The Journal of Foot & Ankle Surgery 56 (2017) 1114–1120

Contents lists available at ScienceDirect

The Journal of Foot & Ankle Surgery

journal homepage: www.jfas.org

Functional Outcomes After Heel Pad Reconstruction: A Review of 7 Cases

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ARTICLE INFO

Level of Clinical Evidence: 4

Keywords:
calcaneus
flap reconstruction
heel pad
microvascular reconstruction
outcome

ABSTRACT

Sensate, durable heel pad reconstruction is challenging. The present study assessed the functional outcomes after heel pad reconstruction using various flap techniques at our institution. From June 2011 to June 2016 (5-year period), 7 consecutive patients underwent heel pad reconstruction for various etiologies, with 3 microvascular free flaps (42.9%; 2 musculocutaneous flaps [66.7%] and 1 contralateral medial plantar flap [33.3%]) and 4 local pedicle flaps (57.1%; 3 instep medial plantar artery flaps [75.0%] and 1 distally based reverse sural flap [25.0%]). The patient records and demographic data were reviewed, and surgically related information was obtained and analyzed. The subjective components of the American Orthopaedic Foot and Ankle Society hindfoot clinical ratings scale were used to evaluate the pain and functional outcomes. Sensation was assessed using Semmes-Weinstein monofilaments, and ulcer recurrence was recorded. The mean age of the patients was 41.7 (range 11 to 70) years, the mean defect size was 59 (range 12 to 270) cm^2, and the mean follow-up duration was 22 (range 15 to 43) months. Complete flap survival was achieved without significant complications in all 7 patients. Patients treated with the sensate medial plantar artery flap recorded the highest mean American Orthopaedic Foot and Ankle Society score of 57.3 (maximum score of 60) and experienced a return of deep sensation at 6 (range 6 to 24) months and protective sensation at 1 year. This was followed by the reverse sural flap and the musculocutaneous flap. No recurrent heel ulceration was observed in our series of patients. In conclusion, the sensate medial plantar flap is a satisfactory method for coverage of small- to moderate-size heel defects.

The heel pad serves an important function in weightbearing, shock absorption, and proprioception. It is subject to more repetitive trauma and loading stress than any other part of the body. As one of the most specialized tissues in the body, the heel pad poses a challenge to any reconstructive surgeon attempting to repair and restore its functionality. Various techniques have been described in published studies, ranging from the use of local regional flaps to free microsurgical flaps, with variable outcomes (1–9).

Numerous studies have reported the outcomes of foot- and ankle-related problems, mainly determined from patient-reported symptoms (10–12). Although various clinical tools are available to assess function, no single tool has been found to be superior for evaluating heel pad function (13–15). In 1994, Kitaoka et al (16) described the American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot clinical ratings scale to objectively and subjectively assess foot function. The subjective component of this scale has been shown to be a valid health measurement (17). In addition to the subjective outcomes, sensation and the avoidance of recurrent ulceration after soft tissue reconstruction of the heel pad have been shown to be associated with patient satisfaction (18). Furthermore, Semmes-Weinstein monofilaments can be used to evaluate the return of sensation after various flap reconstructions (19). Hence, a combination of subjective and objective clinical assessments can be used to meaningfully assess the functional outcomes after pedal flap reconstruction.

The demand for limb salvage surgery has been increasing, and the orthoplastic approach has been deemed necessary to prevent amputation. Heel pad loss after trauma, complicated diabetic foot ulcers, and soft tissue tumor extirpation can lead to limb amputation in the absence of a sound reconstructive approach. The expectation of regaining good functionality, sensation, and durable tissue (rather than mere wound coverage) further complicates the aims of limb

Financial Disclosure: None reported.

Conflict of Interest: None reported.

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http://dx.doi.org/10.1053/j.jfas.2017.04.024

Table 1
Demographic data (N = 7 patients)

Pt. No.	Age (y)	Sex	Comorbidity	Etiology	Defect Size (cm × cm = cm^2)	Procedure	Operating Time (h)	Secondary Procedure, Complication	Hospital Stay (days)	Follow-Up Duration (mo)
1	12	Male	Congenital heart disease	Traumatic	15 × 18 = 270	Free latissimus dorsi flap	5	Delayed skin graft	19	18
2	45	Female	Hypertension	Traumatic	10 × 5 = 50	Free serratus anterior flap	7	Delayed skin graft	23	26
3	22	Male	None	Traumatic	6 × 6 = 36	Free sensate medial plantar flap	6.5	None	76	16
4	70	Female	Diabetes mellitus, hypertension	Diabetic ulcer	7 × 5 = 35	Pedicle sensate medial plantar flap	2.5	Delayed skin graft donor	30	16
5	62	Female	Diabetes mellitus, hypertension	Diabetic ulcer	6 × 7 = 42	Distally based reverse sural flap	2.5	None	48	17
6	66	Female	None	Melanoma	5 × 5 = 25	Pedicle sensate medial plantar flap	4	None	24	15
7	18	Male	None	Recurrent ulcer after reverse sural flap	5 × 4 = 20	Pedicle sensate medial plantar flap	3	None	22	43

Abbreviation: Pt. No., patient number.

salvage surgery. The present study reviewed and compared the functional outcomes after heel pad reconstruction using various methods conducted at our center.

Patients and Methods

A retrospective analysis was performed by 1 of us (K.K.L.) using the medical records of 7 patients who had undergone soft tissue reconstruction of the heel pad by a senior surgeon (W.A.S.) at our medical center from June 2011 to June 2016. For each patient reviewed, the following data were recorded and tabulated: age, sex, concomitant medical illness, etiology, defect size, flap size, duration of surgery, complications, and follow-up duration (Table 1).

Subsequently, 1 of us (K.K.L.) performed the assessments using questionnaires adapted from the subjective components of the AOFAS hindfoot clinical ratings scale to determine the pain and functional outcomes according to limitations of activity, walking distance, and walking surfaces (Table 2). Sensation was objectively assessed by 1 of us (K.K.L.) using the Semmes-Weinstein monofilament test at the flap site, with 3 different monofilament sizes (size 6.65 = 300 g for deep sensation, size 4.31 = 2 g for protective sensation, and "normal" size 3.61 = 0.4 g). A clinical assessment was also performed to evaluate the presence of ulcers at the flap site or other sites of the foot bilaterally.

All assessments were performed by 1 of us (K.K.L.) and included the clinical assessment of the return of sensation using the Semmes-Weinstein monofilament test, the presence of ulceration, and completion of the AOFAS hindfoot clinical ratings scale. The mean AOFAS scores were calculated and summarized according to 3 different flap selections: musculocutaneous flap, sensate medial plantar flap, and distally based reverse sural flap (Table 3).

Results

The mean age of the patients was 42 (range 11 to 70) years, and 3 patients were male and 4 were female. Of the 7 patients, 3 (42.9%) had diabetes and 2 (28.6%) had hypertension. Also, 1 patient (14.3%) smoked

Table 2
Outcomes of reconstructed heel pads with various flaps*

Pt. No.	Flap Selection	Pain	Function			Total AOFAS Score (Subjective Components; Maximum Score 60)	Return of Deep and/or Protective Sensation	Heel Pad Ulceration
			Limitations in ADLs	Maximum Walking Distance (1 Block = 150 m)	Walking Surfaces With Difficulty			
1	Free latissimus dorsi flap	2 (30)	2 (7)	3 (2)	2 (3)	42	No return of deep sensation at 1 y	No
2	Free serratus anterior flap	2 (30)	2 (7)	2 (4)	2 (3)	44	Deep sensation at 2 y; no protective sensation at 2 y	No
3	Free sensate medial plantar flap	1 (40)	1 (10)	2 (4)	2 (3)	57	Deep sensation at 6 mo; no protective sensation at 14 mo	No
4	Pedicle sensate medial plantar flap	1 (40)	1 (10)	2 (4)	2 (3)	57	Deep sensation at 6 mo; protective sensation at 1 y	No
5	Distally based reverse sural flap	2 (30)	2 (7)	1 (5)	2 (3)	45	Deep sensation at 1 y; no protective sensation	No
6	Pedicle sensate medial plantar flap	1 (40)	1 (10)	1 (5)	2 (3)	58	Deep sensation at 6 mo; protective sensation at 1 y	No
7	Pedicle sensate medial plantar flap	1 (40)	1 (10)	2 (4)	2 (3)	57	Deep sensation at 6 mo; protective sensation at 2 y	No

Abbreviations: ADLs, activities of daily living; AOFAS, American Orthopaedic Foot and Ankle Society (Ankle-Hindfoot clinical ratings scale); Pt. No., patient number.
Subjective assessments of AOFAS ankle-hindfoot clinical ratings scale for pain: 1, none (40 points); 2, mild, occasional (30 points); 3, moderate, daily (20 points); 4, severe, almost always present (0 points).
Subjective assessments of AOFAS Ankle-Hindfoot clinical ratings scale for function (total, 50 points): (1) limitation of ADLs: 1, no limitation of activity in daily life (10 points); 2, no limitation of daily activities, limitation in recreational activities, no support needed (7 points); 3, limited daily and recreational activities, support with cane needed (4 points); 4, severe limitation of daily activity, walker, crutches, wheelchair, braces needed (0 points); (2) maximum walking distance (blocks = 150 m): 1, >6 blocks (5 points); 2, 4 to 6 blocks (4 points); 3, 1 to 3 blocks (2 points); 4, <1 block (0 points); and (3) walking surfaces: 1, no difficulty walking any surface (5 points); 2, some difficulty on uneven terrain, stairs, ladders, inclines (3 points); and 3, severe difficulty on uneven terrain, stairs, ladders, inclines (0 points).
Sensation evaluation using Semmes-Weinstein monofilament assessments (size 6.65 = 300 g for deep sensation; size 4.31 = 2 g for protective sensation; normal size 3.61 = 0.4 g) performed at each visit.
Clinical evaluation of the presence or absence of ulcers on the flap or foot.
* Subjective assessments of AOFAS Ankle-Hindfoot clinical ratings scale, objective sensory assessment using Semmes-Weinstein monofilament test, and clinical evaluation of ulceration (n = 7 patients).