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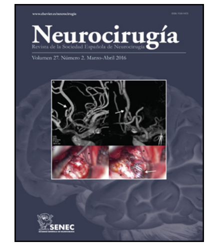

Clinical Research

3D anatomy of cerebellar peduncles based on fibre microdissection and a demonstration with tractography☆,☆☆

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ABSTRACT

Objective: To perform an anatomical and radiological study, using fibre microdissection and diffusion tensor tractography (DTT), to demonstrate the three-dimensionality of the superior, middle and inferior cerebellar peduncles.
Material and methods: A total of 15 brain-stem, 15 cerebellar hemispheres, and 5 brain hemispheres were dissected in the laboratory under the operating microscope with microsurgical instruments between July 2014 and July 2015. Brain magnetic resonance imaging was obtained from 15 healthy subjects between July and December of 2015, using diffusion-weighted images, in order to reproduce the cerebellar peduncles on DTT.
Results: The main bundles of the cerebellar peduncles were demonstrated and delineated along most of their trajectory in the cerebellum and brain-stem, noticing their overall anatomical relationship to one another and with other white matter tracts and the grey matter nuclei the surround them, with their corresponding representations on DTT.
Conclusions: The arrangement, architecture, and general topography of the cerebellar peduncles were able to be distinguished using the fibre microdissection technique. This knowledge has given a unique and profound anatomical perspective, supporting the correct representation and interpretation of DTT images. This information should be incorporated in the clinical scenario in order to assist surgeons in the detailed and critical analysis of lesions that may be located near these main bundles in the cerebellum and/or brain-stem, and

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therefore, improve the surgical planning and achieve a safer and more precise microsurgical technique.

Anatomía de los pedúnculos cerebelosos en 3D basada en microdisección de fibras y demostración a través de tractografía

Palabras clave:
Cerebelo
Pedúnculo cerebeloso inferior
Pedúnculo cerebeloso medio
Pedúnculo cerebeloso superior
Técnica de microdisección de fibras
Tractografía

RESUMEN

Objetivo: Realizar un estudio anatómico de microdisección de fibras y radiológico mediante tractografía basada en tensor de difusión (DTT) para demostrar tridimensionalmente los pedúnculos cerebelosos superiores, medios e inferiores.

Material y métodos: Bajo visión microscópica y con el uso de instrumental microquirúrgico en el laboratorio, se disecaron 15 troncoencéfalos, 15 hemisferios cerebelosos y 5 hemisferios cerebrales humanos, entre julio de 2014 y julio de 2015. Se obtuvieron imágenes de resonancia magnética cerebrales realizas a 15 sujetos sanos entre julio y diciembre de 2015, empleando secuencias potenciadas en difusión para el trazado de los pedúnculos cerebelosos y su reproducción mediante DTT.

Resultados: Se demostraron y describieron anatómicamente las principales fibras de los pedúnculos cerebelosos a lo largo de gran parte de su trayectoria en el cerebelo y troncoencéfalo, identificando las relaciones entre sí y con otros haces de sustancia blanca y núcleos de sustancia gris que los rodean, con la correspondiente representación mediante DTT.

Conclusiones: Mediante la técnica de microdisección se apreció la disposición, arquitectura y organización topográfica general de los pedúnculos cerebelosos. Este conocimiento ha aportado una perspectiva anatómica única y profunda que ha favorecido la representación y correcta interpretación de las imágenes de DTT. Esta información debe ser trasladada a la práctica clínica para favorecer el análisis crítico y exhaustivo por parte del cirujano ante la presencia de lesiones que puedan localizarse cercanas a este grupo de haces en el cerebelo y/o troncoencéfalo, y, en consecuencia, mejorar la planificación quirúrgica y alcanzar una técnica microquirúrgica más segura y precisa.

Introduction

The cerebellum constitutes the posterior part of the metencephalon and can be divided into 2 fundamental parts: the flocculonodular lobe and the corpus cerebelli. The latter consists of the anterior lobe and the posterior lobe (also known as the middle lobe). The cerebellum is connected to the rest of the brainstem through 3 pairs of projection fibre tracts known as cerebellar peduncles: the superior cerebellar peduncles, with efferent fibres leading towards the midbrain and thalamus, involved in the coordination of muscle activity; the middle cerebellar peduncles, with afferent cerebellopontine fibres which mainly lead towards the neocerebellum and form an essential circuit in the cerebellar movement control system (movement planning or programming); and the inferior cerebellar peduncles, with both efferent and afferent fibres which connect it to the medulla oblongata, linked to transmission of proprioceptive information, and tied to movement and position in relation to gravity, as well as motor learning.[1–4]

Histological staining techniques applied to anatomical study have improved understanding of the organisation of the white matter in the central nervous system. However, from a surgical perspective, the fibre dissection technique, reported widely in the literature,[5–14] represents the best method to acquire accurate and precise knowledge of the inner structures of the brain.

Moreover, advances in neuroimaging through the introduction and development of diffusion tensor imaging (DTI), based on magnetic resonance imaging (MRI),[15,16] have enabled identification *in vivo* since their first studies of some details of the organisation of the main white matter nerve pathways in human beings, in both healthy brains and brains with disease.[17–19] This promising technology and mathematical models are becoming increasingly sophisticated with the development of diffusion tensor tractography (DTT),[20,21] thereby enabling individual delineation and assessment *in vivo* of the main white matter tracts. This is essential for neuroscientific studies and in the clinical practice of neurosurgery.[22–37]