MOTOR CORTEX STIMULATION FOR CENTRAL PAIN SYNDROMES

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Technical innovation has been the force that "through the green fuse" drives the flower of progress in the field of neurosurgery. Each of the papers presented in this inaugural symposium on epidural motor cortex stimulation (MCS) reflects this observation. Each article expands on Tsubokawa's seminal work published a decade ago in which he treated seven patients with thalamic pain by epidural MCS.

In the opening article the authors summarize the background of discovery that led to the conceptualization of MCS for deafferentation pain. The writers review the conclusions from ensuing publications. Why does MCS help alleviate symptoms in patients with central and neuropathic pain syndromes? Of interest is the work of Garcia-Larrea, et al., Tsubokawa found that MCS increased cerebral blood flow (CBF) in the thalamus and hypothesized that thalamic burst activity was inhibited. Garcia-Larrea, et al., used positron emission tomography to demonstrate that CBF not only increased in the ipsilateral thalamus but also in other sites including the cingulate gyrus, orbitofrontal cortex, and brainstem. The authors correlated the degree of pain relief with the volume of blood flow in the cingulate gyrus. They suggest that MCS improves the suffering component inherent in chronic pain.

There were only a few articles published in the first half decade following Tsubokawa's paper. It was difficult to identify accurately the precentral gyrus while the procedure remains epidural. The far-field, evoked-potential technology used initially to confirm the site of the central sulcus is tedious. Not until Nguyen, et al., applied computer neuronavigation to the task of targeting the precentral gyrus did the field blossom. The operation became much simpler and results improved, especially in patients

with facial neuropathic pain, presumably because the cortical facial representation is so much larger and easier to identify. Using neuronavigation for target identification, Nguyen, et al., reported substantial pain relief in patients with central pain and 75% substantial relief in up to 77% of their patients with facial neuropathic pain. This is a major medical breakthrough for conditions thought to be untreatable.

Enlarged panel from the painting "Massacre of the Innocents" by Matteo di Giovanni di Bartolo (Matteo da Siena 1435–1495) painted as a decoration for the pavement of the Cathedral of Siena in Italy.

With this background in mind, each of the papers in this issue explores technical variations in the established operative approach. In their paper, "Motor cortex stimulation for deafferentation pain," Saitoh, et al., were unable to confirm any predictive benefit from preoperative pharmacological evaluation in which intravenous phentolamine, ketamine, and morphine are administered, as has been hypothesized by Tsubokawa. They were able to reestablish effective pain relief, which had ceased 6 months after epidural stimulation, by placing a new electrode in the subdural space. They also performed chronic stimulation from within the central sulcus itself. Finally, they expand the indications of treatment to include brachial plexus injury, spinal cord injury, and phantom limb pain.

In the second paper, "Motor cortex stimulation for neuropathic pain," Smith, et al., describe successful alleviation of pain only in patients in whom motor contractions could be elicited by stimulation during their evaluation. They confirm the findings of Katayama, et al., that the presence of moderate to severe paralysis in the region of neuropathic pain correlates with poor postcortical stimulation results.

In their paper, "The Zeiss-MKM system for frameless

image-guided approach in epidural motor cortex stimulation for central neuropathic pain," Pirotte, et al., confirm the accuracy of neuronavigation in target identification. The mean distance between magnetic resonance (MR) imaging-defined and the actual central sulcus was 2.4 mm. Intraoperative median nerve evoked potential localization of the central sulcus was, however, not easily reproducible, and it was also less accurate. The authors confirm that their best clinical results were in patients with trigeminal neuropathic and central poststroke pain syndromes.

In the final paper, "Epidural motor cortex stimulation with functional imaging guidance," Mogilner and Rezai introduce the intriguing integration of functional MR imaging and magnetoencephalography for preoperative mapping of the stimulation target. The possibility of precise preoperative target determination based on the individual patient's functional representation rather than a mapped equivalent speaks to a hopeful future concerning this well-established operation for the treatment of patients with a most difficult, and previously untreatable, syndrome.

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