Commentary

The intranuclear length of the electrode trajectory according to the 'port' model for deep brain stimulation of the nucleus accumbens

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I read the article by Zhang *et al.* (1), on deep brain stimulation (DBS) of the ventral capsule/ventral striatum (VC/VS) for the treatment of neuropsychiatric disease, with great interest. They describe the development of a new electrode for simultaneous and independently programmed stimulation of the nucleus accumbens (NAc) and the anterior limb of the internal capsule (ALIC) based on the anatomical features of the VC/VS (1). The purpose of this communication is to comment on some aspects of the anatomy of the NAc as reported by Zhang *et al.* (1).

According to these authors, the electrode configuration for DBS should be specifically tailored to the geometry and properties of the target area and, accordingly, their VC/VS-specific electrode has the potential to enhance stimulus intensity and provide independent and flexible target stimulation (1). The described new electrode (SceneRay 1242) is quadripolar with a diameter of 1.27 mm, contact length 3 mm, 0.5 projecting from the electrode tip, and contact spacing 4 mm except for the two deepest contacts where this spacing is 2 mm (1).

In their article's 'Materials' section, Zhang *et al.* (1) mentioned that "*the electrode contact size was set to 3 mm for several reasons, and primarily based on anatomical studies suggesting that the human NAc is approximately 8 mm in length*" and "*thus, a 3-mm contact length combined with a 2-mm contact interval should completely cover the NAc*" and cited two articles regarding the anatomy of the NAc (2,3). The first was written by Lucas-Neto *et al.* (2) and the second by Mavridis *et al.* (3). However, the length of the human NAc was reported to be 19.4 mm ("entire length") in the first article and 12.4±2.7 mm ("mean length") in the second. A closer view on the anatomy of the human NAc can clarify this ambiguity.

When talking about length of a brain structure in anatomical studies we mean its antero-posterior dimension, unless otherwise determined. In this context, the NAc length measurements in the two above mentioned studies refer to its antero-posterior dimension. However, the "length" of the NAc, which is crucial for determining the geometrical features of the NAc DBS electrodes, is the intranuclear length of the electrode trajectory for NAc DBS. Importantly, this length has been determined in anatomical studies and described as one of the anatomical parameters of the safe navigation model ('port' model) for DBS of the human NAc. According to this model, (the coronal contour of) the mean intranuclear length of the safest electrode trajectory to the NAc is 7.3±1.7 mm (in the clinically relevant stereotactic plane 2 mm anterior to the anterior commissure) (4-6). This finding actually favors the design of the SceneRay 1242 DBS electrode by Zhang *et al.* (1).

So, 6 years after the description of the 'port' model for safe navigation to the NAc, which determined the intranuclear length of the safest electrode trajectory for NAc DBS, Zhang *et al.* (1) report the development of a new electrode for NAc and/or ALIC DBS, the geometrical characteristics of which are in accordance with this length. This fact anatomically supports the aim of the authors to achieve selective NAc stimulation, an aim which remains to be clinically confirmed.

Furthermore, the authors elsewhere mentioned that "*the*

distance from the ventral edge of the ALIC to the NAc ventral margin is approximately 13 mm" (1). This statement could be realistic considering the greatest distance (not in stereotactic plane 2 mm anterior to the anterior commissure) from the ventral edge of the ALIC to the NAc inferior margin, as shown for example in the atlas of Mai *et al.* (7).

The statement of the authors, that the currently mixed results of DBS for the treatment of refractory mental illness necessitate serious efforts to fully explore its therapeutic utility and improve its effectiveness (1), is really important. In this direction, I would like to congratulate Zhang *et al.* (1) for their efforts. The ability to stimulate two brain areas, namely the NAc and ALIC using two different sets of parameters is a significant advantage of their new electrode (1).

Time will tell whether the prediction of Zhang *et al.* (1), that this new electrode can be used in the future to more clearly distinguish the therapeutic effects of NAc versus ALIC stimulation (1), will become true, thus increasing further their contribution to the difficult and challenging field of DBS for psychiatric disorders.

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Footnote

Conflicts of Interest: The author has no conflicts of interest to declare.

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