Surface brachytherapy for squamous and basal cell carcinoma of the skin

Michael E. Kasper M.D. F.A.C.R.O.
Lynn Cancer Institute
Boca Raton Regional Hospital, USA

Potential Conflict of Interest Disclosure

• Consulting fees : Nucletron / Elekta
  – Training Sessions
  – Roundtable Discussions
Acknowledgements

- Physicians:
  - Tim Williams
  - Rashmi Benda
  - Jeffrey Fromowitz
  - John Strasswimmer

- Physicists:
  - Zoubir Ouhib
  - Jeremy Cole
  - Charles Shang

- Dosimetrists:
  - Amy Schramm
  - Regina Girouard
  - Erica Bode

Skin Function

- First line of defense; keeps body in homeostasis - protects from germs, dehydration, injury.
- Regulates body temperature
- Protects from UV radiation
- Synthesizes Vitamin D
- Temporary storage of glucose, fat, water and salt.
- Can absorb chemical substances (e.g. Nitroglycerin patch, ointment for rashes, pain patches, etc.)

- Site of many nerve endings/ major sensory organ

Scope of the problem

• 1 in 5 Americans will develop skin cancer in their lifetime.

• Annual new cases exceed totals of breast, prostate, lung and colon cancers.

Estimated Skin Cancer Incidence

• Basal cell ca: > 2,800,000
• Squamous cell ca: > 700,000
• Malignant Melanoma: > 76,000
Basal Cell Carcinoma

- Nodular BCC
- Sclerosing BCC

Squamous Cell Carcinoma
Role of radiotherapy in the management of skin cancer

What is the role of radiotherapy in the management of skin cancer?

- Dermatology controls the skin cancer patients
- Radiation oncology controls radiotherapy (changing?)
- Data suggest that when multidisciplinary teams including dermatologists and radiation oncologists are involved in the treatment of NMSC patients in 19% of cases radiotherapy is prescribed (Culleton 2011)

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Synovate current situation</th>
<th>Multidisciplinary team, Culleton 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>excision</td>
<td>45%</td>
<td>31%</td>
</tr>
<tr>
<td>Moh's surgery</td>
<td>24%</td>
<td>24%</td>
</tr>
<tr>
<td>ED&amp;C</td>
<td>24%</td>
<td>4%</td>
</tr>
<tr>
<td>topical</td>
<td>7%</td>
<td>11%</td>
</tr>
<tr>
<td>RT</td>
<td>1-2%</td>
<td>19%</td>
</tr>
<tr>
<td>observation</td>
<td>7%</td>
<td></td>
</tr>
<tr>
<td>None/other</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

Indications to Consider RT

- Fixation to underlying structures, i.e. cartilage or bone
- Perineural involvement
- Poorly differentiated subtypes
- Recurrent disease
- Positive margins
- Infiltrative growth patterns
- Rapid growth

Indications to Consider RT

- **Challenging anatomic locations**
  - Larger, less well demarcated lesions of the nose, ears or lips
  - Pre-tibial skin in patients with PVD

- **Patients with surgical contraindications**
  - Co morbidities
  - Blood thinners
  - Lower extremities in diabetics
Brachytherapy applicators for skin cancer

Skin Applicators
Leipzig Applicators

- Inner diameters of 1, 2, and 3 cm
- SSD of approx 15 mm
- 1 mm thick plastic cap
- Fixed diameter, tungsten steel surface applicators
Electronic Brachytherapy

Electronic Brachytherapy is a method of radiation therapy using an electrically generated source of ionizing radiation to deliver a radiation dose at a distance of up to a few centimeters by intracavitary, intraluminal or interstitial application, or by applications with the source in contact with the body surface or very close to the body surface.

Axxent Skin Applicator System
Axxent Skin Applicator System

- Applicator development of 10mm, 20mm, 35mm, 50 mm
- Xray source: 50 kV
- Stainless Steel:
  - Easily sterilizable
  - Applicator cone and source channel (shown with V-Groove SC)
  - Flattening filter integrated in Cone

ESTEYA
Esteya applicator size options

10mm  15mm  20mm  25mm  30mm

Esteya Specs

• The system uses electronically generated X-rays through a small end-window type X-ray source, proprietary design
  -- Dose rate: 2.7 Gy / min @ 3mm
  -- X-ray source operating range: 69.5 kV
  -- X-ray radiation, defined by x-ray source; with 69.5 kV and the 1.6 mm Aluminium filter at an SSD of 60 mm.
  -- Source maintenance interval: 4,000 fractions
  -- Dose profile designed to mimic HDR Valencia
Treatment Margins

- 4mm – low risk lesions
- 6mm - high risk lesions
- Minimum margin necessary to achieve >95% tumor clearance by Mohs surgery
- Zitelli and Brodland

Risk Stratification

- Zitelli and Brodland criteria for high risk
  - Tumor diam > 2 cm
  - Mod or poorly diff histology
  - >2mm subcutaneous tissue invasion
  - High risk locations
    - scalp, nose, ears, lips, and eyelids
Depth Dose Considerations

![Graph showing PDD Skin normalized to 3mm for different depths and x-ray energies.]

Beam Profile

![Graph showing beam profile for different applicators and distances.]

- 520 pts. since 1987
- Sites: skin of face, oral cavity, perianal and external genitalia
- Mostly BCC and SCC of the skin but also others
- Dose: 30 to 40 Gy in 5 to 10 Gy fx, once or twice/wk
- 92% local control rate; no severe late reactions

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Gauden, S. et al. BRACHY Vol 7, April 2008

- 85 pts / 92 lesions tx’ d with the Leipzig Applicator
- Histology – 43 BCC, 41 SCC, 1 Merkel Cell
- Sites – 78 H&N, 10 Extremity and 4 trunk
- Dose – 36 Gy / 12 fx
- Median F/U – 37 mo
- Local Control – 90/92 (97%)
- Cosmesis – good to excellent 81/92 (88%)
- Late hypopigmentation in 10 pts (11%)
Valencia Data

- 33 pts / 48 lesions (45 BCC, 3 Bowens)

- Median F/U 47 mo (range 31-60 mo)
  - 93% of pts had at least 36 mo f/u

- Gr 1 or less toxicity in all but 1 case
  - The Gr 2 case took 2 months to resolve

- 47/48 lesions NED with Median F/U 47 mo

Electronic Brachy Tx Results

Bhatnagar, A. BRACHY:2013

- 122 patients with 171 NMSC lesions were treated with EBS (Xoft)

- 40 GY / 8 fractions

- No recurrences after a mean f.u. of 10 months (range 1-28 months)

- 46 lesions (42 patients) had a f.u. of more than 1 year

- Cosmesis was excellent in 93% and good in 7%

Acute Effects

SCC Treated with Valencia App

1 wk s/p 42Gy/6 Valencia

1 WEEK POST
BCC of Lower Lip

3 wks s/p 42Gy/6fx

BCC of Lower lip

2 mo S/P 42 Gy / 6 fx
SCC Pre-tibial skin

3mo s/p 42 Gy/6 fx

LATE EFFECTS /RESULTS
BCC Left Nose
5 yrs, 3 mo s/p 42 Gy/6 fx

Nodular BCC of Forehead
NED 30 mo S/P 42 Gy/6 fx
Nodular BCC

NED 28 mo
S/P 42 Gy / 6 fx

SCCA Left Medial Ankle
Pallor 29 mo s/p 42Gy/6 fx
Skin Surface Flaps and Molds

Catheter Flap
Surface Mould

Freiburg Flap
Freiburg Flap

Silicone rubber applicator material

- 5 mm distance between catheter plane and skin
- Predrilled holes 1 cm apart for embedding HDR catheters
- Can easily be cut to size to fit lesion
- Use 2 cm beyond lesion in all directions

HDR Surface Molds and Flaps Characteristics

- HVL for IR-192 is 3 mm Pb, allowing easy shielding selected areas of treatment field

- Treats more superficially than electrons

- Faster dose fall-off than superficial X-rays (100kVp)
HDR Surface Molds and Flaps: Advantages

- Conforms easily to curvature of skin
- Optimization algorithms are used to improve dose homogeneity at depth
- Improved radiation safety profile relative to LDR
- Can be useful for sites other than skin, i.e., certain H&N sites and IORT

Large SCCA of Pretibial Skin
CT Planning
SCCA skin of left triceps region

4 wks s/p 42 Gy/7 fx  5 mo s/p 42 Gy/7 fx
Interpret post-RT biopsies with caution

- False positives occur due to delayed tumor regression
- False negatives can occur due to sampling error (less likely for skin)
- Indeterminate biopsies are common showing radiation effect in residual tumor of uncertain viability
- Best to wait until clear progression to biopsy

Thank you

- Questions?
Case study

76 y.o gentleman with hx. of enlarging lesion over 7 mo. Had been excised 3 times over past 2 yrs.

Now described by Derm. as 2cm with poorly defined borders.

After 3 stages of Moh’s, still pos margins and exposed periostium. Prob perineural invasion confirmed by Path consultants at UCSF.

Large Flap reconstruction making area at risk difficult to assess

Large SCC S/P Mohs and Flap
SCC Scalp S/P Mohs: Simulation

CT Planning 3-D Reconstruction
Treatment Planning

SCC Scalp S/P Mohs and Flap

10 days s/p 40Gy/10 fx