Virtual Reality Based on 3D Modeling of Intramedullary Subependymoma Metastasis and Associated Neural Tracts

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Introduction

Subependymomas (SEs) are typically benign, low grade, and discrete tumors commonly attached to the lateral ventricle or fourth ventricular wall (1). SEs are rare intracranial tumors, and their presence in the cervical spinal cord is even more scarce. The authors report one case of intramedullary subependymoma metastasis from a previously resected spinal cord tumor.

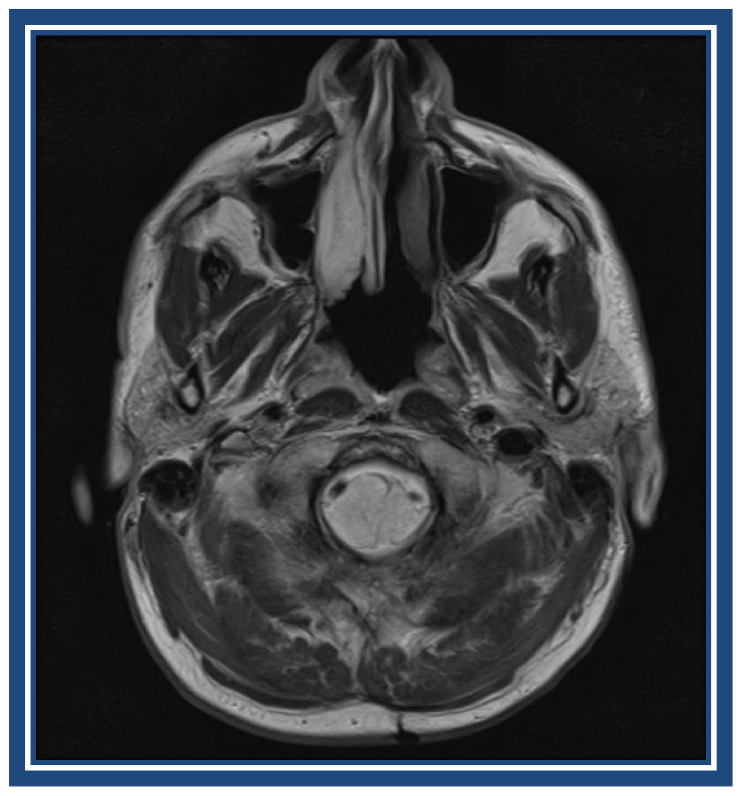
The 38-year-old patient presented with worsening generalized weakness and overall neurological deterioration. Magnetic resonance imaging (MRI) and diffusion tensor imaging (DTI) were obtained to locate the lesion and identify relevant white matter tracts. Cervical spine MRI revealed an expansile heterogeneous extending from the obex to the upper edge of C6. The intramedullary tumor was excised following considerable preoperative planning. Using the MRI data, the tumor and brainstem were segmented and reconstructed, while neural tracts were reconstructed via DTI. The final three-dimensional (3D) models were transferred to the VR system.

Methods

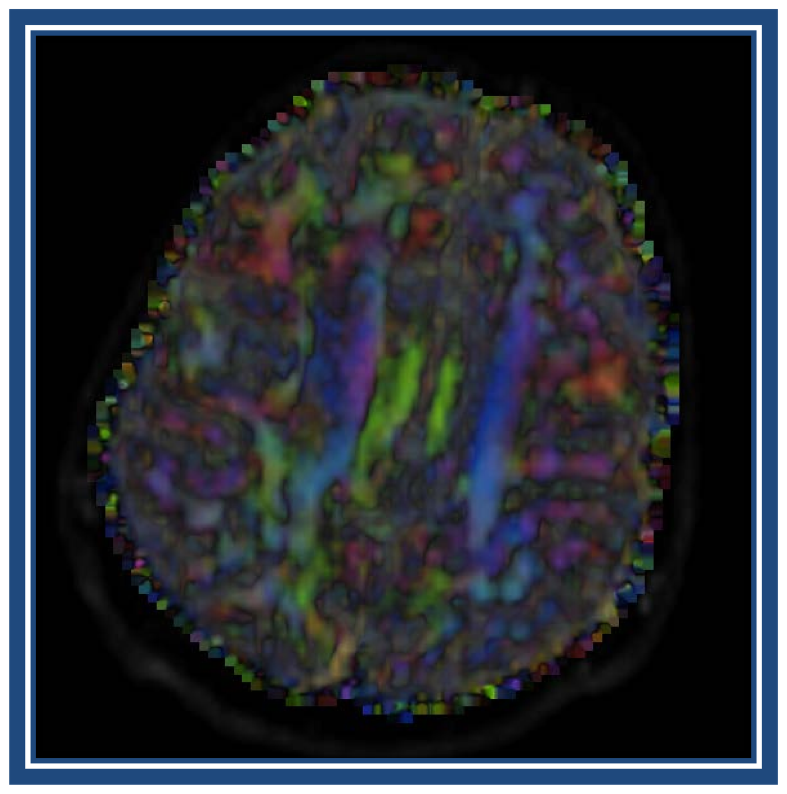
Using high-definition imaging data and image processing software, we are able to generate a three-dimensional model of a cervical subependymoma and its associated white matter tracts. Prior to tumor resection, brain MRI with DTI was obtained. Patient-protected health data was de-identified from DICOM files using *DICOMAnonymizer* program. Tumor segmentation and cortical spinal (CST) tractography were performed using *3D Slicer*. Following file conversion, the 3D models were imported into *Unity* for virtual reality (VR) testing.

Results

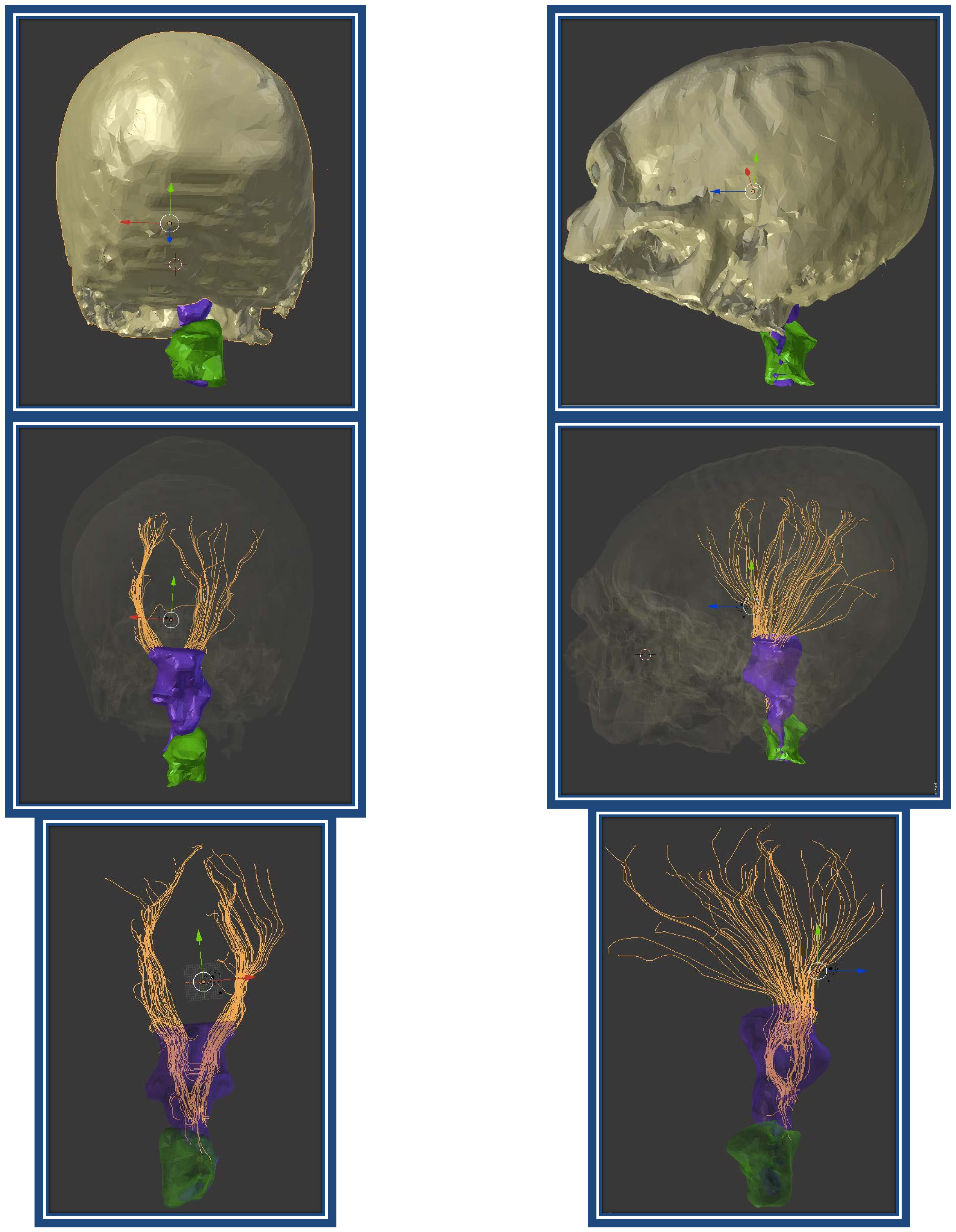
Tumor MRI



Brain DTI



Virtual 3D Renderings



Discussion

This report presents a novel application of 3D modeling in spinal cord lesions and tractography. Few articles exist modeling neurological tumors and their respective white matter tracts (123). Even rarer documentation exists for cervical spine lesions. We provide a novel case modeling cervical spine tumor and tracts incorporating VR formats. Here at Ochsner medical 3D laboratory, we aim to expand these methods for eventual intraoperative assistance. Further development of spinal DTI and mixed-reality registration is required. Neurosurgical faculty evaluations of this technology were favorable in our institution.

Conclusions

Understanding spatial relationships of neuroanatomy is fundamental to neurosurgical intervention. 3D modeling lesions and their neural tracts may improve operative planning in neuro-oncologic cases. This technology has considerable potential in virtual reality applications.

References

1.Kleinschmidt-DeMasters, B.K., et al. Diagnostic pathology neuropathology. Elsevier, 2016.
2.Ellison, David. Neuropathology: A reference text of CNS pathology (3rd ed.) Elsevier, 2013.
3.Karimi, Sasan, editor. *Atlas of brain and spine oncology imaging*. Springer, 2015.
4.Sun, G et al. Impact of Virtual and Augmented Reality Based on Intraoperative Magnetic Resonance Imaging and Functional Neuronavigation in Glioma Surgery Involving Eloquent Areas. World Neurosurg. 2016;96:376-82. Epub.
5.Qiu, TM et al. Virtual reality presurgical planning for cerebral gliomas adjacent to motor pathways in an integrated 3-D stereoscopic visualization of structural MRI and DTI tractography. Acta Neurochir. 2010;152(11):1847-57. Epub.
6.Thawani, JP et al. Three dimensional printed modeling of diffuse low-grade gliomas and associated white matter tract anatomy. Neursurgery. 2017;80(4):635-45. Epub.