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Sural Nerve Donor-Site Morbidity

Thirty-Four Years of Follow-up

Frank F. A. Ijpma, MD, Jean-Phillipe A. Nicolai, MD, PhD, and Marcel F. Meek, MD, PhD

Abstract: This study presents a long-term evaluation of sural nerve donor-site morbidity in patients with at least 15 years' follow-up (mean 26 years) after sural nerve harvesting for peripheral nerve repair. Twenty-nine patients (mean age 30 years at time of surgery) participated in a retrospective analysis using a questionnaire. The subjective patient evaluations indicated a significant recovery of the sural nerve donor site with regard to sensory loss, pain, and cold sensitivity over time. Beyond 5 years, no further improvement is to be expected. Our findings provide a guideline for general patient information regarding sural nerve donor-site morbidity. An area of sensory loss of approximately the size of 5×6 cm is to be expected, and 20%–30% of the patients experienced minimal levels of pain, cold sensitivity, functional impairment, and scar discomfort. The latter 2 were confined to inconvenience with bumping of the donor site and putting on shoes.

Key Words: sural nerve, donor-site morbidity, nerve graft donor site, recovery of donor site

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Peripheral nerve injuries occur in many different situations, eg, during activities at home or work or during nightlife activities.¹ After nerve transection, microsurgical adaptation of the nerve is warranted to create the possibility to restore nerve function.¹ In case of a defect, when tension on the suture site cannot be avoided, nerve grafting should be performed.

The sural nerve is frequently used as graft to restore an injured peripheral nerve elsewhere in the human body. Except for unmyelinated autonomic fibers, the sural nerve is entirely sensory.² It innervates the lateral and posterior third of the lower leg and the lateral aspect of the ankle, foot, and heel.² Sural nerve grafting results in areas of sensory loss and paresthesia at the donor area, which may be clinically less important than functional motor and sensory impairment of

the injured nerve that is being repaired. A decrease in area size of sensory loss at the donor site is expected over time because collateral sprouting and regeneration from surrounding sensory nerves will reinnervate the area.^{3–5} Harvesting of a peripheral nerve results in cortical changes in the brain.⁵ The cortical area previously mapped by the harvested donor nerve is taken over by cortical mapping of surrounding nerves.⁵ A dual mechanism of collateral sprouting of surrounding nerves at the donor extremity, together with cortical reorganization, is believed to be the basis of sensory recovery at the donor site over time.⁵ In a clinical setting, the donor morbidity is subordinate to the outcome of the acceptor site. Therefore, literature on the sural nerve donor area is scarce, with no studies of long-term follow-up available.^{5–10}

The aim of this study is to assess the long-term morbidity of the sural nerve donor site in patients in whom the sural nerve was previously harvested for restoration of a peripheral nerve.

MATERIALS AND METHODS

Study Population

Data from medical charts were collected from patients who sustained a peripheral nerve injury and subsequent repair with a sural nerve graft at the Department of Plastic Surgery of the University Medical Centre Groningen, the Netherlands, between 1972 and 1991. In all patients, the common sural nerve trunk was harvested. The proximal nerve stump was implanted into muscle.

Excluded from the study were patients below the age of 18 years at the time of surgery, patients with a follow-up duration less than 15 years, patients known to have a disease or secondary surgery affecting the function or sensation in the donor nerve extremity, patients who could not remember their situation after surgery, and patients who had died at follow-up. Patients were approached by posted mail with a questionnaire to evaluate the subjective donor-site morbidity of the sural nerve donor area.

Questionnaire

Thirty-four questions were asked regarding donor-site factors, such as sensation, pain, cold sensitivity, functional impairment, scar tissue, and satisfaction. To investigate sensation, pain, and cold sensitivity, the patients were asked to recall their situation of a few months postoperatively and at the present time. To evaluate the size of the area of sensory loss, patients were asked to estimate how many squares as

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depicted in the questionnaire would cover the area of sensory loss at the donor site. Each square contains 16 cm². Levels of sensory loss, pain, cold sensitivity, functional impairment, and scar discomfort were assessed on a visual analogue scale (VAS sensory loss: 0 = no sensory loss, 10 = complete sensory loss; VAS pain: 0 = no pain, 10 = unbearable pain; VAS cold sensitivity: 0 = no cold sensitivity, 10 = extreme cold sensitivity; VAS functional impairment: 0 = no functional impairment, 10 = extreme functional impairment; VAS scar discomfort: 0 = no scar discomfort, 10 = extreme scar discomfort). In addition, each patient was asked to describe activities associated with functional impairment and scar discomfort. Satisfaction about the sural nerve donor site after follow-up with regard to sensory loss, pain, cold sensitivity, functional impairment, scar discomfort, and total satisfaction was recorded on a VAS (VAS satisfaction: 0 = unsatisfied, 10 = completely satisfied).

Statistical Methods

Data analysis was performed using SPSS version 12.0.1 statistical software. The association between the sural nerve donor-site morbidity post-nerve graft surgery and after follow-up, with regard to the number of patients who reported sensory loss, pain, or cold sensitivity, was analyzed by a χ^2 analysis. A Wilcoxon signed ranks test was used to compare postsurgical and present time area size of sensory loss and the levels of sensory loss, pain, and cold sensitivity of the donor site. A *P* value of <0.05 was considered statistically significant.

RESULTS

Demographics

Eighty-one patients met the inclusion criteria and were approached by a questionnaire. Twenty-nine patients (36%) responded to the mail survey with a completed questionnaire. Fifty-two questionnaires (64%) were not returned, because the patients did not respond or could not be contacted because they had moved and their current address was unavailable.

The study sample consisted of 29 patients (21 males and 8 women) with a mean age of 30 years (range, 18–49 years) at the time of sural nerve harvesting. The average follow-up duration since nerve graft surgery was 26 years (range, 16–34 years). The reasons for nerve graft surgery included repair of median, ulnar, radial, digital, and facial nerves.

Donor-Site Factors

Twenty-seven out of 29 patients (93%) reported sensory loss at the sural nerve donor site postsurgery; this number diminished significantly over time to 22 patients at the time of questioning (76%) (Pearson $\chi^2 = 6.751$, *P* = 0.009). The average size of the area of sensory loss was 47 cm² and decreased significantly to 33 cm² over time (*Z* = −3.328, *P* = 0.001). The reported average level of sensory loss decreased significantly over time from 4.7 to 3.8 points on the VAS score (*Z* = −3.117, *P* = 0.002, Table 1).

Ten out of 29 patients (35%) reported to have had pain at the donor site; this number was reduced significantly to 5 patients (17%) over time (Pearson $\chi^2 = 8.400$, *P* = 0.004). The reported average level of pain decreased significantly

over time from 1.1 to 0.5 points on the VAS score (*Z* = −2.666, *P* = 0.008, Table 1). The pain was located at the lower part of the calf, heel, and lateral side of the foot. None of the patients had been operated for a neuroma of the proximal nerve stump.

Fifteen out of 29 patients (52%) reported cold sensitivity; this number was reduced significantly to 10 patients (34%) over time (Pearson $\chi^2 = 4.887$, *P* = 0.027). The reported level of cold sensitivity decreased over time from an average level of 2.5 to 1.7 points on the VAS score, although not statistically significant (*Z* = −1.587, *P* = 0.113, Table 1).

Discomfort with ice skating, bumping of the donor area, and putting on shoes were the major reasons for functional impairment and scar discomfort. Minimal functional impairment was reported by 5 out of 29 patients (17%), with an average level of 0.5 on the VAS score after follow-up. Minimal scar discomfort was reported by 7 out of 29 patients (24%), with an average level of 0.4 points on the VAS score (Table 1).

Satisfaction with regard to sensory loss, pain, cold sensitivity, functional impairment, scar discomfort, determined by the average VAS score for each item, was, respectively, 7.9 for sensory loss, 8.9 for pain, 9.0 for cold sensitivity, 8.6 for functional impairment, and 8.3 for scar tissue discomfort (Table 1; Fig. 1). The overall satisfaction, including all previous items of sural nerve donor-site morbidity after an average follow-up duration of 26 years, was recorded by an average of 8.4 on the VAS score. Six out of 29 patients (21%) even reported complete resolution of the sural nerve donor-site morbidity with regard to sensory loss, pain, cold sensitivity, functional impairment, and scar discomfort after a follow-up period of, respectively, 25, 26, 28, 30, 31, and 33 years.

DISCUSSION

The sural nerve is frequently harvested as a donor nerve graft for restoration of an injured peripheral nerve elsewhere in the human body. A dual mechanism of collateral sprouting of surrounding nerves at the donor extremity and cortical reorganization is believed to be the basis of sensory recovery at the donor site over time.⁵ Previous studies evaluated the subjective recovery of nerve graft donor-site morbidity with regard to sensory loss, pain, cold sensitivity, scar discomfort, and functional impairment up to an average period of 5 years post-nerve graft surgery.^{5,6} The extent of the hypothesized recovery of donor site beyond 5 years of follow-up has not been described so far. The population of the northern part of the Netherlands is characterized by little migration. This provides the possibility to locate many patients for long-term assessment.

Previous studies on the subjective sensory recovery of nerve graft donor sites reported satisfactory results.^{5,6} Miloro and Stoner⁶ evaluated the subjective donor-site morbidity of 26 patients (mean age 32 years) at an average follow-up period of 3 years after sural nerve graft surgery for trigeminal nerve repair (Table 1). They reported a significant decrease in area size and level of sensory loss over time (*P* < 0.001, *P* < 0.001).⁶ Twenty-five patients (97%) had an area size of

TABLE 1. Characteristics of Donor-Site Morbidity With Regard to Sensory Loss, Pain, Cold Sensitivity, Functional Impairment, Scar Discomfort and Satisfaction After, Respectively, 3, 5 and 26 Years of Follow-up in Miloro et al, Ehretzman et al, and Ijpma et al (present study)^{5,6}

Characteristics	Miloro et al, 3-Year Follow-up (n = 26)			Ehretzman et al, 5-Year Follow-up (n = 31)		Ijpma et al, 26-Year Follow-up (n = 29)		
	Postoperative (%)	Follow-up (%)	P Value	Follow-up (%)	P Value	Postoperative (%)	Follow-up (%)	P Value
Sensory loss								
Patients	—	—	—	—	—	27 (93)	22 (76)	0.009
Area	0 (0); <quarter 4 (15); quarter 14 (54); tennis ball/orange 6 (23); softball/ grapefruit 2 (8); >softball/ grapefruit	15 (58); <quarter 10 (39); quarter 1 (4); tennis ball/ orange 0 (0); softball/ grapefruit 0 (0); >softball/ grapefruit	<0.001	20 (65); golf ball	0.005	47 cm ²	33 cm ²	0.001
Level†	5.46	1.31	<0.001	21 (68); low* 10 (32); high*	0.024	4.7	3.8	0.002
Pain								
Patients	19 (73); pain for 2 months 6 (23); pain for 6 months 1 (4); pain for 1 year	0 (0) 0 (0) 0 (0)	—	10 (32)	—	10 (35)	5 (17)	0.004
Level†	2.15	0	<0.001	1.7	—	1.1	0.5	0.008
Cold sensitivity								
Patients	26 (100); for 2 months	0	—	8 (26)	—	15 (52)	10 (34)	0.027
Level†	0.5	0	<0.001	—	—	2.5	1.7	0.113
Functional impairment								
Patients	—	4 (15)	—	5 (16)	—	—	5 (17)	—
Level†	—	—	—	—	—	—	0.5	—
Scar discomfort								
Patients	—	4 (14); effect on work [§] — 10 (38); effect on recreation [§] — 2 (8); effect on personal life [§]	— — —	12 (39)	—	—	7 (24)	—
Level†	—	0.08–0.38	—	—	—	—	0.4	—
Satisfaction*								
Sensory loss	—	—	—	—	—	—	7.9	—
Pain	—	—	—	—	—	—	8.9	—
Cold sensitivity	—	—	—	—	—	—	9	—
Functional impairment	—	—	—	—	—	—	9.6	—
Scar tissue discomfort	—	17 (65); very	—	—	—	—	8.3	—
Overall	—	9 (35); moderate	—	—	—	—	8.4	—

*Low level indicates score 0–3 on a scale from 0–10, high level indicates score >3 on a scale from 0–10.

†Level indicates degree of sensory loss, pain, cold sensitivity, functional impairment and scar discomfort assessed on a scale from 0–10 for Miloro and Ehretzman et al and on a visual analogue scale (VAS) for Ijpma et al.

‡Satisfaction has been assessed on a VAS, rating from 0 (unsatisfied) to 10 (completely satisfied) for Ijpma et al.

§Effect on work, recreation, personal life was assessed on a scale from 0–10 with increasingly severity of impact.
n, number of patients.

FIGURE 1. Box plot representing satisfaction regarding sural nerve donor-site morbidity for each assessed item in this study in 29 patients with an average follow-up duration of 26 years. VAS indicates visual analogue scale, rating from 0 (unsatisfied) to 10 (completely satisfied). Star indicates single patient.

sensory loss equal to or less than the size of a quarter, with an average level of sensory loss of 1.31 rated on a scale from 0–10 at follow-up survey.⁶ Ehretzman et al⁵ evaluated the subjective donor-site morbidity of 31 patients (mean age 38 years) at an average follow-up duration of 5 years and 5 months after sural nerve or medial and lateral antebrachial cutaneous nerve harvesting (Table 1). They reported a significant decrease in area size and in level of sensory loss over time ($P = 0.005$, $P = 0.024$).⁵ Twenty patients (65%) had an area of sensory loss equal to the size of a golf ball (standard size: 14.5 cm²) or smaller. The majority of patients (68%) experienced low levels of sensory loss of 0–3 rated on a scale from 0–10 at follow-up survey.⁵ Our study demonstrates a significant decrease in the number of patients who experienced sensory loss (93% to 76%), area size (47 to 33 cm²) and level (VAS sensory loss = 4.7 to 3.8) of sensory loss at the donor site after an average follow-up duration of 26 years ($P = 0.009$, $P = 0.001$, $P = 0.002$; Table 1). Compared with the previous 2 studies cited, it must be concluded that the area size and the level of sensory loss at the donor site decreases significantly in the first years after nerve graft surgery, and thereafter no further reduction of the area size and level of sensory loss is to be expected.

The number of patients who experienced pain and the intensity of pain at the donor site had decreased significantly after an average follow-up of 26 years in our study ($P = 0.004$, $P = 0.008$). Seventeen percent of our study population only experienced a negligible level of pain (average VAS pain = 0.5). None of the patients reported by Miloro and Stoner⁶ experienced any pain after 3 years (Table 1). Yet,

Ehretzman et al⁵ reported that 10 of their patients (32%) experienced an average pain level of 1.7 on a scale from 0–10 after 5 years (Table 1). It must be concluded that in the first years after nerve graft surgery, pain in the donor site is to be expected. In all 3 studies, however, low levels of pain are recorded which should rather be considered as a minimal inconvenience. Patients and surgeons, therefore, do not have to be concerned about significant levels of pain at the donor site in the long term.

Cold sensitivity also had decreased after an average period of 26 years in our study ($P = 0.027$). The level of cold sensitivity slowly decreased over time, although not significantly ($P = 0.113$). Thirty-four percent of our study population only experienced a negligible level of cold sensitivity at the time of questioning (average VAS cold sensitivity = 1.7). Miloro and Stoner⁶ initially reported a minimal level of cold sensitivity for 1–2 months in all patients; however, none of the patients experienced cold sensitivity after 3 years (Table 1). Ehretzman et al⁵ reported results comparable with ours: 8 patients (26%) experienced cold sensitivity after 5 years (Table 1). It must be concluded that in the first years after nerve graft surgery, donor-site recovery with regard to cold sensitivity is to be expected. Patients and surgeons should therefore not be concerned about a significant level of cold sensitivity in the long run.

Function related to the donor site was impaired in 5 of our patients (17%) after 26 years. Especially ice skating, bumping of the donor site, and putting on shoes were associated with functional impairment, albeit minimal (average VAS functional impairment = 0.5). Four of Miloro and Stoner's⁶ patients (15%) reported that still after 3 years daily activities were affected (Table 1). Five of the Ehretzman et al⁵ patients (16%) said the donor site had an effect on either employment, recreation, or personal life, still after 5 years (Table 1). It must be concluded that functional impairment is equally distributed between short- and long-term follow-up. We considered that function in our study population was minimally impaired and limited to bumping of the donor area and putting on shoes. Neither patients nor surgeons should therefore be concerned about a significant level of functional impairment over time.

Scar discomfort at the sural nerve donor site after an average of 26 years was mentioned by 7 patients (24%) in our study. However, the level of discomfort was almost negligible (average VAS scar discomfort = 0.4). Scar discomfort was also reported by Miloro and Stoner⁶ in the minority of patients (8%–38%) after 3 years: an average level of 0.08–0.38 rated on a scale from 0–10 (Table 1). Ehretzman et al⁵ reported scar discomfort after 5 years in 12 patients (39%) (Table 1). It must be concluded that after 3 years, as well as after 26 years, of follow-up, very low levels of scar discomfort are reported and that patients and surgeons do not have to be concerned about a significant level of scar discomfort over time.

Four out of 29 patients (14%) in our study were unsatisfied. One patient (4%) was moderately satisfied. Twelve patients were satisfied (41%). Twelve patients (41%) were completely satisfied regarding overall satisfaction of all previous items of the sural nerve donor site and scored 10 on

TABLE 2. Patient Information Regarding Sural Nerve Donor-Site Morbidity That Can be Given by the Surgeon to the Patient Prior to Sural Nerve Graft Surgery

Patient Information Prior to Sural Nerve Graft Surgery

- An area of sensory loss at the donor site of approximately the size of 5×6 cm is expected
- In approximately 20–30% of the patients, minimal levels of pain and cold sensitivity are to be expected
- In approximately 20–30% of the patients, minimal functional impairment and scar discomfort are to be expected, especially by bumping of the donor site and putting on shoes
- Approximately 90% of the patients will be satisfied with the outcome of the donor site
- Recovery of the sural nerve donor site can be expected at least up to 5 years after surgery, beyond that time period, no further improvement is expected

the VAS score. Miloro and Stoner⁶ reported very to moderate satisfaction all patients after 3 years (Table 1). Finally, 21% of our patients reported, besides satisfaction, complete resolution of donor-site morbidity. In conclusion, approximately 90% of the patients reported to be satisfied about the outcome of the sural nerve donor site in our study. Donor site recovery in the first few years after nerve graft surgery did result in moderately to very satisfied patients, indicating that recovery is to be expected in the first few years after nerve graft surgery.

Certain limitations regarding this retrospective study should be acknowledged. A low response rate (36%) was expected by the authors because of the long-term follow-up. Therefore, a bias of nonrespondents with poor outcome cannot be excluded. Second, patients were asked to recall donor-site factors with respect to numbness, pain, and cold sensitivity when they initially had their sural nerves harvested at least 15 years prior to the time the questionnaire was sent out. Data based on the patients' memory of so many years previously may be less accurate (with using the VAS), and therefore statistical analysis must be interpreted with caution.

Of course, donor-site morbidity is most often subordinate to the outcome of the acceptor site. However, prior to nerve graft surgery, it is feasible to inform the patients about the prognosis of both the acceptor and donor sites. General information given by the surgeon to the patient about the prognosis of the sural nerve donor site should include that an area of sensory loss of approximately 5×6 cm is to be expected. In 20%–30% of the patients, minimal levels of pain and cold sensitivity are to be expected. In 20%–30% of the patients, also minimal levels of functional impairment and scar discomfort are to be expected, specifically with bumping

of the donor site and putting on shoes. Approximately 90% of the patients will be satisfied with the outcome of the donor site. Recovery of the donor site is expected up to at least 5 years. Beyond this time period, no further improvement is to be expected (Table 2).

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