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LETTER TO THE EDITOR

Comment on: "The role of white matter dissection technique in modern neuroimaging: can neuroradiologists benefit from its use?"

Ilyess Zemmoura[1,2]

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In their article "The role of white matter dissection technique in modern neuroimaging: can neuroradiologists benefit from its use?", Liakos and Koutsarnakis [3] raise an interesting question resulting from the limitations of diffusion tractography, a novel neuroimaging technique on the point of becoming a routine investigation. Nevertheless, although a perfect understanding of the three-dimensional anatomy of brain connectivity, a compulsory prerequisite to operate brain tumors, is undoubtedly only achieved after a long practice of fiber dissection, I would moderate the authors' point of view concerning its use by neuroradiologists. Indeed, there are at least two arguments against the practice of dissection by neuroradiologists, which I detail further; but it is first important to understand why fiber dissection is nowadays considered as a valuable tool to enhance our knowledge about brain connectivity.

Indeed, diffusion tractography, despite new technical refinements—such as Q-ball imaging, diffusion spectrum imaging or spherical deconvolution, which are high-resolution methods partially resolving the problem of crossing fibers by identifying multiple diffusion directions inside each voxel—provides an *indirect* representation of underlying anatomy. This explains why results of tractography can vary widely in physiological conditions—depending on MRI acquisition parameters, tractography algorithms, and manual operations such as regions of interest (ROIs) placement or the choice of fractional anisotropy threshold—and even more in pathological conditions that modify water diffusion or fiber tracts course.

These limitations have led to the current idea that tractography needs an independent validation by other methodologies. Fiber dissection, which has the major advantage to offer a direct and reliable visualization of anatomy [4], has then been proposed as a validation tool [5]. Nonetheless, as none of the proposed validation methods is free from limitations, it is nowadays generally accepted that tractography validation will need a multimodal approach combining for example dissection [4] with polarized light imaging [1] or optical coherence tomography, two techniques having a higher resolution than dissection, and maybe other techniques such as axonal tracing with manganese [2].

Now, considering the use of dissection by neuroradiologists, two other limitations are to be considered.

First, fiber dissection is not only a time-consuming method but also, as stated by Liakos and Koutsarnakis [3], a complex method, even for neurosurgeons, who have yet developed expert manual skills during their neurosurgical training (containing multiple workshops on cadaver) and practice. Thus, the recommendation to practice fiber dissection may not only be unrealizable, but also discouraging in neuroradiologists' hands, not adequately trained to dissection.

Second, the main aim of dissection, as discussed in the article, is to better achieve a mental imaging of three-dimensional morphology of fiber tracts, and transpose this mental imaging to the operating room. This mental imaging is efficiently improved by dissection and especially by the manually operated manipulations it requires. Indeed, diffusion tractography provides an MRI graphical

✉ Ilyess Zemmoura
ilyess.zemmoura@univ-tours.fr

[1] Service de Neurochirurgie, CHRU de Tours, Tours, France

[2] Université François-Rabelais de Tours, Inserm, Imagerie et Cerveau, UMR U930, Tours, France

representation of this anatomy, in a reference space very different from the operating room. Nonetheless, this mental transposition from one reference space to another is reserved to neurosurgeons, who exercise this skill in their everyday practice, and does not seem this important for neuroradiologists.

As a conclusion, I would rather recommend that neuroradiologists actively practice diffusion tractography with different tractography tools and appreciate their limitations—which are inherent to the technique itself— to become expert clinicians of this promising imaging technique. Indeed, I believe that only neuroradiologists can provide (1) radiological evidences that tractography can be useful in clinical practice and (2) guidelines to the use of tractography, with details on the advantages and limitations of each tractography method for each pathology considered.

References

1. Axer M, Amunts K, Grassel D et al (2011) A novel approach to the human connectome: ultra-high resolution mapping of fiber tracts in the brain. Neuroimage 54:1091–1101
2. Knösche TR, Anwander A, Liptrot M, Dyrby TB (2015) Validation of tractography: comparison with manganese tracing: validation of tractography with manganese tracing. Hum Brain Mapp. doi:10.1002/hbm.22902
3. Liakos F, Koutsarnakis C (2015) The role of white matter dissection technique in modern neuroimaging: can neuroradiologists benefit from its use? Surg Radiol Anat. doi:10.1007/s00276-015-1546-0
4. Zemmoura I, Blanchard E, Raynal P-I et al (2015) How Klingler's dissection permits exploration of brain structural connectivity An electron microscopy study of human white matter. Brain Struct Funct. doi:10.1007/s00429-015-1050-7
5. Zemmoura I, Serres B, Andersson F et al (2014) FIBRASCAN: a novel method for 3D white matter tract reconstruction in MR space from cadaveric dissection. NeuroImage 103:106–118