Leveraging three-dimensional printing to customize facial shielding over irregular surfaces in radiation therapy of facial mycosis fungoides

Aaron Seo, PhD, MS4, Bryan Jackson, MS2, Kara Charlick, CMD3, YoungJu Kim, RT(R)(T)3, Aaron S. Kusano, MD, SM3,4,5

1School of Medicine, University of Washington, Seattle, WA, 2Northwest Medical Physics Center, Lynnwood, WA, 3Anchorage and Valley Radiation Therapy Centers, Anchorage, AK, 4Dept of Radiation Oncology, University of Washington, Seattle, WA, 5WWAMI Medical Program, University of Alaska, Anchorage, AK.

INTRODUCTION

Three-dimensional printing has emerged as a promising method for generating custom accessories for radiation therapy. When treating abutting electron fields or shielding at risk structures adjacent to irregular surfaces such as the eyes and lacrimal glands, customized on-skin lead shielding improves collimation and reduces scatter but can be challenging to tightly conform to the face. Here, we report use of three-dimensional printing to aid in formulation of conformal, on-skin lead shielding in electron treatment of the face.

CASE DESCRIPTION

A middle aged male presented with stage IIB mycosis fungoides confined to the face and scalp. Tumors became refractory to topical steroids and he developed painful weeping ulcers in the left mid face, forehead and scalp with excellent local control. He subsequently developed progressive disease in the right midface/nose as well as large patches of involvement directly adjacent to previous treatment fields. When seen in 1 and 3 month follow up the patient had excellent local control without evidence of toxicity.

TREATMENT PLAN

Treatment planning software was utilized to design a plan delivering 2000 cGy in 10 fractions prescribed to 90% for the target areas. The large exophytic tumor in the right midface was treated with 12 MeV electrons with wet gauze bolus. The right nares/midface treatment field abutted a previous treatment field in the left midface and came in close proximity to the inferior right orbit. The right parietal/occipital scalp area was large and over a curved surface and would require two adjacent electron fields.

METHODS

Treatment fields with desired blocking were outlined on the patient with radio-opaque wiring. A high resolution head CT scan was then obtained to provide a full 3D contour of the head with treatment fields. Using MIM® software, the facial contour was exported as a 3D printable file and then printed in house on a fused filament 3D printer using PLA plastic.

The 3D printed facial contours provided a full scale physical model on which double layer lead shielding (1.6mm each) was pressed and pounded by mallet with significant force to achieve on skin shielding that tightly conformed to anatomic contours. After customized lead shielding was complete, the patient was brought back and adequacy of fit was confirmed.

METHODS

Three-dimensional printing has emerged as a promising method for generating custom accessories for radiation therapy. When treating abutting electron fields or shielding at risk structures adjacent to irregular surfaces such as the eyes and lacrimal glands, customized on-skin lead shielding improves collimation and reduces scatter but can be challenging to tightly conform to the face. Here, we report use of three-dimensional printing to aid in formulation of conformal, on-skin lead shielding in electron treatment of the face.

METHODS

Treatment fields with desired blocking were outlined on the patient with radio-opaque wiring. A high resolution head CT scan was then obtained to provide a full 3D contour of the head with treatment fields. Using MIM® software, the facial contour was exported as a 3D printable file and then printed in house on a fused filament 3D printer using PLA plastic.

The 3D printed facial contours provided a full scale physical model on which double layer lead shielding (1.6mm each) was pressed and pounded by mallet with significant force to achieve on skin shielding that tightly conformed to anatomic contours. After customized lead shielding was complete, the patient was brought back and adequacy of fit was confirmed.

METHODS

Three-dimensional printing has emerged as a promising method for generating custom accessories for radiation therapy. When treating abutting electron fields or shielding at risk structures adjacent to irregular surfaces such as the eyes and lacrimal glands, customized on-skin lead shielding improves collimation and reduces scatter but can be challenging to tightly conform to the face. Here, we report use of three-dimensional printing to aid in formulation of conformal, on-skin lead shielding in electron treatment of the face.

METHODS

Treatment fields with desired blocking were outlined on the patient with radio-opaque wiring. A high resolution head CT scan was then obtained to provide a full 3D contour of the head with treatment fields. Using MIM® software, the facial contour was exported as a 3D printable file and then printed in house on a fused filament 3D printer using PLA plastic.

The 3D printed facial contours provided a full scale physical model on which double layer lead shielding (1.6mm each) was pressed and pounded by mallet with significant force to achieve on skin shielding that tightly conformed to anatomic contours. After customized lead shielding was complete, the patient was brought back and adequacy of fit was confirmed.

TREATMENT RESULTS

Conformal fit of the blocks was outstanding. We elected to provide additional eye shielding for the left eye that was placed directly below the custom block.

The patient tolerated daily setup and treatment well with relatively fast clinical improvement in the treated tumors during therapy. There was no acute eye irritation noted and no increase in acute skin changes at the abutting fields or where current treatment fields were directly adjacent to previous treatment fields.

We have successfully used this approach in other patients requiring treatment of the nose or in very close proximity to the eyes with good results seen in long term follow up.

CONCLUSIONS

Three-dimensional printing is a time and cost-effective method to obtain accurately molded shields for electron therapy. This method improves the quality of lead shielding, does not require prolonged patient presence and saves time compared to the iterative process of manual bending.

ACKNOWLEDGEMENTS

We appreciate the patience and willingness to share of our patient.

CITATIONS


We appreciate the patience and willingness to share of our patient.