

Scientific Article

Single Institution Experience of Postoperative Electron Beam Radiation Therapy in the Treatment of Keloids



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Received 1 June 2020; revised 27 September 2020; accepted 13 October 2020

Abstract

Purpose: Surgical excision followed by postoperative radiation therapy is an accepted modality to prevent keloid recurrence. Our practice has been to use electron beam radiation postoperatively to prevent recurrence, and we share our experience with this method in this study.

Methods and Materials: Twenty-two patients with 40 keloids treated postoperatively with electron beam radiation at our institution from 2014 to 2019 were analyzed retrospectively. Electron beam radiation was used for treatment in all cases, and radiation was initiated within 24 hours of surgery. A dose of 20 Gy in 5 fractions was delivered to the postoperative scar in 95% of the sites, and 8 Gy to 10 Gy in a single fraction was delivered to the remaining 5%. The patients were followed up, and recurrences were documented.

Results: At a mean follow-up of 35 months (range, 7-66 months), local control and cosmesis were achieved in 90% (36 of 40) of the treated sites with electron beam radiation therapy delivered at a dose of 20 Gy in 5 fractions. All recurrent keloids were located on the anterior chest wall over the sternum. There was no difference in outcome based on age, sex, or keloid length.

Conclusions: Electron beam radiation therapy is a feasible, convenient, and safe modality for postoperative treatment of keloids. It achieves excellent local control with no grade 3 or higher toxicities.

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Introduction

Keloids (derived from the Greek word meaning “crab’s claw”) are a result of increased tissue response to

injury to the dermis. Keloids are characterized by fibroblast proliferation and increased collagen production in the dermis and adjacent subcutaneous tissues. Keloids, unlike hypertrophic scars, have a tendency to extend beyond the original site of injury. Keloids cause cosmetic disfigurement, and large keloids can lead to functional impairment. Keloids are predominantly seen on the upper chest, back, shoulders, and ear lobes. Pain and pruritus over the keloid are common symptoms necessitating treatment.

Sources of support: This work had no specific funding.

Disclosures: none.

All data generated and analyzed during this study are included in this published article.

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<https://doi.org/10.1016/j.adro.2020.10.009>

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Multiple options are available for treating keloids, but there is no single universally accepted treatment. Medical management of keloids includes massage therapy, silicone gel sheeting, intralesional corticosteroids, intralesional fluorouracil or mitomycin C administration, and imiquimod treatment.¹⁻⁵ Surgical options include cryotherapy, laser excision, and intralesional excision.^{1,3,4-6} There is no consensus in the literature as to the most effective treatment modality.

Some of the best results have been obtained after immediate surgery and radiation therapy in the postoperative setting.⁷⁻⁹ A meta-analysis published in 2017 concluded that postoperative radiation therapy is very effective in reducing recurrence.⁹ A variety of radiation therapy techniques, including x-ray, cobalt-60, electron beam, and brachytherapy, have been used for treatment, but no single dose or technique is universally accepted.⁹

In this study, we present our experience of treating keloids postoperatively with electron beam radiation.

Methods and Materials

Twenty-two patients with 40 keloids treated postoperatively with electron beam radiation at our institution from 2014 to 2019 were analyzed retrospectively. With the exception of 6 patients, all had received some form of treatment before excision. Intralesional injection of steroids was the most common treatment received. At our center, all patients underwent intralesional excision of keloids, except for 1 site, where flap reconstruction was necessary to cover a large defect.

Electron beam radiation was used for treatment in all cases, and radiation was initiated within 24 hours of surgery. An appropriate field size was used to cover the postoperative scar, and a suitable electron energy was chosen to cover the surgical bed. A postoperative dose of 20 Gy in 5 fractions was delivered to the postoperative scar in 95% (38 of 40) of the sites. In 2 places, a different fractionation schedule was used due to the physician's preference.

Our follow-up policy for patients with keloids consists of a 3-month observation after radiation therapy. We used telephone interviews for some patients who could not visit our hospital. All patients enrolled in the present study were followed up for 6 months or longer. At follow-up, cosmesis and complications were noted, and recurrences, if any, were documented.

Results

Details of the treatment and patient characteristics are given in Table 1. At a mean follow-up of 35 months (range, 7-66 months), local control and cosmesis were achieved in 90% (36 of 40) of the treated sites. All

Table 1 Patient characteristics

Sex	
Male	9
Female	13
Age	
10-20	4
21-30	10
31-40	2
41-50	0
51-60	3
61-70	2
>70	1
Median (range) = 29 (17-76).	

recurrent keloids were located on the anterior chest wall over the sternum. The recurrence-free interval was less than 6 months in all but 1 patient. One sternal keloid, which was slow-growing and asymptomatic and therefore did not require further treatment, recurred at 6 months. In 1 patient, recurrence occurred at the same site; this patient underwent salvage laser excision and was asymptomatic at the last follow-up. The other 2 patients continued to receive intralesional steroids when symptomatic (Tables 1 and 2). There was no difference in outcome based on age, sex, or keloid length.

Discussion

Symptomatic treatments for keloids such as intralesional steroids are limited by noncompliance with repeated treatments and high recurrence rates.^{2,3} Surgical excision alone has been shown to achieve poor local control (45%-100%).⁸ Postoperative triamcinolone injections have shown good effects but are considerably painful.¹⁰ The best results have been obtained with surgical excision followed by adjuvant radiation therapy (<10% recurrence).⁴ However, previous studies have

Table 2 Keloid characteristics

Site	Number (n = 40)
Anterior chest wall	14
Ear lobe	11
Shoulder	03
Back	05
Anterior abdominal wall	06
Neck	01
Dose	
20 Gy in 5 fractions	38
8 Gy/1 fraction	1
10 Gy/3 fractions	1
Energy	
4 Mev	23
6 Mev	17

reported 12% to 28% recurrence rates following postoperative radiation therapy. There is no consensus on the optimal dose or fractionation schedule for postoperative keloid radiation therapy. Treatment schedules vary from a single fraction to 10 fractions.^{9,11} Various authors have reported a 1.6% to 18% recurrence rate with 20 Gy in 5 fractions, corresponding to a median biologically effective dose of 60 Gy₂.^{12,13} We observed a 9% (4 of 40) recurrence rate in our cohort treated with the same dose and fractionation schedule.

Adjuvant radiation therapy can be delivered by kilovoltage x-ray, electrons, or brachytherapy, but there is no consensus on the ideal modality.¹⁴⁻¹⁶ In agreement with Ogawa et al,¹⁷ we believe that electron-beam radiation is the most effective modality for preventing postoperative keloid recurrence. Various dose and fractionation schedules have been used for the treatment of keloids. Flickinger¹⁸ reported that keloids have a low α/β ratio and that therefore the optimal treatment should include a limited number of fractions and a high dose per fraction. He also noted that at similar doses, deep-penetrating radiotherapies such as electron beam lead to significantly lower recurrence rates after keloid resection than other radiation techniques that have a more rapid dose falloff with depth. Sakamoto et al¹⁹ studied the dose-response relationship for postoperative keloids and noted that recurrence rates increased from 11% to 43% when the dose was under 20 Gy in 5 fractions. This schedule was therefore proposed to achieve good local control with acceptable adverse effects. We followed the same schedule of 20 Gy in 5 fractions delivered over 5 days with 1 fraction daily by electrons with excellent local control and no grade 3 or higher toxicity.

Ollestein et al⁷ first showed that immediate postoperative radiation therapy reduces recurrence rates. Since then, the standard practice has been to deliver the first dose of radiation therapy within 24 to 48 hours of surgery. We were able to treat all our patients within 24 hours of surgery. Studies in the literature report that high dose rate brachytherapy for keloids allows good local control.^{14-16,20}

Yossi et al¹⁶ compared postoperative electron treatment with brachytherapy and observed no statistically significant difference in local control between the 2 modalities. Moreover, brachytherapy cannot be offered to all patients for technical and logistic reasons. Many of the patients in our study underwent surgery at a different center and were referred to our hospital for radiation. Offering brachytherapy in such situations is practically difficult. Superficial x-ray is not available in most centers, and there has been a gradual decline in the use and availability of cobalt-60 teletherapy machines. Electron treatment is convenient, as the majority of centers have a linear accelerator providing different electron energies. Our low recurrence rates may thus encourage the use of electron beam radiation.

Long-term toxicities induced by radiation therapy include telangiectasia and hypopigmentation, but radiation-induced secondary malignancies are the most severe. After a thorough search of the literature, Ogawa et al²¹ concluded that the risk of carcinogenesis attributable to keloid radiation therapy is very low when surrounding tissues are adequately protected. Despite anecdotal reports, radiation can be considered a safe modality for the treatment of keloids.

Although the median follow-up in this study was only 35 months, we did not observe secondary cancer in any of the patients. Sakamoto et al¹⁹ noted that the occurrence of late complications increases at doses above 20 Gy. We used a dose below 20 Gy and did not observe grade 3 or higher toxicity in our study.

The 4 instances of recurrence in our study involved the anterior chest wall. Some authors have suggested a higher dose per fraction (20 Gy/4 fractions) for the chest wall and shoulder, specifically the scapular and suprapubic regions.²¹ It will be interesting to evaluate the effect of this treatment to see if recurrence can further be reduced at these sites.

The shortcomings of our study are its retrospective design, small sample size, and relatively short follow-up.

Conclusions

Electron beam radiation therapy is a feasible, convenient, and safe modality for postoperative treatment of keloids. A dose of 20 Gy in 5 fractions achieves excellent local control with no grade 3 or higher toxicity provided that treatment is initiated within 24 hours of surgery.

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