Characterizing the Treatment and Risk Factors Impacting Outcomes and Spinal Deformity for Pediatric Neuroblastoma

Hilary M. Wright, MS,1 Tanu A. Patel, BS,2 Lydia W. Ng, MD,3,7 Kenneth Wong, MD,3 Lindsay M. Andras, MD,4 Araz Marachalian, MD,5 Erin N. Kiehna, MD6

1 Tulane University; School of Medicine, New Orleans, LA
2 University of Southern California; Keck School of Medicine, Los Angeles, CA
3 Department of Radiation Oncology, Keck School of Medicine of USC, University of Southern California, Los Angeles, CA
4 Department of Orthopedic Surgery, Children’s Hospital Los Angeles, Keck School of Medicine of USC, University of Southern California, Los Angeles, CA
5 Division of Hematology, Oncology and Blood and Marrow Transplantation, Department of Pediatrics, Children’s Hospital Los Angeles, Keck School of Medicine, University of Southern California, Los Angeles, CA
6 Medical Director, Pediatric Neurosurgery, Hemby Children’s Hospital, Novant Health
7 Department of Radiation Oncology, Mayo Clinic and Foundation, Rochester, MN

Poster #42129
Disclosures

• None
Introduction

• Historically, long-term survivors of neuroblastoma have a high incidence of spinal deformity, approaching 76%; this is often attributed to paraspinal/intraspinal disease, asymmetric radiotherapy, and instability post-laminectomy

• Our goals are to:
  
  • Assess the modern incidence of spinal deformity in patients with neuroblastoma undergoing multimodality treatment
  
  • Identify risk factors for the development of spinal deformity (i.e. degree of invasiveness, tumor site, treatment modality)
  
  • Identify risk factors impacting long-term functional outcomes (i.e. degree of scoliosis, symptomatic deficits-motor, sensory, gastrointestinal/genitourinary)
Methods

• IRB approved retrospective analysis of children <15 years diagnosed with neuroblastoma at Children’s Hospital Los Angeles (CHLA) from 2000 to 2016

• Minimum follow-up of 1 year

• Variables:
  • Patient sex, age at diagnosis, and age at most recent follow-up
  • Tumor pathology (INSS)
  • Treatment
  • Modified McCormick Scale at presentation and follow-up
  • Cobb angles at presentation and follow-up
    • Serial upright x-rays were used when available and/or CT scans or spine MRIs
Results

Neuroblastoma patients treated at CHLA (n=488)

- Excluded patients (n=280)
- Neuroblastoma patients included in study (n=208)
  - Laminectomies/laminoplasties (n=19)
    - Chemotherapy and Radiation (n=7)
      - Chemotherapy (n=8)
    - Neurosurgery Only (n=4)
  - Paraspinal disease not requiring neurosurgery (n=189)
    - Chemotherapy and Radiation (n=110)
      - Observation Only (n=40)
    - Chemotherapy (n=39)

Figure 1. Flow chart of neuroblastoma patients treated at a single institution between January 2000 and June 2016 by treatment modality.
Results

• We identified 208 patients, median age = 2.6 years (range 0 - 14.6 years) diagnosed with neuroblastoma

• We assessed tumor and treatment related variables for a correlation between these variables and outcomes
  • Median follow-up = 4 years, range 1-17 years

• Tumor staging, risk stratification, and adjuvant intensity-modulated radiotherapy did not impact spinal deformity; nor did age at laminectomy, junctional laminectomy, or segment length
Results

• Nineteen of the 208 (9%) patients had undergone laminectomy for epidural disease and spinal cord compression, and of these 47% (9/19) developed scoliosis.

• Of the 81% (189/208) that did not have a laminectomy for epidural disease, only 5% (10/189) developed scoliosis.

• Patients with a laminectomy were significantly more likely to develop scoliosis (p<0.01).

• For patients requiring a laminectomy, there was a significant increase in Cobb angle between pre and post-operative measurements (p=0.013).
  • Mean curve at diagnosis = 4.26
  • Mean curve post-laminectomy = 13.84 (max curve 62°)
Results

- The mean preoperative Cobb angle for patients undergoing laminectomy was 4.26 compared to 13.84 post-laminectomy (range 0-62, p=0.013)

- Patients with laminectomies were also significantly more likely to have functional impairment (MMS II-IV), p<0.01
  - 9/19 (47%) of patients with laminectomy
  - 11/189 (6%) of patients without epidural disease/laminectomy

<table>
<thead>
<tr>
<th>Grade</th>
<th>Modified McCormick scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Intact neurologically, normal ambulation, minimal dysesthesia</td>
</tr>
<tr>
<td>II</td>
<td>Mild motor or sensory deficit, functional independence</td>
</tr>
<tr>
<td>III</td>
<td>Moderate deficit, limitation of function, independent with external aid</td>
</tr>
<tr>
<td>IV</td>
<td>Severe motor or sensory deficit, limited function, dependent</td>
</tr>
<tr>
<td>V</td>
<td>Paraplegia or quadriplegia, even w/flickering movement</td>
</tr>
</tbody>
</table>
Discussion

- In the 21st century, spinal deformity is rare following pediatric neuroblastoma treatment
  - 9% in the modern era versus up to 76% historically
- There have been significant advances in chemotherapy treatment regimens and delivery of radiotherapy (now IMRT) over the past 20 years
Summary Points

- Laminectomy for spinal cord compression due to epidural tumor spread is associated with spinal deformity
  - 47% of laminectomy patients developed scoliosis (4.3% overall)
  - 15% required fusion (1.4% overall)
- Functional outcomes are preserved for the majority of patients