Keloid Treatment with High Intensity Focused Radiofrequency: A Case Report

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Keloids and hypertrophic scars are the product of an imbalance in collagenesis and lysis following damage to the skin. A variety of surgical and nonsurgical approaches have been used to treat keloids, but the results have typically been disappointing. High-intensity focused radiofrequency (HiRF) is a novel treatment method for cutaneous conditions, including scar revision; this method involves fractionated radiofrequency (RF) energy being delivered via insulated microneedles at preset depths in the dermis. The present case study assessed treatment of keloids with HiRF. A 27-year-old Caucasian female developed keloids along the jawline following the appearance of pregnancy-related cystic acne. She was treated with two sessions of HiFR at a four-week interval, with three passes at varying depths for each session. Erythema and edema appeared post-treatment but resolved spontaneously. Ten weeks after the final session, significant improvement was noted with high patient satisfaction. While this is only a single case report, the positive result for this difficult-to-treat keloid scar merits further studies with larger populations of keloid sufferers. This unique method of delivery of fractionated RF energy directly into the dermis, under an intact epidermis, using HiFR via insulated microneedles at three decreasing preset depths for each session, may have corrected the imbalance between collagenesis and lysis through induction of the wound healing process. This 'bottom up' method of damage delivery and repair might offer better results in keloid scars than the traditional 'top down' approach associated with laser treatment.

Key words

Keloids; Collagen type III; Insulated microneedles; High-intensity focused radiofrequency; Wound healing; Collagen imbalance

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INTRODUCTION

Keloids and hypertrophic scars (HSs) are fibrous tissue growths that result from overproduction of immature collagen, especially collagen type III, during the wound healing process.¹ Keloids and HSs commonly present following disruption of the dermis, whether from burns, surgery, vaccinations, piercings, lacerations, or abrasions, although in the case of keloids their presence may be completely spontaneous, in the absence of injury.² Following disruption of the dermis, the human body engages its natural wound healing mechanism by chronologically proceeding through the following phases: inflammation, proliferation, and matrix remodeling.³ The proliferation phase consists of production of granulation tissue, well vascularized collagen type III, that is then used as a scaffold from which the extracellular matrix (ECM) forms with deposition of collagen type I and elastin fibers from fibroblasts, which also synthesize the lubricating ground substance. Physiologically, it is important to balance the deposition and degradation of the ECM. Deposition is the job of the fibroblasts, but at the same time they also produce matrix metalloproteinases (MMPs), whose job is to curb any overproduction of collagen through lysis of the over-produced fibers. Disruption of the deposition and degradation balance results in keloid and HS formation. The epidemiology of keloids, as distinct to that of HSs, shows no difference among sex, a higher incidence in Hispanic and African Americans, with an incidence of 6% to 16%, and the greatest incidence in the second and third decade.⁴

The clinical difference between keloids and HSs is that keloids are non-regressing, extend beyond the original wound and most commonly present on the anterior chest, shoulders, earlobes, upper arms and cheeks. The origin of the word keloid is the Greek '*chele*', with the meaning here of the pincers of a crab, and the suffix *-oid*, meaning '-like', as the growth of the keloids beyond the borders of the original wound often resembles pincer-like tissue growth. Keloids are not only cosmetically disfiguring, but also painful, pruritic, and hyperesthetic. Successful treatment of keloids is challenging, and clinicians are often faced with a high recurrence rate. Current therapeutic interventions include pressure therapy, silicone gel sheeting, flavonoids, topical imiquimod, intralesional corticosteroid injections, cryotherapy, radiotherapy, laser surgery and surgical excision. These interventions have varying success rates.⁵ With the development of microneedling fractional radiofrequency (RF), also known as high-intensity focused RF (HiFR), as a new modality

which has attracted a great deal of attention for scar revision and tissue laxity,⁶ we felt this unique method of sub-epidermal controlled damage delivery might also be of interest in the treatment of keloids. We therefore present herein a case study of a 26-year-old Caucasian female with a keloid diagnosis who was treated with HiFR.

CASE REPORT

A 27-year-old Caucasian G1P1 female presented with a 2-year history of keloids which emerged during her first pregnancy at age 25 years. The patient had no prior history of acne other than occasional minor breakouts. During pregnancy, the patient began to experience acne breakouts of increasing frequency and severity leading to cystic acne. At the beginning of her third trimester of pregnancy, the cystic acne transitioned to keloids, with predominance at the jawline, that were pruritic and very dry.

We decided to treat the keloids with HiFR using the INFINI system (Lutronic Corp., Billerica, MA, USA). The system handpiece has a tip delivering a 1 cm² matrix of 49 insulated microneedles. The needles are completely insulated apart from the 300 μ m at the tip which acts as the RF electrode. The needles are paired as return and delivery electrodes, thus delivering RF in a bipolar fashion. The depth of the needles in the dermis is adjustable, thereby permitting delivery of zones of controlled coagulation at different depths in the dermis. The HiFR treatment protocol in the present study consisted of two treatments provided one month apart. The first treatment session consisted of three passes made over the keloid formations at depths of 2.75 mm, 2 mm, and 1.5 mm at the respective preset energy levels of H (high), M (medium), and L (low), with a total of approximately 420 pulses. The second treatment session consisted of three passes at depths of 2.75 mm, 2.25 mm, and 1 mm at the respective energy levels of M, L, L with a total of approximately 520 pulses.

Four weeks following the first treatment, the patient's keloids demonstrated some reduction in thickness and erythema. At 10 weeks following the second treatment, continued improvement in keloid erythema, pruritis, and dryness was noted and the patient expressed high satisfaction with the improvement in her keloids following two HiFR treatments (Fig. 1 and 2).

DISCUSSION

The keloids in the case presented in this report developed during pregnancy following a severe cystic acne

Fig. 1. (A) 27-year-old Caucasian G1P1 female at pretreatment baseline showing keloids on the left cheek and jawline. (B) Ten weeks following treatment of the keloids with the high-intensity focused radiofrequency (HiFR) device. Improvement is clearly seen.

Fig. 2. (A) Keloids on the right cheek of the same patient as in Fig 1 at baseline. (B) Ten weeks following HiFR treatment of the keloids with obvious improvement.

breakout. Cystic acne disrupts the dermis that initiates the natural wound healing process, and which in the worst case puts the skin at risk for developing an imbalance between collagen deposition and degradation. This imbalance of collagen, where deposition outweighs degradation, leads to the formation of HSs and keloids. Pregnancy appears to be associated with a greater risk of keloid development. It has been hypothesized that the increase in sex hormones associated with pregnancy contribute to vasodilation which in turn leads to an increased exposure of inflammatory substances, promoting scar development.⁷

The keloids in this case were treated with the HiFR device for a total of two treatments with individualized energy levels and total pulse count. The HiFR device utilizes high intensity focused radiofrequency energy delivered through bipolar insulated microneedles that target the

dermis with no epidermal damage. The device allows for the user to customize each treatment by optimizing the desired microneedle depth, energy level, and exposure time. HiFR treatment creates zones of coagulative damage in a fractionated manner, causing cells to enter the wound healing process, leading to replacement of damaged tissue with new collagen and elastin. Following two HiFR treatments, the patient's jawline keloids displayed a noticeable shrinkage in height and surface area, reduced erythema, and decreased pruritus and dryness as seen in Fig. 1 and 2.

It is unknown why this patient developed keloids rather than atrophic or even hypertrophic scars following the severe acne-related scar formation. She had no history as a keloid former. Acne scars tend mostly to be atrophic, but the possible contribution of the hormonal changes associated with pregnancy, as already mentioned, predisposed

the ECM towards vasodilation and related inflammatory changes in the dermis. The abundant production of immature collagen type III without the restraining influence of matrix metalloproteinase I (MMP I) allowed the buildup of the scar tissue, with a preponderance of collagen type III which had not matured to collagen type I. The stimulation with the controlled dermal damage leading to induction of wound healing under the intact epidermis may have restored the balance and resulted in lysis of at least some of the excess collagen type III, with the possible maturation to type I of some of the remainder. Biopsies and histological analysis would perhaps have helped to explain the result, so the lack of such histology is a limitation of this case study.

When fractional lasers, ablative or nonablative, are used in scar revision they produce damage in a 'top down' fashion, and in the case of ablative systems, also cause damage to the epidermis. The use of fractional ablative lasers for keloids is not associated with much success compared with the good results often seen in hypertrophic scars,⁸ with the potential for even further scar formation. This may be because of the 'top down' damage delivery. HiFR on the contrary induces wound healing from a 'bottom up' perspective under the intact epidermis. In fact, the mechanical microneedling of both the epidermis and the dermis may also be contributing to the beneficial effect noted in the present study.⁹

CONCLUSION

Keloids remain a conundrum for the dermatologist, both regarding their formation and especially for their treatment. The HiFR approach used in the present single case study produced significant improvement in all aspects of the keloid scars in which the microneedling RF was used for treatment, without any adverse side effects. These optimistic results for HiFR in keloid scars merit further larger and controlled studies, including histological analysis, to confirm the efficacy and safety of this minimally-invasive approach, and allow a fuller understanding of how damaging the dermal layer of the keloid tissue in

this 'bottom up' approach allows for tissue remodeling with a more natural collagen deposition and degradation balance in these difficult-to-treat scars.

CONFLICT OF INTEREST

The authors have no conflict of interest to disclose. No funding was provided.

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