

S9-Ictal Intracranial Electroencephalography Wavecluster Analysis of High-frequency Oscillations and Conventional Frequency Activities

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Objective: We investigated the correlation between high-frequency oscillations (HFOs), conventional frequency activities (CFAs) and seizure onset zones (SOZs) in 20 medically intractable epilepsy patients.

Methods: 20 patients with medically intractable underwent chronic (iEEG) using subdural electrodes. Ictal activities within ± 4 s of video-iEEG ictal onset were extracted by wavelet clustering and thresholding in 11 bandwidths including extended fast ripple (550-799 Hz), high fast ripple (350-549 Hz), low fast ripple (250-349 Hz), high ripple (140-249 Hz), low ripple (100-139 Hz), high gamma (60-99 Hz), low gamma (30-59 Hz), beta (13-29 Hz), alpha (8-12 Hz), theta (4-7 Hz) and delta (1-3 Hz). Cluster epileptogenicity indices (CEIs) and amplitudes of waveclusters were calculated. The temporal analysis window was locked to the timing of the maximum CEI wavecluster. Percentages of zones within seizure onset zone were calculated for all bandwidths.

Results: Percentages of zones with maximum CEI waveclusters were significantly higher in comparison to the random distribution in delta, beta, ripple and fast ripple ($p=0.018, 0.003, 0.165, 0.006, 0.006, 0.049, 0.174, 0.052, 0.033, 0.461, 0.192$ and 0.015 from higher to lower bandwidths, Mann-Whitney U test). Percentages of zones with maximum amplitude waveclusters were significantly higher in comparison to the random distribution in most bandwidths except alpha ($p=0.026, 0.01, 0.028, 0.001, 0.002, 0.005, 0.013, 0.035, 0.429, 0.007$ and 0.04 from higher to lower bandwidths, Mann-Whitney U test).

Conclusions: The automatic quantitative ictal iEEG analysis may be effective in delineating the seizure onset zone.

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S10-IS DBS or High Cervical SCS for Combined Post-stroke and Pain of Spinal Origin?; A Decision of One's Own

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Objective: The uses of spinal cord stimulation (SCS) or Deep brain stimulation (DBS) for post-stroke pain have been alleged some effect as well as the pain origin from spine. However, the surgical decision regarding on neuromodulation technique is quite challenging for combined post-stroke pain and the pain of spinal origin, if the nature of pain is mixed both.

Cases 1: 54 year old male patient had history of paraplegia due to thoracic cavernous malformation and hypertensive intracerebral hemorrhage at right basal ganglia. He had combined post-stroke pain and post-plegic pain. His pain was medical refractory. We underwent high cervical spinal cord stimulation for both post-stroke and post-plegic pain. His severe pain improved from 10 to 4 (VAS scoring). He can be tolerated with dramatically reduced pain medication.

Case 2: 57 year old male patient had history of hypertensive ICH. He had post-stroke pain on left side. Ever since fusion surgery for spinal disease, his left post-stroke pain and left leg pain aggravated. His terribly painful leg, body and arm was not controlled with medication. His neuropathic pain was controlled with Vc thalamic DBS. We had achieved dramatically drug reduction after DBS surgery.

Conclusion: The nature of pain was not stereotypical for neurosurgeon. We have to tailor neuromodulation technique for each patient to cover his or her own pain if the pain is mixed nature. Therefore, a surgical decision of one's own pain truly relies on your patient.

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S11-Patients with Idiopathic Trigeminal Neuralgia Have a Sharper Than Normal Trigeminal-pontine Angle and Trigeminal Nerve Atrophy

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Objective: Trigeminal neuralgia (TN) is primarily diagnosed by symptoms and patient history. Magnetic resonance (MR) imaging can be helpful in visualizing the neurovascular compression of the trigeminal nerve in TN patients, but the current parameters used as diagnostic markers for TN are less than optimal. The aim of this study was to assess whether the angle between the trigeminal nerve and the pons (the trigeminal-pontine angle) on the affected side of patients with idiopathic TN differs from that of the unaffected side and that found in controls without TN.

Methods: A case-control study of 30 clinically-diagnosed idiopathic TN patients aged 30 to 79 years and 30 age- and sex-matched controls was conducted. We compared the trigeminal-pontine angle and trigeminal nerve atrophy via fast-imaging employing steady-state acquisition (FIESTA) MR imaging.

Results: A sharp trigeminal-pontine angle was observed in 25 patients (25/30) on the affected side. As such, the mean angle of the trigeminal nerve on the affected side (40.17) was significantly smaller than that on the unaffected side (48.91, $p=0.001$) and that in the control group (52.02, $p<.001$).

Conclusions: A sharp trigeminal-pontine angle on the affected side was found in idiopathic TN patients by FIESTA imaging. This suggests that a sharp trigeminal-pontine angle increases the chance of neurovascular compression on the medial side of the trigeminal nerve.

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S12-Occipital Nerve Stimulation for Medically Refractory Hypnic Headache

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Objective: Hypnic headache is a rare, primary headache disorder which exclusively occurs regularly during sleep. We present a case of hypnic headache successfully managed with occipital nerve stimulation.

Methods: A 64-year-old female presented with a 4-year history of a right occipital headache that regularly awakened her from sleep. The headache, which was dull and throbbing, would awaken her regularly at 04.00 h, 5 hours after bedtime at 23.00 h. No photophobia, nausea or vomiting, lacrimation, or other autonomic symptoms were present. The headache was refractory to various medical treatments, including indomethacin, flunarizine, propranolol. She underwent a trial of occipital nerve stimulation with a lead electrode using a medial approach.

Results: During the 10 day trial stimulation, she reported almost complete relief from hypnic headache. Chronic occipital nerve stimulation replicated the trial results. The attacks of hypnic headache recurred in one year with loss of stimulation-induced paresthesia; a subsequent x-ray showed electrode migration. After revision of the electrode to the original location, the effectiveness of the occipital nerve stimulation against hypnic headache was achieved again, and this effect has been consistent through 36 months of follow-up.

Conclusion: Occipital nerve stimulation was effective in a patient with chronic, refractory hypnic headache.

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S13-Experience of Spinal Cord Stimulation in Cervical Spine for Chronic Upper Extremity Pain

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Objective: While most spinal cord stimulation (SCS) is performed in the thoracolumbar spine to control chronic pain of low back and lower extremities, SCS is sometimes needed for the control of pain of upper extremities. Because cervical region is different from thoracic spine due to inherent mobility and narrow CSF space, there are some technical considerations in implantation of electrodes in the cervical epidural space. We retrospectively reviewed the results of trial stimulation, technical considerations, and the long-term results of SCSs performed in the cervical spine.

Methods: Among total 102 cases of SCS trials during last 8 years, 17 trials were done in the cervical spine for chronic pain of upper extremities. There were 17 patients (male 11, female 6) and the mean age was 55.7 years (range, 34-73 years). The entities of chronic pain which needed trial of SCS were: failed neck surgery syndrome (FNSS) in five, pain of brachial plexus injuries (brachial plexus injury 2, brachial plexus avulsion 1), peripheral nerve injury (toxic neuropathy of the ulnar nerve 1, stump and neuroma pain 1, neuroma pain 1), incomplete spinal cord injury (2), postherpetic neuralgia (PHN, 1), chronic cervical spondylotic radiculopathy (2), upper extremity pain of central poststroke pain (CPSP) (1). Degree of preoperative pain was $7.4 \pm 0.96/10$ (standard deviation) and duration of pain was 41.44 ± 54.8 months. Trials of SCS were performed using cylindrical or paddle electrode under local or general anesthesia with an aid of intraoperative monitoring.

Results: Trial stimulation was effective in 9 out of 17 (53%) with more than 50% improvement of pre-trial pain. The mean postoperative VAS at 12 months follow-up was 3.22 ± 0.67 (range, 2-4/10, n=9). However, the analgesic effect was lost in 4 patients and the hardwares were removed and one patient died of traffic accident. With follow-up period of 19 months (range, 10-36 months) in the remaining chronic stimulation group (n=4), the degree of pain relief was about 51%. During the implantation of electrodes, replacement with readjustment of electrode position was needed in 5 patients. The cause of revision was; combined spinal stenosis associated with previous surgery (3), incomplete paresthesia coverage (1), electrode migration (1). The reason for trial failure was incomplete pain relief despite of adequate coverage of painful area with stimulation-induced paresthesia. In the long-term stimulation group, there was no complication which is related to the electrode migration or wound infection. The success rate was higher in patients with failed neck surgery syndrome (3 out of 5) than other causes of chronic pain (peripheral nerve injury, brachial plexus injury, SCI pain, spondylotic radiculopathy).

Conclusion: Our results indicates that the overall long-term success rate of cervical SCS is lower than that of thoracolumbar SCS. The chornic stimulation was more effective in those patient with failed neck surgery syndrome than other cause of upper extremitiy pain. During implantation of electrode in cervical spine, there was particular difficulty in patients who underwent previous anterior and/or posterior instrumented fusion and associated cervical stenosis.

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S14-Demonstration of Involvement of Dorsolateral Quadrant of the Spinal Cord in Central Pain of Syringomyelia

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Objective: Dysesthetic pain is a common complaint of patients with syringomyelia, traumatic paraplegia and various myelopathic conditions. Extension of syrinx onto the dorsolateral quadrant of the spinal cord at the level of pain have been regarded as a pathophysiologic mechanism of dysesthetic pain in syringomyelia. However, involvement of dorsolateral quadrant is not clearly reported in our society. We report the evidence of extension of syrinx onto the dorsolateral quadrant of the spinal cord in a patient with central pain from syringomyelia and discuss the pathophysiology of central pain of spinal cord origin.

Case: A 34 year-old female patient presented severe burning dysesthetic pain in her right arm for 1 year. Minimal weakness of hand and appendicular ataxia was noted on examination. MRI of the cervical spine showed a huge syringomyelia due to type I, Chiari malformation. Foramen magnum decompression was performed with expansion duroplasty and her dysesthetic pain was almost alleviated. One year after the decompression surgery, a typical burning, deep pressure-like, dysesthesia recurred progressively and subsequent MRI showed nearly completely resolved syrinx cavity without recurrence. On MRI, the collapsed cavity typically showed involvement of the dorsolateral quadrant of the spinal cord which is consistent with dorsal root entry zone and Rexed lamina 1-5. Medical treatment including gabapentin 180 mg, amitriptyline 20 mg, oxycontin 40 mg transdermal fentanyl (50 ug) was maintained to control the dysesthetic pain. However, her dysesthetic pain did not responded to maximal medical treatment and repeated sympathetic blocks. Finally thalamic ventralis caudalis deep brain stimulation was performed with successful relief of dysesthetic pain.

Conclusion: This demonstration of involvement of the dorsolateral quadrant of the spinal cord in syrinx shows that painful dysesthesia can be caused by a disturbance of pain-modulating centers in the dorsolateral quadrant of the spinal cord and have an insight that certain causalgia-like features that respond in an unpredictable way to surgical collapse of the syrinx.

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