Proton therapy patterns of care among pediatric and adult patients with CNS tumors

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Background

- Proton therapy (PT) is associated with reduced integral dose to normal brain tissue (Figure 1). While preliminary data is evolving on the efficacy of PT for CNS tumors, little is known regarding which CNS patients are treated with PT.
- We hypothesized that a large proportion of CNS patients treated with PT are young (pediatrics: ≤18 years, young adults: 19-40 years) given the longer life expectancy over which they are at risk for CNS toxicity.

**Figure 1.** (a) Photon intensity-modulated RT (IMRT) plan and (b) proton pencil-beam scanning (PBS) plan for a 5-year-old boy with ependymoma.

Methods

**Cohort:** 1295 patients with diagnosis of primary brain tumor treated with PT between 2009-2017 at 8 academic and community PT centers in the United States
- Patients enrolled onto prospective Proton Collaborative Group (PCG) registry
- Excluded patients with spine tumors (n=8)
- Pathology locally reviewed and classified as per 2007 WHO classification of tumors of the CNS
- Age categorized as
  - Pediatrics: ≤18 years
  - Young adult: 19-40 years
  - Adult: >40 years

**Statistical considerations**
- Descriptive analysis: relative proportion of WHO classification of tumors by age category

Results

**Table 1. Characteristics of patients with CNS tumors treated with PT.**

<table>
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<tr>
<th>Age at RT, median (range, years)</th>
<th>30.7 (0.73-92.2)</th>
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**WHO classification of tumors**
- Astrocytic tumors
- Tumors of the meninges
- Embryonal tumors
- Ependymal tumors
- Tumors of the sellar region
- Oligodendroglial and oligoastrocytic tumors
- Tumors of the pineal region
- Other

**Race**
- White: 1020 (78.8%)
- African American: 240 (18.3%)
- American Indian or Alaska native: 9 (0.7%)
- Pacific Islander: 3 (0.2%)
- Other/unknown: 141 (10.9%)

**Sex**
- Male: 680 (52.5%)
- Female: 614 (47.5%)

**Proportion of Age Group**
- Pediatrics (≤18 years): 489 (37.8%)
- Young adult (19-40 years): 288 (22.3%)
- Adult (>40 years): 517 (39.9%)

**Proton radiation timing and intent**
- PT used more frequently at initial diagnosis (67.3%) than recurrence (32%). Timing was unknown in n=7 (0.5%)
- N=184 (14.2%) had prior radiation
  - Astrocytic tumors (35.3%)
  - Tumors of the meninges (27.2%)
  - Oligodendroglial and oligoastrocytic tumors (10.3%)
- N=19 (1.5%) treated with palliative intent
  - 5 at initial diagnosis (26.3%)
  - 14 at recurrence (73.7%)

**Cranial-spinal irradiation (CSI)** (Figure 2)
- N=195 (15.1%) treated with CSI
  - Embryonal tumors (71.3%)
  - Tumors of the pineal region (16.9%)
  - Ependymal tumors (4.1%)
- CSI use by age category
  - Pediatrics (63.6%)
  - Young adult (30.3%)
  - Adult (6.2%)
- CSI use remained relatively constant over time

**Figure 2.** Bar chart of number of CNS patients treated with proton therapy over time, categorized by receipt of cranial and spinal irradiation (CSI) or not. Note that PT centers joined the PCG registry at different times, which in part contributes to the increased number of patients treated over time.

**Summary and conclusions**

- Primary brain tumor patients treated with PT are young, with the majority treated for relatively favorable tumor types
  - Likely reflects selection of patients that may derive the greatest benefit from reduction in brain dose
- A wide variety of tumors are being treated with PT
- PT is used in a notable minority of patients for recurrent disease
  - Approximately 15% of patients had prior RT
  - PT likely used to minimize dose to adjacent cranial structures in light of re-treatment
- Additional studies including comparison of tumor types among CNS patients treated with photons are warranted

**References**