



Orthopaedic and plastic surgery collaboration in resolution of plantar heloma and metatarsalgia using lipofilling: a retrospective evaluation

R. Iannuzzi¹ · S. Caravelli² · C. Pungetti³ · M. Di Ponte² · S. Zaffagnini² · M. Mosca²

Received: 1 June 2022 / Accepted: 8 January 2023 / Published online: 13 January 2023
© The Author(s), under exclusive licence to Istituto Ortopedico Rizzoli 2023

Abstract

Background Plantar heloma is a keratotic disorder that can be described as a circumscribed area of thickening with a central core that may penetrate the dermis. Although often considered a minor complaint, longstanding lesions can be debilitating and severely impact on person's quality of life. We present the first retrospective case series at long-term follow-up about the use of plantar lipofilling as a treatment for metatarsalgia caused by plantar heloma.

Materials and methods Six patients affected by plantar heloma associated to external metatarsalgia underwent plantar lipofilling. The surgical session was performed as an outpatient procedure. Clinical evaluation was performed using the AOFAS lesser metatarsophalangeal-interphalangeal (MTP-IP) score.

Results Mean AOFAS lesser MTP-IP score improved from a preoperative score of 66.6 ± 3.2 points (range 47–77 points) to a post-operative score of 92.8 ± 2.7 points (range 86–95 points); all patients were satisfied with the outcome at the final follow-up. Post-operative clinical examination at final follow-up showed an increase in thickness of the subcutaneous layer and a decrease of dermal layer thanks to the supporting and trophic action of fat cells.

Conclusions Plastic regenerative procedures applied to a typical foot and ankle surgery field, such as metatarsal overloading, metatarsalgia and forefoot problems, should be encouraged to allow new treatment horizons.

Keywords Metatarsalgia · Plantar heloma · Lipofilling

Introduction

Plantar heloma is a keratotic disorder that can be described as a circumscribed area of thickening with a central core that may penetrate the dermis [1]. It usually develops near the toes with a typical rubbery texture, causing considerable pain and disability during movement. This lesion mainly affects patients over 50 years with systemic diseases such as diabetes, stroke, system sclerosis and rheumatoid arthritis or with foot deformities, mostly due to changes in plantar pressure distribution [2]. Etiopathology is not completely known, but it seems that a repetitive pressure or friction on

some apparently healthy skin leads to a decrease of desquamation, hyper-keratinization and thickening of the stratum corneum. Although often considered a minor complaint, longstanding lesions can be debilitating and severely impact on person's quality of life.

Many therapeutic strategies, conservative and surgical, have been proposed but none proved to be long-lasting and completely successful. Understanding if the underlying cause can be represented by a mechanical overload due to a hindfoot or forefoot deformity is fundamental to take into consideration the proper treatment.

We present the first retrospective case series at long-term follow-up about the use of plantar lipofilling as a treatment for metatarsalgia caused by plantar heloma.

Materials and methods

Six patients affected by plantar heloma associated to external metatarsalgia underwent plantar lipofilling between 2016 and 2021. The indications for the procedure were a

✉ S. Caravelli
doct.car@gmail.com

¹ Department of Plastic Surgery, INI Istituto Neurodermatologico Italiano, Grottaferrata, Rome, Italy
² II Clinic of Orthopaedics and Traumatology, IRCCS Istituto Ortopedico Rizzoli, Bologna, Italy
³ Department of Orthopaedics and Traumatology, Ospedale Maggiore "A. Pizzardi", Bologna, Italy

painful plantar heloma associated to walking alterations, non-responding to conservative treatment (cryosurgery, shoe modification, plantar orthosis, and topical use of cortisone) in patients older than 18 years.

Informed consent was obtained from the patient before the surgery was scheduled, following the Declaration of Helsinki. All study data were treated with maximum confidentiality.

Operative technique

A lipofilling session was planned in order to regenerate the skin and subcutaneous layer. Treatment was performed as an outpatient procedure, under local anaesthesia using Klein Solution (normal saline, lidocaine 1%, epinephrine, sodium bicarbonate, triamcinolone acetonide). 10 cc of serum fat emulsion has been harvested from the lower abdominal quadrants; about 5 cc of adipose tissue isolated by decantation and centrifugation was infiltrated under the overload region.

The post-operative period has been characterized by 15 days of partial hindfoot weight-bearing.

Clinical radiographic evaluation

Preoperative radiographic evaluation was performed in every case in order to highlight possible severe mechanical issues or bony anatomical changes.

Patients were retrospectively evaluated at a minimum 12-month follow-up. Clinical evaluation was performed using the AOFAS lesser metatarsophalangeal-interphalangeal (MTP-IP) score. This is not a patient-reported outcome but is designed for physicians to standardize the assessments of patients and evaluates functional, clinical and anatomical results. The AOFAS scoring system (100 points total) provides different score ranges: > 85 indicates “excellent” results, 70 to 85 “good” results, 55 to 69 “fair” results and < 55 a “poor” result. Patients’ satisfaction at final follow-up was evaluated with subjective assessments.

Results

Six patients (2 females and 4 males) with a mean age at surgery of 55.4 ± 5.3 years (range 39–71) were evaluated at a mean of 39.3 ± 7.3 months post-operative (range 12–60).

The clinical examination revealed, regarding foot morphology, 3 patients with excessive supination, 2 patients with excessive pronation and 1 patient with a regular planigrade foot. Forefoot deformity (hallux valgus and/or hammertoes with painless moderate external metatarsophalangeal instability) and the increased thickness of the dermal layer together with sclerosis of the subcutaneous layer were

registered in all patients (Fig. 1). An overloading area was detected under the metatarsal heads. The lesions were in correspondence of the plantar aspect of the second, third and fourth metatarsal heads in 3 patients, at the second and third metatarsal head in 1 patient and isolated at the second metatarsal head in 2 patients.

The standard dorsoplantar, weight-bearing, plain X-rays showed second and third slightly hypermetric metatarsals in 2 patients (about + 2.5 mm, evaluated with respect to the normal range of the metatarsal formula).

Mean AOFAS lesser MTP-IP score improved from a pre-operative score of 66.6 ± 3.2 points (range 47–77 points) to a post-operative score of 92.8 ± 2.7 points (range 86–95 points); all patients were satisfied with the outcome at the final follow-up.

Post-operative clinical examination at final follow-up showed an increase in thickness of the subcutaneous layer and a decrease of dermal layer thanks to the supporting and trophic action of fat cells (Fig. 2). Plantar fat pad thickness in the treated area was found to be preserved and functional.

No post-operative ecchymosis, local sign of infection or bleeding was reported. Local oedema lasted 3 weeks. No difficulty in walking was reported.

Discussion

Despite its intrinsic nature of just a minor complaint, plantar heloma molle can cause pain and disability, like greater difficulty descending or ascending stairs or walking on level ground and, if left untreated, may cause considerable damage to deeper tissues.

The underlying dermis, in fact, exhibits significant degeneration of collagen fibres and an increased number of fibroblasts. In some individuals, for unknown reasons, the process of hyperkeratosis becomes excessive



Fig. 1 Standard dorsoplantar, weight-bearing, plain X-rays showed hallux valgus and moderate second and third metatarsals hypermetry

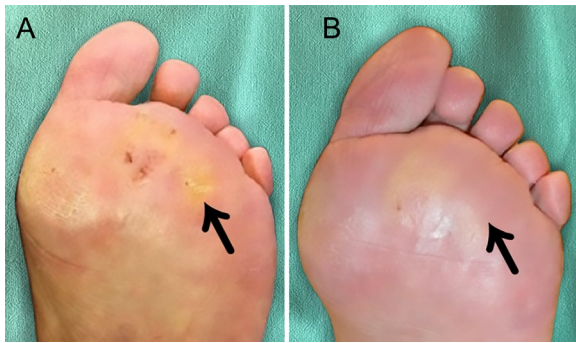


Fig. 2 The repeated overload of the skin overlying a bony prominence leads to a protective body reaction leading to an excess of epithelial corneous layer to prevent skin ulceration. In **A** a plantar heloma (black arrow) in correspondence of the second, third and fourth metatarsal heads. At the final follow-up **B**, an increase in thickness of the subcutaneous layer, a decrease of dermal layer and disappearance of the hyperkeratotic lesion are shown (in less obvious cases, monitoring may be conducted using ultrasounds)

resulting in a large build-up of keratinized, dense tissue [3]. Thus, a common and usually protective mechanism of hyperkeratosis after a skin injury, becoming excessive, induces a cycle of repair and adaption that finally determines an extremely painful compression of nerve endings in the papillary dermis [4]. The plantar overloads are frequently due, in the common orthopaedic practice, to intrinsic abnormal mechanical stresses, such as deformity of the lesser toes or hypermetry of the central metatarsals. Extrinsic factors such as unsuitable footwear or high levels of activity can be added to these by aggravating the above-mentioned mechanical issues [1, 5]. Posited risk factors for keratotic lesions formation can be divided into intrinsic factors (age, sex, foot deformities and malalignment, co-morbidities) and extrinsic risk factors (ill-fitting footwear and lifestyle or occupational factors). The increased prevalence with advancing age is most probably related to age-related changes in skin structure [6].

Different therapeutic strategies have been proposed like topical treatments (with salicylic acid, silver nitrate, silicone or hydrocolloid wound dressing), injection therapy (with sodium chloride, alcohol and liquid silicone), orthosis and shoe inlays, as well as surgical ablation using electro-surgery, cryosurgery, laser treatment or re-sculpture technique [7–9].

In case of abnormal mechanical overloads, due to forefoot deformities or abnormal length of the metatarsals, different orthopaedic surgical solutions are possible and described in the literature. Among these shortening or translating metatarsal osteotomies or metatarsophalangeal joints arthroplasty [10–13]. Despite the good results reported in the literature, early and time-consuming post-operative complications have been described and may slow post-surgical recovery [14, 15].

In addition, recovery time and rehabilitation plans could be notoriously longer.

Lipofilling is a well-established procedure in plastic surgery, used for both aesthetic procedures that reconstructive. It involves the application of fat stem cells, after taking and processing [16]. Fat graft is commonly performed either to increase subcutaneous tissue or to improve vascularization and texture as a gold standard method in regenerative surgery. In foot and ankle surgery different examples of lipofilling have been reported in the literature. Luu CA et al. in a recent work reported satisfactory results at 6-week follow-up in the treatment of plantar ulceration in the diabetic foot [17]. In 2014, Nicoletti G et al. highlighted the good clinical and functional results of plantar lipofilling in cases of subcutaneous substance loss and post-traumatic skin instability of the foot sole, at 3 years of follow-up. In their case, two consecutive treatments were needed 12 weeks apart [18].

To our best knowledge, no case series have been published regarding the application of regenerative technique, through autologous fat tissue transplant, in the treatment of external metatarsalgia due to mechanical overload. Thus, plantar heloma should benefit from a fat graft for both rations and our case proved to be efficient, fast, and safe compared to surgical treatments.

This case series represents an orthopaedic and plastic surgeon cross-over treatment. Plantar heloma is a relatively common disease, currently managed with conservative interventions. Surgery may be indicated for cases that fail to respond to conservative approaches (such as shoe inlays, orthosis, NSAIDs and daily activities changes). Lipofilling seems to be an interesting, safe and fast tool that may solve this kind of complaint after traditional conservative treatments have not led to satisfactory results.

Plastic regenerative procedures applicated to a typical foot and ankle surgery field, such as metatarsal overloading, metatarsalgia and forefoot problems, should be encouraged to allow new treatment horizons. Further studies and clinical trials, with a larger cohort and longer follow-up, are needed to test the effectiveness of this technique for the treatment of other kinds of keratotic disorders. Another limitation of this study is that it did not possess and compared the cost–benefit ratio of these procedures, related to the orthopaedic field, and a cost analysis comparing them to the classic bony procedures. For this reason, other dedicated studies will be useful in the future.

Funding The author(s) received no financial support for the research, authorship, and/or publication of this article.

Declarations

Conflict of interests The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval Local Ethical Committee approval was not necessary, in view of the purely retrospective observational nature of this study.

Consent to publish All authors read and approved the final manuscript. All Authors give their consent for the publication of this article, in every part, in the above-mentioned Journal.

Informed consent The patient was informed about the surgical procedure, post-operative treatment and possible complications and signed a written informed consent before the procedure was scheduled. The study was conducted according to the Declaration of Helsinki.

References

- Singh D, Bentley G, Trevino SG (1996) Callosities, corns and calluses. *BMJ* 312:1403–1406
- Gillet HGDP (1979) Interdigital clavus. *Clin Orthop Relat Res* 142:103–109
- Thomas SE, Dykes PJ, Marks R (1985) Plantar hyperkeratosis, a study of callosities and normal plantar skin. *J Invest Dermatol* 85:394–397
- Murray HJ, Young MJ, Hollis S, Boulton AJ (1996) The association between callus formation, high pressures and neuropathy in diabetic foot ulceration. *Diabet Med* 13(11):979–982
- Silfverskiöld JP (1991) Common foot problems. Relieving the pain of bunions, keratoses, corns, and calluses. *Postgrad Med* 89:183–188
- Amerio PL, Bernengo MG, Calvieri S (2009) *Dermatologia e venereologia*. II ed. edizioni Minerva Medica
- Scullion PG (1984) Dermatologic review: scalpel technique in removing heloma and hyperkeratosis. *J Foot Surg* 23(4):344–349
- Report on the clinical evaluation of glutaraldehyde cross-linked collagen (Keragen) implant treatment of heloma durum and heloma molle. Collagen Podiatric Investigation Group (1986) *J Foot Surg* 25(6):427–35.
- Morgenstern RL (1957) Treatment of heloma durum with cryotherapy. *J Natl Assoc Chiropr* 47(4):186–187
- Pontious J, Lane GD, Moritz JC, Martin W (1998) Lesser metatarsal V osteotomy for chronic intractable plantar keratosis. Retrospective analysis of 40 procedures. *J Am Podiatr Med Assoc* 88:323–331
- Monteagudo M, Maceira E (2019) Evolution of the Weil osteotomy: the triple osteotomy. *Foot Ankle Clin* 24(4):599–614
- Marti-Martinez LM, Gracia-Sánchez A, Ferrer-Torregrosa J, Lorca-Gutierrez R, Garcia-Campos J, Sánchez-Pérez SP (2019) Description of the surgical technique for condylectomy with minimally invasive surgery to treat interdigital helomas on the lesser toes: a Delphi study. *J Foot Ankle Res* 14(12):13
- Matthews AH, Jagodzinski NA, Westwood M, Metcalfe JE, Trimble KT (2018) Effectiveness of the Cobb-Stainsby excision arthroplasty. *Foot Ankle Surg* 24(1):49–53
- Highlander P, VonHerbulis E, Gonzalez A, Britt J, Buchman J (2011) Complications of the Weil osteotomy. *Foot Ankle Spec* 4(3):165–170
- Reddy VB (2018) Metatarsal osteotomies: complications. *Foot Ankle Clin* 23(1):47–55
- Gutowski KA (2009) Current applications and safety of autologous fat grafts: a report of the ASPS fat graft task force. *Plast Reconstr Surg* 124(1):272–280
- Chairman EL (1994) Restoration of the plantar fat pad with autologous fat transplantation. *J Foot Ankle Surg* 33:373–379
- Luu CA, Larson E, Rankin TM, Pappalardo JL, Slepian MJ, Armstrong DG (2016) Plantar fat grafting and tendon balancing for the diabetic foot ulcer in remission. *Plast Reconstr Surg Glob Open* 4(7):e810

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Springer Nature or its licensor (e.g. a society or other partner) holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.