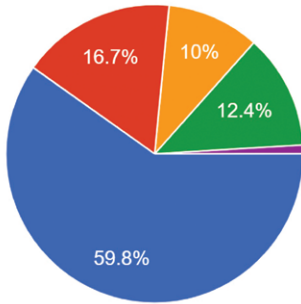
Treatment Experiences before Surgery and Feelings on the Referral Process

With regard to treatment experiences before the presentation, the distribution of total number of physicians seen: 0 (0%), 1–3 (28.7%), 4–6 (42.1%), 7–10 (16.7%),

11–15 (7.7%), 16–20 (4.8%) (Fig. 8). In total, 70.0% (95% CI = [63.1%, 76.0%]) felt they should have been referred earlier; 51.2% (95% CI = [44.2%, 58.2%]) were not told that nerve surgery was an option for their problem; and 68.8% (95% CI = [62.0%, 75.0%]) were told that nothing could be done. An estimated 83.1% (95% CI = [77.3%, 87.9%]) felt that earlier referral would have improved their quality of life, and 88.5% (95% CI = [83.3%, 92.5%]) stated that if they could go back in time, they would have the surgery again (Figs. 9–11).

Impact of Nerve Surgery on Improving QOL

- Significantly helped (75-100% improvement), 59.8%
- Moderately helped (50-75% improvement), 16.7%
- Somewhat helped (25-50% improvement), 10.0%
- Did not help (0-25% improvement), 12.4%
- Made things worse, 1.0%



Patients reporting **significant (59.8; 95% CI = [52.8%, 66.5%]) or at least moderate (76.6%, 95% CI = [70.2%, 82.1%]) improvement on QOL by nerve surgery (significance level = 0.05)***, reported improvement in the following variables:

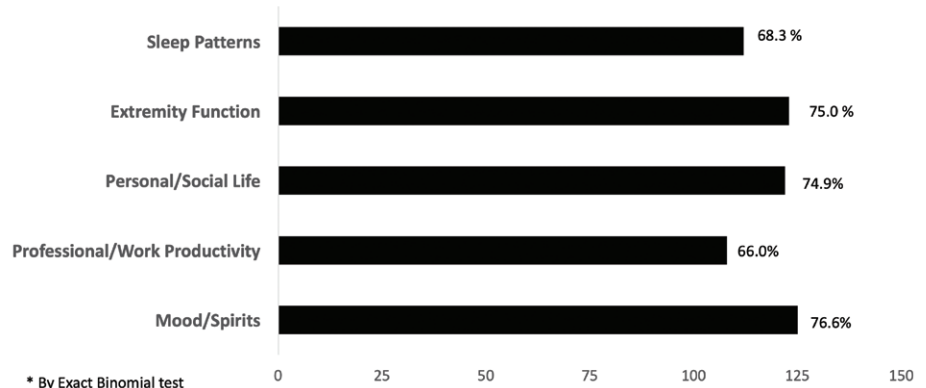


Fig. 7. Impact of nerve surgery on improving quality of life.

Specialists Seen Prior to Nerve Surgery Evaluation

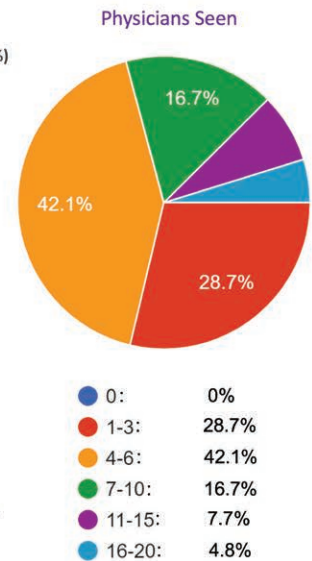
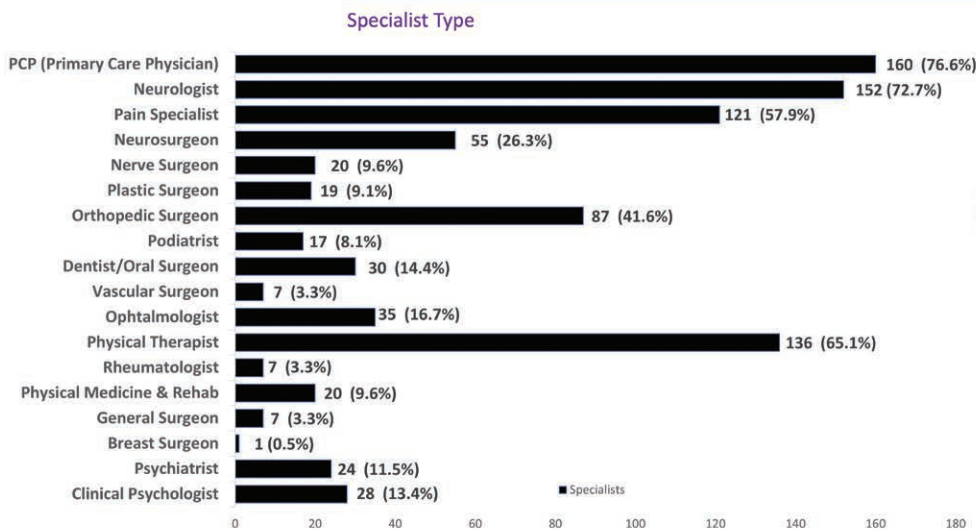


Fig. 8. Other physicians seen before referral to nerve surgeon.

The average overall satisfaction with nerve surgery was 8.04/10—48.8% rated 10/10 (Fig. 12). Complication rate was 8.3%, and all complications were minor (delayed wound healing, dehiscence due to noncompliance, infection requiring oral antibiotics), with no complications requiring hospitalization or return to the operating room (Fig. 13).

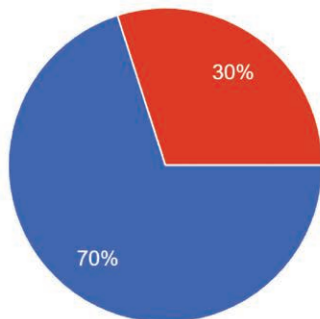
DISCUSSION

Traditional outcomes reporting in nerve surgery focuses on objective clinical motor or sensory grading systems. However, patients themselves may experience

the impact of nerve injuries and outcome of nerve surgeries very differently. The pain and bodily dysfunction that clinicians seek to characterize are in reality only some of the contributors to the overall negative impact that nerve injuries create on a patient’s quality of life. Pain and sensory/motor dysfunction are a problem because they create a negative change in patients’ standard of living that they are unable to overcome without medical intervention. This negative chapter in a patient’s life story can be unduly extended when treating clinicians do not diagnose the problem correctly or do not refer the patient for appropriate nerve surgery intervention, which is often the

Specialists & Referral Issues Prior to Nerve Surgery Evaluation

70.0% (95% CI = [63.1%, 76.0%]) felt they should have been referred earlier



51.2% (95% CI = [44.2%, 58.2%]) were not told that nerve surgery was an option for their problem

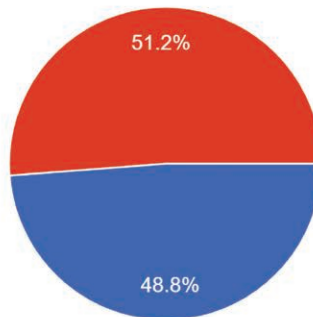
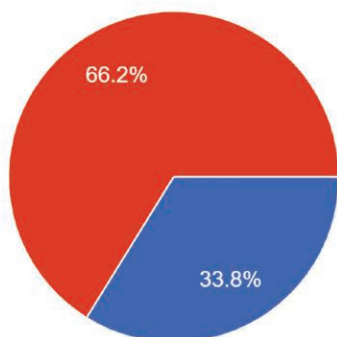


Fig. 9. Patients' feelings and experiences regarding referral process.

Specialists & Referral Issues Prior to Nerve Surgery Evaluation

33.8% (95% CI = [30.1%, 39.8%]) were told no nerve intervention needed, nerve will recover, but it might take a year or more



68.8% (95% CI = [62.0%, 75.0%]) were told that nothing could be done for their nerve problem

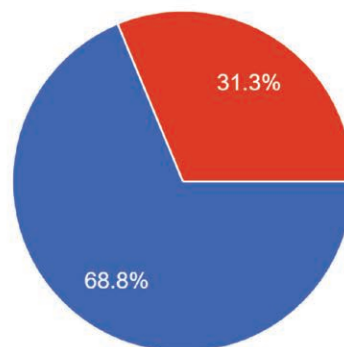


Fig. 10. Patients' feelings regarding availability of information for treatment options.

only means of permanently restoring or at least approximating the patient's prior quality of life.

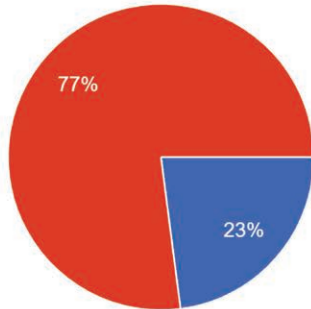
It has been our observation over 2 decades of clinical practice that patients' interpretation of their experience does not always correlate with either objective outcome measures, or validated surrogate measures aimed at quantifying QoL variables. Therefore, this study was designed to directly query surgical patients' perceptions of the quality of life changes imparted by nerve injuries, and the effect of nerve surgery on quality of life. This study was administered as a cross-sectional survey intended to capture patient perceptions following the conclusion of their experience with nerve surgery. Although outcomes such as pain scores were included in the study results, this study was not intended to be a validated outcomes study for pain or physical function. Rather, traditional outcome measures were only included to allow patients to give context

to their subjective QoL responses, which were the primary data collected. The goal, simply, was to understand to what extent nerve injuries had a negative impact on quality of life, and whether nerve surgery broadly was helpful in improving QoL for these patients.

Findings of this study included characterization of the symptoms associated with nerve injuries that patients felt affected their QoL, the subjective severity of these symptoms, and their impact on QoL (Table 1, Figs. 1, 3, 6). Respondents in our study reported chronic nerve injuries affected the QoL domains of sleep, social functioning, and global QoL; findings that are in concordance with other studies that have used the SF-36 (short form 36) to demonstrate an impact of medically-treated neuropathic pain on these domains.⁸ Our patients further reported impacts on professional activities, mood, and ambulation or use of extremity (as we queried patients with a broader set of

Specialists & Referral Issues Prior to Nerve Surgery Evaluation

77% (95% CI = [70.7%, 82.6%]) thought their provider to whom they first brought-up nerve related problem did not manage them in a timely manner



83.1% (95% CI = [77.3%, 87.9%]) felt that earlier referral would provide more complete outcome and improved their quality of life

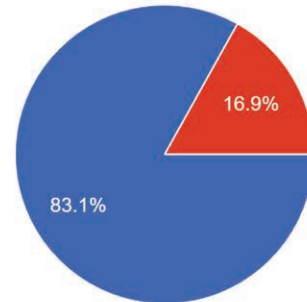
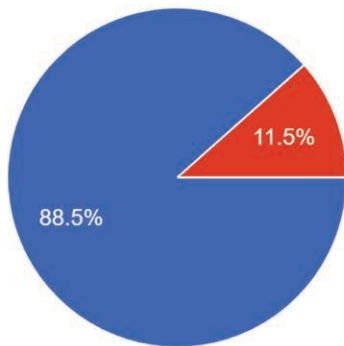


Fig. 11. Patients' feelings on timeliness of referral and outcome.

Patient Satisfaction with Nerve Surgery Outcomes

88.5% (95% CI = [83.3%, 92.5%]) stated that if they could go back in time, they would have the surgery again



8.04/10: overall average satisfaction
(48.8% rated 10/10)

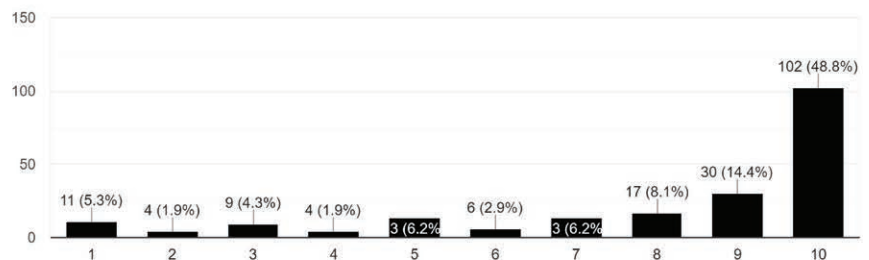


Fig. 12. Patient satisfaction with nerve surgery.

nerve injuries rather than only those causing neuropathic pain) (Table 1).

A majority of our patients reported chronic symptoms that were substantially disabling in their frequency, duration, and severity (Figs. 1, 3). Regarding the negative impact of nerve injury symptoms on QoL, 97.6% of patients reported at least a moderate impact, and 84.7% reported a significant impact on QoL (Fig. 6). The finding of a negative impact on QoL is in agreement with prior population survey studies, wherein respondents with medically-treated neuropathic pain had lower SF-36 HR-QOL (short form 36 health-related quality of life) scores than patients with non-neuropathic pain, even after adjusting for pain score.^{9,10} Taken together, our findings regarding duration and severity of symptoms, and level of impact on QoL indicate that this subset of nerve injury patients presenting for ambulatory nerve surgery had relatively chronic, established conditions with a pronounced

negative effect on QoL; perhaps because they are referred for surgery after other conditions have been tried and failed.

Although there are a multitude of published studies that report the outcome of nerve surgery in terms of VAS (visual analog scale) pain reduction and changes in a variety of physical functioning metrics, there are surprisingly few reports of the direct effect of nerve surgery on QoL.¹¹ Yang et al demonstrated an improvement in SF-36 scores in patients undergoing lower extremity nerve decompression surgery for painful diabetic neuropathy, in a case series of 19 patients.¹² Domeshek et al reported a statistically significant improvement in QoL rated on a VAS scale in a case series of 70 patients with upper and lower extremity neuromas.¹³ However, a meta-analysis examining surgical treatment of painful neuromas did not identify meaningful reporting on QoL from other publications.¹¹ Our results echo those of the few other studies reporting

Nerve Surgery Safety

91.7% (298/325) of nerve surgeries had no complications

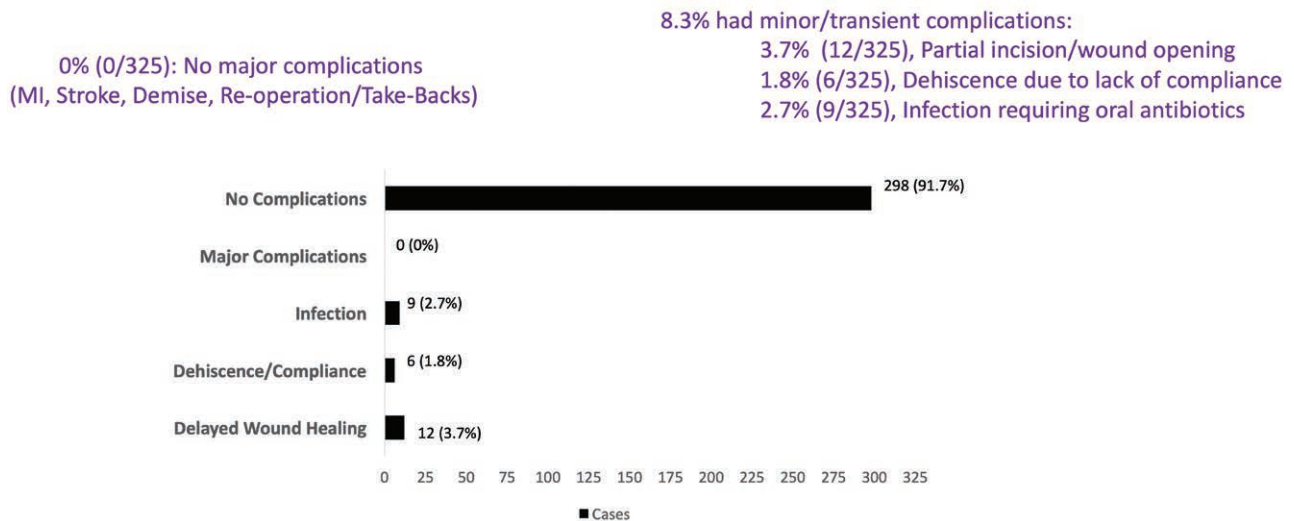


Fig. 13. Safety of nerve surgery.

improvement in QoL following surgical treatment for nerve injuries, and our results are notable in comparison for examining both a larger cohort of patients and a broader range of chronic nerve injury conditions. The majority of respondents in our study reported that nerve surgery improved QoL to a significant (59.8%) or at least moderate (76.6%) degree, and at least 65% of patients reported specific improvements in each of the domains of sleep pattern, extremity function, personal/social life, professional productivity, and mood (Fig. 7). These data support the existing body of literature demonstrating that nerve injuries are associated with a negative impact on quality of life¹⁴⁻¹⁶ and that surgical treatment of nerve injuries is an important consideration in patients' care when a reasonable short period of conservative measures has not led to resolution of symptoms.^{3,11,13,17}

The study findings also provided a description of the process of finding care for nerve injuries. Survey results confirmed that most patients had seen multiple specialists before referral for nerve surgery evaluation, and that many patients experienced subjective frustrations and delays during the referral process before ultimately undergoing evaluation by a nerve surgeon (Figs. 9-11). The majority of patients felt that they should have been referred earlier (Fig. 9), and most patients either were not told that nerve surgery was an option for them, or were told that nothing could be done for their problem (Figs. 9, 10). Notably, 77% of patients felt that they were not managed in a timely manner and 83.1% felt that earlier referral would have improved their quality of life. We are not able to confirm with this study whether earlier surgical treatment would have improved outcomes of our patients in terms of pain reduction; however, Kato et al have demonstrated that delayed surgical treatment of brachial plexus injuries are associated with poorer pain outcomes in addition to the

expected poorer functional outcomes.¹⁸ These findings appear to validate the assumption of many nerve surgeons that closer interdisciplinary care of nerve injury patients would reduce suffering for the patient and hasten recovery in their personal, daily, professional, and social lives.

The overall importance of our findings should be interpreted in the context of interdisciplinary management and of the existing literature regarding management of chronic neuropathic pain. Outside of surgical literature and practice, the term "neuropathic pain" is broad, and includes pain resulting from phenomena varying from nonsurgical conditions such as postherpetic neuralgia, to conditions such as neuroma that result from nerve injury and have been repeatedly demonstrated to respond to surgery.¹⁹ The predominance of published literature regarding management of chronic neuropathic pain is medical or pharmacologic in scope and tends not to consider conditions leading to neuropathic pain as surgically-treatable injuries of nerves. Thus, even though parallel surgical literature offers clear recommendations on timing for surgical intervention for all types of nerve injuries, none of this literature is included in commonly referenced treatment algorithms,²⁰ guidelines,²¹⁻²⁴ and society consensus statements²⁵ that are used to guide medical treatment of chronic nerve injuries.

There are multiple examples of conditions whose pathophysiology and treatment are viewed differently by medical and surgical providers, and for which a shared terminology and concept of disease would likely improve multidisciplinary management to the benefit of patients. Our study population included, for instance, those with neuromas undergoing excision or excision and reconstruction, those with painful diabetic neuropathy related to nerve compression, those with complex regional pain syndrome, and those with chronic headaches related to

sensory nerve entrapment or injury. Multiple publications have shown that surgical treatment of neuromas improves pain^{11,26,27} and quality of life.¹³ Surgical literature is also replete with studies demonstrating improvements in pain,^{28–31} sensibility,^{32–34} and quality of life¹² after nerve decompression in painful diabetic neuropathy—a condition for which only pharmacologic treatment is traditionally considered in nonsurgical literature,^{20–25} despite extensive publications examining its negative impact on quality of life.^{35–38} Chronic migraine headaches, although traditionally considered a source of neuropathic pain only treatable with chronic medication, have also been repeatedly demonstrated to be treatable with surgical decompression of entrapped sensory nerves,^{38–41} or excision of neuroma in cases of nerve injury masquerading as headaches such as in postoperative headaches following acoustic neuroma excision that are associated with occipital nerve neuromas.^{42,43} The same circumstance has lately been recognized in phantom limb pain—a condition traditionally treated pharmacologically that has now been shown to be treatable with nerve transfer surgery.^{44,45} The greatest barrier to effective multidisciplinary treatment for these conditions seems to be one of terminology and ideation, and it may be this barrier that is partially responsible for our findings of delayed presentation for surgical treatment. It stands to reason, therefore, that unified algorithms with common terminology and incorporating both medical and surgical recommendations for treatment would improve patients' outcomes and decrease the quality of life burden experienced by patients with chronic nerve injuries.

Limitations of the study include a relatively low response rate, which may have to do with attrition of respondents over a long study period. There were differences in survey response rates among surgery types; however, the percentage of respondents by surgery type generally approximated the percentage of the patients who had undergone that surgery type. The retrospective nature of the survey relies on patient recall, possibly affecting outcome interpretation. However, ultimately, it is the patient's final impression of the experience after completion of treatment that we are concerned with. Arguably, the lack of a validated outcomes measure for quality of life is a weakness; however, we were specifically interested in patients' responses to direct questions regarding QoL and the referral process, rather than validated but less specific surrogate measures. Despite these study limitations, this preliminary report does serve to call awareness to the issues of decreased quality of life and delays in referral for surgical care in patients suffering from chronic nerve injuries. Future prospective studies utilizing validated patient-reported outcome tools that measure QoL would add further perspective to these preliminary but significant findings.

CONCLUSIONS

Among patients with nerve injury referred for nerve surgery, most report decreased quality of life associated with their injury. Nerve injury patients also report that the referral process of finding appropriate surgical care

may be frustrating or protracted, and that this further negatively impacts their ultimate outcome and quality of life. Greater recognition of the quality of life burden that nerve injury patients face while finding appropriate surgical care for their condition should highlight the need for closer interdisciplinary management of these patients. Treatment algorithms incorporating both medical and surgical perspectives on the treatment of chronic neuropathic pain would improve interdisciplinary management.

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REFERENCES

1. Pelz M, Merskey H. A description of the psychological effects of chronic painful lesions. *Pain*. 1982;14:293–301.
2. Novak CB, Anastakis DJ, Beaton DE, et al. Biomedical and psychosocial factors associated with disability after peripheral nerve injury. *J Bone Joint Surg Am*. 2011;93:929–936.
3. Novak CB, Anastakis DJ, Beaton DE, et al. Patient-reported outcome after peripheral nerve injury. *J Hand Surg Am*. 2009;34:281–287.
4. Ring D. Symptoms and disability after major peripheral nerve injury. *Hand Clin*. 2013;29:421–425.
5. Korff MV, Simon G. The relationship between pain and depression. *Brit J Psychiat*. 1996;168:101–108.
6. Heary KO, Wong AWK, Lau SCL, et al. Quality of life and psychosocial factors as predictors of pain relief following nerve surgery. *Hand (N Y)*. Published online March 19, 2020. doi:10.1177/1558944720911213
7. Meyer-Rosberg K, Kvarnstrom A, Kinnman E. Peripheral neuropathic pain: A multidimensional burden for patients. *Eur J Pain*. 2001;5:379–89.
8. Jensen MP, Chodroff MJ, Dworkin RH. The impact of neuropathic pain on health-related quality of life: Review and implications. *Neurology*. 2007;68:1178–82.
9. Smith BH, Torrance N, Bennett MI, et al. Health and quality of life associated with chronic pain of predominantly neuropathic origin in the community. *Clin J Pain*. 2007;23:143–149.
10. O'Connor AB. Neuropathic pain: Quality-of-life impact, costs and cost effectiveness of therapy. *Pharmacoeconomics*. 2009;27:95–112.
11. Poppler LH, Parikh RP, Bichanich MJ, et al. Surgical interventions for the treatment of painful neuroma: A comparative meta-analysis. *Pain*. 2018;159:214–223.
12. Yang W, Guo Z, Yu Y, et al. Pain relief and health-related quality-of-life improvement after microsurgical decompression of entrapped peripheral nerves in patients with painful diabetic peripheral neuropathy. *J Foot Ankle Surg*. 2016;55:1185–1189.
13. Domeshek LF, Krauss EM, Snyder-Warwick AK, et al. Surgical treatment of neuromas improves patient-reported pain, depression, and quality of life. *Plast Reconstr Surg*. 2017;139:407–418.
14. Bailey R, Kaskutas V, Fox I, et al. Effect of upper extremity nerve damage on activity participation, pain, depression, and quality of life. *J Hand Surg Am*. 2009;34:1682–1688.
15. Novak CB, Mackinnon SE. Evaluation of cold sensitivity, pain, and quality of life after upper extremity nerve injury. *Hand (N Y)*. 2016;11:173–176.

16. Ciaramitaro P, Mondelli M, Logullo F, et al; Italian Network for Traumatic Neuropathies. Traumatic peripheral nerve injuries: Epidemiological findings, neuropathic pain and quality of life in 158 patients. *J Peripher Nerv Syst*. 2010;15:120–127.
17. Poppler LH, Mackinnon SE. The role of the peripheral nerve surgeon in the treatment of pain. *Neurotherapeutics*. 2019;16:9–25.
18. Kato N, Htut M, Taggart M, et al. The effects of operative delay on the relief of neuropathic pain after injury to the brachial plexus. *Bone Joint J*. 2006;88-B:756–759.
19. van Hecke O, Austin SK, Khan RA, et al. Neuropathic pain in the general population; A systematic review of epidemiological studies. *Pain*. 2014;155:654–662.
20. Finnerup NB, Otto M, McQuay HJ, et al. Algorithm for neuropathic pain treatment: An evidence based proposal. *Pain*. 2005;118:289–305.
21. Attal N. Pharmacological treatments of neuropathic pain: The latest recommendations. *Rev Neurol (Paris)*. 2019;175:46–50.
22. Finnerup NB, Attal N, Haroutounian S, et al. Pharmacotherapy for neuropathic pain in adults: A systematic review and meta-analysis. *Lancet Neurol*. 2015;14:162–173.
23. Dworkin RH, O'Connor AB, Audette J, et al. Recommendations for the pharmacological management of neuropathic pain: An overview and literature update. *Mayo Clin Proc*. 2010;85(Suppl 3):S3–14.
24. O'Connor AB, Dworkin RH. Treatment of neuropathic pain: An overview of recent guidelines. *Am J Med*. 2009;122(Suppl 10):S22–S32.
25. Attal N, Cruccu G, Baron R, et al; European Federation of Neurological Societies. EFNS guidelines on the pharmacological treatment of neuropathic pain: 2010 revision. *Eur J Neurol*. 2010;17:1113–1e88.
26. Ducic I, Mesbahi AN, Attinger CE, et al. The role of peripheral nerve surgery in the treatment of chronic pain associated with amputation stumps. *Plast Reconstr Surg*. 2008;121:908–914.
27. Decrouy-Duruz V, Christen T, Raffoul W. Evaluation of surgical treatment for neuropathic pain from neuroma in patients with injured peripheral nerves. *J Neurosurg*. 2018;128:1235–1240.
28. van Maurik JFMM, Oomen RTW, Hal M, et al. The effect of lower extremity nerve decompression on health-related quality of life and perception of pain in patients with painful diabetic polyneuropathy: A prospective randomized trial. *Diabetic Med*. 2015;32:803–809.
29. Dellon AL. Treatment of symptomatic diabetic neuropathy by surgical decompression of multiple peripheral nerves. *Plast Reconstr Surg*. 1992;89:689–97; discussion 698.
30. Wieman TJ, Patel VG. Treatment of hyperesthetic neuropathic pain in diabetics. Decompression of the tarsal tunnel. *Ann Surg*. 1995;221:660–4; discussion 664.
31. Wood WA, Wood MA. Decompression of peripheral nerves for diabetic neuropathy in the lower extremity. *J Foot Ankle Surg*. 2003;42:268–275.
32. Dellon AL, Muse VL, Nickerson DS, et al. Prevention of ulceration, amputation, and reduction of hospitalization: Outcomes of a prospective multicenter trial of tibial neurolysis in patients with diabetic neuropathy. *J Reconstr Microsurg*. 2012;28:241–246.
33. Aszmann OC, Kress KM, Dellon AL. Results of decompression of peripheral nerves in diabetics: A prospective, blinded study. *Plast Reconstr Surg*. 2000;106:816–822.
34. Ducic I, Felder JM, Iorio ML. The role of peripheral nerve surgery in diabetic limb salvage. *Plastic Reconstr Surg*. 2011;127:259S–269S.
35. Gore M, Brandenburg NA, Hoffman DL, et al. Burden of illness in painful diabetic peripheral neuropathy: The patients' perspectives. *J Pain*. 2006;7:892–900.
36. Gore M, Brandenburg NA, Dukes E, et al. Pain severity in diabetic peripheral neuropathy is associated with patient functioning, symptom levels of anxiety and depression, and sleep. *J Pain Symptom Manage*. 2005;30:374–385.
37. Galer BS, Ganas A, Jensen MP. Painful diabetic polyneuropathy: Epidemiology, pain description, and quality of life. *Diabetes Res Clin Pr*. 2000;47:123–8.
38. Ducic I, Felder JM III, Fantus SA. A systematic review of peripheral nerve interventional treatments for chronic headaches. *Ann Plast Surg*. 2014;72:439–445.
39. Guyuron B, Reed D, Kriegler JS, et al. A placebo-controlled surgical trial of the treatment of migraine headaches. *Plast Reconstr Surg*. 2009;124:461–468.
40. Hatfeg DA, Gutowski KA, Culbertson GR, et al. A comprehensive review of surgical treatment of migraine surgery safety and efficacy. *Plast Reconstr Surg*. 2020;146:187e–195e.
41. Ducic I, Hartmann EC, Larson EE. Indications and outcomes for surgical treatment of patients with chronic migraine headaches caused by occipital neuralgia. *Plast Reconstr Surg*. 2009;123:1453–1461.
42. Ducic I, Felder JM III, Endara M. Postoperative headache following acoustic neuroma resection: Occipital nerve injuries are associated with a treatable occipital neuralgia. *Headache*. 2012;52:1136–1145.
43. Ducic I, Felder JM, Khan N, et al. Greater occipital nerve excision for occipital neuralgia refractory to nerve decompression. *Ann Plast Surg*. 2014;72:184–187.
44. Dumanian GA, Potter BK, Mioton LM, et al. Targeted muscle reinnervation treats neuroma and phantom pain in major limb amputees. *Ann Surg*. 2018;270:1–9.
45. Mioton LM, Dumanian GA, Shah N, et al. Targeted muscle reinnervation improves residual limb pain, phantom limb pain, and limb function: A prospective study of 33 major limb amputees. *Clin Orthop Relat Res*. 2020;478:2161–2167.