Dermatologic surgery

Postoperative electron beam radiotherapy for keloids: objective findings and patient satisfaction in self-assessment

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Abstract

Aim To evaluate the role of postoperative radiotherapy in the management of keloids.

Methods Forty-seven patients with a combined total of 60 keloids were treated with 6-MeV electron beam radiotherapy after surgical excision of the keloids. Mean daily fractions of 4 Gy (range, 3–5 Gy) were administered up to a total dose of 16 Gy (range, 12–18 Gy). The median follow-up was 70 months. Patients were asked to complete a questionnaire addressing their satisfaction with the treatment results. This self-assessment was compared with the clinical outcome.

Results Four keloids (7%) relapsed completely, and five recurrences (8%) were classified as limited relapses. All recurrences were observed at sites of high stretch–tension. Keloid-associated symptoms, e.g. itching and pain, were improved in 81%. Hypopigmentation was observed in 29 patients (62%), a mild redness of the scar in eight patients (17%), and grade 1 telangiectasias in two patients (4%). No severe complications or secondary malignancies were observed. Self-assessments did not fully correspond to the clinical examination and recurrence status. Twelve patients were not satisfied with the treatment result, but only two of these relapsed completely. Three relapsed patients described the result of therapy as excellent or good.

Conclusion Postoperative electron radiotherapy is well tolerated and very effective in preventing keloid recurrence. To avoid an overestimation of cosmetic outcome, patients should be informed about achievable results before therapy starts.

Introduction

Keloids are benign fibrous tumors resulting from an abnormally healed skin wound. They belong to the group of hyperproliferative diseases, such as Dupuytren’s disease or pterygium of the eye.1,2 Keloids extend beyond the confines of the original wound and can reach up to 1 cm above the skin surface. Keloids are composed of intrinsically normal polyclonal fibroblasts which respond to an abnormal extracellular signal, resulting in increased production of scar tissue.3 Later, fibroblasts are replaced by collagen, leading to a loss of skin texture and a glassy appearance of the lesion. The main sites of keloid formation are the presternal area, back, ear, and shoulder.4 The incidence varies widely from around 0.1% in Middle Europe to 12% in Central Africa.5,6 Clinically, keloids are not just a cosmetic problem. Discomfort, with pain and itching, is frequently described by patients.

The majority of patients relapse after surgery alone. Different conservative adjuvant therapies have been tested to reduce the recurrence rate.5,6 Postoperative radiotherapy is a well-accepted procedure without serious side-effects.5,6,10,11

This study analyzes the role of radiotherapy in the management of keloids. In addition, the long-term patient satisfaction with treatment results was compared with objective findings, such as the recurrence rate and side-effects.

Patients and Methods

Patients

From 1987 to 2002, 62 white patients were treated with postoperative radiotherapy after keloid excision. Patients were asked to complete a questionnaire addressing their satisfaction with the cosmetic treatment results (four categories from excellent to not satisfied), late effects, and discomfort after therapy.

Forty-seven patients (31 women and 16 men) with a total of 60 keloids answered the questionnaire and were invited to an additional follow-up examination (Table 1). The median follow-up period was 70 months (range, 10 months to 13 years). All keloids were completely extirpated prior to radiotherapy and the clinical diagnosis was confirmed histologically. The median length of the keloids was 5 cm (range, 2–21 cm). Keloids that occurred at different sites in the same patient (e.g. earlobes, breasts) were deemed to be different lesions (13 patients with 26 keloids). Keloids were mainly localized on the trunk (48%) and the ear (18%). Thirty-eight patients (81%) suffered from keloid-associated symptoms, such as itching or pain.
Patients were subgrouped into three categories according to the treatment result: no relapse, relapse, and limited relapse with < 50% return of the keloid. The clinical outcome was compared with each patient's self-assessment. Treatment-related side-effects were graded according to the LENT-SOMA (Late Effects on Normal Tissue – Subjective, Objective, Management, and Analytical) scoring system for late effects.12

Surgical technique
All patients included in the study had complete keloid excision prior to adjuvant radiotherapy. Patients with recurrent keloid presenting after more than one excision and patients with large keloids that could not be extirpated in one surgical procedure were excluded from the analysis.

Keloids were excised extralesionally, such that a flat scar was obtained. The wounds were primarily closed with a three-layer suture. Muscle, subcutaneous tissue, and deep dermis were approximated with 4-0 or 5-0 polyglycolic acid sutures. Skin edges were then aligned precisely with a slight eversion, using running 6-0 absorbable sutures. In some patients, monofilament 6-0 nylon or prolene sutures were used rather than absorbable sutures according to the surgeon’s best judgment; however, absorbable sutures exposed to the surface of the wound can be removed more easily than nylon sutures. Nonabsorbable sutures were removed 3–7 days (depending on the anatomical location of the wound) after surgery to avoid leaving suture marks. The wound was usually reinforced with skin tapes at this time (Steri-strip, 3M Corp., St. Paul, MN).

Radiotherapy
Postoperative radiotherapy was applied exclusively following primary and complete keloid excision. Radiotherapy was initiated in 39 patients (83%) within 24 h after surgery. Eight patients (17%) started radiation treatment after > 1 day following surgery (four patients after 2 days, two patients after 4 days, one patient after 6 days, and one patient after 10 days). Treatment fields were strictly confined to the keloid region. A skin area of about 3 mm at each margin of the suture line was included in the irradiation field as a safety margin. The treatment fields were bound laterally by individually tailored blocks consisting of a lead alloy to shield the surrounding skin. The region underneath the earlobes was shielded to avoid irradiation of the mastoid. All patients were treated with 6-MeV electrons (Siemens KD2 linear accelerator, Concord, CA) plus 0.5 cm tissue-equivalent bolus material to achieve a homogeneous and precise depth dose distribution (Fig. 1). Mean daily fractions of 4 Gy (range, 3–5 Gy) were administered up to a mean total dose of 16 Gy (range, 12–18 Gy).

Results
Objective findings
Nine of the treated keloids (15%) in eight patients relapsed (Table 2). Four keloids relapsed completely and five recurrences were classified as limited relapses with < 50% return of the keloid. All recurrences were observed in sites of high stretch-tension and occurred within 1 year of completion of treatment. Six keloids (67%) were observed within 6 months. No difference in recurrence rate was detected according to keloid length (Table 2). One patient (2%) had an infection of the surgical wound. This patient has been recurrence free over a period of 11 months.

Keloid-associated symptoms, such as itching and pain, were improved in 81% and unchanged in 19%.
Grade 1 erythema occurred in 12 patients (26%) during or directly after completion of radiation therapy. No other acute effects were seen.

Hypopigmentation was documented in 29 patients (62%) and a mild redness in eight patients (17%). Grade 1 telangiectasias developed in two patients (4%). No secondary malignancies were observed.

**Patient self-assessment**

Treatment results were rated by 29 patients (62%) as excellent or good in the self-assessment questionnaire (Fig. 2). Six patients (13%) described the result as sufficient, and 12 patients (25%) were not satisfied. The subjective assessments did not always correspond fully to the patient’s clinical examination and recurrence status (Fig. 3).

Twelve patients were not satisfied with the cosmetic result, but only two of these patients relapsed completely. Two patients complained of a “gaping scar” at sites with high stretch-tension (sternal region and shoulder). Two patients had a limited relapse with < 50% return of the keloid. Six patients were dissatisfied with the scar color or symptom relief.

One patient with a complete relapse and two patients with limited recurrences described the results of therapy as excellent or good. All patients had relief from keloid-associated symptoms.

**Discussion**

Keloid surgery alone has a recurrence rate of 60–90%.8-9 Postoperative radiotherapy, first described by Freund in 1913, can significantly reduce relapses.10,11,13 Our study showed a response rate of 85% after keloid excision and postoperative irradiation.

Most of our patients were irradiated within 24 h after operation. Various literature reports have shown a correlation

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**Table 2** Recurrence rate in 60 keloids treated with postoperative electron beam radiotherapy

<table>
<thead>
<tr>
<th></th>
<th>No recurrence (n)</th>
<th>Recurrence (n)</th>
<th>Recurrence rate (%)</th>
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<tbody>
<tr>
<td>Total</td>
<td>51</td>
<td>9</td>
<td>15</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>25</td>
<td>6</td>
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<tr>
<td>Male</td>
<td>14</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>Region</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sternum</td>
<td>9</td>
<td>5</td>
<td>36</td>
</tr>
<tr>
<td>Shoulder</td>
<td>5</td>
<td>2</td>
<td>29</td>
</tr>
<tr>
<td>Mammary fold</td>
<td>9</td>
<td>2</td>
<td>18</td>
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<tr>
<td>Cause of keloids</td>
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</tr>
<tr>
<td>Sternotomy</td>
<td>9</td>
<td>5</td>
<td>36</td>
</tr>
<tr>
<td>Mammaplasty</td>
<td>6</td>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td>Operation</td>
<td>14</td>
<td>2</td>
<td>12</td>
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<tr>
<td>Keloid length</td>
<td></td>
<td></td>
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<tr>
<td>≤ 5 cm</td>
<td>24</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>&gt; 5 cm</td>
<td>27</td>
<td>5</td>
<td>16</td>
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between favorable treatment results and a short time interval between operation and radiotherapy.14,17 In vitro studies have revealed a significantly reduced population doubling time of keloid fibroblasts and a reduced number of apoptotic cells.5,13 The application of postoperative radiation therapy rapidly after surgery induces apoptosis and can prevent an accelerated repopulation of fibroblasts. We found significantly different treatment outcomes depending on the anatomical site of the keloid. All relapses were observed at the anterior chest wall and the shoulder, as also shown in other series.6,13 Several researchers have postulated a correlation between the relapse rate and higher skin stretch–tension in the sternal region or traction in the region of the female breast, but the exact mechanisms are unclear.14,15 In agreement with other case series, the recurrence rate was not influenced by the keloid length.11,13,14

Local control was the most important factor, but only one factor involved in treatment satisfaction as shown by the patient self-assessments. Our study showed a response rate of 85%, but only 62% of patients classified the result as excellent or good. Gapping scars in sites of high stretch–tension, continuing discomfort, and an overestimation of the expected results were responsible for this discrepancy. By contrast, 33% of patients with keloid relapse were highly satisfied because of a partial response or symptom relief after treatment.

In addition to good local control, postoperative radiotherapy is well tolerated and has very few late effects.11,13 There is a small stochastic risk of cancer induction following radiation treatment; however, there have been only sporadic reports of malignancies arising from the radiotherapy of keloids. In a literature review, Ragoowansi et al. estimated a crude risk of around one cancer case in > 1300 treated keloids. Nevertheless, an exact quantification of the risk is very difficult, because cancer is a common disease and a direct association between radiotherapy and tumor induction cannot be proven in individual cases. Consequently, it is necessary to confine the radiation treatment field to the keloid to spare the underlying normal tissue, and to explain the theoretical risk of carcinogenesis in the consent procedure. Because of the higher risk of tumor induction in growing tissue, treatment of children should be avoided.16

All patients were treated with 6-MeV electrons from a linear accelerator to achieve a homogeneous dose in the region of the scar. The depth dose distribution and the respective dose range in tissues can be controlled by electron energy. Compared with photon irradiation or conventional kilovoltage X-rays, the steep dose fall-off of electrons protects the deeper lying, radiation-sensitive tissue (Fig. 1). For example, after radiotherapy of abdominal wall keloids, the bowel dose at a depth of 7 cm is 200 times higher with kilovoltage X-rays and 750 times higher with photons compared with that of 6-MeV electrons. Similar to treatment with electron beams, postoperative brachytherapy provides an efficient dose distribution in the region of the scar, and prevents underlying normal tissue. Guix et al.17 achieved excellent results with an interstitial high-dose-rate brachytherapy. It should be noted that the radiation dose of 12 Gy was administered within 1 day in four 3-Gy fractions. The low local failure rate of 4% is possibly the result of the selection of the group of patients; therefore, it may be difficult to extrapolate these results to other series. Other studies have reported local control rates of 13–21%, which are comparable with those observed after external beam radiotherapy.18,29 The published data emphasize the positive results with no significant complications after postoperative radiotherapy.

Other adjuvant therapies for keloids have been investigated, but relapse rates of 30% and various side-effects have been reported.20–22 For example, intrallesional cortisone injections can be painful, and skin atrophy and inhibited wound healing are possible outcomes.23 In a randomized trial, a higher recurrence rate was observed after surgery and steroid injection compared with surgery and postoperative radiotherapy.31 Cryosurgery can provide good results for early keloids, which are more vascularized than older lesions.22 Gupta and Kumar22 reported keloid flattening of more than 75% in seven of 12 patients with large and bulky keloids after cryosurgery. Depending on the response, intralesional cysygery with lumbar puncture and/or hypodermic needles was repeated for 5–10 sessions over 6–12 months. Bouli-Kasapidou et al.33 found significant response rates after polytherapy consisting of cryotherapy, intrallesional triamcinolone acetonide injections, and silicone gel. Patients were treated monthly with cryotherapy and injections, and three times daily with local applications of silicone gel for 1 year. Bandage pressure therapy is possible, especially for small lesions, but the bandage can be uncomfortable and requires high patient compliance for > 6 months.28 Sheeting the scars with silicone increases the hydration of the underlying tissue, and can decrease collagen synthesis. Silicone sheets must be worn for 6–12 months, and response rates of 40% are possible.24 Weekly intralesimal injections of 5-fluorouracil can flatten keloids in more than 50% of patients, but must be repeated for up to 4 months.24 Other treatment methods, such as intrallesional injections of bleomycin or interferon α–2b and postoperative topical application of 5% imiquimod cream, have been tested, but a larger number of patients and more long-term results are necessary to assess the therapeutic benefit and possible side-effects of these treatments.25,26–29

In conclusion, postoperative radiotherapy with electrons is well tolerated and very effective at preventing keloid recurrence. Radiation treatment should be started soon after surgical excision to prevent the repopulation of fibroblasts. Patient satisfaction is not only determined by recurrence status, but also by other factors. Patients should be informed about possible changes in scar color, gaping scars, or continuing

symptoms before the start of treatment to avoid an over-estimation of the achievable cosmetic results.

References


