Case Study: Dilemma-Pregnant Non-Compliant Pt. with Sarcoma...HDR to the Rescue!!!!!!

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Disclosure

- There are no disclosures to report
University of Maryland Dosimetry Division

Dosimetrists Rock!
Objective

- Etiology of Epithelial Sarcoma
- Staging
- Treatment options-surgery and radiation
- Prognosis
- H&P
- Role of Brachytherapy
- Implementation of HDR and challenges faced
- Follow-up

Etiology

Epithelioid sarcoma

- rare soft tissue sarcoma in young adults age 20-39 years of age
- usually arise in the upper extremities 60% of the time
- in a large retrospective study the mean age of presentation was 27 years
- tumor is more common in males (1.8:1) but more favorable prognosis in female population
- most common primary site of involvement was found in hands and forearm
- Involves the tendons, subcutaneous tissue and fascia invading large vessels and nerves
Staging

The stages of sarcoma are:

Stage I
- Stage IA tumors are 5 cm or smaller (T1).
- They can be superficial (T1a) or deep (T1b).
- The cancer has not spread to lymph nodes (N0) or more distant sites (M0). Stage IA tumors are low grade (G1) or the grade is unknown (GX).
- Stage IB is the same as stage IA except the primary tumor is larger than 5 cm (T2).

Stage II
- Stage IIA tumors are 5 cm or smaller (T1), have not spread (N0, M0), and are either intermediate (G2) or high (G3) grade.
- Stage IIB tumors are larger than 5 cm, have not spread, and are intermediate grade (G2).

Stage III
- The primary tumor is larger than 5 cm (T2), has not spread (N0, M0), and is high grade (G3). Stage III tumors can also be of any size or grade and spread to lymph nodes (N1, M0).

Stage IV
- These sarcomas can be of any size or grade and have spread to distant sites (M1).

NCCN Guidelines

NCCN staging for Sarcoma of the limb
Surgery usually the primary treatment option

Chart 2.1.1 Treatment options

<table>
<thead>
<tr>
<th>Primary treatment</th>
<th>Surgical results</th>
<th>Adjunct treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgery</td>
<td>Margins 1 cm or fascia not cut</td>
<td>Start Care after treatment</td>
</tr>
<tr>
<td></td>
<td>Margins 2 cm and fascia were cut</td>
<td>Stage IA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Start Care after treatment, or</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Consider radiation therapy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stage IB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Consider radiation therapy</td>
</tr>
</tbody>
</table>
Treatment options

- Wide surgical resection remains the most recommended choice of treatment
- With 77% recurrence rate, amputation is likely to be considered
- Chemotherapy agents such as doxorubicin have been administered for large >5cm multifocal disease
- External Radiation therapy is considered for limb salvage with comparable outcomes to amputation – late effects may include scarring, stiffness, neuropathy

Prognosis

- 5 year survival rate is approximately 50-70%
- 10 year survival rate is approximately 42-55%
- Gender has demonstrated more favorable outcome in large studies for female patients
- Distal lesions tend to have better outcome than proximal lesions
- Tumors > 2 cm with vascular invasion correlate with poorer outcome
History & Physical

- 24 Year old Female African American
- Malignant neoplasm of connective and soft tissue origin of right upper limb to include shoulder
- High grade epithelioid sarcoma
- s/p wide local excision
- Patient presents for Radiation Oncology consult pregnant-
- Other presenting factors- schizophrenic disorder, mentally non-compliant
- Course of treatment altered from External beam irradiation to brachytherapy due to pregnancy and non-compliance

Course of Treatment

Multi-disciplinary approach with Surgical Oncologist and Radiation Oncologist
- Surgical resection with HDR catheter placement
- Brachytherapy
- Early Induction of labor/delivery
- External beam irradiation XRT
Initial Treatment-Surgical Resection

This case required multi-disciplinary approach with Surgical Oncologist and Radiation Oncologist.

1. Wide resection performed
Surgery

Tendons spared during wide resection

[Surgical placement of HDR Catheters]

HDR catheters are placed strategically intra-operatively- note buttons utilized to lock catheters preventing possible migration
Resection flap re-attached over catheters with ports to monitor pulse and temperature.
Brachytherapy Rationale

Due to pregnancy XRT is not recommended ……

**BRACHYTHERAPY TO THE RESCUE!**

- Use of short range radiation-sources placed directly at site of cancerous tumor *(resected surgical bed)*
- High dose localized irradiation with reduced probability of damage to surrounding normal, healthy tissue *(fetus)*
- Can be used in an interdisciplinary approach with surgery
- Treatments are administered quickly *(non-compliant schizophrenic pt.)*
- Course of brachytherapy can be delivered with fewer visits as compared to XRT *(Pt. admitted to psych unit)*

HDR Facts

- Iridium 192 is the radioactive isotope utilized
- Source is housed in an afterloader device
- Transfer channel tubes are utilized to connect the catheters from the tumor to the afterloader device
- Each numbered transfer tube is inserted into the subsequent position number on the afterloader faceplate
- Customized treatment plan is created via Dosimetry to adequately irradiate the tumor
- Plan information i.e. catheter position, dwell times, etc. is sent electronically to the afterloader device
HDR Afterloader

HDR Equipment
**HDR Workflow**

- Catheters are placed intra-operatively in the tumor bed/cavity
- Series of CT images are acquired to delineate catheters and gross disease
- Images are imported into dedicated TPS for brachytherapy planning
- Radiation Oncologist contours targeted disease along with normal organs/structures
- Dosimetrist utilizes TPS to reconstruct each catheter- tip end position being crucial
- Customized dose optimization plan is created to best irradiate target while sparing ROI's
- After physician approval, Physics performs thorough QA before plan is exported to Afterloader workstation
- Physicist performs a QA and warm-up of afterloader device and workstation
- Time out procedure and patient identification is performed in HDR suite
- Physicist and physician verbally confirm each catheter and dwell time in plan
- RTT obtains fluoroscopic image set for confirmation of catheters
- Physician connects transfer tube as corresponds to plan position number into afterloader faceplate
- Treatment is administered

**HDR Game Plan**

- Multi-disciplinary team approach to treatment
- Care for resection site housing catheters
- Treatment position reproducibility
- Efficient methodology for catheter position confirmation
- Care for vented patient during initial simulation
- Management for patient’s psych needs during actual treatment
- Safety/protection for unborn fetus during “dwell time on”
Our patient came to department vented with affected arm in a cast

**HDR Directive**

Radiotherapy Prescription (HDR)

<table>
<thead>
<tr>
<th>Treatment Site:</th>
<th>Right AC fossa (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Dose (cGy):</td>
<td>1700</td>
</tr>
<tr>
<td>Fraction Dose (cGy):</td>
<td>340</td>
</tr>
<tr>
<td>Number of Fractions:</td>
<td>5</td>
</tr>
<tr>
<td>Daily # of Fractions(1):</td>
<td>1</td>
</tr>
<tr>
<td>Weekly # of Fractions(2):</td>
<td>5</td>
</tr>
<tr>
<td>Second Calculation(3):</td>
<td>0</td>
</tr>
<tr>
<td>Energy / Modality:</td>
<td>18 MEV</td>
</tr>
<tr>
<td>Applicator Type and Dimensions:</td>
<td>50 cm HDR catheters with bumper</td>
</tr>
<tr>
<td>Depth/Target/Plan:</td>
<td>0.5 cm - PTV</td>
</tr>
<tr>
<td>Resident Name (if any):</td>
<td>[Redacted]</td>
</tr>
<tr>
<td>Re-assess @ Dose (cGy):</td>
<td>Single fraction on PM of 11-8 then BB and until 11/10</td>
</tr>
<tr>
<td>Special Instructions:</td>
<td>SHIELDING AROUND ARM - OSLDs with FRACTIONS</td>
</tr>
<tr>
<td>Revisions (with Date):</td>
<td>[Redacted]</td>
</tr>
</tbody>
</table>

Additional Comments: Planned initial brachytherapy boost per Sarcoma MDT/Dosimetry Board. May follow with EBRM later in course following healing.
**HDR Planning Goals**

- Treatment Planning Comments:
- Critical Organ Contours for Planning:
- Target Coverage Planning Goals:

<table>
<thead>
<tr>
<th>Target</th>
<th>Constraints</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTV (plane=mm)</td>
<td>D95 &gt; 93% V150 &lt; 60%</td>
<td>(identify any change from guidelines)</td>
</tr>
</tbody>
</table>

- Critical Organ Dose Constraint Goals:

<table>
<thead>
<tr>
<th>Organs At Risk</th>
<th>Constraints</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bladder</td>
<td>V150 &lt; 45%</td>
<td>(identify any change from guidelines)</td>
</tr>
<tr>
<td>Rectum</td>
<td>V150 &lt; 50%</td>
<td>(identify any change from guidelines)</td>
</tr>
<tr>
<td>Vascular anastomosis as identifiable</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Attending Physician Attestation:**

Above listed procedures, isodose planning and additional services are ordered in accordance with applicable departmental guidelines and policies.

I personally developed this treatment plan, and I agree with the contents of this document.

This document has been electronically signed and approved, in its entirety, by:

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**HDR Source**

- Indium-192 ($^{192}$In)
- $\gamma$-rays
- 73.8 days
- 0.30 MeV (mean)

**University of Maryland Medical Systems**

**Treatment Unit**

- Treatment unit name: $\mu$Ci v3 (18)
- Treatment unit type: MicroSelectron v3
- Source: 192-Io-HDR-u2
- Isotope: I-192
- Air kerma rate constant (cGy cm$^2$/h/mCi): 4.082

**Calibration data**

- Calibration date/time: 19 Oct 2017 12:00:00
- Air kerma strength (cGy cm$^2$/h): 40330.00
- Apparent source activity (Ci): 11.63978
HDR Catheter Delineation

Each catheter was tracked and contoured

HDR Catheter Index

The final plan achieved 9 catheters with various measured index lengths

<table>
<thead>
<tr>
<th>Applicator Details</th>
<th>Catheter Length (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catheter #1</td>
<td>1487</td>
</tr>
<tr>
<td>Catheter #2</td>
<td>1496</td>
</tr>
<tr>
<td>Catheter #3</td>
<td>1459</td>
</tr>
<tr>
<td>Catheter #4</td>
<td>1460</td>
</tr>
<tr>
<td>Catheter #5</td>
<td>1464</td>
</tr>
<tr>
<td>Catheter #6</td>
<td>1469</td>
</tr>
<tr>
<td>Catheter #7</td>
<td>1485</td>
</tr>
<tr>
<td>Catheter #8</td>
<td>1489</td>
</tr>
<tr>
<td>Catheter #9</td>
<td>1494</td>
</tr>
</tbody>
</table>
Final plan had the following dwells

HDR Plan Report

Universities of Maryland Medical System

<table>
<thead>
<tr>
<th>Catheter (channel) Times</th>
<th>Sister positions</th>
<th>Channel length (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/1</td>
<td>16</td>
<td>1</td>
</tr>
<tr>
<td>1/2</td>
<td>16</td>
<td>1</td>
</tr>
<tr>
<td>1/3</td>
<td>16</td>
<td>1</td>
</tr>
<tr>
<td>1/4</td>
<td>16</td>
<td>1</td>
</tr>
<tr>
<td>1/5</td>
<td>16</td>
<td>1</td>
</tr>
<tr>
<td>1/6</td>
<td>16</td>
<td>1</td>
</tr>
<tr>
<td>1/7</td>
<td>16</td>
<td>1</td>
</tr>
<tr>
<td>1/8</td>
<td>16</td>
<td>1</td>
</tr>
</tbody>
</table>

DVH statistics for PTV coverage and Joint sparing

HDR Plan Report
HDR Plan Report

Isodose distribution

HDR Physics QA

Physics performs a thorough QA
- Catheter position- tip end confirmation
- Dwell time appropriateness
- Independent second calculation

<table>
<thead>
<tr>
<th>Name</th>
<th>X (mm)</th>
<th>Y (mm)</th>
<th>Z (mm)</th>
<th>Abs. Dose (Gy)</th>
<th>Rel. Dose (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYSICIST</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>100.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>
HDR Treatment

Before patient arrives in the HDR suite the following tasks are adhered to:

- QA of afterloader and workstation via Physics
- Pre-procedure review

State regulations require patient identification and room survey.
The most important aspect in the treatment delivery was reproducibility and keeping dose to abdomen/fetus to a minimum!

Once all sources had delivered their respective dose a post procedure report was completed.
HDR Treatment

The in-vivo diode readings were obtained with better than acceptable results for minimal dose to abdomen

Special Dosimetric Measurement Summary
(PATIENT In-Vivo)

<table>
<thead>
<tr>
<th>Date of Measurement</th>
<th>Measurement Specific Details</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/8/2017</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Diagnosis: Primary G59.11 - Malignant neoplasms of connective and soft tissue of right upper limb, including shoulder. High grade epithelioid sarcoma s/p wide local excision with HDR catheter placement intraop in pregnant female patient. Diagnosed 10/18/2017 (Active)

Special dosimetric measurement is requested for the above named patient and performed according to the parameters described below:

- **Date of Measurement**: 1/8/2017
- **Device Type**: OSLD NanoDot
- **Entire Plan or Field #**: Current Plan
- **Measurement Location**: Abdomen anterior, Middle, Inferior, Right and Left
- **Expected Dose (cGy)**: N/A
- **Measured Dose (cGy)**: 0.03 (0.0x0.0x0.19)
- **Ratio (Mux/Exp)**: 0
- **Expected Uncertainty**: ±10%

Follow-up

Post surgical and brachytherapy follow-up

- Post surgical wound infection requiring incision and drainage of abscess along with antibiotics- healed within first month post-op
- Limited mobility in thumb and first 2 fingers- related to muscles that were resected
- Good mobility of last 2 fingers
- Intermittent swelling in hand- resolved with activity and elevation
Follow-up

Patient is now 5 months post RT follow-up

• Pt and mother declined early induction of labor
• Declined XRT after delayed delivery
• Pt received 2/3 of normal adjuvant dose via brachytherapy
• Baby well- no evidence of abnormalities attributed to RT
• Pt, mother, and baby relocated to NYC
• Surveillance at this point

Outcome

• Multi-disciplinary collaboration resulted in a favorable outcome for this patient
• Surgical resection was achieved with minimal post-operative sequela
• Brachytherapy was administered as planned with substantial dose delivery despite patient declining XRT
• Minimal radiation dose to fetus during treatment
• Baby was born healthy with no RT side effects
• No amputation was necessary-good dexterity thus far
Thank you to the amazing staff at UMMC for always thinking outside of the box!!!

DR. JW Snider
Radiation Oncologist

Dr. Byungyong Yi
Medical Physicist

Felita Christie CMD
Medical Dosimetrist

Kristin Knudt CMD
Medical Dosimetrist

Questions