1 Introduction

A keloid scar can appear after a local trauma: surgical excision, ear piercing, vaccination, skin burn or infection. Keloids are more frequent in certain families and especially in blacks (8). Preferential location are the ear, the presternal and the deltoid region. Clinical symptom usually relate to cosmetic effects particularly on the face or other uncovered/unprotected portions of the body, but also to other secondary effects such as pain, tingling, itching and burning.

A variety of treatments can be used:

- surgery followed by post operative injection of corticosteroids. The risk of recurrence remains high in about a third of the patients (17). surgery alone, but the risk of local recurrence is about 2/3 of the cases.
- laser, prolonged local compression (several months), retinoic acid or silicone gel, but results are not very encouraging.
- Post-operative radiotherapy following excision of a keloid is regularly used to prevent the keloid reforming and even non-excised keloid lesions can be reduced in thickness with a fractionated course of radiotherapy (12,18).

2 Anatomical Topography

Keloids can appear in the skin everywhere on the body (Fig 33.1-3) but are most frequent on ear lobe or pinna and in the pre-sternal and deltoid region. When improving cosmetic appearance is the main reason for treating a keloid, the resulting cosmetic effect of re excision (always a longer scar) must be anticipated before decision for treatment is taken. Also the presence of radiosensitive tissues in the neighbourhood of the keloid must be critically evaluated. (8,16)

3 Pathology

Keloids and hypertrophic scars develop because of over proliferation of fibroblasts associated with hyperproduction of collagen. A normal scar can become keloid resulting in an intradermic fibromatous tumefaction (8).

4 Work Up

Because of the increased risk on long term side effects and cancer induction, keloids should not or only in extreme conditions be treated in children. In adolescents growth stop should be documented by measuring length. Further there is no specific work up except general exams to determine if there is no contra indication for local excision. It is recommended to make a complete skin examination to detect eventual other lesions.
5 **Indications, Contra-indications**

Simple surgical excision of keloids can result in recurrence rates of 60-80%. Postoperative irradiation to a minimal dose of 10-15 Gy can reduce this recurrence rate to 2.4 à 20% (2,3).

A decision to give perioperative brachytherapy must be taken with the patient after discussing with him success rate and long term risks (1/50 000 cancer induction) and the cosmetic or clinical burden of the keloid for the patient. Because the effect on tissue growth and possible cancer induction, brachytherapy should not be carried out in children, except in very critical situations where accepting the risk is worthwhile.

![Fig 33.1-3: Three keloid scars in the same patient: post trauma in the submental area, post vaccination on the skin of the shoulder, post cosmetic surgery of the breast.](image)

6 **Target Volume**

The gross tumour volume (GTV) includes the whole scar that is left after excision of the keloid. Some authors advise incomplete excision of the keloid leaving 1 or 2 mm of keloid edge. The CTV including the scar and traumatised skin has to be covered by the cigar shaped PTV around the source. This PTV should cover an area of at least 5 mm both sides of the scar (8).
7 Technique

The technique for irradiating keloids with brachytherapy was initially described by Nicoletis and Chassagne in 1967(18). Both hypodermic needles and plastic tubes can be used as source carrier, but plastic tubes are recommended because they adapt easily to curvatures in the scar.

Two kinds of plastic tubes can be used: the "classical" one, and the small inner plastic tube used for loading of the former ones. The classic plastic tube with an external diameter of 1.6 to 1.9 mm, is used for large scars. The small tubes with an external diameter of 0.9 mm are less traumatising for tissues and can therefore decrease the risk of recurrence. They are used in the face and for small scars.

After surgical excision of the keloid (Fig 4) the plastic tube is implanted, before closing the sutures, in the dermis at about 3 mm under the epidermis to cover with the PTV the junction between dermis and epidermis. In large excision wounds it is advocated to close the wound with subcutaneous sutures to approximate the wound rims before inserting the plastic tube. The tubes are inserted at 3 to 5 mm both sides of the scar. This will maintain their position during suturing the skin.

The surgical skin sutures are strictly intradermal, the epidermis is not pierced but closed by adhesive strip.

It is important to leave a plastic or metallic guide wire in the tube to prevent occlusion of the lumen while suturing the skin. This wire stays in place till afterloading of the implant.

After deciding the length of the iridium wire, the loading has to be performed within 48 h. The iridium wire is about 10 mm longer (5 mm both sides) than the traumatised skin area (surgical scar and entrance and exit points) to avoid recurrence at both ends of the target volume (Fig 33.5).

Fig 33.4: Surgical excision of two keloids. Fig 33.5: The end of perioperative brachytherapy: the plastic tubes are implanted, the scar is closed by adhesive strips, metallic buttons maintain the iridium wires and plastic tubes in place.

A second technique reported by Xiaoping (21) uses a postoperative mould irradiation.

Other techniques use contact brachytherapy with Sr 90 applicators (20).
8 Dosimetry

For interstitial brachytherapy the reference isodos e in the central plane is at 5 mm from the iridium source, encompassing a target volume of +/- 10mm of diameter with a total length length equal to the traumatised skin length (as in endovascular brachytherapy). Therefore the active source length should be 10 mm (both sides 5 mm) longer than the length measured between the exit points at the skin.

For the mould application the distance of the reference isodose is at 5 mm depth.

9 Dose, Dose Rate, Fractionation

For control of keloids a minimal dose of 10 Gy - 16 Gy should be delivered to reach acceptable control rates (2,3,7)

For a LDR brachytherapy the delivered dose is usually 12 to 20 Gy at 5mm. The dose rate is classical LDR irradiation 0.4-0.6 Gy/h.

For HDR brachytherapy, Guix (10) has given 4 fractions of 3 Gy (at 1cm from the source corresponding to 6 Gy per fraction at 5 mm) in 24 hours. The same author has reported his experience of HDR brachytherapy in keloids irradiated without surgery; in these cases 6 fractions of 3 Gy were given in 48h.

For the postoperative mould application the doses also range from 10 to 20Gy.

10 Monitoring

The implant site should be carefully monitored during stay in the department. No acute side effects besides normal wound healing are to be expected.

Extreme care should be taken to keep the scar in sterile conditions and avoid additional trauma. Infection but also bruising and loosened stitches have been associated with recurrence risk of the keloid (8). Removal of skin suture is carried out one week after leaving the hospital.

11 Results

Escarmant (8) published experience of 783 keloids treated by iridium LDR peri operative brachytherapy. The sex ratio was 1 : 4 M : F, 97% were of mixed race, 38% had keloid family antecedents.

Factors for recurrence after treatment were: the large and symptomatic or previously treated keloids, localisation at the pinna or earlobe, post operative bruising and loosening of stitches, haematoma formation, and infection. All patients were treated within 6 hours so it was not possible to study the effect of delaying treatment interval.

The observed recurrence rate was 21%, disappearance or reduction in symptoms in 80% of cases, and good cosmetic results in 75% of patients.

In other brachytherapy series including mould technique and HDR brachytherapy the results are similar (table 1) Recurrence. Rates of 4 to 35% have been reported.
For external irradiation following excision, the control rates are between 73 - 93% reported by Kovalic (113 keloids) (12), 93% by Durosinmi (454 keloids)(15) to 97.6% by Borok (393 keloids)(3).

Scalfani (17) compared corticosteroids and radiation therapy: the recurrence rate was 33% for surgery + steroid injection, and 12.5% for surgery and radiation therapy.

Overall the local recurrence rate is between 2.4 to 20% and good cosmetic results are obtained in 15 to 18%.

Most LDR irradiation is delivered in about one day except for HDR brachytherapy without surgery when the dose of 18 Gy is delivered in 2 days (6 sessions).

Table 33.1: Keloids : Results of Brachytherapy

<table>
<thead>
<tr>
<th>Author</th>
<th>Patients/ Keloids (N)</th>
<th>Brachytherapy</th>
<th>Local recurrence (%)</th>
<th>Good cosmetic results (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bertiere (1)</td>
<td>34 / 46</td>
<td>Ir LDR 15-18 Gy</td>
<td>13</td>
<td>80</td>
</tr>
<tr>
<td>Clavere (4,5)</td>
<td>43 / 51</td>
<td>Ir LDR 12-18 Gy</td>
<td>35</td>
<td>88</td>
</tr>
<tr>
<td>Escarmant (8)</td>
<td>544 / 855</td>
<td>Ir LDR 20 Gy</td>
<td>21</td>
<td>80</td>
</tr>
<tr>
<td>Gerbaulet (9)</td>
<td>157 / 201</td>
<td>Ir LDR 15-20 Gy</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td>Guix (10)</td>
<td>169</td>
<td>Ir HDR No surgery 6x3 Gy Surgery 4x3 Gy</td>
<td>6 4</td>
<td>77 97</td>
</tr>
<tr>
<td>Malaker (14)</td>
<td>30</td>
<td>Ir LDR 20 Gy</td>
<td>17</td>
<td>97</td>
</tr>
<tr>
<td>Nicoletis (15)</td>
<td>20</td>
<td>Ir LDR 15-20 Gy</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Wagner (20)</td>
<td>139 / 166</td>
<td>Sr/Y HDR 14 Gy</td>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td>Xiaoping (21)</td>
<td>31</td>
<td>Ir mould 10-20 Gy</td>
<td></td>
<td>90</td>
</tr>
</tbody>
</table>

12 References


