

High Definition Fiber Tractography for preoperative planning of Brainstem Cavernous Malformations: a Preliminary Experience

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Introduction

Conventional MRI provides limited information on how normal anatomy is distorted around a brainstem cavernoma. This uncertainty contributes significantly to the high rate of new permanent post-operative deficits, reported to reach 50-60%. High-Definition Fiber Tractography (HDFT) has been shown to accurately replicate the anatomy of white matter tracts in both normal and disease states, refining our ability for selecting the optimal surgical corridor and deciphering eloquent lesional boundaries. Here, we review our preliminary experience using HDFT for the pre-operative planning of brainstem cavernomas.

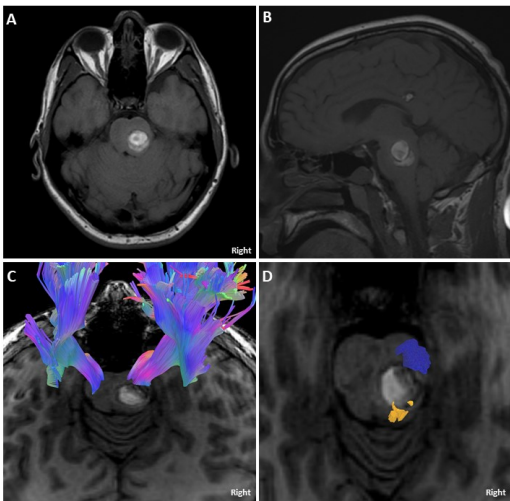
Methods

We retrospectively evaluated 8 patients with brainstem cavernomas who had HDFT as part of their pre-operative work-up. Fiber tracking was performed using a GQI algorithm, shown to have the best valid connections with >90% accuracy. The optimal surgical approach and the most eloquent lesional boundaries were determined according to the relationship of the cavernoma to the surrounding fiber-tracts.

Results

Cavernoma locations were: 3 lateral pontine (2 right, 1 left), 2 left-sided pontomesencephalic, 1 thalamo-mesencephalic, 1 posterior midbrain (right superior colliculus), 1 posterior pontine (floor 4th ventricle). Surgical approaches included: 6 subtemporal-transtentorial (3 left, 3 right), 1 infratentorial/suprecerebellar and 1 telovelar. Gross total resection was achieved on 6 (75%) patients. Five (62.5%) patients had transient worsening of preoperative symptoms or new deficit. All new postoperative deficits improved (average time for improvement 1.8 months). None of the patients in our series had new permanent neurodeficit. Preoperative symptoms recovered partially in 5 (62.5%), and complete in 3 (37.5%) patients. With a mean follow-up of 29 months, there have been one

Illustrative case 1



Illustrative case 1: 37-year-old man presenting with paresthesia in left hemibody and face. A, Superior view of an axial T1-weighted image showing a cavernous malformation in the right posterolateral aspect of the pons. B, Sagittal T1-weighted image showing the area affected by the cavernoma in the vertical plain, as an additional finding, there is a small cavernous malformation superior to the corpus callosum. C, HDFT showing bilateral corticospinal tracts, notice on the right side the cavernoma is barely displacing the right corticospinal tract anteriorly. D, HDFT image, blue corticospinal tract, yellow sensory tracts (medial lemniscus and spinothalamic tracts). Noticed significant displacement of the sensory tracts posteriorly explaining patient symptoms.

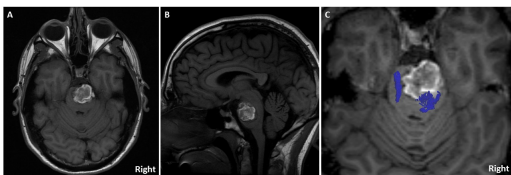
Conclusions

Fiber tractography provides critical anatomical information, which helps select the optimal surgical corridor, and define eloquent lesional boundaries. In our preliminary experience with brainstem cavernomas, this technology appears to decrease morbidity. Additional data using HDFT for such complex surgical areas may solidify its value.

Learning Objectives

1. Describe the applications of HDFT in preoperative planning of Brainstem Cavernous Malformation.
2. Define relevance of eloquent tracts surrounding a brainstem cavernous malformation.
3. Describe potential advantages of HDFT on brainstem cavernoma surgery.
4. Define future directions of HDFT as preoperative planning tool for brainstem cavernous malformation.

Illustrative Case 2



Illustrative case 2: 31-year-old man presenting with left-sided hemiparesis and left-sided central facial weakness. A, Superior view of an axial T1-weighted image showing a right-sided cavernous malformation in the anterior aspect of the pons with extension towards the left side. B, Sagittal T1-weighted image showing the area affected by the cavernoma in the vertical plain, noticed that the lesion covers almost the entire anterior aspect of the pons. C, HDFT showing severe displacement of the right corticospinal tract posteriorly explaining patient symptoms.

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