Integration of Particle Therapy into the Daily Clinical Routine in the Hospital: Just Another Tool or a Universal Solution?

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To the job right, you need the right tool!
Some jobs require hammers!
Some jobs require screw drivers !!!!
Some jobs require kV photons or MV electrons!

Pre-Rx

1 year after 70 Gy/35 fx
9 MeV electrons plus bolus
Some jobs managed very well with 3D conformal XRT!
Some jobs managed better with IMRT!
Protons reduce integral dose, although for some patients this may not be critical.
For 18 year old girl with unresectable osteosarcoma, protons were CRITICAL for normal tissue sparing
C2 Chordoma

77.4 Gy RBE

19.8 Gy IMRT + 57.6 Gy RBE 3-D protons

For others, the best plan employs photons and protons!
Compared pure proton, pure IMRT photon (PTV 1 or 3 mm), and mixed modality plans with protons and photons in 5 patients with skull base chordoma.

Conclusions: There are dosimetric advantages to using either IMRT 1 mm or proton plans, with the combined photon/proton plans yielding the best target coverage and conformality.
Particles: Another Tool

• Hence, particles perhaps best viewed as another tool that we can use to optimally manage patients
• How can we best integrate its use into the operation of a radiation oncology department?
  – Physical location of the facility
  – Process for selection and intake of patients
  – Treatment planning
  – Treatment delivery
Location, Location, Location

• Ideally sited in the medical center
  – Access to Radiation Oncology department
    • MDs, CT simulators, Linacs
    • QA: establish parallel processes
  – Anesthesia, diagnostic radiology (i.e. lumbar instillations)
Patient Selection/Intake

• Establish list of patients/protocols to guide intake coordinators

• System to gather and screen patient intake materials
  – MD review → Proton Rounds → Patient accepted
  – Intake sheet to intake coordinator/scheduler
    • Treatment plan outline with # of photon/proton fractions
    • Immobilization parameters
    • CT simulation parameters (i.e. oral, iv contrast)
    • Start date (i.e. if specific date mandated by research protocol, such as within 30 days of surgery)
Treatment Planning

- Immobilization devices compatible with both photons and protons
- Standardized acquisition of CT planning data
- PACS to push diagnostic scans to planning stations
- Treatment planning system that can integrate photon and proton treatment plans
Treatment Delivery

- Coordination/scheduling of photon/proton fractions
  - Photon fractions in reserve
- Comparable degrees of image guidance for photon/protons
FHBPTC Equipment Areas

- Nozzle
- Snout (with aperture & bolus)
- 6-axis patient positioner
- Gantry 1

Cyclotron and Beam Lines

- 11/7/01 (TR1)
- 5/27/03 (TR2)
- 4/1/02 (TR3)
- 1/04
- 7/26/06
Francis H. Burr Proton Therapy Center

• Equipment
  – Cyclotron 230 MeV (IBA)
  – 3 Treatment rooms
    • Two 360° rotational gantries (Double scattered)
    • Fixed horizontal beams room
      – Eye station- Degraded 70 MeV beam
      – STAR ( single scattered)
  – Experimental room
    • Horizontal beam
STAR: Stereotactic Assisted Radiosurgery/Therapy

- STAR
  - Radiosurgery
  - Fx radiotherapy
- Unique facility optimized for cranial fields treatments
Burr Proton Therapy Center

• First patient treatment: November 8, 2001

TREATMENT STATISTICS

• First year 11/01-10/02: 208 patients
• Second year 11/02-10/03: 366 patients
• Third year 11/03-10/04: 404 patients
• Fourth year 11/04-10/05: 509 patients
• Fifth year 11/05-10/06: 602 patients
• Sixth year 11/06-10/07: 621 patients
• Seventh year 11/07-10/08: 818 patients
• TOTAL 3528 patients
Department of Radiation Oncology MGH

- Average daily patient treatments
  - Photon: 190
  - Proton: 60

- F. H. Burr Proton Therapy Center
  - 818 patients 11/107-10/31/08
    - Adult patients: 732, 89%
    - Pediatric patients: 86, 11%
### Francis H. Burr Proton Therapy Center

<table>
<thead>
<tr>
<th>Category</th>
<th>Patients</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>CNS</td>
<td>294</td>
<td>36%</td>
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<tr>
<td>Eye</td>
<td>157</td>
<td>19%</td>
</tr>
<tr>
<td>Bone/Soft Tissue</td>
<td>97</td>
<td>12%</td>
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<tr>
<td>Prostate</td>
<td>80</td>
<td>10%</td>
</tr>
<tr>
<td>Head/Neck</td>
<td>56</td>
<td>7%</td>
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<tr>
<td>Skull Base</td>
<td>55</td>
<td>7%</td>
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<tr>
<td>Lung</td>
<td>8</td>
<td>1%</td>
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<tr>
<td>Liver</td>
<td>4</td>
<td>0.5%</td>
</tr>
<tr>
<td>Other</td>
<td>67</td>
<td>8%</td>
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</tbody>
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Proton Clinical Research

- **Prostate:** Drs. Shipley, Zietman, Coen, Efstathiou
- **Pediatrics:** N. Tarbell MD, T. Yock MD, S. Macdonald MD
- **Brain/CNS:** J. Loeffler MD, H. Shih MD, K. Oh MD
- **Head/Neck/Sinus:** P. Busse MD, N. Liebsch MD, A. Chan MD
- **Gastrointestinal:** Ted Hong, MD
- **Gynecologic:** Anthony Russell, MD
- **Sarcoma:** T. DeLaney MD, Y-L Chen MD, PhD
- **Thoracic:** N. Choi, MD, H. Willers
- **Eye:** Y-L Chen MD, H. Shih MD
- **Breast:** A. Taghian, MD, S. Macdonald MD
- **Statistics:** B. Yeap PhD
Proton Clinical Research

• “Optimizing Proton Radiation Therapy”
  • NCI program project grant with MD Anderson
  • Funded through 8/31/2013

• Project 1: Non-Small Cell Lung Cancer
  • Central Early Stage: 87.5 GyRBE/35 fx of 2.5 GyRBE
  • Locally Advanced: 74 Gy IMRT vs. 3D Proton ChemoRT

• Project 2:
  • Pediatric: Medulloblastoma, Rhabdomyosarcoma, QOL
  • Adult: Liver, Paranasal sinus, Spine/Skull base
Proton Therapy Program Project
MGH/MD Anderson

• Project 3: Reducing Range Uncertainties in Proton Radiation Therapy