

Abstract of PhD Thesis

Microsurgical Anatomy of the Meyer's Loop Demonstrated Using Fiber Microdissection and Diffusion Tensor Imaging Tractography

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Background. Meyer's loop is commonly known as the temporal loop of the anterior fibers of the optic radiation that originate in the lateral geniculate body and course into the temporal lobe, where they turn posteriorly to reach the occipital visual cortex. However, the ultimate anatomical details of the Meyer's loop continue to elude us. Knowledge of the anatomy of the Meyer's loop is essential for minimizing the risk of damaging this structure during surgery for temporal lobe lesions and epilepsy. The gold standard for white matter anatomic investigation is the fiber microdissection technique. Fiber microdissection technique involves peeling away matter fiber tracts of the brain to display its three-dimensional anatomic organization, and is a particularly relevant and reliable method for neurosurgeons to study the details of the white matter architecture. Diffusion tensor imaging (DTI) is an advanced magnetic resonance imaging (MRI) technique that provides a unique noninvasive, in vivo, visualization of the white matter architecture and offers the basis from which diffusion tensor tractography (DTT) images are generated. DTT is the method to three-dimensionally reconstruct individual white matter fiber systems. Because DTT is the only currently available method for an in vivo investigation of individual white matter fibers, it might provide additional data regarding the complex network of fibers involved in the formation of the Meyer's loop that may complement the anatomy revealed by fiber microdissection.

Object. To explore and further refine our comprehension of the anatomical features of the temporal loop, known as Meyer's loop, by combining two complimentary techniques, fiber microdissection and DTT.

Methods. The lateral and inferior aspects of 20 previously frozen, formalin-fixed human brains specimens were dissected under the operating microscope using fiber microdissection. To complement and compare our anatomical findings derived from fiber microdissection on cadaveric brain specimens, an additional, in vivo DTT study was performed. Ten healthy subjects underwent MRI with DTI at 3 T. Using a region-of-interest (ROI) based DTI and fiber tracking software (Ingenia, Philips, Extended MR Workspace 2.6.3.3) sequential ROI were placed to reconstruct visual fibers and

neighboring projection fibers involved in the formation of Meyer's loop. The three-dimensional reconstructed fibers were visualized by superimposition on three-planar MRI brain images to enhance their precise anatomical localization and relationship with other anatomical structures.

Results. A loop of the fibers in the anterior temporal region was clearly demonstrated in all our dissections. Our fiber microdissection revealed that various projection fibers, rather than only individual optic radiation fibers, form the temporal loop. Projection fibers for the temporal and occipital regions that emerge from the sublenticular portion of the internal capsule, which are the temporo-pontine fibers, occipito-pontine fibers and the posterior thalamic peduncle (that includes the optic radiation), participate in this temporal loop, and together course in the roof of the temporal horn of the lateral ventricle as a joint layer of densely packed fibers, the sagittal stratum, to reach their cortical terminations. No individual optic radiation fibers, originating in the lateral geniculate body and terminating in the occipital visual cortex, could be differentiated in the temporal loop. Our dissections also disclosed that the anterior extension and angulation of the temporal loop vary significantly. Six white matter tracts relevant to the Meyer's loop were reconstructed by using the DTT including the posterior thalamic peduncle with the optic radiation, the occipito-pontine/parieto-pontine fibers, the anterior commissure, the occipitofrontal fasciculus, the uncinate fasciculus and the inferior longitudinal fasciculus. Meyer's loop was reconstructed in all individual subjects and was composed of several projection fibers system that could be individually demonstrated, the posterior thalamic peduncle that includes the optic radiation, and the occipito-pontine/parieto-pontine fibers, thus validating our findings with the fiber microdissection. Two patterns of angulation of the Meyer's loop were found both in our fiber microdissection and with the DTT.

Conclusions. The fiber microdissection technique provides clear evidence that a loop in the anterior temporal region exists, but that this temporal loop is not formed exclusively by the optic radiation. Various projection fibers from the sublenticular portion of the internal capsule, of which the optic radiation is only one of the several components, display this common course. The inherent limitations of the fiber dissection technique preclude accurate differentiation among individual fibers of the temporal loop, such as the optic radiation fibers. DTT offers a three-dimensional reconstruction of this various projection fibers that participate in the formation of the Meyer's loop that validates the evidence derived from fiber microdissection. Two patterns of angulation of the Meyer's loop may exist in the human population, and these distinct configurations may relate to the embryological development of the brain. The combination of the fiber microdissection technique with the DTT provides a unique three-dimensional knowledge that is especially relevant for planning strategies and tactics of neurosurgical procedures. The combination enriches both techniques reciprocally because one solves the limitations of the other. Future work by using more

advanced, high-definition DTT might be able to produce more comprehensive and accurate demonstrations of the intricate white matter architecture, particularly for highly complex structures such as the Meyer's loop, that could be safely applied in preoperative planning and incorporated into the intraoperative guidance systems for neurosurgical procedures.

Key Words • DTI tractography • fiber dissection • Meyer's loop • microsurgical anatomy • optic radiation • projection fibers • temporal loop • white matter anatomy