JULY 12–16 2020 VIRTUAL
JOINT AAPM | COMP MEETING
EASTERN TIME [GMT-4]

A Conformal Planning Technique for Total Cranial-Spinal Irradiation Utilizing VMAT

Lulin Yuan Ph.D. and Siyong Kim Ph.D.
Virginia Commonwealth University Medical Center, Richmond, VA

INTRODUCTION

Craniospinal irradiation (CSI) is used to treat the entire craniospinal axis for certain neoplasms of the CNS, such as medulloblastomas. CSI is a technically challenging treatment. It involves two lateral brain fields and one or two spinal fields. The matching of the field borders is critical during planning and treatment setup because the overlap (overdosing) in the spinal cord may have devastating outcome for patient. We developed a novel technique that can significantly reduce treatment setup complexity as well as normal tissue irradiation with the patient in supine position by replacing the upper and lower spine fields with VMAT fields.

PURPOSE

To present a novel technique for delivering craniospinal irradiation (CSI) utilizing Volumetric Modulated Arc Therapy (VMAT) to both reduce treatment setup complexity and improve normal tissue sparing.

METHOD

CSI is typically delivered by half-beam blocked opposed-lateral cranial fields and one or two spinal fields (i.e., upper spine (US) and lower spine (LS)). A FIF technique was used to feather the craniospinal and spinal-spinal junction daily by varying the match line over 2 cm. In this study, we developed a new delivery method by replacing each spinal field with two short 30 degree long, left and right posterior VMAT arcs. A field-in-field (FIF) technique is used to create a smooth dose fall off at the inferior border of the brain field. The isocenters of the upper and lower spinal field are placed so that there is 4 cm overlap at each filed junction. The VMAT fields are inverse optimized to get adequate dose coverage in both junction areas and conformal dose to the PTV.

To ensure a smooth transition in the junction areas and robust plan setup, two planning techniques were investigated: one was an iterative planning approach (iterative-VMAT). We first placed a fixed lower PA spine field with FIF to create a dose fall-off ramp in the junction area, and then a VMAT US field was inverse optimized on top of the dose from the fixed PA LS field, finally, a VMAT LS field replaced the fixed LS field and was optimized on top of the dose from the US field. The second method was to optimize both the US and LS VMAT fields simultaneously (simultaneous-VMAT). Fig 1 illustrates the field setup.

The planning techniques were evaluated with CT images of a humanoid phantom. In addition, film dosimetry was performed for verification.

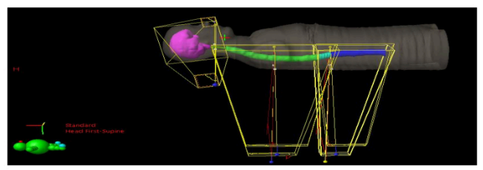

Fig. 1. Field setup for the lateral brain fields, upper spine and lower spine VMAT fields

RESULTS

Comparison of the VMAT CSI and 3D feathered CSI techniques: VMAT planning techniques significantly reduced the dose wash to the normal tissues and hot spot as shown in Fig 2 (119% VMAT vs 126% conventional 3D).

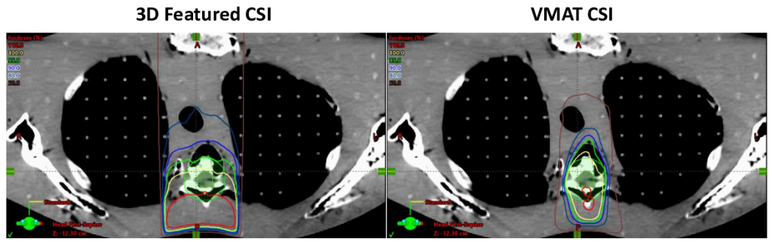

Fig. 2. Isodose distribution on a transverse CT slice by the VMAT CSI and 3D feathered CSI techniques

Comparison of the iterative-VMAT and simultaneous-VMAT techniques: Fig 3 shows the dose profiles along the upper-lower spine junction from each of the VMAT sub-field. While the simultaneous-VMAT technique created the step-like dose profile the iterative-VMAT technique provided smoother dose fall off.

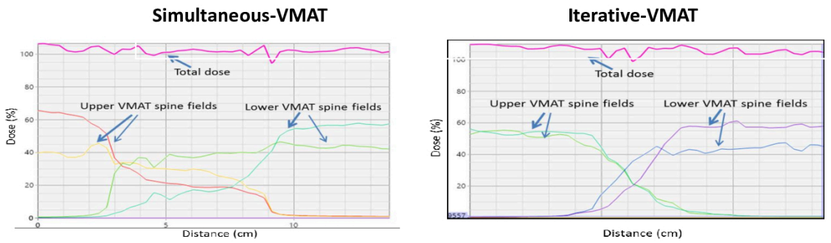

Fig. 3. Dose profiles along the upper-lower spine junction for the two VMAT planning method

Film Verification of delivered dose in phantom: The film measurement for the two junction areas showed smooth dose coverage without apparent hot or cold spot with maximum intensity variation <1.5% (see Fig 4).

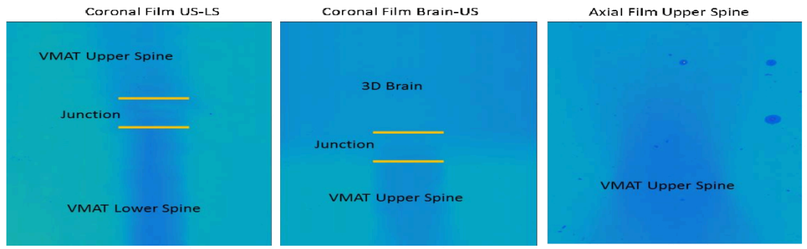

Fig. 4. Film dose verification of the dose distributions in the junction areas and on a transverse plane

CONCLUSIONS

The VMAT CSI treatment technique provides an efficient way to deliver treatment dose with significantly improved normal tissue sparing.

CONTACT INFORMATION

Lulin.Yuan@vcuhealth.org
Siyong.kim@vcuhealth.org