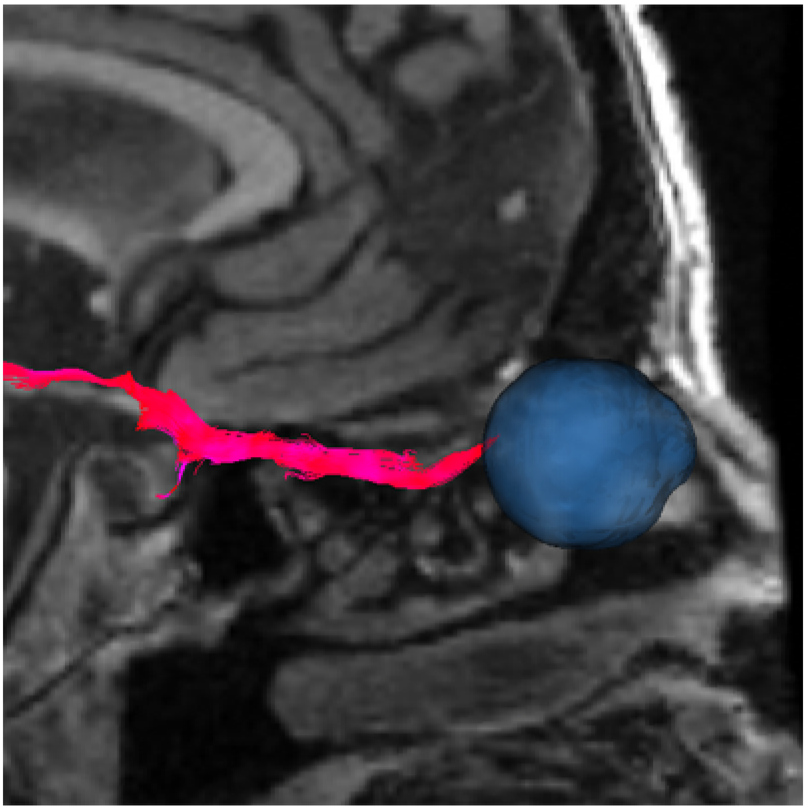
Cranial nerve tractography



Diffusion imaging tractography caught the attention of the scientific community by describing the white matter architecture in vivo and noninvasively, but its application to small structures such as cranial nerves remains difficult. The few attempts to track cranial nerves presented highly variable acquisition and tracking settings.

A “targeted” review of the scientific literature was carried out using the MEDLINE database.

Jacquesson et al., selected studies that reported how to perform the tractography of cranial nerves, and extracted the following: clinical context; imaging acquisition settings; tractography parameters; regions of interest (ROIs) design; and filtering methods.

Twenty-one published articles were included. These studied the optic nerves in suprasellar tumors, the trigeminal nerve in neurovascular conflicts, the facial nerve position around vestibular schwannomas, or all cranial nerves. Over time, the number of MRI diffusion gradient directions increased from 6 to 101. Nine tracking software packages were used which offered various types of tridimensional display. Tracking parameters were disparately detailed except for fractional anisotropy, which ranged from 0.06 to 0.5, and curvature angle, which was set between 20° and 90°. ROI design has evolved towards a multi-ROI strategy. Furthermore, new algorithms are being developed to avoid spurious tracts and improve angular resolution.

This review highlights the variability in the settings used for cranial nerve tractography. It points out challenges that originate both from cranial nerve anatomy and the tractography technology, and allows a better understanding of cranial nerve tractography [1].

Case series

Five neurologically healthy adults and 3 patients with brain tumors were scanned with diffusion spectrum imaging that allowed high-angular-resolution fiber tracking. In addition, a 488-subject diffusion magnetic resonance imaging template constructed from the Human Connectome Project data was used to conduct atlas space fiber tracking of CNs.

The cisternal portions of most CNs were tracked and visualized in each healthy subject and in atlas fiber tracking. The entire optic radiation, medial longitudinal fasciculus, spinal trigeminal nucleus/tract, petroclival portion of the abducens nerve, and intrabrainstem portion of the facial nerve from the root exit zone to the adjacent abducens nucleus were identified. This suggested that the high-angular-resolution fiber tracking was able to distinguish the facial nerve from the vestibulocochlear nerve complex. The tractography clearly visualized CNs displaced by brain tumors. These tractography findings were confirmed intraoperatively.

Using high-angular-resolution fiber tracking and atlas-based fiber tracking, we were able to identify all CNs in unprecedented detail. This implies its potential in localization of CNs during surgical planning [2].

Videos

Visualization of Cranial Nerves Using High-Definition Fiber Tractography

<html><iframe width="560" height="315" src="https://www.youtube.com/embed/RZglfrcb-Q8" frameborder="0" allow="accelerometer; autoplay; encrypted-media; gyroscope; picture-in-picture" allowfullscreen></iframe></html>

References

1)
Jacquesson T, Frindel C, Kocevar G, Berhouma M, Jouanneau E, Attyé A, Cotton F. Overcoming Challenges of Cranial Nerve Tractography: A Targeted Review. Neurosurgery. 2019 Feb 1;84(2):313-325. doi: 10.1093/neuros/nyy229. PubMed PMID: 30010992.
2)
Yoshino M, Abhinav K, Yeh FC, Panesar S, Fernandes D, Pathak S, Gardner PA, Fernandez-Miranda JC. Visualization of Cranial Nerves Using High-Definition Fiber Tractography. Neurosurgery. 2016 Jul;79(1):146-65. doi: 10.1227/NEU.0000000000001241. PubMed PMID: 27070917.