Experiences with fasciocutaneous flaps vs. muscle flaps as a cover of defects of the sole of the foot: analysis of the long-term clinical and functional results

Erfahrungen mit fasziokutanen Lappen vs. Muskellappen als Defektdeckung an der Fußsohle: Analyse der klinischen und funktionellen Langzeitergebnisse

Abstract

Introduction: Reconstructing foot defects is a great challenge for plastic surgeons. The clinical and functional results (proprioceptive and exteroceptive) have been inconsistent for defect reconstructions on the weight-bearing and non-weight-bearing area of the foot. Moreover, no final conclusion has been reached about the best type of flap to cover the defect on the weight-bearing area of the sole of the foot. It would be desirable to know whether the clinical and functional results and proprioceptive and exteroceptive qualities on the reconstructed foot provide a reliable indication of the long-term results after reconstruction of defects in the soft tissues in the loaded and unloaded foot.

Methods: This retrospective study contains the results from 23 of 39 patients who were operated on between 2001 and 2010. The mean follow-up period was 46.6 months. In 10 patients with a defect cover on the loaded sole of the foot, the clinical and functional parameters were compared for different flap plasties (muscle flap vs. fasciocutaneous flap). In addition, we examined the ability of all 23 patients to differentiate two points, hot and cold, and sharp and blunt, as well as vibration sensitivity in the reconstructed flap area.

Results: Nineteen (19) of the 23 patients (82.6%) could be reintegrated in their original occupations. The group of patients with a muscle flap on the loaded sole of the foot (Group 1) were kept in hospital for a much longer period (67.6 days for Group 1 versus 22.2 days for Group 2 with a fascio-cutaneous flap to the loaded sole of the foot). In addition, the operation time was much longer in Group 1 than in Group 2 (485.3 min for Group 1 versus 296.6 min for Group 2). The rate of revision was 66.7% in Group 1 and 28.6% in Group 2. A single patient suffered ulceration in each of the two groups. The proprioceptive and exteroceptive qualities were independent of the type of flap and were essentially the same in the two groups.

Discussion: Even though the perioperative parameters (operation-time, hospital-stay, rate of revision) were better in the group of patients with a fasciocutaneous flap to the weight-bearing area of the foot there was no evidence from our data for a clear correlation between ulceration and a loss of sensitivity to vibration. The long-term clinical and neurological results after covering a soft tissue defect in the foot are rather inconsistent, most of our patients (82.6%) could be reintegrated into their original occupations. What is decisive for optimal functional analysis after reconstruction of a soft tissue defect in the foot is not the clinical, perioperative and neurological investigation, but an analysis of the walking cycle with insole-pedobarography.

Keywords: proprioception, exteroception, foot reconstruction, long-term clinical course
Zusammenfassung


Ergebnis: 19 von den 23 Patienten (82,6%) konnten in den ursprünglichen Beruf integriert werden. Die Gruppe der Patienten mit einem Muskellappen zur belasteten Fußsohle (Gruppe 1) hatte eine deutlich längere Krankenhausaufenthaltsdauer (67,6 Tage Gruppe 1 vs. 22,2 Tage Gruppe 2 fasziokutaner Lappen zur belasteten Fußsohle). Auch die Operationsdauer war in der Gruppe 1 deutlich länger als in Gruppe 2 (485,3 Minuten Gruppe 1 vs. 296,6 Minuten Gruppe 2). Die Revisionsrate in Gruppe 1 betrug 66,7% und in Gruppe 2 28,6%. Sowohl in der fasziokutanen als auch in der Muskellappengruppe trat bei jeweils einem Patient eine Ulzeration auf. Die Proprio- und exterozeptiven Qualitäten waren unabhängig von der gewählten Lappenart und zeigten weder in der fasziokutanen noch in der Muskellappen-Gruppe eindeutig bessere Ergebnisse.

Diskussion: Obwohl die periorientativen Parameter (Operationsdauer, Krankenhausaufenthaltsdauer, Revisionsrate) in der Gruppe der Patienten mit einem fasziokutanen Lappen zur belasteten Fußsohle besser waren, konnten wir eine klare Korrelation zwischen Ulzeration und aufgeholtem Vibrationsempfinden anhand unserer Daten nicht feststellen. Trotz dieser eher uneinheitlichen Ergebnisse in Bezug auf die klinisch-neurologischen Langzeitergebnisse nach einer Weichteildefektdeckung am Fuß zeigte sich, dass ein Großteil unserer Patienten wieder in den ursprünglichen Beruf integriert werden konnte (82,6%). Entscheidend für eine optimierte Funktionsanalyse nach einer Rekonstruktion eines Weichteildefektes am Fuß ist nicht die klinisch-neurologische Untersuchung sondern eine Analyse des Gangzyklus mit insole-Pedographie.

Schlüsselwörter: Propriozeption, Exterozeption, Fußrekonstruktion, Langzeitverlauf
Introduction

After plastic surgery for the reconstruction of soft tissue defects on the foot, the objective is that the patient should be rehabilitated as completely as possible into his professional and private environment. The foot contour should correspond to that of the normal foot, so that normal shoes can be worn. As a protection, the reconstructed area should be sensitive, and the transferred flap should be reliably anchored to the deep structures [1]. After successful plastic surgical reconstruction of the soft tissues in the foot, the most important complication is recurrent ulceration in the area of the soft tissue reconstruction [2]. The patient then suffers increased morbidity. Additional treatment and operations may be necessary, leading to additional costs for the health system [3].

Reconstruction of a defect wound on the foot is often a very difficult problem for the plastic surgeon [4]. Although a variety of possible methods for plastic surgery defect reconstruction on the foot have been described in the literature [5], [6], [7], [8], [9], [10], [11], [12], [13], [14] and in clinical practice (see our own results), they all have difficulties in replacing the functionally complex construction of the skin and soft tissue in the sole of the foot [15], [16]. There is no single optimal flap for all patients and the decision to use a specific flap for a specific patient is influenced by many factors [17].

It may be desirable that a free flap to cover a defect in the sole of the foot should be innervated, in order to achieve better function or to lower the rate of complications. Ducic et al. were unable to provide a conclusive answer to this question in their review article [18]. An analysis of the available literature does not permit the conclusion that an innervated free flap plasty in the loaded area of the sole of the foot gives better results with respect to lifetime and function [18].

Sönmez et al. compared free fasciocutaneous flaps with free muscle flaps in covering defects in loaded areas of the sole of the foot. They found that the patients with a fasciocutaneous flap gave better results with respect to the postoperative ulceration rate and pain intensity [2]. In Germany there are many diabetics with wounds to their feet; their rate of amputations is very high [19], [20], [21]. We therefore consider it very important to study the functional clinical results after defect reconstruction to the soft tissue in the feet, in order to win insights that could help to optimise the treatment of these patients.

The analysis of the results of defect reconstruction in the feet can either be clinical and functional, using proprioceptive and exteroceptive test methods [2], or can employ instrumental functional measurements, such as insole pedobarography [3]. How reliable are clinical and functional (proprioception, exteroception) results with respect to the long-term results after reconstruction of defects in the soft tissue in the loaded and unloaded foot? The data in literature dealing with this question is limited [11], [22], [23]. Mostly protective sensibility is the only mentioned quality.

In the present article, we wish to present our results on the clinical, perioperative and functional follow-up studies on our patients. In the context of the available literature, we will discuss the differences between the two types of flap-coverages – muscle flaps and fasciocutaneous flaps –, particularly in patients with a covered defect in the loaded sole of the foot. In addition, we recorded and analysed the ability of all 23 patients to differentiate two points, hot and cold, and sharp and blunt, as well as vibration sensitivity in the reconstructed flap area.

Methods

This retrospective study contains the results from 23 of 39 patients who were operated on in the Department of Plastic, Hand and Reconstructive Surgery in Hannover Medical School and in the Friederikenstift in Hannover, between 2001 and 2010. One patient died within the follow-up period; one patient could not take part in the follow-up examination, as he was suffering from acute pneumonia that required respiration therapy; one patient had moved abroad and the remaining patients either could not be contacted, or were not prepared to take part in the follow-up study, e.g. due to the long distances they would have had to travel. All patients were informed of the study and gave their written consent to participation. Procedures were in accordance with the Helsinki Declaration for the Ethical Treatment of Human Subjects and the experiments were approved by the regional ethics committee in Hannover.

Nineteen of the study participants were male and 4 female. The mean age at the time of the follow-up was 48 (19–66) years. In 19 cases, the wound was caused by trauma; 4 patients suffered from chronic ulceration after burns or due to vascular problems. The mean period of the follow-up was 3.88 years, or 46.6 months (0.22 to 11.15 years). The various types of flap were distributed as follows: 5 suralis flaps, 5 latissimus dorsi flaps, 5 parascapular flaps, 4 ALT flaps (anterolateral thigh flaps), 2 serratus flaps, 1 instep flap and 1 radial artery flap.

Of the 23 patients in the follow-up, 10 patients were given defect covers in the loaded sole of the foot; 13 patients were given reconstructions in the non-loaded area of the foot. In 10 of these patients with defect covers in the loaded sole of the foot, the clinical functional parameters were compared for the different types of flap: 3 patients with latissimus dorsi flaps (Group 1 – Figure 1) and 7 patients with a fasciocutaneous flap (Group 2 – Figure 2).

In addition, we measured exteroceptive stimuli – two point differentiation, hot-cold differentiation and sharp-blunt differentiation – and proprioceptive stimuli – vibration sensitivity – in the area of the reconstructed flap in all 23 patients. To measure vibration sensitivity, a tuning fork (128 Hz) was hit. On the scale of 0–8 on the tuning fork, the value was read off at which the patient no longer felt vibrations.
Results

Of the 23 investigated patients, 19 (82.6%) could be re-integrated into their original occupation. All patients were asked if they would select a defect reconstruction again or rather amputation should they be in a similar situation again. 100% of our patients would decide for reconstruction again.

Results for the 10 patients with a flap in the weight-bearing area of the foot

The group of patients with a muscle flap in the weight-bearing area of the foot (Group 1) were in hospital for a longer period than the comparator group with a fasciocutaneous flap (group 2) (67.6 days for Group 1 versus 22.2 days for Group 2).

In addition, the operation time was much longer in Group 1 than in Group 2 (485.3 min for Group 1 versus 296.6 min for Group 2).

The rate of revision was 66.7% in Group 1 and 28.6% in Group 2.

The rate of active nicotine consumption was similarly high in the two groups, with 66.7% and 13.5 pack-years in Group 1 and 71.5% and 12.5 pack years in Group 2.

In both groups, the occupational rehabilitation into the same profession as before the reconstruction was good, with 66.7% in Group 1 and 71.4% in Group 2.

One patient from Group 1 (latissimus dorsi flap) and 1 patient from Group 2 (suralis flap) was found to have ulceration in the area of the reconstruction.

Results of all 23 followed-up patients with flaps on the foot

In this evaluation, we classified all 23 of our patients into 2 groups. Group A (7 patients) corresponds to the patients with a muscle flap as defect cover and Group B (16 patients) corresponds to the patients with a fasciocutaneous flap cover. In the analysis of the total group of 23 patients, the following results were found for proprioception and exteroception:

Two point differentiation (2-PD) was measured in the reconstructed flap area, with a 10 mm gap between the 2 measuring points and with the patient’s eyes closed.
In Group A, 2 of 7 patients had 2-PD under 10 mm (28.6%). In Group B, 5 of 16 patients had 2-PD under 10 mm (31.3%). There were essentially no differences between Group A and Group B with respect to 2-PD (Table 1).

Table 1: 2-point differentiation: >10 mm or <10 mm

<table>
<thead>
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<th>2-PD &gt;10 mm</th>
<th>2-PD &lt;10 mm</th>
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<tbody>
<tr>
<td>Muscle flap Group A</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Fasciocutaneous Group B</td>
<td>11</td>
<td>5</td>
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Hot-cold differentiation was measured in the reconstructed flap area, with the patient's eyes closed. In Group A, 2 of 7 patients were able to differentiate hot and cold (28.6%). In Group B, 8 of 16 patients were able to differentiate hot from cold (50.0%) (Table 2).

Table 2: Hot-cold differentiation: present or absent

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<thead>
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<tbody>
<tr>
<td>Muscle flap Group A</td>
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<td>2</td>
</tr>
<tr>
<td>Fasciocutaneous Group B</td>
<td>8</td>
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Sharp-blunt differentiation was measured in the reconstructed flap area, with the patient's eyes closed. In Group A, 3 of 7 patients were able to differentiate sharp and blunt (42.9%). In Group B, 6 of 16 patients were able to differentiate sharp and blunt (37.5%). There were essentially no differences between the groups with respect to the ability to differentiate sharp and blunt (Table 3).

Table 3: Sharp-blunt differentiation: present or absent

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<th>absent</th>
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<tbody>
<tr>
<td>Muscle flap Group A</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Fasciocutaneous Group B</td>
<td>10</td>
<td>6</td>
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Vibration sensitivity

Vibration sensitivity was totally eliminated in 3 of 16 patients (18.8%) with a fasciocutaneous flap and in 1 of 7 patients (14.3%) with a muscle flap.

Discussion

There are many different possible approaches to reconstructing defects in the human foot [24], but reports are rare on the functional clinical results after reconstruction of a defect in the soft tissue of the foot [25]. Sönmez et al. [2] and Potparic et al. [26] have found contradicting results when they both compared complication rates and postoperative ulceration rates for patients with different flap coverages to the sole of the foot. In this article, we wish to present and discuss our results with a group of patients with defect cover on the foot.

On the basis of our data, it can firstly be said that patients with a fasciocutaneous flap to cover a defect in the loaded sole tend to give better results – a shorter period in hospital; shorter operation time; lower revision rate. However, ulceration [2] as the most important complication after defect cover in the loaded area of the foot occurred in both groups.

The proprioceptive and exteroceptive properties were essentially the same for the two types of flap. Neither the 2 point differentiation test, nor sharp-blunt differentiation, nor hot-cold differentiation showed a clear difference between the groups.

There was no evidence from our data for a clear correlation between ulceration and a loss of sensitivity to vibration. Sönmez emphasised that all patients lacking vibration sensitivity suffered from ulcerations [2]. In our group of patients, both patients with ulceration exhibited good vibration sensitivity, with 6/8 and 7/8. The proportion of patients totally lacking vibration sensitivity was 14.3% (muscle flaps) and 18.8% (fasciocutaneous flaps).

In spite of these rather inconsistent results on the clinical neurological results after cover of a soft tissue defect in the foot, it was found that most of our patients could be reintegrated in their original occupation (82.6%) and all patients would have been willing to repeat the operation.

What is decisive for optimised functional analysis after reconstruction of a soft tissue defect in the foot is not the clinical neurological investigation (2-PD, hot-cold differentiation, sharp-blunt differentiation, vibration sensitivity), but an analysis of the walking cycle with insole-pedobarography, in order to discover pathological movements within the walking cycle, to record peak pressure values in the soles and then to achieve a permanent stable result for the patient, by means of pressure-reducing shoe inlays or modification of the flap plasty (flap reduction) [3].

The limitations of this study are that the group of patients were heterogeneous and with different types of flaps. Moreover, the number of patients was small. There was therefore no statistical evaluation. Our study had a much longer follow-up interval than other investigations [27], namely a mean of 47 months.

Notes

Competing interests

The authors declare that they have no competing interests.
References


Corresponding author:
Dr. med. Max V. Meyer-Marcotty
Klinik für Plastische, Hand- und Wiederherstellungschirurgie, Soest Hospital,
Senator-Schwartz-Ring 8, 54949 Soest, Deutschland
meyer-marcotty@klinikumstadtssoest.de

Please cite as
DOI: 10.3205/gpras200016, URN: urn:nbn:de:0183-gpras2000162

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