A Paradigm Shift Towards MRI-Guided and *MRI-Verified* DBS surgery

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To The Editor

We read with interest the editorial by Dr Elias: "Deep brain stimulation and intraoperative MRI". The use of electrophysiology, clinical testing and intraoperative MRI in DBS surgery on patients under local anesthesia is described as a "paradigm shift".[5] However, many European centers and, more recently, a few US centers have long moved past this particular milestone. The paradigm shift in functional neurosurgery is not simply the use of MRI to guide the surgical procedure. It is the use of stereotactic imaging to both guide *and verify* the DBS procedure.

Appropriate stereotactic MRI sequences can localize intracranial structures directly in patients under general anesthesia (GA), without the need for intraoperative clinical testing or neurophysiological recording.[18] The radiological anatomy enables direct targeting, confirms lead position and guides relocation if required. Moreover, systematic analysis of targeting errors permits development of strategies to improve surgical accuracy and precision during subsequent procedures, thus tending to minimize the number of brain penetrations.[7] Audit of lead location and its correlation with long-term clinical outcome can also inform on targeting strategies to improve clinical outcome and minimize adverse effects secondary to stimulation.[16,17]

The editorial rightly points out a major limitation of its accompanying study, the lack of clinical information and outcome data.[4] However, other studies using a purely image-guided and image-verified approach do provide clinical outcome data and are not cited by either article. The Montpellier group has published excellent long term results after MRI-verified pallidal DBS for dystonia under GA.[3,8] The Bristol group presented clinical hemibody results 6-months after MRI-verified DBS for PD.[13] UPDRS data 9-months following MRI-verified STN DBS under GA has also been published by the San Francisco group.[15] The Phoenix group are currently collecting clinical outcomes data after employing an image-verified approach to DBS under GA.[10] Yet another US center advertises the benefits of the MRI-verified technique under GA to patients via their website.[20]

Our group at Queen Square, London, has performed MRI-guided and MRI-verified DBS without microelectrode recording (MER) since 2002. Clinical results after surgery under general anesthesia and comprehensive clinical results 1, 5 and 8 years after STN DBS surgery have been published, including UPDRS data, quality of life scores and neuropsychological evaluations.[1,6,11]

DBS aims to improve quality of life; therefore, safety is an absolute priority. An MRI-guided and MRI-verified approach is associated with a significantly lower incidence of all types of intracranial hemorrhage, including those leading to death or disability - an observation readily explainable by the fewer brain penetrations required by this technique.[19]

Additional benefits of the MRI-guided and MRI-verified approach include increased patient comfort and reduced anxiety as well as avoidance of complete levodopa withdrawal and consequently less confusion in the perioperative period. Moreover, significantly shorter operative times and cost ultimately allow more patients to access DBS therapy.[9] During DBS surgery under GA, positive pressure ventilation increases intracranial pressure that, combined with meticulous entry planning on a gyrus and short "dura open" time, prevents brain slump. Consequently, CSF egress, pneumocephalus and brain shift are minimized.[12] Conversely, and somewhat perversely, huge targeting errors of >5-10 mm have been reported in patients undergoing MER during awake stereotactic surgery, presumably secondary to large amounts of pneumocephalus and brain shift.[2,14]

The editorial suggestion that "a hybrid technique that emphasizes electrophysiology and intraoperative imaging may become the standard for stereotactic surgery" may instead negate many of the advantages of a purely MRI-guided and MRI-verified approach. Ultimately, individual neurosurgeons should decide which techniques to use when performing a procedure. However, many of the benefits of a paradigm shift towards MRI-Guided and MRI-Verified DBS surgery may never materialize if combined with traditional techniques.

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