Quantifying Recovery of White Matter Tracts: A New Outcome Measure in Tumor Surgery

Sebastian F. Koga MD, MSt; Smaranda Fillip MD

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Introduction

Advances in diffusion tensor imaging and neuronavigation have brought white matter tractography to the forefront of brain tumor surgery. The technology is used in several centers for planning transsulcal parafascicular approaches to subcortical lesions. Our study is the first to define and quantify the distortion of white matter tracts pre-operatively and the recovery of white matter tracts post-operatively. This provides a proxy outcome measure based on neuroimaging, and opens new avenues for studying the progression of subcortical lesions.

Methods

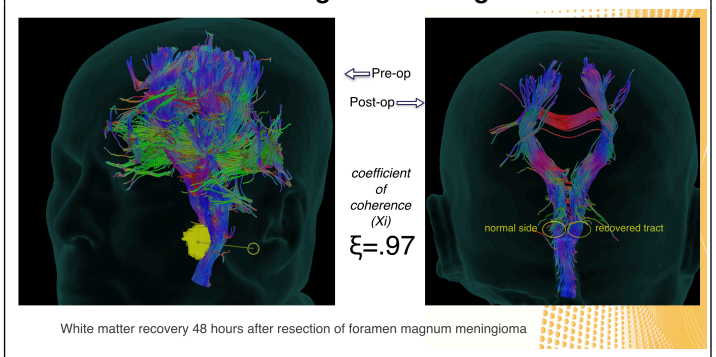
A prospective study of 32 patients undergoing resection of subcortical lesions was undertaken using transsulcal parafascicular approaches. Three dimensional fiber tract maps were created from DTI MRI images and these were analyzed in a dynamic fashion using automated computational models and dynamic manipulation of the fiber tracts. The concept of "tract recovery" was developed by quantifying deviation, deformation, infiltration, interruption and degeneration before and after surgery. Complex computational models were reduce to create a simple "coefficient of coherence (?)" measuring tract variation from the normal hemisphere, and from known normal anatomy based on brain atlas models.

Results

Our quantification model using high-fidelity tractography allows surgeons to demonstrate white matter recovery and to plan optimal corridors for tract preservation. Recovery of white matter tracts was noted in all cases, even in congenital lesions, yielding unexpected insights into neural plasticity. The workload of 3D computational analysis was reduced to a clinically useful "coefficient of coherence (?)" which indicates return to normal anatomy. Tractography outcomes were accurately correlated to clinical outcomes.

Conclusions

The advent of tridimensional DTI maps and automated tractography can enhanced not only surgical planning, but also the measurement of surgical outcomes using existing neuroimaging tools. Meaningful simplification of algorithms can help quantify recovery fo white matter tracts, giving surgeons an crucial new tool in the form of coefficient of coherence (?).



Coefficient of coherence between pre- and post-op white matter bundles at the foramen magnum.

Learning Objectives

Surgeons will learn the utility of DTI in clinical applications, and have a new tool to measure the degree of white matter recovery. This concept teaches the benefits of parafascicular corridors. Beyond the notion of 'tumor cytoreduction' surgeons will learn to assess the return of normal anatomy, and advance the general understanding of neural plasticity in the setting of various brain lesions.

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