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Contarino, M.F.

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Chapter 9

Bilateral cerebellorubrothalamic fibers stimulation for essential tremor

Maria Fiorella Contarino, Johannes D. Speelman, Rob M.A. De Bie, P. Richard Schuurman, Pepijn Van Den Munckhof

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We would like to describe a patient with Essential tremor undergoing DBS, in whom posterior subthalamic area (PSA) was targeted as a result of extensive intraoperative testing, after Vim stimulation did not produce a satisfying benefit.

The patient is a 66-year-old lady with medication-resistant head, voice and arm tremor since the age of 35. The total score on the Essential Tremor Rating Scale (ETRS) was 53. The thalamic nucleus ventralis intermedius (Vim) was localized on frame-based MRI at 15 mm lateral, 2 mm superior and 8 mm anterior to the posterior commissure (PC). Left-sided intraoperative stimulation from 6 mm above to 2 mm below target depth had no benefit. A second, more medial and posterior Vim target was calculated at 13 mm lateral and 6 mm anterior relative to PC. At 4 mm below target depth, slight tremor reduction occurred at 4.5 mA, accompanied by hand paresthesias. We subsequently targeted the Zona Incerta at 7 mm lateral, 3 mm inferior and 6 mm posterior to the midcommissural point (MCP). Stimulation from 2 mm above to 2 mm below target depth produced slight tremor reduction with a persistent unpleasant feeling. We therefore returned to the more medial and posterior Vim target. At 8 mm below target depth, tremor was abolished completely at 2 mA, with transient hand paresthesias. For the right side, we only tested this last target. Stimulation at 2 mA, at 6 and 8 mm below target depth, completely abolished tremor, with transient hand paresthesias. The permanent electrodes (3389, Medtronic; Minneapolis, MN) were implanted 8 mm below target depth bilaterally.

After surgery, a marked microlesional effect was noticed. Two weeks later, tremor recurred to preoperative intensity. Bilateral stimulation (monopolar 0-, 3.3V, 180 Hz, 60 μsec) abolished voice tremor and markedly reduced postural arm and head tremor, with a residual intention component on the right arm (ETRS total score 35, 34% reduction). Higher voltages induced dysarthria and paresthesias. The patient complained also of some gait instability, which was not improved by changing stimulation settings. This side effect profile is similar to that reported after bilateral Vim stimulation.

A postoperative CT was co-registered with the frame-based MRI using Leksell SurgiPlan® software (Elekta Instrument AB, Stockholm, Sweden). The left active contact was localized at 9.6 mm lateral, 4.2 mm inferior and 8.2 mm posterior to MCP, the right at 9.2 mm lateral, 4.1 mm inferior and 8.7 mm posterior to MCP. On both sides, the active contact targeted the area adjacent to the lateral border of the red nucleus (Figure 1A), similar to Blomstedt et al. The DBS target within the PSA varies between the different groups, as revised by Blomstedt. According to the Atlas by Schaltenbrand and Wahren, the PSA contains the zona incerta, medial lemniscus, fasciculus Q and prelemniscal radiation (Raprl), including cerebellothalamic fibers. According to Duvernoy's Atlas, the area immediately adjacent to the lateral border of the red nucleus harbors cerebellorubrothalamic fibers. In the stereotactic atlases by Morel and by Mai et al., this area harbors cerebellorubrothalamic fibers. Since these fibers are thought to play an important role in tremor, one could hypothesize that the beneficial effect of DBS at this area occurs through cerebellorubrothalamic fibers stimulation.
Figure. a) T2-weighted MR image showing the active contacts adjacent to the lateral border of the red nucleus. b) Plate from Duvernoy’s atlas of the human brain stem and cerebellum (page 88, figure 2.20), showing the cerebellorubrothalamic fibers running lateral to the red nucleus.

It is not possible to state which PSA substructure contributes to the therapeutic effect. However, since determining the precise relationship between the neuroanatomical location of the active contact and the therapeutic effect is critical, we postulate that the fibers of the cerebellorubrothalamic tract are the structures through which the effect of stimulation is produced. Eventually, comparing DBS for tremor at the different PSA and thalamic substructures will further elucidate the optimal target.

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REFERENCE LIST


