The pedunculopontine and peripeduncular nuclei: a tale of two structures

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Research on the pedunculopontine nucleus (PPN) has identified this structure as a potential new target for deep brain stimulation (DBS) in patients with axial movement disorders refractory to other forms of treatment (Pahapill and Lozano, 2000; Jenkinson et al., 2004). Stefani et al. recently presented their surgical approach for DBS of the PPN (Stefani et al., 2007). Although they describe their anatomical target as the PPN, Figure 2 of their paper and sections of the text clearly show that they have actually targeted the peripeduncular nucleus (PPD). The pedunculopontine nucleus (PPN) and the peripeduncular nucleus (PPD) are distinct anatomical structures with different configurations and very different anatomical boundaries at different levels of the brainstem.

The PPN is an elongated neuronal collection lying lateral to the decussation of the superior cerebellar peduncle and medial to the medial lemniscus; it does not abut the pial surface. This nucleus is labelled as the Griseum circumflexum brachii conjunctivi (Gr. cf. b. cj.) in the Schaltenbrand Atlas (Schaltenbrand and Wahren, 1977). In the same atlas, the PPD is labelled as the nucleus peripeduncularis (Ppd). The PPD lies lateral to the medial lemniscus with aspects of its posterior and lateral margins abutting the pial surface; the nucleus has an arch-like configuration (which Stefani et al. wrongly attribute to the PPN).

The pedunculopontine nucleus (PPN) has its long axis roughly parallel to the floor of the fourth ventricle and aqueduct. Photographs and diagrams of the human brainstem show the PPN in axial sections taken 31 mm through 36 mm rostral to the obex (Paxinos and Huang, 1995). On the other hand, the most caudal aspect of the PPD starts at axial section taken 40 mm rostral to the obex. The PPD then extends superiorly as far as the inferior aspect of the medial geniculate body. Animal and human studies on the PPD have focused on its putative role in sexual function. However, its widespread connections include the basal ganglia and the PPN (Arnault and Roger, 1987; Goldstein et al., 2005).

Functional neurosurgical procedures necessarily commence with initial targeting of an anatomical structure. Targeting may then be refined by an exploration of the clinical and physiological observations at the target region. Finally, an assessment of the actual (as opposed to the desired) structure that has been targeted must be made.

Once again, this article highlights the uncertainty of the anatomical specificity of microelectrode recording (MER) (Hariz et al., 2004). Indeed, it also implies the importance of pre- and post-operative anatomical localization in functional neurosurgery. Attention to detail during anatomical targeting must necessarily be the initial step in any functional neurological procedure. MER cannot correct for gross anatomical mistargeting and is certainly no substitute for post-operative stereotactic images when documenting the precise location of electrode contacts within the brain.

We would take this opportunity to make a plea to the functional neurosurgery community to obtain post-operative stereotactic MR imaging in every patient undergoing DBS to verify the anatomical placement of electrode contacts. Only then can we correctly interpret the relationship between the anatomical interventions that we inflict and the functional outcome that we observe in our patients.

The results presented by Stefani et al. remain exciting. However, if the contacts that produced the described clinical effect are actually located within the pedunculopontine nucleus (PPN), the electrode location has certainly been misrepresented in their paper and the precise location...
of the active contacts remains unknown. On the other hand, Stefani et al. may have inadvertently discovered an unexpected beneficial effect of low frequency DBS in the peripeduncular nucleus (PPD). Thin slice, high resolution post-operative stereotactic MR images would probably have resolved the matter.

References