The Foot 24 (2014) 21–27

Contents lists available at ScienceDirect

The Foot

journal homepage: www.elsevier.com/locate/foot

Lipofilling for functional reconstruction of the sole of the foot

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ARTICLE INFO

Article history:
Received 23 October 2013
Received in revised form 20 February 2014
Accepted 24 February 2014

Keywords:
Lipofilling
Sole reconstruction
Plantar insole
Rehabilitation
Trauma

ABSTRACT

Background: New advances in regenerative surgery may increase the potential for rehabilitation in the injured foot.
Objectives: A clinical prospective observational study was carried out to assess the effectiveness of lipofilling to improve the functional recovery of the injured foot.
Methods: Four patients with anatomical–functional impairment following repair of post-traumatic soft tissue loss of the foot were involved in the study. All of the patients complained of pain in the repaired plantar weight bearing area, skin instability, recurrent ulcerations and were walking on crutches.

A combined plastic surgery and technical orthopaedic assessment identified the plantar areas requiring anatomical changes for load redistribution. Two selective sequential lipofillings with a 12 weeks' time interval were performed. Manufacturing of custom-made plantar insoles and/or shoes followed each surgical procedure.
Results: After the treatment all of the patients progressively recovered both a better plantar load distribution and a local soft tissue stability, referred the remission of chronic pain and discontinued the use of crutches.
Conclusion: Lipofilling proved to be an effective and versatile surgical technique for both reconstructive and regenerative purposes. The interaction between the Plastic Surgery staff and the Orthopaedic Technician outlined a successful multidisciplinary approach model for the rehabilitation of the injured foot.

1. Introduction

The reconstruction of the plantar soft tissue of the foot remains a complex and challenging undertaking as it traditionally relies on flaps and skin grafts [1] that often leave disabling after effects. Although flaps provide a stable and effective reconstruction, scars and deformity are often the unavoidable price to pay for such a choice. On the other hand skin graft repair is not a satisfactory therapeutical solution in the injured foot, too. Skin grafts are usually unstable in the long term, are not fit for weight bearing and inexorably undergo retraction with subsequent foot deformity. Pain is the common denominator of all of these after effects.

Orthopaedic Technicians are able to improve the functional performance of a reconstructed foot with custom made plantar insoles and/or shoes. Nevertheless manufacturing of such effective devices is not possible in all of the clinical situations, as in case of severe degree of residual anatomical and functional disruption and deformity.

In our experience the limits of traditional post-reconstructive rehabilitation of the injured foot was overcome by the integration of orthopaedic custom made devices and selective lipofilling.

2. Materials and methods

Four male patients (age 33–71 years) were enrolled in the study over a period of 3 years, from March 2008 to May 2009, at the Plastic and Reconstructive Surgery Unit of the University of Pavia, Salvatore Maugeri Research and Care Institute, Pavia, Italy. All of the patients had undergone repair of post-traumatic soft tissue loss of the foot: three of them with a split thickness skin graft and one with

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http://dx.doi.org/10.1016/j.foot.2014.02.003

Fig. 1. Injection of centrifuged adipose tissue in the recipient site.

Fig. 2. Case 1. Unstable ulceration on the site of a previous split thickness skin graft on the outer side of the right heel.

a cross-leg fascio-cutaneous flap. They were in good general conditions, had no history of metabolic, chronic skin and/or neurological diseases and did not undergo pharmacological therapies potentially or actually impairing the wound healing process; they also had no history of previous muscular-skeletal disease before injury. All of the patients complained of pain in the repaired plantar weight bearing area, local skin instability with recurrent ulcerations and callus formation and were walking on crutches. At the time of clinical enrolment the patients underwent a combined plastic surgery and technical orthopaedic assessment.

At this stage a podoscopic and podometric study of plantar footprints was carried out using the mirror podoscope and the ink pad system. Each patient was taken dynamic and static plantar footprints in both feet in order to compare the injured foot with the healthy one. The study allowed for screening of both the plantar weight bearing pattern and the sites of potential conflicts with the shoe. The plantar footprint also allowed for identification of the metatarsal heads location, the key for planning the load redistribution. Such procedures allowed to identify the plantar areas requiring the increase of weight bearing surface and tissue thickening. This information was discussed with the surgical staff for outlining of the appropriate operative planning.

Lipofilling was carried out according to modified Coleman's technique [2]. The fat grafts were harvested from the abdominal subcutaneous tissue by using a local superwet saline plus Epinephrine ($1/1 \times 10^{-6}$) infiltration. Syringe liposuction was carried out using 1 mm blunt round tip cannulas [3]. The aspirated fat was processed in a centrifuge at 1500/rpm for 2 min [4] to get the appropriate purified adipose fraction. A gentle meticulous lysis of the scar tissue in the recipient sites was carried out with the blunt round tip cannulas through multiple punctiform skin incisions in order to create multiple subcutaneous tunnels crossing each other in multiple planes. The purified adipose fraction was injected in small amounts in a retrograde direction along these multiple subcutaneous tunnels (Fig. 1).

The patients were advised to avoid both dynamic and static plantar weight bearing in the operated foot for 2 weeks after surgery. A 30% partial dynamic and static plantar weight bearing using crutches and a soft sock was then allowed for the following 2 weeks. At the end of this time, 4 weeks after the surgical procedure, a technical orthopaedic post-operative assessment was scheduled for manufacturing of the custom-made plantar insoles and/or shoes. A progressive recovery of full dynamic and static plantar weight bearing was then allowed within 2 weeks after manufacturing of the custom made plantar insoles and/or shoes.

Adequate fitting of the custom-made devices was checked 4 weeks after full dynamic and static plantar weight bearing recovery and requirements for a further lipofilling were discussed with the surgical staff.

Twelve weeks after the first surgical procedure a second lipofilling session was then carried out. The post-operative static and dynamic plantar weight bearing protocol and the technical orthopaedic procedures repeated the sequence of the first stage.

Eventually the long term follow-up was scheduled yearly once.

In our experience two lipofilling procedures could provide an objective and subjective satisfactory result in all of the cases.

All of the patients signed informed consent forms for both the surgical procedure and the medical photography.

The study was carried out according to the declaration of Helsinki and was approved by the Plastic and Reconstructive Surgery Unit of the University of Pavia, Salvatore Maugeri Research and Care Institute, Pavia, Italy ethical committee.

2.1. Cases report

2.1.1. Case 1

A 33-year-old male patient presented with a 20 mm × 10 mm unstable ulceration on the site of a previous split thickness skin graft on the outer side of the right heel.

The patient referred a domestic accident occurred 15 years before with post-traumatic soft tissue loss of the anterior two thirds of the right heel that was repaired with a split thickness skin graft.

A thick hyperkeratosis was appreciated along the margins of the previously grafted area that appeared atrophic, stiff and retracted. A relevant callus formation was also appreciated in the plantar skin at the level of the metatarsal heads together with a localized malleolar oedema (Fig. 2). The patient was walking on crutches because of the local pain and therefore was forced to a sedentary lifestyle since the time of injury.

The patient underwent lipofilling of the unstable skin grafted area with 30 ml of purified adipose fraction harvested from the lower abdominal subcutaneous region. After manufacturing of a custom made shoe at the end of the post-operative rehabilitation protocol the patient progressively discontinued the use of the crutches due to significant reduction of the local pain. Ten weeks post-operatively the skin graft appeared pliable, stable and trophic. Nevertheless in the grafted heel a relevant surface depression was still appreciated. Therefore a second lipofilling session was carried out 12 weeks after the first one with injection of 25 ml of purified adipose fraction harvested from the lower abdominal subcutaneous region. Following the second surgical stage, the previously