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Long-term sensation in the medial plantar flap: A two-centre study

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ABSTRACT

Background: Reconstruction in the foot and ankle region is challenging. This study aimed to quantify objective sensation return when a sensate medial plantar flap is used for like-for-like reconstruction of foot and ankle defects.
Methods: Two-point discrimination (2PD) was assessed in flap and normal tissue at a minimum of 1 year post-operatively. A paired *T*-test assessed for significance.
Results: 8 patients were included. Mean 2PD in normal tissue and flap was 29 mm (SD: 11.9) and 33 mm (SD: 9.97) respectively with no statistically significant difference between the two (two-tailed *p*-value: 0.1898). Mean age was 53.2 years (range: 15–84). There was no statistically significant correlation between age and 2PD in flap tissue ($r = 0.6$, $p = 0.15$).
Conclusions: This is the largest case series of its kind. Our results suggest that sensation in medial plantar flaps can return to near normal and demonstrate the important role the medial plantar flap plays in soft tissue reconstruction in this region.

1. Introduction

Defects in the foot and ankle region represent a difficult reconstructive challenge. The glabrous plantar skin found in this region is unique and perfectly adapted to its weight bearing role. Vertical compartmentalised fibrous septa extend between underlying fascia and dermis, absorbing shock and providing resistance against shearing forces during ambulation [1]. These unique properties can make following Gillie's principle of replacing losses in kind [2] challenging. Soft-tissue reconstruction in this region must be durable and permit normal range of movement [3]. Return of sensation is also vital to help prevent further injury secondary to mechanical trauma [4].

A number of strategies for the reconstruction of weight bearing regions of the foot have been proposed. Skin grafting has not proved durable enough to cope with the added strains of the foot and ankle [5]. The use of local flaps such as the filleted toe flap has been described but is associated with great toe amputation [6]. Other local flaps such as reverse dorsal metatarsal artery flaps, webspace neurovascular island flaps, distally based dorsalis pedis flaps and partially filleted toe flaps are restricted by a limited arc of rotation [7–9]. Free-tissue flaps such as rectus abdominis, latissimus dorsi, gracilis and radial forearm flaps have provided satisfactory results [10–14] but are limited by not containing the unique weight bearing properties of the foot and ankle.

On standing, up to 80% of body weight is supported by the heel; the remainder is supported by the metatarsals and distal sole [3,4]. The medial plantar region of the sole is non-weight bearing but retains its weight bearing properties, making it well suited for repair of heel and ankle defects. Donor site morbidity includes some loss of the intrinsic mechanical properties of the foot but no effect on gait [15]. A sensate medial plantar flap can be raised based on the medial plantar artery [16,17] using a branch of the medial plantar nerve [17] and transferred to defects in this region, providing like-for-like tissue reconstruction (Fig. 1).

Use of medial plantar flaps to repair foot and ankle defects is well documented [18–21]. They have proved both reliable and versatile, and their long-term durability in the foot and ankle region has been clearly demonstrated [19,20]. Some sensation return to medial plantar flaps used in this region has also been demonstrated [19–21], however, whilst case reports have been encouraging [21], evidence documenting the extent of

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Fig. 1. A local medial plantar flap used to repair a chronic ulcer over the achilles tendon.

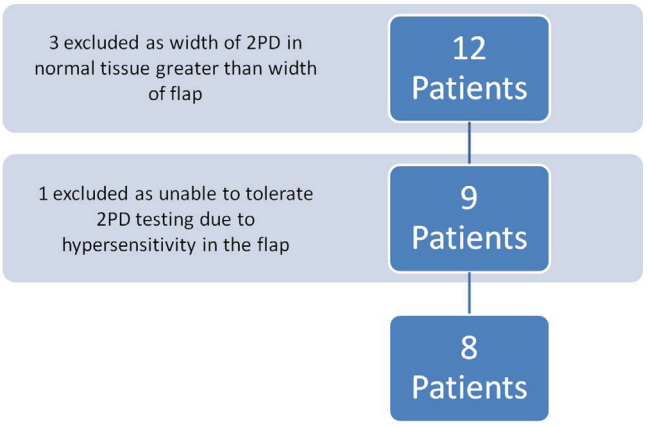

Fig. 2. Flow scheme of patients excluded from study.

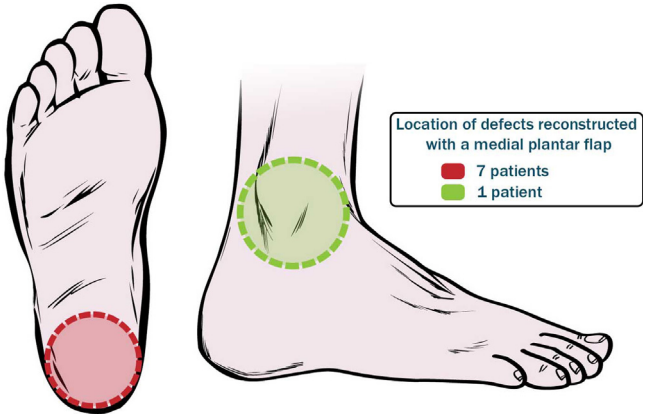

Fig. 3. Location of defects reconstructed with a medial plantar flap in this study.

sensation return to these flaps and its comparability to normal tissue is limited. This study aims to quantify long-term sensation return in medial plantar flaps used to repair defects in the foot and ankle and compare this with sensation in the normal tissue of this region.

2. Method

Patients from Frenchay Hospital, Bristol (UK) and Jinnah Hospital, Lahore (Pakistan) who had undergone a medial plantar flap transfer for foot and ankle defects were reviewed a minimum of 12 months after surgery. Free flap reinnervation was achieved by way of an end-to-side nerve coaptation to a recipient plantar nerve to avoid the morbidity of an end-to-end coaptation. Studies have shown that the end-to-side neurorrhaphy produces sprouting of donor nerve axons into the nerve fascicles of the flap [22]. The procedures in the UK centre were performed by the senior author whereas those in the Pakistan centre were performed by one surgeon who was trained by the senior author and uses the same technique for harvesting and insetting of the flap.

Two-point discrimination (2PD) was assessed to the nearest millimetre in both flap and normal tissue of the contralateral foot using a paperclip with a specified intertip distance. Patients were excluded where it was impossible to assess outcome using 2PD. This included patients whose normal tissue 2PD on the non-affected foot was wider than the width of the flap, making meaningful comparison of flap and normal tissue in these patients impossible using 2PD. Patients who could not tolerate 2PD testing were also excluded. 2PD measurement with a paperclip is an accurate and reproducible test [23], and was chosen to ensure standardisation between the two centres involved in this study.

Mean 2PD and standard deviation were calculated for both flap and normal tissue. A paired *T*-test was used to assess for a significant difference between flap and normal tissue. This test was chosen as it compares two sets of observations on a single sample and is thus appropriate for this study. The null hypothesis was that there is a statistically significant difference in 2PD between flap and normal tissue. A *p*-value of less than 0.05 was considered significant. Correlation between age and 2PD in both contralateral normal tissue and flap was also investigated using Pearson's correlation coefficient.

3. Results

Twelve patients across both centres were reviewed in clinic. A total of 4 patients were excluded (Fig. 2). Three of these were excluded as 2PD in their normal tissue on the non-affected foot was larger than the width of their flap, making comparison between flap and normal tissue using 2PD impossible. The fourth patient was excluded as he was unable to tolerate 2PD testing due to hypersensitivity in the flap. Of the remaining eight patients, seven had received a medial plantar flap to repair a heel defect and one had received a medial plantar flap to repair an ankle defect (Fig. 3). Three of the flaps were local and five were free flaps taken from the contralateral foot.

Individual 2PD results are shown in Table 1. Mean 2PD in the normal tissue of the contralateral foot was 29 mm (SD: 11.9) and mean 2PD in the medial plantar flaps was 33 mm (SD: 9.97) (Fig. 4). No statistically significant difference in 2PD was found between flap and normal tissue of the contralateral foot (two tailed p value = 0.1898).

Mean age was 53.2 years (range 15–84). 2PD in the normal tissue of the contralateral foot was measured in all 12 patients and a statistically significant correlation between age and 2PD was seen ($r = 0.756$, $p = 0.011$). No statistically significant correlation

Table 1
2PD in flap and normal tissue.

Patient number	2PD in flap (mm)	2PD in normal tissue (mm)
1	33 mm	18 mm
2	26 mm	27 mm
3	38 mm	40 mm
4	30 mm	29 mm
5	53 mm	53 mm
6	26 mm	20 mm
7	25 mm	21 mm
8	40 mm	24 mm