**Functional specificity of the left frontal aslant tract: evidence from intraoperative language mapping**

Olga Dragoy1,2, Andrey Zyryanov1, Oleg Bronov3, Elizaveta Gordeyeva1, Natalya Gronskaya4, Oksana Kryuchkova5,Evgenij Klyuev6,Dmitry Kopachev7,Igor Medyanik6,Lidiya Mishnyakova8, Nikita Pedyash3, Igor Pronin7, Andrey Reutov5,Andrey Sitnikov8, Ekaterina Stupina1, Konstantin Yashin6, Valeriya Zhirnova1, Andrey Zuev3

1 National Research University Higher School of Economics, Moscow, Russia

2 Center for Cerebrovascular Pathology and Stroke, Moscow, Russia

3 National Medical and Surgical Center named after N.I. Pirogov, Moscow, Russia

4 National Research University Higher School of Economics, Nizhny Novgorod, Russia

5 Central Clinical Hospital of the Presidential Administration of the Russian Federation, Moscow, Russia

6 Volga Research Medical University, Nizhny Novgorod, Russia

7 N.N. Burdenko National Scientific and Practical Center for Neurosurgery, Moscow, Russia

8 Federal Centre of Treatment and Rehabilitation of the Ministry of Healthcare of the Russian Federation, Moscow, Russia

**Introduction**

The left frontal aslant tract (FAT), a frontal intralobular white-matter pathway, connecting the posterior regions of the superior and inferior frontal gyri, has been proposed to be relevant for language, and specifically – for speech initiation and fluency. Individuals with stroke (Kinkingnehun et al., 2007; Basilakos et al., 2014), tumor (Bizzi et al., 2012; Chernoff et al., 2018) and primary progressive aphasia (Catani et al., 2013; Mandelli et al, 2014) showed reduction of spontaneous speech production whenever the left FAT was involved. A few recent studies combined intraoperative direct electrical stimulation (DES) with white matter reconstructions to tap into linguistic relevance of the left FAT (Fujii et al., 2015; Kinoshita et al., 2015; Sierpowska et al., 2015; Vassal et al., 2014). However, convincing evidence that DES of the FAT affects specifically spontaneous speech initiation, and not a general language production ability, was missing. The aim of this study was to test linguistic functional specificity of the left FAT in the awake surgery settings.

**Method**

Ten consecutive patients (three female; age range 25-64, M=41 y.o.) underwent awake craniotomy with language mapping for removal of a brain pathological tissue (9 primary brain tumors, WHO grade 1-4, and 1 focal cortical dysplasia) in proximity of the left FAT. Two language tasks were used in combination with cortical DES: picture naming – a standard and widely used test for intraoperative language production mapping; and sentence completion, tapping more specifically into spontaneous speech initiation. Diffusion-tensor imaging sequences were acquired for all patients preoperatively, using 3T or 1.5T scanners (64 directions, 2.5 or 3 mm isovoxel, b=1500 or 1000 s/mm2, two repetitions with opposite phase encoding directions). After preprocessing in FSL (Jenkinson et al., 2012) and ExploreDTI (http://www.exploredti.com) using the deterministic diffusion tensor imaging approach, the left FAT in each of the patients was reconstructed in TrackVis (http://www.trackvis.org) manually. The language-positive sites revealed during the intraoperative procedure were further mapped onto those individual reconstructions.

**Results**

Intraoperative stimulation of the exposed cortex in all ten cases resulted in language-positive sites, with a task dissociation revealed. Some sites were predominantly responsive to sentence completion: being stimulated on those, patients could not complete a sentence, but were able to name a picture. Overlaying the revealed positive sites, which were specifically responsive to sentence completion, and not to action naming, on tractography reconstructions demonstrated that all of them were located precisely on individual cortical terminals of the left FAT in the superior and/or inferior frontal gyri.

**Conclusion**

Direct electrical stimulation of the left FAT was associated with a specific language impairment – inability to complete sentences, in contrast to a spare ability to name a picture. This proves linguistic functional specificity of the left FAT as a tract underlying spontaneous speech initiation and suggests the sentence completion task as an adequate tool for intraoperative functional mapping of the FAT.