Supine Adult Craniospinal Irradiation: A Case Study

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Objectives

- Background
- Review the disease indication for this case study
- Challenges/Considerations associated with simulation and treatment
- Overview of Simulation Process
- Overview of Treatment Planning
- Discuss optional CSI techniques
The first craniospinal radiation was delivered in the late 1920’s.

Paterson and Farr noted necessity of treating entire neuroaxis beginning in the 1940’s

Source: Patterson, E.; Farr, R.F. Cerebellar medulloblastoma: Treatment by irradiation of the whole central nervous system. *Acta Radiol.* 39:3-36; 1953
For many years patients were treated prone
Calculations

If 2 PA spinal fields required, simply do a gap calculation between the two fields:

\[
G1 = \left( \frac{1}{2} \text{ sup. PA field length} \right) \left( \text{Depth at vert. body} \right) / \text{SSD}
\]

\[
G2 = \left( \frac{1}{2} \text{ inf. PA field length} \right) \left( \text{Depth at vert. body} \right) / \text{SSD}
\]

\[
\text{Gap} = G1 + G2
\]

To determine collimator angle of lateral cranial fields to match the spinal field:

\[
\text{collimator angle} = \arctan \left( \frac{1}{2} \text{ PA field length} \right) / \text{SSD}
\]

To determine the angle to kick the couch (toward the gantry):

\[
\text{couch kick angle} = \arctan \left( \frac{1}{2} \text{ cranial field length} \right) / \text{SSD}
\]
Must account for Divergence

1. Cranial Field – rotate collimator to match divergence from PA spine field

2. PA spine field – “kick couch” to account for divergence from cranial fields
SUPINE POSITION

- Use standard head and neck mask for reproducibility
- Position more tolerable for patient
- Likely to have less movement/more reproducible
- Does require special imaging to verify isocenter/junction as spine is treated from below
Specific Indication for CSI

- Average-risk and hi-risk Medulloblastoma
  Medulloblastomas occur in the cerebellum.
Specific Indication for CSI

- Primitive Neuroectodermal Tumor (PNET)

PNET is a name used for tumors which appear identical under the microscope to the medulloblastoma, but occur primarily in the cerebrum.

Almost exclusively in young children
More frequent in males
The Tentorium Cerebelli

Supratentorial (cerebrum)

Tentorium

Infratentorial (cerebellum)
CNS PNET umbrella

- Pineoblastoma
- Polar spongioblastoma
- Medulloblastoma
- Medulloepithelioma
Supratentorial Primitive Neuroectodermal Tumor (sPNET)

World Health Organization report

< 100 sPNET cases reported Internationally in adult patients as of 2012

PNETs commonly contain areas of necrosis, cysts, and/or calcifications as shown on CT.

MRI scans can provide an indication of tumor size.

MRI scans are the imaging study of choice.
Symptoms

- Depends largely on the location and tumor size
- Most common:
  - Headache
  - Vomiting
  - Unsteady gait
  - Extreme fatigue
  - Blurred Vision

- Diagnostic test of choice - MRI
Adult sPNET

- Complete surgical resection
- Radiotherapy to the entire neuroaxis is recommended because cerebrospinal dissemination at the time of diagnosis was found in almost 10% of all cases.
- 54 Gy PF, 36 Gy CSI, 1.5 Gy/day
- Chemo reserved for relapse
Case Report

- 55 year old female
- Left arm weakness x a few months
- Progressive disorientation and mental status change
- Transferred to hospital post 911 call
- MRI: Rt parietal brain lesion
- Surgery: RT parietal craniotomy for gross total resection
Treatment Recommendation 10-2012

- CSI
- Chemotherapy
Challenges with this CSI patient

- Patient comfort-treatment position reproducibility
- Body Habitus-large patient, short neck
- Left arm weakness and disorientation
- The possible need to maintain daily junction matches.
- Rapid turn around time from CT-Sim to treatment
- Prior radiation to operative bed to be constrained
CT-Sim Scan Parameters

- Scan from top of head through the thecal sac (S2/S3)
- Scan thickness .3cm for head
- Scan thickness .5cm for torso
Cranial image initial surg bed red
Isocenter Placement
PA SPINE
118 SSD
Composite plan
Isocenter Placement & Beam Divergence Concerns
Treatment Field Setup

Fig. 1. Schematic diagram of the CSI technique as applied to a supine patient.
Treatment procedure:

- Position patient as per simulation instructions
- Ensure that head rest is set at the appropriate registration.
- Align to body lasers
- Make sure the patient is straight from top of head down through lower spine field.
- To ensure proper alignment, longitudinally move patient out so the central axis is on throughout the entire vertebral column.
Treatment procedure con’t

- Then rotate the Gantry to zero. move the table in to the marked spine isocenter.

- Make shifts and mark iso for spine.

- Draw any positioning marks

- Verify the SSD for the spine setup Isocenter
- Validate isocenter via OBI.

- Rotate couch 90 degrees and raise to 118 SSD PA
Junctioning fields

Theoretically no junction feathering is necessary with this technique
Supine craniospinal irradiation

- Indicated in patients who are unable to tolerate prone positioning
- May be considered in those with significant cranial nerve and cerebellar dysfunction from posterior fossa surgery
- 0.3cm safety gap is introduced into the CSI junction both to avoid overlap and make an overlap obvious should it occur
- Couch “kicked” to create an exact geometrically gapped match at the brain + spine fields in contrast to prone technique
- Lateral and PA port films are taken to demonstrate presence of the gap
Supine craniospinal radiation

- Patient is treated at extended SSD so that entire spine can be encompassed in one field
Supine spine field

- The extended SSD spine field eliminates the need to match 2 spine fields
Supine craniospinal irradiation

- **Advantages**
  - Significantly greater patient comfort
  - Easier to immobilize with head and neck mask
  - Improved setup reproducibility of cranial fields
Supine craniospinal irradiation

- Disadvantages
  - most significant is inability to directly visualize the craniospinal junction on skin
  - more technically demanding than conventional prone CSI
  - requires additional rigorous Q/A to assure there is no overlap at the level of the spinal cord and junction of the brain and spine field
Lessons Learned

- Two posterior spine fields would have reduced planning time needed working with field in field to minimize max doses in spine.
- Two posterior spine fields would have used one inferior ISOCENTER shift.
- The use of several posterior partial arcs would have reduced the dose to normal structures considerably.
Summation

- Several different methods were possible
- The single PA spine method offers more efficiency.
- Patient comfort continues to be an important factor.
- Helpful with greater comfort level in treating supine technique on linac with kV imaging capabilities.

- Patient was released to hospice 6 months after completion of CSI treatment and is still being seen in follow-up today.
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