

Single Case

Disabling Plantar Keloids Treated with Brachytherapy and Free Flap Reconstruction: A Case Report

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Abstract

Introduction: Keloids result from a disorganized fibroproliferative collagen response that extends beyond the original wound margins and fails to regress. They are associated with a high recurrence rate despite various treatment options. Keloids on the sole of the foot are exceedingly rare and pose significant challenges for both patients and surgeons. To date, only 15 cases of plantar keloids have been described in the English literature. Management options for this region include observation with custom-made footwear, steroid injections, surgery alone, or surgery followed by multimodal therapy. This report presents the first documented case of a plantar keloid treated with surgical excision, brachytherapy, and free flap reconstruction. **Case Presentation:** We describe the case of a plantar keloid treated with surgical excision followed by high-dose-rate brachytherapy and free flap reconstruction. At 18 months postoperatively, the patient was ambulating independently without crutches, though hypersensitivity persisted. The scars at the donor site and the medial ankle exhibited keloids, but all scars subjected to brachytherapy were normal. **Conclusion:** The free flap approach may not be the optimal reconstruction method for plantar keloids, as skin grafts appear to have better outcomes, according to the literature. Also, in our patient, brachytherapy has proven its effectiveness in preventing further keloid formation as shown in the literature.

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Introduction

Keloids arise from a disorganized fibroproliferative collagen response that extends beyond the original wound margins and fails to regress [1]. These lesions typically develop within months of injury and may cause cosmetic deformities, functional impairments, and psychological distress. They are often symptomatic, presenting with pain and pruritus [2]. Keloids can result from a variety of causes, including surgical procedures, body piercings, folliculitis, vaccinations, traumatic wounds, and acne [3]. Risk factors for keloid formation include a personal or family history of keloids, pregnancy, puberty, hypertension, obesity, and skin of color [4]. Despite extensive research, the pathogenesis of keloids remains incompletely understood.

Keloids are associated with a high recurrence rate, despite the availability of various treatment modalities. These include intralesional corticosteroid injections, pressure therapy, topical silicone, cryotherapy, laser therapy, radiotherapy, surgery, and multimodal approaches combining surgery with one or more adjuvant therapies [5]. Additionally, several innovative therapies are under investigation, including mesenchymal stem cells, angiotensin-converting enzyme inhibitors, fat grafting, and calcium channel blockers [6]. Among the current options, surgery combined with radiotherapy has demonstrated the lowest recurrence rates [7].

The most common anatomical sites for keloids are the earlobes, presternal region, neck, and shoulders [8]. Keloids on the sole of the foot are exceedingly rare, with approximately 15 cases reported in English literature, primarily as case reports [9]. This rarity may initially lead clinicians to consider other, more aggressive conditions, such as plantar fibromatosis or malignant skin tumors.

Plantar keloids are particularly challenging for patients, as they cause pain during walking and avoidance of regular footwear. These lesions are also challenging for surgeons, as treatment outcomes are frequently unsatisfactory. Various therapeutic approaches have been proposed for plantar keloids, including custom-made shoes, steroid injections, surgery alone, and surgery followed by multimodal therapy. Here, we describe a case of a plantar keloid treated with surgical excision, brachytherapy, and free flap reconstruction, followed by an 18-month postoperative follow-up.

Case Report

A 38-year-old male presented to the outpatient department of Maxillofacial Surgery at Lyon Sud Hospital with a 5 × 4 cm tumor, which was hard, mobile, and located on the plantar aspect of his right foot (Fig. 1). The patient had no significant medical or surgical history, and was not on any medications or known to have allergies. His past medical history included a keloid on the anterior aspect of the right shoulder, which was treated with corticosteroid infiltration. He was classified as Fitzpatrick skin type V.

The tumor appeared 6 years previously, likely following manipulation of a callus, and gradually increased in size, becoming painful, particularly during walking. Four years ago, initial magnetic resonance imaging was performed, revealing a hypervascularized tumor within the subcutaneous soft tissue, measuring 16 × 7 mm. No osteolysis or signs of malignancy were observed. At the 2-year mark, the tumor had increased to 4 cm in diameter. Two separate biopsies were conducted 6 months apart, both indicating hypertrophic scar/keloid formation with no malignant features. All immunohistochemical markers for malignancy were negative. The patient was treated with a daily application of clobetasol propionate cream for 12 weeks, but with no improvement in symptoms.



Fig. 1. Appearance in 2022.

As the tumor continued to cause pain and discomfort, the patient sought treatment at our department. After a thorough examination, we proposed surgical excision of the keloid, placement of brachytherapy sheaths, and subsequent flap reconstruction. An anterolateral thigh (ALT) flap was selected for reconstructing the surgical defect. The patient consented to the proposed treatment after being informed of potential complications.

The surgery was performed under general anesthesia, with no intraoperative complications (Fig. 2). The keloid was excised along with a skin lozenge down to the subcutaneous plane. The surgical incision was extended to allow access to the posterior tibial vessels. A 10 × 5 cm ALT perforator flap was harvested. Microanastomoses were performed between the flap vessels and the posterior tibial pedicle. Brachytherapy sheaths were placed in the dermal plane along the flap edges, with one sheath extending along the pedicle incision. Postoperative recovery was uneventful, and the patient did not experience any major complications during hospitalization.

Brachytherapy was initiated 7 days postoperatively, using an iridium source with an initial activity of 233–231 GBq to deliver high-dose-rate (HDR) brachytherapy (Fig. 3). The treatment was administered in a lead-shielded room in the radiotherapy unit, with a total dose of 18 Gy delivered in three sessions (6 Gy per session). The second session occurred the morning following the first, and the third was performed 8 h thereafter. Radiotherapy was carefully excluded from the area within 12 cm of the vessels to protect the pedicle. Brachytherapy sheaths were removed following the final session without complications (Fig. 3). The patient was discharged 11 days postoperatively, with instructions to avoid weight-bearing on the operated foot.

The final pathological examination confirmed that the lesion was a keloid (Fig. 4). Fifteen days after surgery, the patient developed dehiscence at the flap edges and reported mild evening pain, which was well-controlled with over-the-counter analgesics. Two



Fig. 2. Surgical excision and flap design.

months postoperatively, the patient presented with intense pain in the most lateral portion of the flap at the plantar level (Fig. 5), accompanied by a 4-cm wound dehiscence in the same area. Computed tomography revealed no evidence of infection or fluid collection. The patient described episodes of localized sweating, swelling, and sensations of painful electric shocks, which suggested neuropathic pain. He was prescribed stronger pain medications, including 100 mg of pregabalin every 12 h, which led to symptom improvement.

At 6 months postoperatively, scarring was nearly complete, with no hypertrophic changes observed around the flap (Fig. 6). However, hypertrophic scarring was noted around the vascular pedicle at the ankle and in the central portion of the left thigh. The patient was able to bear weight on the affected foot and wear normal footwear, though he continued to use crutches for walking. Pain control was still necessary, though less frequently.

Eighteen months after surgery, the scarring process was complete, with no recurrence of hypertrophic scars around the flap (Fig. 7). However, there was a recurrence of keloid formation around the vascular pedicle at the ankle and in the donor site incision. The patient still required lidocaine patches to manage persistent neuropathic pain. He was able to walk without crutches and without significant discomfort.

Discussion

The incidence of keloids varies widely depending on factors such as age, skin type, and anatomical location. Plantar keloids are exceptionally rare, which is likely to be due to the scarcity of pilo-sebaceous units and the protective effects of pressure exerted on the plantar skin during standing and walking. This rarity presents significant challenges in both diagnosis and treatment.

In the present case, two separate biopsies were performed, to rule out other potential diagnoses, including desmoid tumor, inflammatory myofibroblastic tumor, dermatofibrosarcoma,



Fig. 3. Brachytherapy schemes.

neurothekeoma, Kaposi's sarcoma, and carcinomatous proliferation. Furthermore, magnetic resonance imaging was used to evaluate the tumor's characteristics, ruling out invasive features or osteolysis. A familial predisposition to keloids was also noted, as the patient and his sister had prior keloid lesions. These factors, combined with histological findings, supported the diagnosis of a keloid. Such thorough diagnostic evaluation is essential before proceeding with surgical management, to exclude malignancies.

Initial conservative management with clobetasol propionate cream yielded no improvement in our patient. While some studies suggest that plantar keloids may stabilize or

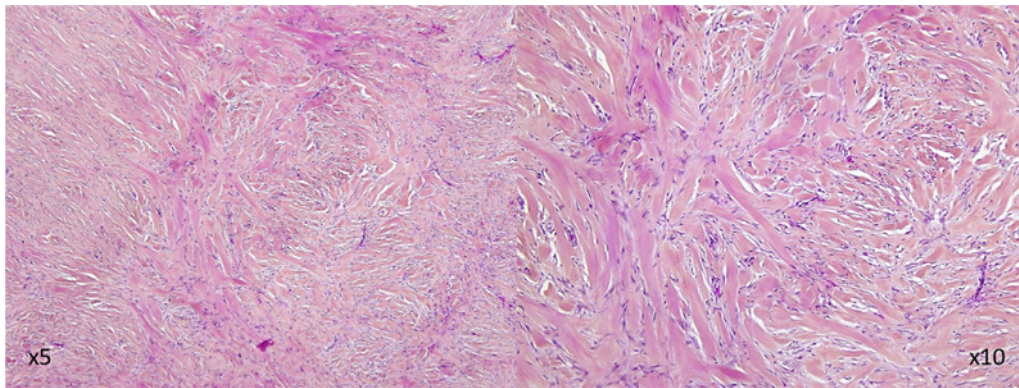


Fig. 4. Histological pictures (Keloid-like fascicles with a perivascular lymphoplasmacytic infiltrate and no sign of malignancy).



Fig. 5. Appearance 2 months after surgery.

flatten with conservative approaches, this was not observed during the 5-year progression of the lesion, which continued to enlarge. Orthopedic shoe inserts have been proposed to alleviate pain by redistributing weight, though they do not directly address keloid growth. Intralesional corticosteroid injections, although effective in temporarily reducing keloid size, require frequent administration. However, in the plantar region, these injections are particularly painful and often necessitate general or epidural anesthesia, limiting their feasibility.

In our department, a standardized protocol for keloid treatment involves surgical excision followed by HDR brachytherapy. This approach has demonstrated efficacy in managing keloids in various anatomical regions [10], including the plantar area [11]. Following surgical excision, reconstruction of the surgical defect presents unique challenges, especially for plantar lesions, due to functional and esthetic considerations as well as the risk of recurrence.

The options for defect closure include:

1. Secondary intention healing, while simple, carries the risk of prolonged healing and recurrence due to radiotherapy effects.
2. Split-thickness skin grafts are prone to secondary contracture and graft failure due to radiotherapy, with additional complications from friction at the plantar site.



Fig. 6. Appearance 6 months after surgery.

3. Full-thickness skin grafts reduce the contracture risk but share the challenges of graft failure, donor site keloid formation, and friction-related complications.
4. Tissue scarcity in the lower leg complicates loco-regional flap harvesting without tension, and new keloids may form along incision lines.
5. Free flaps offer robust coverage but carry risks of donor site keloids and potential flap failure due to early radiotherapy.

In this case, a free ALT perforator flap was utilized. This provided adequate tissue coverage and enabled functional restoration. Postoperative HDR brachytherapy was implemented to mitigate recurrence risk. Park et al. [12] reported no keloid formation at the groin donor site in a cohort of 79 patients who underwent full-thickness skin grafts for dorsal foot keloids. This observation supports the feasibility of tissue harvest from less keloid-prone regions.

To our knowledge, there are no reports in the literature describing plantar keloids treated with surgical excision, brachytherapy, and reconstruction using a free flap. In this case, our protocol for brachytherapy was adjusted as follows:

- It was not administered immediately after surgery but delayed by 7 days, to allow for proper healing of the vascular anastomoses.
- Brachytherapy was avoided within 6 cm above and below the vascular anastomosis, to reduce the risk of compromising the flap's vascularization.



Fig. 7. Appearance 18 months after surgery. The English in this document has been checked by at least two professional editors, both native speakers of English. For a certificate, see: <http://www.textcheck.com/certificate/E0pKD4>.

To understand more fully the effects of brachytherapy on free flap survival and healing, we reviewed studies involving patients treated for sarcomas. Dumans et al. [13] initiated brachytherapy 5 days postoperatively and ensured microvascular anastomoses were positioned outside the radiation zone, resulting in a 100% flap survival rate. Lee et al. [14] began brachytherapy 5–7 days after surgery, maintaining a mean distance of 3.5 cm between the microvascular anastomoses and the target radiation area. They encountered one case of venous thrombosis requiring reexploration and flap salvage. They recommended placing the anastomoses as far as possible from the irradiated zone. Geiger et al. [15] used intraoperative brachytherapy for head and neck cancers and compared complications between pedicle and free flaps. They observed that free flaps were associated with higher rates of wound dehiscence and operative revisions. However, they did not find a higher incidence of vascular complications in free flaps, as compared to pedicle flaps. They hypothesized that the increased complication rate was due to the reduced muscle tissue in free flaps, as compared to pedicle flaps.

In our case, wound dehiscence occurred 15 days postoperatively and worsened after 2 months, with reopening of the lateral portion of the flap. This finding suggested that the 7-day delay for brachytherapy may not prevent wound dehiscence, but further studies are required to establish an optimal time interval.

The patient also developed significant neuropathic pain in the right leg, which was likely to be due to prolonged inactivity and non-weight-bearing on the affected limb. The pain is currently well-controlled using a lidocaine patch applied to the sole. Earlier mobilization could potentially mitigate such symptoms; however, given the incomplete wound healing, weight-bearing was deferred to avoid further complications.

Brachytherapy for keloid treatment is generally well-tolerated, with most side effects being mild and temporary. However, potential long-term side effects include fibrosis and hardening of tissues near the treatment site, chronic pain, and neuropathy, leading to persistent discomfort and, rarely, secondary cancer due to radiation exposure in adjacent tissues.

At the 18-month follow-up, the patient demonstrated satisfactory functional outcomes, walking without crutches or significant discomfort. A keloid scar was observed in the left

thigh and central ankle, while scars treated with radiotherapy showed no recurrence of keloids. To reduce the risk of recurrence, future treatments should include brachytherapy at donor sites. Plans are underway to remove the keloids on the malleolus and left thigh, followed by brachytherapy.

Based on this case and literature evidence, free flaps may not be the optimal solution for plantar keloid reconstruction. Skin grafts, which have demonstrated better outcomes in other studies, may be a more suitable alternative. Also, in our patient, brachytherapy has proven its effectiveness in preventing further keloid formation as shown in the literature.

The CARE Checklist has been completed by the authors for this case report, attached as online supplementary material (for all online suppl. material, see <https://doi.org/10.1159/000545053>).

Statement of Ethics

This retrospective review of patient data did not require ethical approval, in accordance with local and national guidelines. Written informed consent was obtained from the participant for the publication of case details and any accompanying images.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions

Andrea Varazzani: conceptualization, writing – original draft preparation. Pierre Petolat: data curation, writing – original draft preparation. Louis Brochet: validation and investigation. Nicolas Graillon: writing – review and editing and supervision. Alice Prevost: writing – review and editing and visualization. Antoine Pierrefeu: resources and supervision.

Data Availability Statement

All data generated or analyzed during this study are included in this article and its online supplementary material files. Further inquiries can be directed to the corresponding author.

References

- Trace AP, Enos CW, Mantel A, Harvey VM. Keloids and hypertrophic scars: a spectrum of clinical challenges. *Am J Clin Dermatol*. 2016;17(3):201–23. <https://doi.org/10.1007/s40257-016-0175-7>
- Ghazawi FM, Zargham R, Gilardino MS, Sasseville D, Jafarian F. Insights into the pathophysiology of hypertrophic scars and keloids: how do they differ? *Adv Skin Wound Care*. 2018;31(1):582–95. <https://doi.org/10.1097/01.ASW.0000527576.27489.0f>

- 3 Ogawa R. Keloid and hypertrophic scars are the result of chronic inflammation in the reticular dermis. *Int J Mol Sci.* 2017;18(3):606. <https://doi.org/10.3390/ijms18030606>
- 4 Adotama P, Rutherford A, Glass DA. Association of keloids with systemic medical conditions: a retrospective analysis. *Int J Dermatol.* 2016;55(1):e38–40. <https://doi.org/10.1111/ijd.12969>
- 5 Ekstein SF, Wyles SP, Moran SL, Meves A. Keloids: a review of therapeutic management. *Int J Dermatol.* 2021; 60(6):661–71. <https://doi.org/10.1111/ijd.15159>
- 6 Naik PP. Novel targets and therapies for keloid. *Clin Exp Dermatol.* 2022;47(3):507–15. <https://doi.org/10.1111/ced.14920>
- 7 Liu EK, Cohen RF, Chiu ES. Radiation therapy modalities for keloid management: a critical review. *J Plast Reconstr Aesthet Surg.* 2022;75(8):2455–65. <https://doi.org/10.1016/j.bjps.2022.04.099>
- 8 Bayat A, Arscott G, Ollier WE, Ferguson MW, Mc Grouther D. Description of site-specific morphology of keloid phenotypes in an Afrocaribbean population. *Br J Plast Surg.* 2004;57(2):122–33. <https://doi.org/10.1016/j.bjps.2003.11.009>
- 9 Vanhaecke C Jr, Hickman G, Cavelier-Balloy B, Masson V, Duron JB, Gorj M, et al. Plantar keloids: diagnostic and therapeutic issues in six patients. *J Eur Acad Dermatol Venereol.* 2015;29(7):1421–6. <https://doi.org/10.1111/jdv.12625>
- 10 Daurade M, Breton P, Rouard N, Lorchel F, Ibrahim B, Sigaux N. Efficacy of surgical excision and brachytherapy in the treatment of keloids: a retrospective cohort study. *Adv Skin Wound Care.* 2020;33(11):1–6. <https://doi.org/10.1097/01.ASW.0000717228.02752.4e>
- 11 Sandler B. Recurrent plantar keloid. *Cutis.* 1999;63(6):325–6.
- 12 Park TH, Park JH, Chang CH. Clinical features and outcomes of foot keloids treated using complete surgical excision and full thickness skin grafting followed by corticosteroid injections. *J Foot Ankle Res.* 2013;6:26. <https://doi.org/10.1186/1757-1146-6-26>
- 13 Duman H, Evans GR, Reece G, Kroll SS, Miller M, Langstein H, et al. Brachytherapy: reconstructive options and the role of plastic surgery. *Ann Plast Surg.* 2000;45(5):477–80. <https://doi.org/10.1097/0000637-200045050-00002>
- 14 Lee HY, Cordeiro PG, Mehrara BJ, Singer S, Alektiar KM, Hu QY, et al. Reconstruction after soft tissue sarcoma resection in the setting of brachytherapy: a 10-year experience. *Ann Plast Surg.* 2004;52(5):486–92. <https://doi.org/10.1097/01.sap.0000122649.64350.e3>
- 15 Geiger EJ, Basques BA, Chang CC, Son Y, Sasaki CT, McGregor A, et al. Pedicle versus free flap reconstruction in patients receiving intraoperative brachytherapy. *J Plast Surg Hand Surg.* 2016;50(4):227–32. <https://doi.org/10.3109/2000656X.2016.1152974>