Research Article

Evaluation of Sensory Deficit in Foot Following Sural Nerve Graft

Shiza Mehak Sohail [*,1], Faisal Akhlaq Ali Khan[1], Waqas Sami[1], Hiba Moazzam[1], Sumaira Sattar[2], Sana Shoukat[1]

[1]*Department of Plastic Surgery, Civil Hospital, Dow University of Health Sciences (DUHS), Karachi, Pakistan.*

[2]*Department of Plastic Surgery, Shaheed Mohtarma Benazir Bhutto Institute of Trauma (SMBBIT), Karachi, Pakistan.*

Abstract: Background: The sural nerve is the most commonly used donor nerve for autologous nerve grafts in reconstructive surgery. The functional outcomes may be impacted with harvest of SNG as it may lead to sensory deficit at donor site.

Objective: To evaluate sensory deficit and patients' experiences of functional impairment after sural nerve graft.

Materials and Methods: The present prospective observational study was performed in Plastic & Reconstructive Surgery Department of Dr. KM Ruth Pfau Civil Hospital during 1st August 2024 to 28th February 2025. This study received approval from the Institutional Review Board (IRB) at the Dow University of Health Sciences with reference number IRB-3502/DUHS/Approval/2024/176. Sensory examination was performed via Semmes-Weinstein monofilaments. Patients were also asked to report their experience regarding postoperative discomfort, sensory deficits, pain, cold intolerance, and their effect on daily activities, sleep, work, and leisure.

Result: A total of 73 patients were studied with median age of 41 (IQR=26.5-49) years. Some of the patients achieved sensation of 0.5g (30.1%). Majority of patients (42.5%) had mild sensory deficit with who achieved 2.0 g sensation. Around quarter of patients had moderate to profound sensory loss (27.4%). Absence of sensation was not seen in any of the patient. Few patients reported any discomfort in their foot (16.4%), loss of sensation (12.3%), pain in operated leg (11%), cold intolerance (9.6%), sensory deficit effecting daily life (9.6%), sleep (9.6%), work or their attendance (11%) and leisure activities (15.1%).

Conclusion: The findings of present study suggested that according to monofilament examination system nearly a quarter of patients had moderate to severe sensory deficit. However, a smaller proportion of patients reported that their functional activities were impacted substantially after sural nerve graft.

Keywords: Autologous nerve grafts, Sural nerve graft, Sensory loss, Functional outcomes, Donor-site complications, Lateral ankle.

INTRODUCTION

One common ailment that frequently develops as a result of trauma is peripheral nerve injury. Numerous processes, such as laceration, contusion, stretching, or nerve compression, can cause them. They can significantly affect the patient's everyday activities and general quality of life, although not being life-threatening. The rehabilitation of its functions will be facilitated by the restoration of nerve continuity [1]. The gold standard for reconstructing peripheral nerve deficits is still autologous nerve grafts [2].

In reconstructive surgery, the sural nerve is the most often utilized donor nerve for autologous nerve transplants [3]. The fibers from the L4-S1 lumbosacral spinal roots make up the sural nerve, which is a purely sensory nerve. The merger of the lateral and medial sural cutaneous nerves, which are branches of the common peroneal and posterior tibial nerves, respectively, is the traditional description of its origin [1]. It is a dependable option for grafting since it is largely sensory, easily identifiable physically, and formed by the junction of terminal branches of the leg's common peroneal and tibital nerves [4]. The most often used nerve autograft is the sural nerve, which innervates the skin of the lateral ankle and foot. Due to its solely sensory nature and low donor site morbidity, it has been considered a suitable donor nerve autograft [5, 6].

Harvesting the sural nerve offers a significant length that can bridge nerve gaps. Also, it is consistently located in the same anatomical area with minimal variation, and comprises mostly sensory components with the exception of some autonomic fibers that aren't covered by a myelin sheath [7].

Loss of sensation in the area that the sural nerve serves is quite possible, which lowers protective feeling and increases the risk of injury because the sural nerve's function is solely sensory, supplying a territory over the posterolateral lower limb and lateral aspect of the foot [8]. The functional outcomes may be impacted with harvest of sural nerve graft (SNG) as it may lead to sensory deficit at donor site [9]. Clinically, these sensory deficits may exhibit cold sensitivity and pain at donor site as well due to which functional impairments may occur.

* Address correspondence to this author at the Department of Plastic Surgery, Civil Hospital, Dow University of Health Sciences (DUHS), Karachi, Pakistan. Email: shiza_mehak@yahoo.com

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Because everyday activities, especially those that involve the affected area, such as walking or wearing specific shoes, might be impacted by sensory deficiencies [10]. Individual differences may exist in the degree of functional impairment, nevertheless, with some people adjusting with time and others facing severe limitations. Additionally, the procedure must be well described to the patient. To be able to counsel patients on possible residual symptoms and subjective outcomes when the sural nerve is utilized as a nerve graft or for a biopsy, a better understanding of pain, sensory deficit, allodynia, and other problems following sural nerve harvesting is required. With this information, patients can receive more precise and thorough information regarding potential post-procedure complications, which should be weighed against the anticipated outcome of nerve reconstruction. Analyzing the degree to which symptoms arise from using the sural nerve as a nerve graft is therefore of interest. Studies on the effects of SNG on functional results and sensory loss are available internationally [2, 3, 5]. However, there is a dearth of research on the topic in Pakistan. Thus we planned the current study with an intent to evaluate sensory deficit and patients' experiences of functional impairment after SNG.

MATERIALS AND METHODS

The present prospective observational study was performed in Plastic & Reconstructive Surgery Department of Dr. KM Ruth Pfau Civil Hospital in Karachi. The study duration was 1st August 2024 to 28th February 2025. The study was commenced with the approval of Institutional Review Board (IRB) at the Dow University of Health Sciences with reference number IRB-3502/DUHS/Approval/2024/176. Patients aged 12 to 65 years of any gender, underwent unilateral SNG due to traumatic or iatrogenic injury were included. Patients with cognitive impairment, having complex injuries underwent multiple surgeries and burn injuries of lower limbs were excluded. Adults were enlisted with their written informed consent. For children, verbal assent was obtained, and their parents provided written consent.

A sample size of 73 patients was computed taking 86% proportion of sensory loss after SNG [3] at 95% confidence interval and 8% margin of error using online available calculator Open-Epi. Patients were included using consecutive sampling approach.

Sensory examination was performed via Semmes-Weinstein monofilaments, which involved mapping and assessment of the distressed region. It is based on band of 5 filaments made of nylon with varying degrees of rigidness; each filament was exerted on the skin till it deforms; after that each of them exerted a preset pressure. The numbering scheme of the filaments was 2.83, 3.61, 4.31, 4.56, and 6.65 and was based on the pressure they exert; the firmer and fatter ones were assigned higher numbers since they exerted more force. These five monofilaments (2.83, 3.61, 4.31, 4.56, and 6.65) were utilized for conducting the examination. All monofilaments were used thrice at lateral aspect of the foot by the principal investigator; even a single positive response was enough to ascertain feeling with the monofilament in use. Unable to feel any monofilament was labeled as absent sensation. The patient was instructed to answer "yes" when they felt the monofilament push on their flesh after their shoes and socks were taken off and their lower leg was visible. Before starting the sensory evaluation of the leg, a demonstration was conducted on the patient's arm. Throughout the assessment, all patients were told to keep their eyes closed. After pressing the monofilament tip on the skin until it buckled, it was left there for one second. Patients' experiences of sensory loss and functional impairment were evaluated during their follow-up visit in out-patient clinics after two weeks of the surgery. Patients were asked about postoperative discomfort, sensory deficits, pain, cold intolerance, and their effect on daily activities, sleep, work, and leisure.

STATISTICAL ANALYSIS

To conduct statistical analysis, data was entered into Microsoft Excel and subsequently imported into IBM SPSS version 27. Frequencies and percentages were computed for categorical variables. Numerical variable age was tested first for normality assumption with Shapiro-Wilk test which found to be non-normal and hence expressed as median with inter-quartile range (IQR). Tabulation was done to present the analyzed data.

RESULT

A total of 73 patients were studied with median age of 41 (IQR=26.5-49) years. Age range was 18-60 years. The male to female ratio was nearly to 1. Nearly quarter of patients were diabetic (26%) and hypertensive (23.3%). Average time from injury to surgery was 3.1 ±0.08 months. Average nerve gap was 4.4 ± 0.1 cm. Nerve was harvested from right leg in almost half of the cases (50.6%). Table **1** displays summary statistics for patients' profile.

Table 1. Summary Statistics for Patients' Profile.

Patients' Profile	Sub-Groups	Frequency (%)
Age groups	18-20 years	11(15.1)
	21-30 years	12(16.4)
	31-40 years	13(17.8)
	41-50 years	21(28.8)
	51-60 years	16(21.9)
Gender	Male	38(52.1)
	Female	35(47.9)
Comorbidity	Hypertension	17 (23.3)
	Diabetes	19(26)
Smokers	Yes	13(17.8)
	No	60(82.2)

Table **2** displays sensory deficit status of patients using Semmes-Weinstein monofilaments. Some of the patients achieved sensation of 0.5g. Majority of patients (42.5%) had mild sensory deficit with who achieved 2.0 g sensation. Around quarter of patients had moderate to profound sensory loss (27.4%). Absence of sensation was not seen in any of the patient.

Table 2. Sensory Deficit Assessment using Semmes-Weinstein Monofilaments.

Semmes–Weinstein Filament Thresholds	Patient Target n(%)
0.5g (Normal sensation)	22(30.1)
2.0g (Mild sensory deficit)	31(42.5)
10.0g (Moderate sensory loss)	9(12.3)
50.0g (Severe sensory loss)	8(11)
200g (profound sensory loss)	3(4.1)
Absence of sensation	0(0)

Majority of patients had no experiences of pain, loss of sensation, problems in daily life, affected work or sleep. Few patients reported any discomfort in their foot (16.4%), loss of sensation (12.3%), pain in operated leg (11%), cold intolerance (9.6%), sensory deficit effecting daily life (9.6%), sleep (9.6%), work or their attendance (11%) and leisure activities (15.1%) (Table **3**).

Table 3. Patients' Reported Experience of Sensory Loss and Impact on Daily Activities.

Variables	Yes	No
Any foot pain just after the operation?	12(16.4)	61(83.6)
Loss of Sensation in the operated foot compared with the other foot: Yes/No	9(12.3)	64(87.7)
Pain in operated foot/leg	8(11)	65(89)
Facing cold intolerance in operated foot/	7(9.6)	65(89)
Facing pain or tingling in the outer surface of the foot	8(11)	65(89)
Are the problems due to sensory deficit affecting your daily living	7(9.6)	66(90.4)
Are the problems due to sensory deficit affecting your sleep	7(9.6)	66(90.4)
Is the sensory deficit impacting your work/school attendance	8(11)	65(89)
Is the sensory deficit impacting on your leisure activities	11(15.1)	62(84.9)

DISCUSSION

Evaluation sensory loss and functional indicators following SNG is of outmost importance, as harvest of nerve may lead to substantial complications at donor-site [11]. Because of sensory deficit, protective sensation, proprioception and balance may be impaired in lateral ankle and foot, which amplifies risks for mysterious injuries and falls. Patients may also suffer with gait balance problems due to sensory alterations, further causing discomfort in wearing footwear or walking [12]. Moreover, neuropathic pain and cold intolerance may also restrict mobility and daily function [13, 14]. Knowledge of these repercussions of SNG is crucial for preoperative counselling and designing rehabilitation plans for optimizing functional outcomes.

In this study, we employed the Semmes-Weinstein monofilament test an objective instrument for evaluation for sensory loss. This tool provides a measureable and precise observations of sensory loss, diminishing the variability associated with subjective assessments [15]. Existing literature documents effectiveness of the tool in measuring sensory loss among patients of different diseases [16-19]. Utilization of this tool allows to have physicians' view regarding functional impairment through measurable observations of sensory loss. Nevertheless, few researchers have utilized this tool when determining sensory deficit after SNG [2,3,20] while some researchers performed subjective examination [21] or applied other tools for sensory loss assessment [22,23]. Bamba *et al.* [5] reported in his systematic review that commonly use approach for sensory evaluation was survey in 44.4% studies whereas Semmes-Weinstein monofilament test tools was used in one-third studies (33%).

The majority of our patients attained sensory thresholds of 0.5g (30.1%) and 2.0g (42.5%), indicating light touch perception to mild sensory impairment. While few depicted decreased sensation of 10.0g (12.3%) and 50.0g (11%). These findings are in line with a study of Catapano *et al.* [2], who reported threshold 0.5g and 2.0g was achieved in 28.6% and 48.2% patients respectively whereas sensation at filament threshold of 10.0g and 50.0g was achieved by 8.9% and 12.5% patients. Butler *et al.* [20] also established sensation loss via investigating Semmes-Weinstein monofilament but he did not report proportion of patients achieving specific filament thresholds. However, he measured an area of sensory loss using monofilament examination and but he reported that 5 out of 28 patients had no demonstrable sensory loss. In the pediatric study by Lapid *et al.* [3] they also used monofilament system but changed the thresholds of five monofilaments (2.83, 3.61, 4.31, 4.56, and 6.65) for pediatric patients but their findings are still similar to the present study and Catapno study [2] as they reported that sensation of lighter filaments of weight 2.83g and 3.61g was achieved in overall 37% patients whereas severe sensation with filament of thresholds 4.56 and 6.65 was achieved in few patients (14%). But threshold of moderate sensory loss (4.31) was seen in 44.6% patients which is higher than ours and Catapano [2] studies which included adult population.

Some of the researchers used some other tools for evaluating sensory loss after SNG and their tools was also able to indicate sensory loss in terms of no loss to severe or extreme [22, 23]. Tada *et al.* [12] evaluated long terms outcomes with mean follow-up of 29.5 years. Authors measured sensory disturbance in feet using a 0-10 rating scale where 0 indicated no disturbance and 10 indicated disturbance was at extreme level. The average disturbance just before the surgery and after 29.5 years was 3 ± 3.7 and 2.2 ± 3.2 respectively. However, the study did not provide sensory status during these years [22]. Martin *et al.* [23] measured sensory deficit surface area at 15 days, 3 months, 6 months and 1 years post-surgery and reported that a significant decrease of 26.85%, 20.69% and 24.29% was observed from first to second, second to third and third to fourth evaluations, respectively. Because different methods are employed to evaluate sensory abnormalities, it is difficult to directly compare our results to those of similar studies [22, 23].

The findings of this study reveal a notable discrepancy between objective sensory deficits measured by the Semmes-Weinstein monofilament test and patients' subjective perception of sensory loss and functional impairment. Monofilament assessment indicated that 72.6% of patients experienced at least mild sensory impairment (≥2.0 g threshold), with 27.4% exhibiting moderate-to-severe sensory loss (≥10 g threshold**). However, only 12.3% of patients subjectively reported sensory deficits, suggesting that many patients did not perceive the sensory loss as a problem. Additionally, while 11% of patients reported postoperative pain and 16.4% experienced initial discomfort, these symptoms were not widespread. Despite measurable sensory changes, the functional impact remained relatively low in our sample, with only 9.6% of patients reporting difficulties in daily activities and sleep, and 11% experiencing work or school-related limitations and 15.1% reported restrictions in leisure activities. In contrast to our findings, objective evaluation of sensory loss in a study of Halgren *et al.* [21] resulted in higher frequency of negative responses. Like 93% patients reported sensory loss in operated area, 51% patients had feeling of pain in operated area, 85% patients had loss of sensation in operated foot as compared to other non-operated lower limb. Moreover, our findings are in conflict with systematic review of Bamba *et al.* [5] who reported higher frequencies of patients' related symptoms. According systematic review of 9 studies, sensory loss, donor site pain, cold sensitivity, and functional impairment were reported by 87.2%, 25.6%, 22.2% and 10% patients at follow-up respectively. Most of the studies were performed in Western or European populations [2, 3, 20, 21]. In our understanding, the observed differences related to the lower perception of sensory deficits, pain, and negative impact on daily activities could be attributed to variations in pain perception, health awareness, and symptom reporting from population to population. Pakistani patients may exhibit higher tolerance for sensory changes and are less likely to report mild deficits unless they significantly impact daily life. In contrast, Western populations, with greater health literacy and emphasis on symptom recognition, tend to report even minor disturbances more frequently [24, 25].

The findings of present study suggests that majority adapted well, reinforcing the notion that although sural nerve excision leads to measurable sensory loss, the impact on quality of life is often minimal. These findings emphasize the importance of using objective sensory assessment tools rather than relying solely on patient-reported symptoms, as many patients may not recognize or report deficits unless they interfere with daily function.

LIMITATIONS

This study has several limitations, including the lack of long-term follow-up to assess sensory recovery over time and potential underreporting due to cultural influences on symptom perception. Being a single-center study, its generalizability is limited. Additionally, the absence of preoperative sensory assessment and reliance on subjective reporting may impact result interpretation.

CONCLUSION

The findings of present study suggested that according to monofilament examination system nearly a quarter of patients had moderate to severe sensory deficit. However, a smaller proportion of patients reported that their functional activities were impacted substantially after sural nerve graft.

AUTHORS' CONTRIBUTION

Shiza Mehak Sohail: Conceptualization, Study Design, Methodology, Data analysis and interpretation, Writing Draft, Critical review and revision the manuscript, Final approval, final proof to be published.

Faisal Akhlaq Ali Khan: Critical review and revision the manuscript, Final approval, final proof to be published.

Waqas Sami: Study Design, Critical review and revision the manuscript.

Hiba Moazzam: Methodology, Data analysis and interpretation, Writing Draft.

Sumaira Sattar: Conceptualization, Study Design, Methodology, Data analysis and interpretation, Writing Draft.

Sana Shoukat: Study Design, Methodology, Data analysis and interpretation.

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Declared none.

ETHICAL DECLARATIONS

Data Availability Statement

Data are available upon reasonable request. The data used to support the findings of this study are available from the corresponding author upon request.

Ethical Approval

This study received approval from the Institutional Review Board (IRB) at the Dow University of Health Sciences with reference number IRB-3502/DUHS/Approval/2024/176.

Consent to Participate

Informed consented.

Consent for Publication

Consented.

Conflict of Interest

Declared none.

Competing Interest/Funding

Declared none.

Use of AI-Assisted Technologies

The authors declare that no generative artificial intelligence (AI) or AI-assisted technologies were utilized in the writing of this manuscript, in the creation of images/graphics/tables/captions, or in any other aspect of its preparation.

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