What's New in Superficial Radiation Therapy

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Off FDA labeled usages are discussed

Post-Excision Radiation to Reduce Keloid Recurrences

Recurrence Rate of Excised Keloids

JAAD 1997; 37:755-757

Weighted Average Recurrence = 71.2%
Recurrence Rates of Excised Keloids: Effect of Number of Post-Op TAC Injections

<table>
<thead>
<tr>
<th>Recurrence (%)</th>
<th>n=38</th>
<th>n=38</th>
</tr>
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<tbody>
<tr>
<td>single</td>
<td>52.6</td>
<td>47.4</td>
</tr>
<tr>
<td>2 or more</td>
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</table>

NS (p=0.652)

Recurrence Rates of Excised Keloids: Effect of Post-Op TAC Concentration

<table>
<thead>
<tr>
<th>Recurrence (%)</th>
<th>10 mg/cc</th>
<th>&gt;/=20 mg/cc</th>
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<tr>
<td></td>
<td>44.7</td>
<td>55.8</td>
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</table>

NS (p=0.366)

DNA / RNA Damage due to Ionizing Radiation

- Inability for cells to proliferate
- Inability for cells to survive
- Induction of mutations
- apoptosis or malignancy

Ionizing Radiation on Wound Healing

- Full-thickness, 3-cm-diameter, dorsal rat skin, with and without prior local irradiation with 521 rad, was excised
- Control wounds contained:
  - prominent BrdU-positive proliferating cells, at days 3-9 &
  - minimal TUNEL-positive apoptotic cells during healing
- Irradiated wounds had:
  - fewer BrdU-positive proliferating cells and
  - significant TUNEL-positive apoptotic cells at days 3-9, &
  - persistent lower proportion of G2/M phase cells
- Radiation-induced inactive cell proliferation, greater apoptosis, and cell cycle arrest at days 3-9 post-wounding may be cellular mechanisms responsible for delayed wound healing


P53 Mutations & Apoptosis in Keloids

Mutant p53 → Less apoptosis


Post-Excision Radiation & Keloids

- In a retrospective study of 80 keloidectomy patients treated with postoperative single-fraction 10Gy radiotherapy
- 9% of keloids relapsed after 1 year
- 16% of keloids relapsed after 5 years

Post-Excision Radiation of Auricular Keloids

- Retrospective study of suturing lines of 60 keloidectomy patients (76 ear keloids)
- Treated 1-3 days post-operatively with 5 Gy/wk, 25-45 Gy total dose, contact or superficial radiotherapy
- 5 year relapse-free rate of 79.84%
- No pigmentation or telangiectasias

Superficial Radiation Therapy for the Prevention of Keloids After Surgery

- A BED value of 30 Gy can be obtained with:
  - a single acute dose of 13 Gy
  - two fractions of 8 Gy
  - three fractions of 6 Gy
- a single dose of 27 Gy at low dose rate
- The radiation treatment should be administered within 2 days after surgery

Superficial Radiation Therapy (SRT) Post-Keloidectomy

- Kal HB, Veen BE. Keloid Dose and Fractionation Schemes
- A single acute dose of 13 Gy or 2 fractions of 8 Gy or 3 fractions of 6 Gy
- 51 patients with 62 keloids were treated with a BED 30 SRT protocol at 4 facilities from 3/2014 to 5/2016
- The follow-up period ranged from 6 weeks to 1 year
- No (0/62; 0%) recurrences
- Transient hyperpigmentation was most frequent AE

SRT ports for large keloid excision site treatment

- 12.7 cm diameter, 18 cm x 8 cm
- at 25 cm SSD, at 30 cm SSD

Superficial Radiation Therapy (SRT) Post-Keloidectomy

- Chest keloid Pre-excision
- 1 month post-excision and SRT 6 Gy on POD 1, 2, 3

Keloidectomy + BED 30 SRT

- 24 hours after keloid excision, a SRT biologically effective dose (BED) of 30 was achieved by using 1 of 3 protocols: 1 dose of 13 Gy or 2 fractions of 8 Gy or 3 fractions of 6 Gy
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- The follow-up period ranged from 6 weeks to 1 year
- No (0/62; 0%) recurrences
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In-Office SRT for Keloids
- 20 patients (21 keloids, 55% on ears) were excised, intraoperatively injected with platelet rich plasma, and treated with Superficial photon X-ray Radiation Therapy (mean cumulative dose 1682.4 cGy over 2–3 days) - 4 to 11 month follow-up
- No evidence of recurrence, as defined by marked erythema, induration and hypertrophy of the scar beyond the suture line
- As assessed by the Kyoto scar scale, 78% of sites were good/excellent, and 2 (9.5%) poor due to mild hypertrophy and warranted triamcinolone injections (10 mg/ml)
- Radiation induced hyperpigmentation was noted in all patients, but less so with 3 fractions of radiation

Superficial Radiation Therapy for the Prevention of Keloids After Shave Excision
- 69 days after shave excision of keloids allowing for secondary intention healing
- 3 treatments of SRT
- No recurrence
- Small study
- 5 month follow up

Superficial Brachytherapy and Post-Excision Keloid Recurrence
- 36 keloidectomy scars were treated with high-dose-rate superficial brachytherapy after keloidectomy – 20 Gy delivered in 3 or 4 daily fractions to 2 mm below from skin surface
- 9.7% (3/32) (19.4% ITT) keloid recurrence rate at a median follow-up period of 18 months (range, 9 to 29 months)

SRT for Keloids
- Jones, ME et al. Edorium J Otolaryngol 2015;2;14–19
- Superficial Radiation Therapy for the Prevention of Keloids After Shave Excision
- • 69 days after shave excision of keloids allowing for secondary intention healing
- • 3 treatments of SRT
- • No recurrence
- • Small study
- • 5 month follow up

Surgical Keloid Excision With/Without External Beam Radiation vs Brachytherapy
- • 10 year retrospective analysis
- • 264 excised keloids in 128 patients: 28 excised alone, 197 received post-excision EBRT (9-30 Gy over 1-10 daily doses) and 39 received post-excision HDR (6-12 Gy) interstitial Iridium-192 brachytherapy, all but 1 within 36 hrs post excision
- • 54% recurred post-excision alone (9m f/u)
- • 19% recurred post-excision + EBRT (42m f/u, p< .01)
- • 23% recurred post-excision + brachytherapy (42m f/u, p< .01)
- • Longer time to keloid recurrence after EBRT than after brachytherapy (mean difference of 2.5 years, p<.01)
- • No development of malignancy

Post-Keloidectomy e-Beam Radiotherapy
- Treated 91 keloids with by a combination of surgical excision and postoperative electron beam radiation 20 Gy: 5 Fractions (Ear: 16 Gy: 4 Fractions)
- 44% keloid recurrence rate (include symptoms)

Keloid Excision + Radiation: Fibrosarcoma 3.5 Years Later

- In 1963 a 23 yo woman received 22 Gy low energy (80 kV-rays) radiation after excision of keloids on her thigh
- 3 ½ years later a fibrosarcoma was found in that area
- Although keloidal tissue may have possibly underwent malignant transformation, the author noted that 3 ½ years may be too short for this to occur

Our Protocol

- Review treatment / no treatment options
- If recurrent keloid by history recommend excision followed by SRT
- Obtain referral for all procedures
- Excise on day 0 and use SRT on POD 1, 2, 3 each 6 Gy
- PO care use silicone gel

Superficial Radiation Therapy for NMSC

XRT of Basal Cell Carcinoma

- A 40 year review of the literature
- Pooled 4,695 patients with BCC
- Various Energies and Fractions
- Average five year cure rate: 91.3%
- Follow up 2-5 years

“Soft” XRT for Basal & Squamous Cell Carcinoma

- 1,267 lesions (1,019 BCC and 245 SCC and 3 mixed)
- Energy: 45 - 60 Gy
- Fractions: 9 - 10
- 5-Year Cure Rates - 94.8% BCC and 90.4% SCC
- 2.4% of all tumors recurred at the margin of the irradiated field
- Side Effects:
  - Hypopigmentation - 72.7%
  - Telangiectasia - 51.9%
  - Erythema - 44.3%
  - Hypertrophy - 23.4%

Superficial XRT vs Electron Beam NMSC Cure Rates

<table>
<thead>
<tr>
<th>Tumor Size (cm)</th>
<th>Superficial XRT Basal</th>
<th>Electron Beam Tx Cell (BCC)</th>
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<tbody>
<tr>
<td>&lt; 1</td>
<td>90% (68/75)</td>
<td>82% (1/12)</td>
</tr>
<tr>
<td>1 – 1.5</td>
<td>93% (96/100)</td>
<td>73% (8/22)</td>
</tr>
<tr>
<td>&gt; 5 cm</td>
<td>100% (4/4)</td>
<td>82% (4/5)</td>
</tr>
</tbody>
</table>

Mendenhall WM, Ambach M, Herman JW, Cogdell AA, Mendenhall NP. Radiation therapy for cutaneous squamous and basal cell carcinomas of the head and neck. Laryngoscope 2002; 112:2084-9
Surface Electronic Brachytherapy for NMSC
- 200 pts / 297 NMSC lesions
- 40 Gy Surface EBT in 8 5-Gy (50KeV max) fractions 2 /wk
- 16.5 months mean follow-up
- 1 Recurrence

SRT for NMSC – Our Experience
- Installed and inspected in June 2012
- Approximately 450 BCC & SCC treated to date
- SRT for about 10% of NMSC
  - Scalp, lower legs, nose
  - Elderly with co-morbidities
- On average 15 fractions, 3x per week
- No recurrences to date
- Good to excellent cosmesis

Simulation and Treatment
- A custom lead shield of 0.762 mm thickness is used to form a molded, custom shield with a port to correlate with lesion size, including treatment margin
- Additional shielding is used to protect sensitive, normal tissues (intranasal, intraoral, ear canal)
- Total dose of radiation calculated based on applicator size and total fractionation dose and divided into an average of 15 fractionations either 3 or 5 times a week

Squamous Cell Carcinoma
Right Nose Tip
- Biopsy 12/18/12
- Post Radiation #13 1/3/13
- Post Radiation 2/22/13

Squamous Cell Carcinoma
Left Anterior Tibial Lateral
- Simulation 7/20/12
- Post Radiation #14 8/24/12
- Post Radiation 3/27/13

Thank you!