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Successful Adjuvant Intraoperative Electron Beam Radiotherapy for Keloid: First Case Report and Review of Literature

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Abstract

Treatment of keloids is usually challenging, requiring a multimodal approach with no universally accepted treatment modality among the wide range of alternative keloid treatments. Excision of keloid lesion usually eliminates symptoms and it is the main treatment with considerable recurrence rate. Recurrence rate ranges from 45-100% when surgical excision is performed as monotherapy. Furthermore, Recurrent Keloids have a higher recurrence rate after surgery. In this case we discuss a challenging case of young female presented with third recurrence in lobule of the ear with defect necessitated flap reconstruction with concern for possible damage by the flap if radiation was given as external beam postoperatively. Intraoperative electron beam therapy was utilized with high safety and efficacy. To our knowledge this is the first case in the Middle East to use this technique in treating Keloid.

Conclusion

Treatment of keloids is usually challenging, requiring a multimodal approach. Excision of keloid lesion usually eliminates symptoms and it is the main treatment with considerable recurrence rate. Recurrence rate ranges from 45-100% when surgical excision is performed as monotherapy. Furthermore, Recurrent Keloids have a higher recurrence rate after surgery. Radiation is a valid option for decreasing risk of recurrence in recurrent keloid with high safety and efficacy profile. In this case we discuss a challenging case of young female presented with third recurrence in lobule of the ear with defect necessitated flap reconstruction with concern for possible damage by the flap if radiation was given as external beam postoperatively. Intraoperative electron beam therapy was utilized with high safety and efficacy. To our knowledge this is the first case in the Middle East to use this technique in treating Keloid.

Keywords: Keloid; Radiation; Intraoperative Radiation; IOERT



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Clinical Case

Female patient, 19 years old, presented with recurrent Right ear keloid for the third time with history of trauma to right ear lobe 4 years back with subsequent keloid formation. Patient underwent 2 previous excisions with subsequent recurrence occurred twice. Local injection of steroids has been tried after excising second recurrence but unfortunately failed. From plastic surgery point of view excision with reconstruction with free skin graft from skin behind the affected right ear was necessary to fill the resultant gap of tissue loss after the excision and so postoperative irradiation was of a matter of concern not to affect the integrity, viability and healing of skin graft. Patient was referred to radiation oncology clinic for discussion of the option of adjuvant / intraoperative radiation aiming at reducing risk of recurrence after excision and before graft reconstruction not to expose graft to radiation. Patient was discussed and counseled regarding the situation, procedure and possible long term complications including theoretical risk of carcinogenesis at irradiated area. Patient agreed on the procedure and informed consent was obtained.

Technique

At the time of surgery, patient underwent surgical excision followed by intraoperative electron beam irradiation (IOERT) 13 Gy in one fraction using intraop mobetron® and then graft reconstruction. Patient tolerated treatment well with smooth postoperative course and healing. With no early complications. After 3 years of follow up there is smooth course with no signs of recurrence

or late complications. To our knowledge this is the first time of using this technique of intraoperative electron beam radiotherapy in treatment of keloid in the Middle East and early use in this indication across the globe.

Review of Literature and Discussion

Definition of keloids: Keloids are benign fibrous dermal tumors due to excessive collagen formation during tissue repair after skin injury that can sometimes evolve in an unfavorable way with pathological scar formation [1].

Aetiology: Skin injury, after surgery or piercing, is the leading cause of generating keloids. It may follow burn injury, tattooing and even simple acne. However, the cause of keloid formation remained a mystery [1].

Time of development and course: The hypertrophic scars usually occur 4 to 8 weeks postoperatively or after the injury. The time of keloid formation is variable, from generally within 3 months to many years after the dermal injury. Unlike the hypertrophic scars, which often gradually regress after years, keloids persist for longer period of time.

Risk Factors

Race: Black people are more likely to develop keloids, while the Caucasians are least likely. In African populations, the incidence is 6-16%, which is 15 times higher than whites [2].

Gender: Affect males and females equally [3] But due to the more piercing among women might bring the confounding bias of female predominance [4]. Incidence of ear-lobe



keloids following ear piercing is about 2.5% according to a survey of 1000 nurses in UK [5].

Familial tendency and darker skin races: The keloid is gradually considered as a genetic disease with genetic predisposition that shows an autosomal dominant or X-linked inheritance pattern [6]. Keloid is not uncommon in patients genetically predisposed to multiple lesions, related to previous surgery or trauma [3].

Wound tension: In spite of absence of controlled trials to prove, wound tension has been implicated as a factor in the development of keloid and hypertrophic scar formation. Tension may result from attempts to close a wound with tissue loss, overlying bone, or mobility over a joint [7,8] leading to abnormal fibroblastic reaction [9].

Pathophysiological Basis of Keloids Formation

Persistent chronic inflammation: Both keloids and hypertrophic scars are considered results of persistent chronic inflammation. Histologically, continuous local inflammation was observed along with keloid progression [10]. Fibroblast continuous proliferation by persistent activation: The full pathophysiological mechanism is not yet fully known but may be due to a defect in the regulatory mechanisms of cell growth that don't recognize the healing, resulting in continued proliferation of fibroblasts for continuous activation of cell growth factors [11]. Abnormal Fibroblasts response to stimulation; Fibroblasts seen in keloids have different properties than those seen in normal skin and hypertrophic scars. They respond abnormally to stimulation, show a greater capacity to proliferate and produce high levels of collagen (predominantly type I), elastin, fibronectin, and proteoglycan [12,13].

Others: Inflammatory cells, increased numbers of fibroblasts, angiogenesis, and new collagen

deposition were all observed. Besides, inflammatory cytokines or mediators including interleukin (IL)-1 α , IL-1 β , IL-6, and tumor necrosis factor (TNF)- α also overproduced in keloids or hypertrophic scar tissues. This theory is supported by the effectiveness of corticosteroids keloid treatment [12,13].

Clinical Picture

Sites of predilection: As injury has more predilection for the upper half of the body, head, neck, chest, shoulders and arms as a common location. However, any part can be affected. Recently, with the use of new habitual piercing, the most common location is the ear lobe. In the US, the incidence of keloids on ear lobes after piercing, based on a survey of 1000 women, is around 2.5% [11,14].

Symptoms: Esthetic Problem pain and itching are the most common symptoms. Pain and itching are the most common symptoms observed in 91% and 96% of cases respectively [15]. The final clinical result of keloid formation is the development of a Progressive aesthetically unpleasant scar, Painful and itchy lesion. Function disturbance if located in certain areas of the skin (popliteal fossa, neck, and forearm), may induce significant functional limitations. Keloids don't regress spontaneously but they spread on the surrounding healthy skin surface [16].

Recurrence: Keloids also have a high recurrence rate after surgical resection. Keloid management has always been frustrating and challenging. In the treatment of keloids, the recurrence after surgical excision is relatively high [17]. Earlobe is exceptional, which indicate lower recurrence rate under similar treatment. Therefore, this site-specific characteristic provides us the site-specific treatment algorithms, for example, to decide whether or not the lesion requires radiation therapy [6].

Distinguishing hypertrophic scars from keloids: Although usually difficult but Keloids can be defined by Cosman et al's clinical criteria [18] (Table 1).

Differentials: In the ear lobe, the differential diagnosis includes a hypertrophic scar, an embedded foreign body, a sarcoid granuloma and an epidermal cyst [19].

Table 1: Differences between Keloid and Hypertrophic scars.

	Keloids	Hypertrophic scars
Time to formation	Variable, within 3 months to many years after the dermal injury.	Usually occur 4 to 8 weeks postoperatively or after the injury.
Morphology	Firm nodules	More linear, nodular, or papular with more regular borders.
Color	Cosman et al's clinical criteria: be skin colored, dyspigmented, or erythematous due to telangiectasias more likely to be erythematous and telangiectatic in Caucasians , hyperpigmentation is more popular in Blacks [20].	
Border	Lesion always extends beyond the border of demarcated primary lesion, and often with irregular shape, Just like how the word “keloid” originated from the Latin word “crab [6].	Always within the original wound borders [6].
Course	Persist for longer period of time.	Often gradually regress after years. Spontaneous regression is debatable [21,22].
Symptoms	Although both lesions are pruritic, the keloids are more likely to cause significant pain and hyperesthesia [6].	
Response to treatment	often resistant to treatment and have a higher rate of recurrence [23].	More responsive to treatment

Treatment of Keloids: Treatment is usually challenging, requiring a multimodal approach with no universally accepted treatment modality among the wide range of alternative keloid treatments. This is due to the variable quality of reporting of treatment series [22]. Prevention is the best treatment strategy Predisposed persons should avoid nonessential surgery, particularly in body locations at high risk for the development of keloids [22].

Surgery: Excision of keloid lesion usually eliminates symptoms. Recurrence rate ranges from 45-100% when surgical excision is performed as monotherapy [24]. Furthermore, Recurrent Keloids have a higher recurrence

rate after surgery [25]. Keloids following burns had a poorer success rate than those developing after surgery or mechanical trauma ($p < 0.001$) [26]. Keloids existing for more than 2 years before therapy had a recurrence-free response rate of 78.9% in comparison to 68.8% for keloids existing between only 1 and 6 months [26].

Radiation therapy: Keloid scars are the commonest type of benign disease treated by radiotherapy because keloid scars are particularly refractory to most other therapeutic modalities [27].

Surgical excision and adjuvant radiation therapy seems to be the best treatment

modality, confirmed by many studies that the rate of side effects of this treatment modality is low and response rates are high. It drops down the rate of recurrence down to 10-20% when radiation therapy adjuncts surgical excision [6,11,14,28-30].

Postoperative Mechanism of action of radiation: Tissue injury → Histamine release from mast cells → Fibroblasts → TGF-1 beta release → Fibroblast proliferation and angiogenesis → Collagen synthesis (Figure 1).

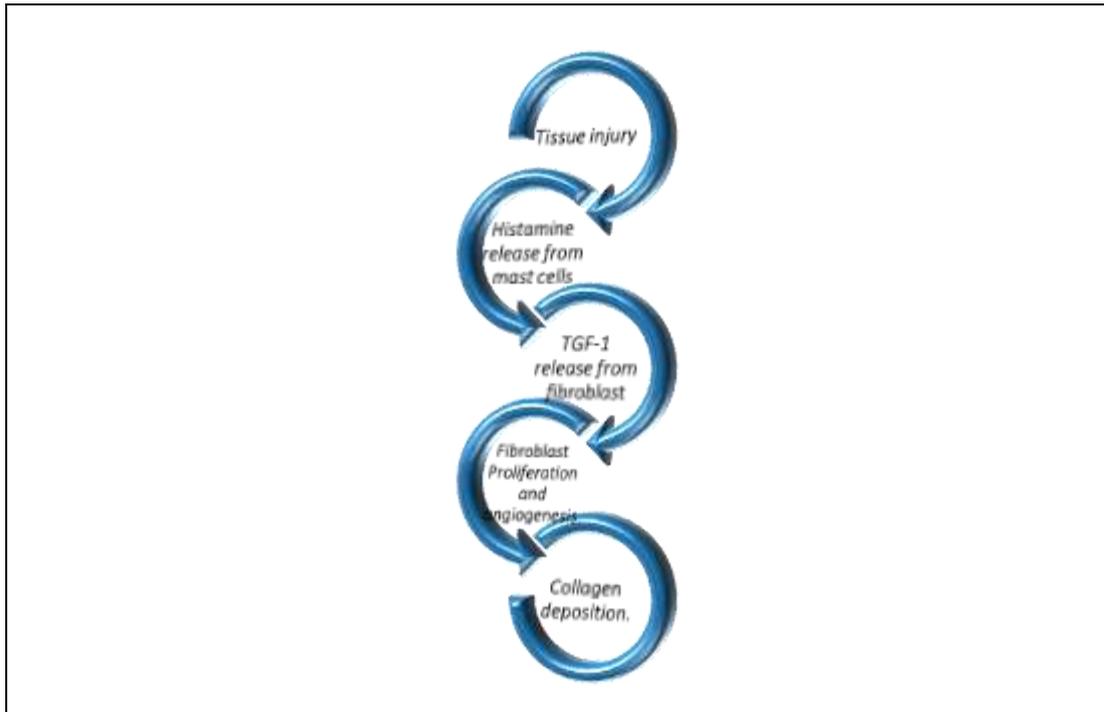


Figure 1: Simplified diagram of pathophysiology of keloid formation.

The proposed mechanism of action Radiation suppresses collagen synthesis in keloids or hypertrophic scars through inhibition of fibroblast proliferation and angiogenesis during the exaggerated wound-healing process [31]. This is mediated by the inhibition of TGF-beta 1 release from fibroblasts which is stimulated by histamine released from mast cells. Treatment is most effective during the first 24-72 hours after surgery which will be discussed later (Section 0).

History and evolution of treating keloid with radiation

First treated keloids: De Bearman and Gourgerot have first treated keloids using

superficial X-ray irradiation in 1906 [32]. Reports on using X-ray as a treatment method for keloids surfaced around 1920 and 1933 [33]. Originally, Kilovoltage therapy with energy of 100-400 keV were used; however, low-energy X-ray resulted with more acute skin side effects. Hyperpigmentation was the main complication in almost one third (30%) of cases [28]. Postoperative radiation for the prevention of keloids recurrence was recommended around the 1940s to 1950s as a proactive approach [30,34,35]. Then dose-dependent approach was disclosed in the year 190 through a study conducted in Melbourne indicated potential dose-dependent results [36]. Although radiation therapy has not been proven yet to be effective in the



following years of the 1960s, and when treating keloids and hypertrophic scars both remained as a problem, preventive X-ray irradiation has already been widely accepted and practiced.

Furthermore, low-dose superficial X-ray irradiation within 48 h postoperatively has proven to prevent keloid relapse [37]. Gradually, further well-designed studies have supported the comparative effectiveness of combination therapy between surgical keloidectomy and postoperative X-ray irradiation therapy [38,39]. Evidence confirming importance of postoperative radiotherapy; more long term retrospective studies on keloids detailed the importance of irradiation postoperatively. Kovalic and Perez, followed 75 patients with 113 keloids for a mean time of 9.75 years, demonstrated an overall control rate of 73% [25]. Some studies mentioned that half of the relapsed cases occurred within 6 months postoperatively and most cases of relapse occurred within 24 months [28,40].

Technique:

X ray irradiation was gradually replaced by electron beam irradiation. Up to a dose of 15 Gy irradiation delivered postoperatively after surgical excision successfully prevented hypertrophic scars or keloids formation and recurrence and results was confirmed in 1990 [41]. Electron beam therapy had advantageous uniform dose distribution curve and steeper dose fall off is, with more condensed radiation deposition and less normal tissue damage [42]. Field set up: The electron field covers the normal skin area 0.5 or 1 cm from the margin of the operative suture lines. The surrounding normal tissue is shielded with lead (equivalent to 6 mm of Pb) [17].

Electron beam: Is usually applied with a 6-MeV energy with 0.5 or 1-cm thick silicone bolus as a tissue compensator is placed on the keloid surgical scar to ensure adequate radiation dose was applied to the surface of the

skin. With the help of a bolus, reduced irradiation dose could achieve excellent clinical outcome [43]. There has not been any consensus formed in standardized treatment despite the International Clinical Recommendations on Scar Management contrived in 2002 [44]. Currently, Many modalities of radiation therapy can be used including radioactive isotope carrying α , β , γ , and neutrons particles, X rays at various energy level, electron accelerators, and heavy particle accelerators. Superficial and orthovoltage X rays (photons) therapy, brachytherapy (β rays using phosphorus 32 [30] strontium 90 [45]), γ rays using cobalt 60[46] with different efficacy and complications. Comparison between different radiation treatments modalities are summarized in (Table 2).

Timing of radiation: As discussed previously, treatment is most effective during the first 24-72 hours after surgery as Postoperative radiotherapy impacts wound healing in patients with keloids at a time when the connective tissue is more radiosensitive by decreasing fibroblast proliferation and causing a rapid degranulation of mast cells the main secretors of histamine [48]. This is during the first 24-72 hours after surgery. Increasing postoperative interval between surgery and radiation therapy negatively correlates with clinical outcome. German studies [26,49] indicated that shorter postoperative interval managed lower rate of relapses. Irradiation within 24 hours after surgery was widely employed. Although, based on studies conducted before the 1990s (before the shift of radiation technique from superficial to iridium brachytherapy that might cause significant bias). Postoperative radiotherapy used a single applied field, with the first fraction delivered within 24 hours of excision to maximize effectiveness. decreases recurrence rates to less than 10 % [50]. A short-time (<7 hours) interval between scar excision and irradiation results in a lower recurrence rate compared with longtime intervals (>24 hours). Doubling the duration of interval from 25.9 h to 43.5 h

might produce significant diminution of apoptotic cells and reduced keloid fibroblasts number decrease [51].

Table 2: Types of modalities used [47].

TYPE	Mechanism	Depth of penetration	Advantages	Disadvantages
Electron beam	electrons delivered via linear accelerato	X-Ray (photon) beams • inexpensive and easy to use	Radioactive source emitting gamma rays delivered via catheter	Radioactive source emitting gamma rays delivered via catheter
Superficial/ Orthovoltage	2-6 CM	5mm/2cm	Inserted into target tissue	Fixed onto skin
High-dose-rate (HDR) interstitial brachytherapy	• Treats superficially without damage to underlying structures • Can treat broad area of skin without radiation dose drop-off	• treats superficially without damage to underlying structures	Involves less normal tissue	Good for long keloids and uneven surfaces
HDR superficial (surface conforming) Brachytherapy	• Cannot use on curved surfaces • Need linear accelerator	dose of radiation drops off at periphery so have uneven dose delivery	Total dose must be delivered in short time frame	Total dose must be delivered in short time frame

Number of fractions: Single-fraction irradiation showed superior results in terms of recurrence rate and patient convenience [52]. Importance of anatomical site of keloid from radiotherapy point of view due to fewer tensions, keloids on ear lobes, head, and neck were generally considered easier to treat compared to other sites such as trunk (especially chest) and limbs. A dose-response analysis verified the fact that earlobe keloids have significantly lower risk of recurrence after similar radiation therapy [15]. Earlobe controlling dose was suggested to be reduced from 15 Gy 3 fractions down to 10 Gy 2 fractions. The diminution of radiation dose might also explain the reason why no prominent adverse effects were observed in following up patients [30].

Dose and fractionation: Most of the current literature recommendations were based on retrospective studies other than prospective studies. Besides, the difficulty in clinical distinction between keloids and hypertrophic scars and the lack of histopathological confirmation decrease the validity of these studies. Therefore, due to the limitations, there are no preferred treatments of keloids in specific sites [53]. Before the year 2000, 15 Gy in total was considered as optimal dose with minimal adverse effect [54]. A dose of at least 15 Gy, delivered in fractions within 10 days of surgery, was recommended in that time by some investigators [22,55]. However, Theodore and colleagues ,through retrospective study reviewing treatment results of 354 sites in 199 patients with a single fraction and skin dose ranging from 2 to 20 Gy and median follow up period of 35 months, found that Postoperative electron beam



irradiation with a single dose of 9 Gy or greater is highly effective in the prevention recurrence of hypertrophic scars or keloids [41]. A total dose >10 Gy can accordingly reduce the recurrence rate, while a total dose >30 Gy will limit the recurrence rate down to <10%. Kal and Veen considered an optimal schedule should at least include a total dose over 30 Gy less than 3 fractions within 48 hours postoperatively [56]. Less than 19.2 postoperative electron beam irradiation could achieve 90-95% favorable control in earlobe sites according to Xu and colleagues [30].

In the retrospective review done by Sakamoto et al. [15], 194 lesions in 119 patients From 1979 to 1994 received postoperative radiotherapy with total dose ranging from 16 Gy/8 fractions to 40 Gy/8 fr (mean: biologically effective dose (BED) 33.5 Gy). Kilo-voltage X-rays (55 or 100 kVp) or electron beams (4 or 6 MeV) with median follow up period of 36 months (12-164 months). A dose response relationship with cutoff point of 20 Gy for both efficacy and complications and relapse rates was observed. Relapse rate was 11% at 20 Gy in five fractions or higher dose, while 43% at less than 20 Gy. On the other hand, the incidence of adverse effects was significantly higher for patients receiving more than 20 Gy in five fractions.

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patients receiving more than 20 Gy in five fractions.

Single fraction replaced multiple fractions

concept: Conventionally, 3 fractions were considered more reliable than single-high-dose scheme, becoming the standard scheme widely [57]. However, hypofractionated radiation therapy control rate was gradually reported significantly superior results to the traditional fraction [56]. Single-fraction electron beam irradiation of a total dose of 10 Gy was used in UK, US, and Asia on patients who were refractory to other treatment modalities except for radiotherapy, demonstrating no recurrence and well tolerance [41,58,59]. In a relatively recent study by Song and colleagues [58] showed that a single dose of 10 Gy within the first 72 h after excision of keloids is both safe and effective with the advantage of being simpler, more convenient, and cheaper than multiple fractionation.

Results of different radiation modalities

External beam radiation: Data are widely variable. The overall recurrence rate reported in literatures varied from 8% to 29.3%, due to different sites and chronological reasons, with a total dose of 15-20 Gy in 3 fractions [56,57]. Additionally, if the surgeons use improved tension-decrease suturing methods, the relapse rate can reach as low as 2.2% in treating smaller (<3 cm) chest keloids [60]. In a large review comparing the effectiveness of different treatments found significantly greater control rates with megavoltage electrons or cobalt-60 X-rays than kilovoltage X-rays. The hypothesis for this difference was the improvement in dose homogeneity with deeper penetrating radiation gives lower recurrence rates [57].

High-dose-rate (HDR) brachytherapy: Later after external beam radiation, high-dose-rate (HDR) brachytherapy provided us with an alternative to external radiation therapy, particularly for patients who are resistant to

adjuvant external beam radiation therapy or corticosteroids, which resulted in a recurrence rate ranging from 4.7% to 21% [61,62].

EBRT versus HDR brachytherapy: Largest single-institution case-control retrospective study (2004-2014) of keloid recurrence rates and complications between postoperative EBRT and HDR brachytherapy revealed that post excision radiotherapy showed significant reduction in keloid recurrence compared to surgery alone.

Recurrence rates were non-significant between external beam radiotherapy and brachytherapy.

Differences in relapse pattern: In cases developed recurrence, keloids treated with EBRT recurred significantly later than those treated by HDR brachytherapy by a mean of 2.5 years [63]. In a meta-analysis of thirty-three studies, High-dose-rate brachytherapy showed lower recurrence rates compared with low-dose-rate brachytherapy and external radiation [52]. In summary, the results from numerous studies demonstrated a significantly lower recurrence rate (ranging from 12% to 28%), proving the effectiveness of postoperative irradiation therapy [54].

Intraoperative Electron beam Radiotherapy: In a recent article by Yang et al. Fourteen patients with keloids underwent radiotherapy using the Intrabeam system from November 2016 to March 2018 compared to data from this cohort to earlier their own data from keloid patients who had previously been exposed to 6 MV electron beams using conventional accelerators. At 22.5 months median follow up there was zero recurrences in the intrabeam group with statistically significant difference compared to the control group (p= 0.016) and excellent cosmetic outcome in 90% of patients [64].

Safety of radiation therapy: The use of a potentially carcinogenic treatment for the treatment of a benign process such as keloid scarring is controversial. Although a large study found no increased risk of malignancy

following radiation therapy for keloids, case reports have outlined the development of carcinoma (two breast, one thyroid) in three patients [27,65]. Moreover, reviewing the literature, only 5 out of more than 6500 cases has been described as potential and doubtful [27,59].

Conclusion: Despite the risk of radiation-induced malignancy being so low, this treatment is not recommended in very young patients unless previous alternative treatments have failed for several years and the keloids cause severe pain and disfigurement with extra caution when considering treatment of keloid or hypertrophic scars in young age and in radiosensitive areas such as the breast or thyroid.

Complications of radiation therapy: Complications or adverse effects of postoperative radiation therapy could be divided into two categories: acute skin reactions and late complications [30] (Table 3). As previously discussed and proved in the retrospective review done by Sakamoto et al. [15], There was a dose response relationship with cutoff point of 20 Gy for both efficacy and complications and relapse rates. The incidence of adverse effects was significantly higher for patients receiving more than 20 Gy in five fractions.

Table 3: Radiation effects on the irradiated skin [47].

Effects	RELATED TO	COMPLICATION TYPE
Acute (within 7-10 days after radiation)	Total dose of radiation given	Erythema. Edema Desquamation. Ulceration. Necrosis
Late (weeks to months after radiation)	Dose of radiation per fraction (Fraction size)	Pigmentary changes (hypo- or hyperpigmentation). Atrophy. Alopecia. Telangiectasias



Final Conclusion

Surgery with adjuvant irradiation is safe and effective for treatment of keloid scars. Recent systematic review of 33 studies [52,63], although lacking of high-quality randomization, recommended the following:

The use of high-dose-rate brachytherapy instead of low-dose rate brachytherapy or external radiation. (2) A short-time interval between operation and irradiation. Single fraction instead of multiple fractions irradiation. A minimum of 12- to 24-month follow-up post treatment.

Other modalities that might be of clinical use in keloid treatment

Intralesional Corticosteroids: Cornerstone for both prophylaxis and treatment of hypertrophic scars and keloids. Leads to softening, flattening, and improvement of symptoms after treatment [66, 67]. Mechanism of Action is through suppression of collagen synthesis by decreased gene expression within the keloid or hypertrophic scar. Combined with surgical excision, the recurrence rate falls below 50% within 5 years [68,69].

Compression therapy

First publication on compression therapy was in the 1960s [70]. Mechanism is not completely understood. But may be due to producing tissue ischemia, decreasing tissue metabolism and increasing collagenase activity [71-73]. Necessity of applying the pressure dressing 18 hours a day for at least 6 months, there is Poor response of Scars older than 6-12 months and Difficulty to reach the required amount of pressure (24-40mm Hg) in locations over a joint because of excessive skin movement. Despite its activity, it has many disadvantages and limitations.

Cryotherapy

May be used As monotherapy or in combination with other techniques [65]. It acts

through induction of ischemic damage to the microcirculation leading to anoxia with eventual necrosis[74]. Achieves good response in majority of patients. It is more effective when combined with intralesional steroids [75]. It has a limited role in facial lesions or older scars more than 12 months which shows a poor response to treatment. Main side effect is permanent hypopigmentation resulting from the cold sensitivity of melanocytes .So, cryotherapy is not desirable in patients with darker skin phenotypes [76].

Topical silicone gel sheeting or cushions

By application for at least 12 hours daily for 2-4 months. It shows significant scar softening and decreased pruritus. Although many of the studies performed is lacking adequate controls [65]. The relatively simple nature of this treatment makes it a popular treatment option[77].

Interferon

Through decreasing types I and III collagen production from fibroblasts [78-81]. Although archives improvements of up to 50% , It has questionable activity [82].

Fluorouracil

Only Two published studies have demonstrated improvement with intralesional use of fluorouracil [83]. No prospective, well-controlled clinical studies are available[76].

Laser therapy

One of the most advantageous modalities. Initial studies showed unacceptably high rates of scar recurrence and other adverse effects including pain, atrophy, and dyspigmentation [84-87]. The first encouraging results was by Alster and colleagues by using pulsed dye laser (PDL laser) in treatment of hypertrophic scars and follow up duration of 10 months [88]. It demonstrated marked improvements in

scar erythema, texture, height, and pliability [89, 90].

Other agents

Bleomycin, tamoxifen, tretinoin, tacrolimus, pentoxifylline, colchicine, calcium antagonists, tranilast, zinc. Studies are often limited by poor design, a paucity of subjects, and short-term follow-up [76].

Table 4: Keloids of the ear: the range of reported outcomes for treatment options [22].

Treatment	Worst reported recurrence rate (%)	Best reported recurrence rate (%)
Steroids alone	50% at 5 years 7	11.2% at 4 years
Surgery alone	100% at 5 years	50% at 5 years
Silicone-gel sheet alone	-	21% at 6 months
Laser surgery	95% at 1 year	30% at 1 year
Surgery and steroids	12 85% at 5 years	5% at 5 years
Surgery, steroids and pressure	-	100% at 18 months
Surgery, intralesional verapamil and pressure	-	48% at 28 months
Surgery and radiotherapy	12.5% at 12 months	2.8% at 5.6 years
Surgery and local flap ^a		0% at 26 months

^aOnly one paper with long-term results available

Conclusion

Treatment of keloids is usually challenging, requiring a multimodal approach. Excision of keloid lesion usually eliminates symptoms and it is the main treatment with considerable recurrence rate .Recurrence rate ranges from 45-100% when surgical excision is performed as monotherapy. Furthermore, Recurrent Keloids have a higher recurrence rate after surgery. Radiation is a valid option for decreasing risk of recurrence in recurrent keloid with high safety and efficacy profile. In this case we discuss a challenging case of young female presented with third recurrence in lobule of the ear with defect necessitated flap reconstruction with concern for possible damage by the flap if radiation was given as external beam postoperatively. Intraoperative electron beam therapy was utilized with high safety and efficacy. To our knowledge this is the first case in the Middle East to use this technique in treating Keloid.

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