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Case Report

The frontal aslant tract: Anatomical description and case report

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ABSTRACT

Background: Advances in surgical techniques, neuroimaging, and white matter fiber dissection have facilitated the identification of critical tracts like the frontal aslant tract (FAT) that have garnered attention, despite remaining poorly recognized within the neurosurgical community.

Case Description: We report the case of a 37-year-old male right-handed patient presenting with headache and epilepsy, in whom neuroimaging revealed an intra-axial lesion in the left middle frontal gyrus closely associated with FAT. Successful navigation-guided resection of the lesion was achieved, resulting in a favorable neurological outcome attributable to the preservation of the tract. This case is complemented by a review of the literature and anatomical dissection of FAT in a human specimen.

Conclusion: The FAT has emerged as a critical white matter structure in neurosurgery, given its involvement in speech and motor functions. This case demonstrates the importance of advanced imaging modalities and intraoperative technologies to ensure safe resection.

Keywords: Anatomy, Aslant, Klingler, Oligodendroglioma, Tract, White fibers

INTRODUCTION

Advances in surgical techniques, imaging studies, and white matter fiber dissection have led to the identification of tracts, enabling an understanding of their function and justification for preservation during neurosurgical procedures. One recently notable tract is the frontal aslant tract (FAT), which remains relatively unknown within the neurosurgical community. The FAT is a cerebral white matter tract connecting the superior frontal gyrus (SFG), specifically the presupplementary motor area (pre-SMA) and supplementary motor area (SMA), to the pars opercularis and pars triangularis of the inferior frontal gyrus (IFG) and anterior insula.[7]

The connectivity between elements involving the FAT, specifically between the pre-SMA and IFG, was only recently discovered in 2007, thanks to advancements in imaging techniques.[1] Other researchers, such as Catani *et al.*[4] and Thiebaut de Schotten *et al.*,[10] were the first to identify and name the FAT due to the arrangement of its fibers in the frontal lobe on coronal sections.

Damage to the FAT during tumor resection can result in relatively subtle neurological deficits.[7] The FAT plays a role in functions related to speech and language (lexical decision-making, speech initiation, and inhibition, sentence production, and verbal fluency), as well as visuomotor activities, executive functions, working memory, orofacial movements, inhibitory control, attention, social community tasks, and music processing.[7] We present a clinical case of a patient with a left frontal intra-axial lesion closely associated with the FAT, highlighting the relevance of understanding this tract from an anatomical and functional perspective for the neurosurgeon.

CASE DESCRIPTION

A 37-year-old man, right-handed with no significant medical history, presented with a 6-month history of moderate-intensity headache characterized by oppressive symptoms, followed by a bilateral tonic-clonic seizure episode, prompting evaluation. Imaging studies revealed an intra-axial lesion in the left middle frontal gyrus with features suggestive of a low-grade glial tumor [Figure 1].

The patient scored 15 points on the Glasgow coma scale, with pupils at 3 mm, reactive, and no cranial nerve deficits. Motor and sensory functions were preserved with hyperreflexia. Language assessment revealed preserved repetition, naming, and comprehension, as well as phonological skills. Further evaluations with functional magnetic resonance imaging and tractography, focusing on language processing, were performed [Figure 2].

The patient underwent a left frontal craniotomy and tumor resection using neuronavigation, with an intraoperative diagnosis of low-grade glioma consistent with oligodendroglioma. Histopathological examination confirmed grade 2 oligodendroglioma [Figure 3]. Following surgery, the patient experienced a complete neurological recovery with no evidence of linguistic deficits.

RESULTS

The FAT is a white matter fiber tract that courses in the coronal plane, connecting the SFG to the ipsilateral IFG.[9] The primary fiber projection of the FAT in the IFG is the pars opercularis, with some fibers also reaching the pars triangularis to a lesser extent.[9] The FAT connects the SFG, specifically, two subdivisions of the SMA complex (6 ma and SFL) and two of the dorsolateral prefrontal cortex (8BL and S6-8).[6] Non-homologous callosal connections between premotor areas have been described, and some authors introduced the concept of the "crossed Aslant tract," which may play a role in recovery from SMA syndrome.[2]

The superior terminations of the FAT are commonly identified in the SMA complex of the SFG, specifically in its medial portion, as well as in the dorsolateral prefrontal cortex of the SFG.[8] The SMA complex is subdivided into the proper SMA, the pre-SMA, and the supplementary eye field, all located on the medial surface of the SFG.[8] The FAT is medial to the superior longitudinal fascicle II and lateral to the fronto-striatal tract and claustrocortical fibers.[3]

Using Klingler's 1935 technique, a post-mortem dissection of white matter fibers was conducted on a right cerebral hemisphere from an adult male autopsy specimen. A right cerebral hemisphere from an adult male was obtained from an autopsy. The brain tissue was fixed in a 10% formalin solution for a few months. Subsequently, the arachnoid and cortical vessels were removed. The cerebral hemisphere was frozen for 10 days. The sample was washed with water, and once thawed, the dissection began with the removal of the cortex and exposure of the U-fibers. The dissection of the white matter was performed as follows: initially, from lateral to medial, starting in the middle frontal gyrus, using wooden spatulas for the initial cortical dissection. Once the U-fibers were identified, metal dissectors with blunt tips were used to complete the dissection. The medial SFG and the pars opercularis/triangularis regions were exposed, revealing the

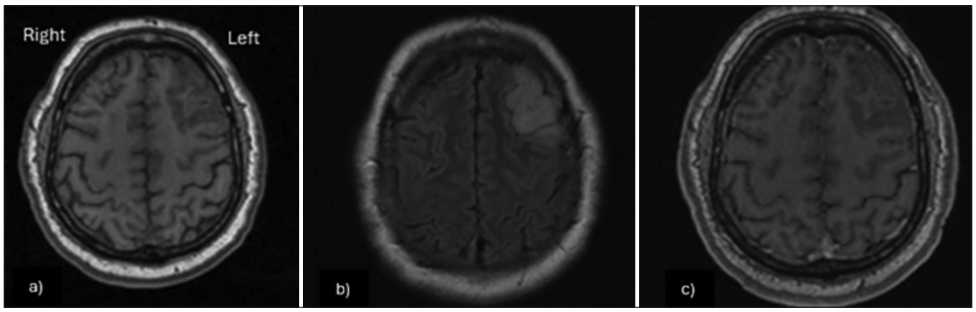

Figure 1: Brain magnetic resonance imaging, (a) axial T1-weighted image showing a hypodense lesion in the left middle frontal gyrus with a hyperdense center, accompanied by minimal perilesional edema compressing the left superior and inferior frontal gyri, (b) hyperdense lesion on T2-weighted image, and (c) minimal enhancement with gadolinium contrast on T1-weighted contrast-enhanced sequence.

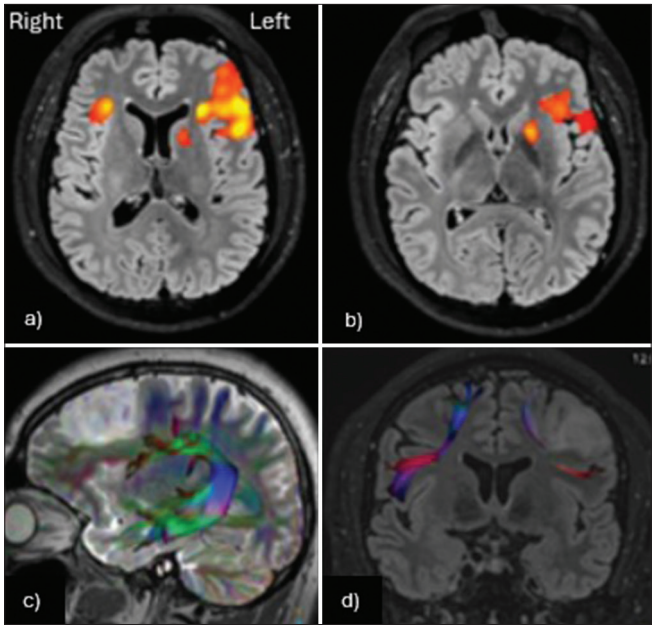

Figure 2: (a and b) Functional magnetic resonance imaging shows clear left-hemisphere dominance for language functions, with activity in the left inferior frontal gyrus. (c) The left arcuate fasciculus appears intact, with mild caudal displacement due to the lesion. (d) The Aslant tracts are visible, with compression and reduced fiber count on the left side, in close proximity to the lesion.

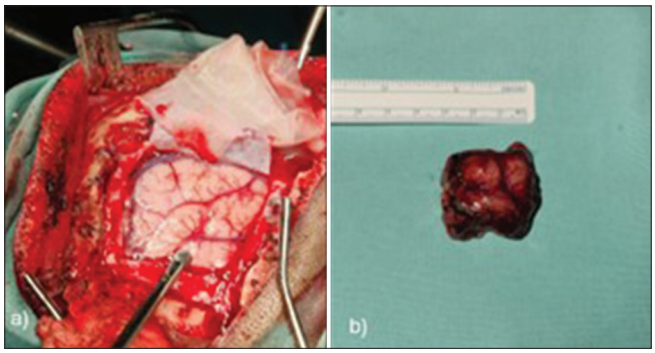

Figure 3: (a) Surgical exposure of the left frontal lesion through a left frontal craniotomy. (b) Macroscopic appearance of the lesion during resection.

FAT's oblique fibers and their medial orientation relative to the SFL [Figure 4].

Surgical damage to FAT fibers has been linked to aphasia and speech disturbances, including word-finding difficulties, conversation pauses, and delayed responses, resulting in impaired verbal fluency.[11] Research indicates that the left FAT specializes in speech planning and articulation, whereas the right FAT is involved in general action planning and visuomotor coordination, regulating manual and eye movements.[5] Therefore, preserving the FAT during surgical procedures is crucial to minimize functional deficits and clinical consequences in patients.

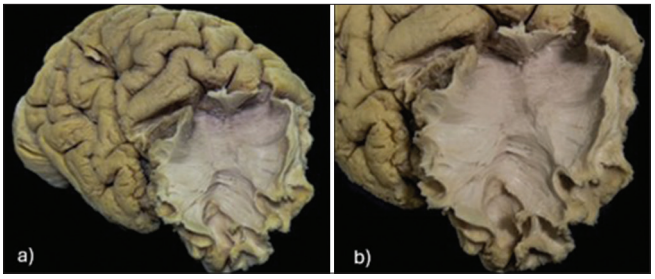

Figure 4: (a) Dissected human right cerebral hemisphere showing exposure of the frontal aslant tract (FAT) in the frontal lobe. (b) Higher magnification of the same specimen, demonstrating the oblique fiber orientation from the medial superior frontal gyrus to the pars opercularis and pars triangularis, comprising the FAT.

CONCLUSION

The FAT has emerged as a critical white matter structure in neurosurgery, given its involvement in speech and motor functions. This case demonstrates the importance of advanced imaging modalities and intraoperative technologies to ensure precise and safe resection, avoiding damage to vital tracts like the FAT. Moreover, it emphasizes the value of white matter dissection in specimens for understanding tract anatomy, ultimately enhancing neurosurgical education and training.

Ethical approval

The Institutional Review Board approval is not required.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Nil.

Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

REFERENCES

1. Aron AR, Behrens TE, Smith S, Frank MJ, Poldrack RA. Triangulating a cognitive control network using diffusion-weighted Magnetic Resonance Imaging (MRI) and functional MRI. J Neurosci 2007;27:3743-52.
2. Baker CM, Burks JD, Briggs RG, Smitherman AD, Glenn CA, Conner AK, *et al*. The crossed frontal aslant tract: A possible pathway involved in the recovery of supplementary motor area syndrome. Brain Behav 2018;8:e00926.
3. Bozkurt B, Yagmurlu K, Middlebrooks EH, Karadag A, Ovalioglu TC, Jagadeesan B, *et al*. Microsurgical and tractographic anatomy of the supplementary motor area complex in humans. World Neurosurg 2016;95:99-107.
4. Catani M, Dell'acqua F, Vergani F, Malik F, Hodge H, Roy P, *et al*. Short frontal lobe connections of the human brain. Cortex 2012;48:273-91.
5. Dick AS, Garic D, Graziano P, Tremblay P. The Frontal Aslant Tract (FAT) and its role in speech, language and executive function. Cortex 2019;111:148-63.
6. Glasser MF, Coalson TS, Robinson EC, Hacker CD, Harwell J, Yacoub E, *et al*. A multi-modal parcellation of human cerebral cortex. Nature 2016;536:171-8.
7. La Corte E, Eldahaby D, Greco E, Aquino D, Bertolini G, Levi V, *et al*. The frontal aslant tract: A systematic review for neurosurgical applications. Front Neurol 2021;12:641586.
8. Ruan J, Bludau S, Palomero-Gallagher N, Caspers S, Mohlberg H, Eickhoff SB, *et al*. Cytoarchitecture, probability maps, and functions of the human supplementary and pre-supplementary motor areas. Brain Struct Funct 2018;223:4169-86.
9. Szmuda T, Rogowska M, Słoniewski P, Abuhaimed A, Szmuda M, Springer J, *et al*. Frontal aslant tract projections to the inferior frontal gyrus. Folia Morphol (Warsz) 2017;76:574-81.
10. Thiebaut de Schotten M, Dell'Acqua F, Valabregue R, Catani M. Monkey to human comparative anatomy of the frontal lobe association tracts. Cortex 2012;48:82-96.
11. Young JS, Morshed RA, Mansoori Z, Cha S, Berger MS. Disruption of frontal aslant tract is not associated with long-term postoperative language deficits. World Neurosurg 2020;133:192-5.

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