Novel Technique of Co-registered Intraoperative CT and Pre-Operative MRI/DTI Navigation in Spinal Cord Tumor Resection

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Abstract

Intradural spinal cord tumors are challenging secondary to local anatomy and close proximity of critical structures, making adequate intraoperative navigation vital. In this abstract we describe three cases in which intraoperative computed tomography(iCT) was coregistered with magnetic resonance and diffusion tensor imaging(MRI/DTI) for guidance in the resection of intraspinal tumors. To our knowledge, this technique has rarely been employed in intradural tumor resection, and never before in the treatment of intramedullary disease.

Co-registered navigation was employed in the resection of two extramedullary lesions and one intramedullary cervicomedullary tumor. Following open midline exposure of bony anatomy, iCT was obtained and co-registered to pre-operative MRI sequences to allow for optical tracking navigation via a stealth station. In the intramedullary tumor, DTI was used for enhanced identification of relevant anatomy. Navigational accuracy for all cases was confirmed to be acceptable at the level of the posterior bony elements, the dura, and the tumor-parenchyma interface.

The co-registration of MR and iCT images allowed for enhanced navigation during resection. During removal of a cervicomedullary ependymoma with marked distortion of longitudinal tracts, iCT/DTI navigation allowed for accurate visualization of critical structures and facilitated delineation of tumor margins. All patients tolerated the procedures well with stable post-operative courses.

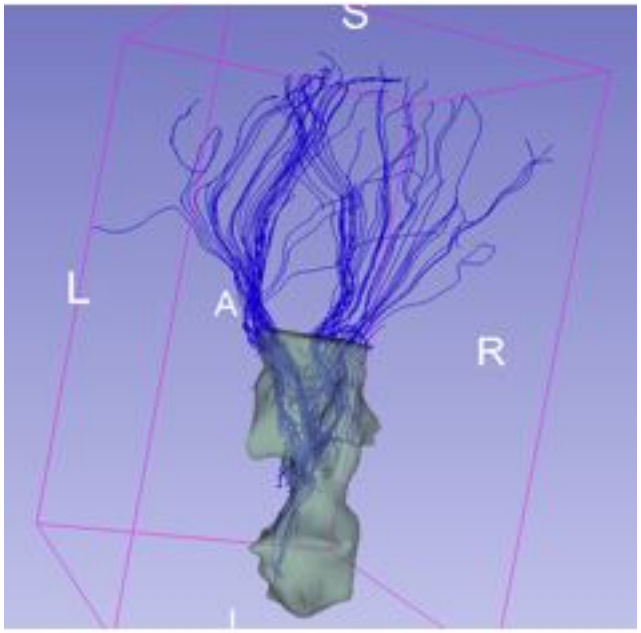
Combined iCT/MRI guidance is routinely employed in the resection in cranial lesions but is more technically difficult in spinal pathology. We describe the use of combined iCT and pre-operative MRI/DTI neuronavigational guidance as an effective approach in the resection of intradural and intramedullary tumors.

Operating Room Setup

Cases Conducted with Merged iCT/MRI Imaging

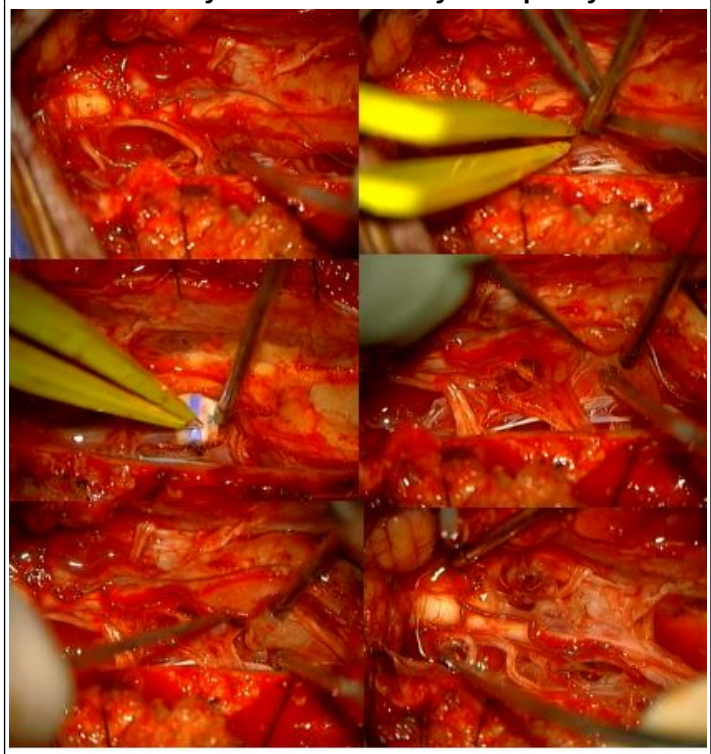
- Majority subtotal resection of recurrent intramedullary cervicomedullary subependymoma in a 38 yo male with progressive functional decline using merged iCT and stealth protocol brainstem and DTI MRI sequences.
- Gross total resection (Simpson I) of intradural extramedullary thoracic psammomatous meningioma in a 53 yo female with over 90% canal compromise and progressive paraparesis using merged iCT and stealth protocol spinal and DTI MRI sequences.
- Gross total resection of intradural extramedullary lumbar spinal neurofibroma in a 28 yo female with progressive radiculopathy and 90% canal compromise using merged iCT and standard spinal MRI sequences.

Diffusion Tensor Imaging



DTI of the spine presents a technical challenge due to heterogeneous magnetic fields and physiologic motion. For the subependymoma section (above and below), a DTI protocol of the brain extending through the brainstem was used to evaluate proximity of long tracks (above) in relation to the intramedullary mass on stealth sequences (below).

DTI/CT Guided Microsurgical Resection of Intramedullary Cervicomedullary Subependymoma



Intraoperative images of microsurgical resection of cervicomedullary subependymoma using merged iCT and stealth MRI/DTI guidance. Following removal of bony elements, the cervicomedullary junction is found to be grossly distorted and dystrophic, making identification of normal anatomy difficult (top left). Merged navigation is then used to identify safe zones for tumor entry (top right) and establishment of dissection planes in the tumor-parenchyma interface (center left). The lesion is then entered and safely de-bulked (center right) and resected in piecemeal (bottom left) with preservation of critical tracts (bottom right).