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Motor Cortex Stimulation in Chronic Neuropathic Orofacial Pain

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Abstract

Motor cortex stimulation (MCS) has been used to treat intractable neuropathic facial pain lasted for early 30 years. Although in some studies the effective rate is as high as 88%, it is quite impressive the variability of treatment response. In addition, MCS is generally considered to gradually reduce remission over time, and there are few long-term studies on efficacy. Complications are generally mild including infections, hardware complications, seizures and transient neurological deficits. Although relatively rarely used, MCS is still a viable treatment option for patients with intractable facial pain refractory to conservative management.

Introduction

Motor cortex stimulation (MCS) has been used to treat refractory central and peripheral neuropathic pain syndrome for nearly thirty years [1]. Penfield and Jasper first proposed in the early 1950s that the neuromodulation of the motor cortex may have analgesic effects [2,3]. The concept of using neuromodulation to relieve pain in the motor area did not become popular until many years later. Chronic neuropathic orofacial pain (CNOP) may be a symptom caused by noxious/physical, neurological, inflammatory and visceral mechanisms. MCS was introduced in the 1990s to treat chronic neuropathic orofacial pain (CNOP), although its effectiveness is uncertain. Tsubokawa et al. published a report on MCS in 1991, since then, for patients who have suffered a stroke, trau-

ma or trigeminal neuralgia, MCS is usually their last choice [4-7].

Mechanisms of Action

The trigeminal afferents, primary neurons that carry sensory information (pain and temperature), enter the pons at their bifurcation and send their caudal branch to the medulla oblongata to form the trigeminal descending path. The secondary neurons extend to the ventroposteromedial nucleus of the thalamus before tertiary neurons terminate at the level of somatosensory cortex, that can attenuate nociceptive signals [8]. Although the mechanism of action of MCS is unclear, it is thought that it can work by inhibiting secondary thalamic sensory neurons that become overactive due to deafferentation. Other possible explanations include the regulation of the overall pain pathway and the releasing enhancement of endogenous opioids in various brain regions [9]. In fact research on patients with intractable pain confirmed that there is a significant increase of cerebral blood flow of the lateral thalamus and medial thalamus, the anterior cingulate gyrus-orbitofrontal cortex and the anterior insula-medial temporal lobe during MCS [10], suggesting that descending axons are mainly activated by MCS and emphasizing that the thalamus is the key structure of functional effects of MCS [11,12]. Two recent PET studies show the role of opioid receptor activation MCS-related in pain relief [13,14].

Materials and Methods

We selected 12 patients who underwent MCS for the neurosurgical treatment of chronic neuropathic orofacial pain in the previous five years. Patients who were referred for surgery had been refractory to previous medical treatments with anticonvulsivants, antidepressants and opioids. Patients were excluded if they had significant psychological or psychosocial overlay and/or secondary gain as judged by the neurosurgical team. The mean age of the patients was 60.5 years (range: 49–72; M: F 7: 5), and the mean duration of the follow-up was 36 months (Table 1).

Pain reduction was assessed with the score on the VAS scale baseline and after one month, 6 months, 1 year and 3 years. The procedure was performed under general intravenous anesthesia with a craniotomy 4 x 4 cm along the course of the precentral gyrus and the central sulcus. The positioning of the quadripolar strip electrode (Resume model 3986A Medtronic Inc.) or 2x8r paddle (Artisan model Boston Scientific) is obtained with neuronavigation methods and is placed perpendicular to the central sulcus in the epidural space. The localization of the central sulcus was confirmed with phase reversal of the somatosensory evoked potential and evoked EMG response of the muscle. A trial external stimulation lasting two / three weeks was performed to evaluate the stimulation parameters and the appearance of motor responses. The characteristics of these parameters are the intensity with values ranging from 1.5 V to 5.0 V, the frequency range between 40 and 60 Hz and the pulse duration with values ranging from 60 μs to 140. μs. If the stimulation was successful (reduction of more than 50% in the VAS score), the electrode was connected to an implantable pulse generator placed in subcutaneous pocket at the subclavicular level. Continuous stimulation is set for all patients.

Results and Discussion

The baseline VAS score was obtained before surgery and postoperatively until 3 years after the procedure. Modifications in the drug regimens were not controlled over time in our study. We observed an overall reduction in pain (68,8%) with a reduction of VAS score especially in the first month, which is maintained in a milder and gradual manner in the following months (Table 1). This result was similar to rates of pain relief in the literature. A recent systematic review and meta-analysis by Henssen [13] found a VAS measured median pain relief of 66.5%. In 2004 Brown provided further support for the use of motor cortex stimulation in facial neuropathic pain and recorded pain improvement measured by multi-dimensional scales. Observations of improvement in movement and sensation during stimulation indicate that stimulation changes cortical plasticity and inhibits thalamic hyperactivity [14]. In the same year Nuti et al. [5] demonstrated that the level of pain relief assessed in the first month after implantation is a powerful predictor of long-term relief. In 2009 Fontaine et al. reviewed the published literature to evaluate the efficacy of and adverse effects after MCS for chronic neuropathic pain. They found a good response to MCS (pain relief > or = 40-50%) in approximately 55% of patients who underwent surgery and in 45% of the

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Table 1: Demographic characteristics, overview of diagnoses causing orofacial pain and efficacy of MCS.

Patient	Sex	Age (years)	Diagnosis	VAS baseline	VAS after 1 month	VAS after 6 months	VAS after 1 year	VAS after 3 years	Median pain reduction (%)
1	M	67	Trigeminal neuralgia (MS lesions)	10	3	4	4	4	60
2	M	51	Trigeminal neuropathic pain	9	5	4	4	3	77
3	F	49	Trigeminal neuralgia (MS lesions)	8	3	3	4	4	50
4	M	55	Idiopathic facial pain	9	4	4	4	4	66
5	F	60	Trigeminal deafferentation pain	10	5	4	4	3	70
6	F	62	Trigeminal neuralgia	9	5	4	2	2	88
7	M	57	Trigeminal neuralgia	9	4	4	4	4	66
8	M	70	Trigeminal neuralgia	8	2	3	3	2	75
9	F	61	Idiopathic facial pain	10	6	4	3	3	70
10	F	60	Idiopathic facial pain	8	2	2	2	3	62,5
11	M	72	Trigeminal neuropathic pain	9	4	3	3	4	66
12	M	62	Trigeminal neuralgia	8	2	3	3	2	75

152 patients with a postoperative follow-up > or = 1 year [15]. A problematic aspect of MCS is the need for multiple programming stimulation parameter options available to the patient. Henderson highlighted that intensive reprogramming can regain the benefits of MCS for patients who have lost pain control. The use of two contacts of a 1 x 4 electrode array instead of a wide dipole of one contact improves the ability to recapture beneficial stimuli with a risk of severe seizures [16]. In terms of safety, the Neuromodulation Appropriateness Consensus Committee only found occasional complications with the use of MCS, including intracranial hemorrhage, infection, neurological deficits and induced seizures. Therefore, it determined that MCS is relatively safe. However, regarding efficacy, they reported that approximately 75% of patients with facial neuropathic pain have a pain reduction of >50%, and 2/3 of patients MCS with post-stroke pain is expected to get good or excellent relief. The consensus committee concluded that MCS is a relatively safe and effective procedure for the appropriately selected patients with intractable pain, though all literature reviewed only surmounted to Level III evidence for this conclusion [17].

Conclusions

Ultimately, MCS seems to be an effective treatment modality, suitable for patients with chronic neuropathic pain. Due to the low complication rate and risk of morbidity, MCS can be considered a safe treatment option for appropriately selected patients. However there is no standardized inclusion or exclusion criteria for this treatment. Despite differences in patient response to treatment, MCS is generally considered to be more effective than other methods in the treatment of neuropathic pain compared with nociceptive pain. The exact mechanism of action of MCS, the best surgical method, the choice of technology and hardware are an unresolved problems. Future studies should examine the potential of placebo effects and long-term efficacy of MCS, and standardization of stimulation parameters with larger groups of patients to improve strength and promotion capabilities.

Conflicts of Interest

The authors have no relevant conflicts to declare.

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