Stereotactic Radiofrequency Medial Thalamotomy For Patients With Central Neuropathic Pain

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Abstract

Introduction

Central neuropathic pain results from direct injury to the central nervous system with pathophysiology still not fully understood, it significantly affects the quality of life and is frequently intractable to pharmacologic treatment, many interventions have been adopted for the treatment of central neuropathic pain starting with ablative procedures and more recently neuromodulation and deep brain stimulation.

Objective

This study aims at assessing the clinical outcome and the safety of radiofrequency thalamotomy in treatment of central neuropathic pain in different etiologies.

Patients and methods

Retrospective review of patients with central neuropathic pain with different etiologies who were medically intractable underwent stereotactic radiofrequency thalamotomy at our institute. Pain disability index (PDI) and visual analogue score were used to assess patients' improvement.

Results

Nine patients were included in this study. Five patients had post-stroke pain, two patients had head injury, one patient with multiple sclerosis and one patient with spinal cord injury. We targeted the medial thalamus at the centromedian parafasscicular, (CM/Pf) nuclei. PDI and VAS were improved in all patients. Mean preoperative PDI was 60.5, it improved to 42.6 at three months and regressed to 46.5 at 6 months. Mean visual analogue score improvement was higher in head injury patients 47%, compared to patients with post stroke pain 28%. No surgery related complications were reported in our patients.

Conclusion

Our study provides support for the safety and efficacy of medial thalamotomy in management of patients with central neuropathic pain refractory to pharmacotherapy, especially in developing countries with limited accessibility to neuromodulation expensive devices or other non-invasive ablative techniques.

BACKGROUND:

Chronic central neuropathic pain is considered a common medical handicapping problem with a reported prevalence of around 10%. [16] Central neuropathic pain is defined as "pain initiated or caused by a primary lesion or dysfunction of the Central nervous system". [3] which is considered chronic when it persists more than 6 months. After failure of medical treatment for more than 6 months condition is considered intractable and surgical intervention is considered in such cases. Different central surgical procedures have been used for management of central neuropathic pain this include either ablative or neuromodulation techniques. There is an ongoing debate regarding which strategy considered the best surgical option. However with all the recent advances in neuromodulation techniques, there is no enough evidence to

consider it as a gold standard technique for management of chronic neuropathic pain or cancer pain. [9, 10] Ablative brain surgery has been widely used to treat intractable neuropathic pain since 1950s. After the introduction of neuromodulation techniques, there was a shift in the practice from ablative procedures supported by a lot of expectations of better outcomes in management of different functional neurosurgical pathologies. [11] Recently, the development of advanced imaging techniques and safer ablative devices raised interest in cerebral ablation. Current ablative brain procedures include gamma knife radiotherapy and focus ultrasound ablation. Although there was a lot of interest in these interventional options which is considered minimally invasive, they have not provided enough evidence to be safer or more cost-effective than conventional radiofrequency ablation procedures.[3, 4, 13, 15] We here present our experience with stereotactic radiofrequency ablation as a practically effective and a safe management option for patients with central neuropathic pain refractory to medical treatment in a developing country with limited accessibility to highly expensive neuromodulation or ablation devices .

METHODS:

We retrospectively reviewed clinical and operative data of patients with intractable neuropathic pain and received Stereotactic radiofrequency medial thalamotomy ablation after failure of medical therapy for more than 1 year. All patients had 6 months post-operative follow up. Patients' data included: Patient's demographics, etiology of neuropathic pain, length of medical treatment or other treatment procedures used before the studied intervention were collected. Preoperative and postoperative Visual analogue score (VAS) were compared to assess degree of patients' pain improvement. Percentage of pain improvement was calculated by dividing change in VAS by the preoperative VAS using this formula: [(*Mean preoperative VAS-Mean 6 months preoperative VAS)/Preoperative VAS*]

Pain disability index was used to assess quality of life during follow up in comparison to preoperative status. Severe disability was considered if PDI > 50 and mild to moderate disability was considered for patients with PDI in the range of 20-50. Data regarding procedure related complications were also collected.

Operative technique:

All patients received centromedian parafasscicular (CM/Pf) Stereotactic radiofrequency thalamotomy.

Elekta G Stereotactic frame was applied at the morning of the operation, stereotactic MRI brain was done for planning. Target coordinates were A-P: 3 mm ant to posterior commissure, Lat: 9 mm to AC-PC line and vertical: 1 mm dorsal to AC-PC line. After doing macrostimulation within the sensory threshold, a temporary lesion is done at the target at 45 degree Celsius for 10 seconds. Re-assessment of the neurological status of the patient was done after temporary lesion. This was followed by permanent lesion at the target, 2 and 4 mm dorsally respectively at 60 degrees Celsius for 60 minutes. All the procedure was done under local anesthesia. Patient was discharged same day from hospital after neurological assessment for any immediate surgery related complications.

RESULTS:

Nine patients were included in this study. Five patients had post-stroke pain, two patients had head injury, one patient had multiple sclerosis and single patient with post traumatic spinal cord injury. All patients had medial thalamotomy for management of intractable pain. Eight patients in our study (8/9), was presented with a neurological deficit associated with pain in the form of hemiparesis in the 5 stroke patients and one of the head injury patients. The spinal cord injury patient presented with quadriparesis, one of the head injury patients had tremors in the upper and lower limbs at the same side of pain. The Multiple sclerosis patient was neurologically free apart from his neuropathic pain in both lower limbs (LL) and single upper limb (UL), He reported diffuse weakness and increased pain through his exacerbation attacks. Our patients had different distribution of pain, (7/9) patient had hemialgia. (Table 1)

Table 1

General characteristics of the patients

Characteristic	Mean (SD) or Number of patients
Age in years	59.6 (9.96)
Sex	
• Males	5/9
• Females	4/9
Diagnosis	
• Post stroke	5/9
• MS	1/9
• Post-head injury	2/9
• Post-spinal cord injury	1/9
Neurological Morbidity	
• Hemiparetic	6/9
• Abnormal movement only	1/9
• Attacks of weakness	1/9
• Spastic Quadriparetic	1/9
Site of pain	
• Same side of weakness	6/9
• Upper limbs and lower limbs with abnormal movements	1/9
• Both lower limbs and one upper limb	1/9
• Four limbs	1/9

PDI and VAS were improved in all patients. Mean preoperative visual analogue score was 7.1 And it improved to 4.3 and 4.8 at 3 months and 6 months respectively. Improvement was higher in head injury patients (47% improvement), compared to patients with post stroke pain (28% improvement). Of note mean preoperative VAS of head injury patients and post stroke patients was 7.5 and 7.2 respectively. The least pain improvement was reported for the patient with the spinal cord injury. Mean preoperative PDI was 60.5 (severe), mean postoperative PDI was improved during follow up period as follows: it improved to 42.6 (mild-moderate disability) at three months follow up, then increased to 46.5 (mild-moderate disability) at 6 months follow up, of note all our patients were in the mild to moderate disability index category at 6 months follow up except for one patient with post stroke pain who had PDI of 56 at 6 months follow up. No surgery related complications were reported in our patients. (Table 2, Figure 1 and 2.)

Table 2

Mean VAS scores for each group of patients based on the diagnosis

Diagnosis	Pre operative VAS	VAS at 3 months follow up	VAS at 6 months Follow up	Improvement at 6 months Follow up
Post stroke	7.2	4.8	5.2	27%
MS	7	4	4	46%
Post-head injury	7.5	3	4	43%
Post-spinal cord injury	6	5	5	17%
All patients	7.1	4.3	4.8	32%

Figure 1

Graph for mean Vas improvement across our study patients according to different etiology

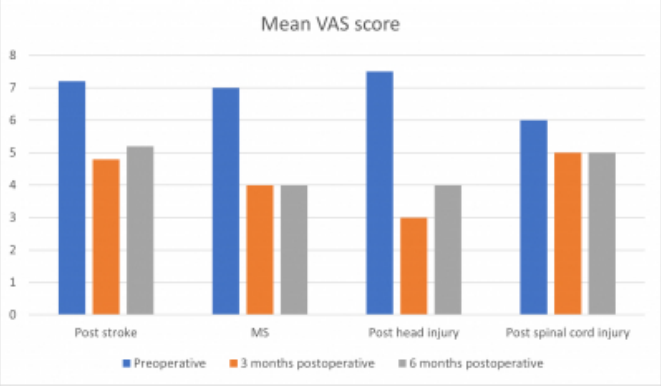

Figure 2

Graph for mean PDI across our study patients according to different etiology

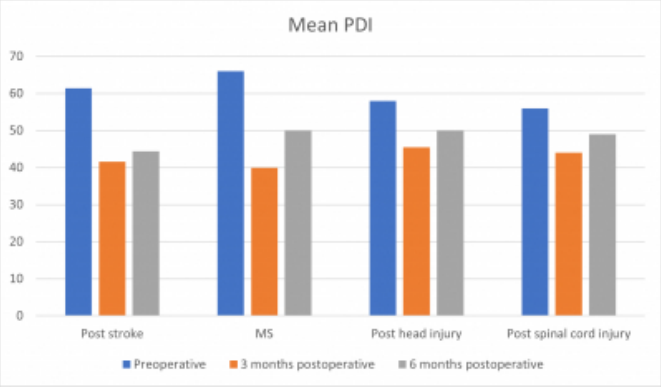

Table 3

Mean PDI scores for each group of patients based on the diagnosis

Diagnosis	Pre-operative PDI	PDI at 3 months postoperative	PDI at 6 months postoperative
Post stroke	61.4 (severe)	41.6 (Mild-Moderate)	44.4 (Mild-Moderate)
MS	66 (severe)	40 (Mild-Moderate)	50 (Mild-Moderate)
Post-head injury	58 (severe)	45.5 (Mild-Moderate)	50 (Mild-Moderate)
Post-spinal cord injury	56 (severe)	44 (Mild-Moderate)	49 (Mild-Moderate)
All patients	60.6 (severe)	42.6 (Mild-Moderate)	46.8 (Mild-Moderate)

DISCUSSION:

Our study supports the evidence of safety and efficacy of ablative cranial procedures for management of intractable neuropathic pain. All our patients had immediate and sustained improvement in VAS of pain and PDI for 6 months. Only one patient with post stroke pain had recurrence had a PDI of 56 at 6 months follow up, 8/9 of our patient had sustained improvement of their disability from severe to mild or moderate disability on the PDI.

We are trying to give a litany of literature on the radiofrequency stereotactic thalamotomy in the era of other less invasive but much expensive modalities like gamma knife or Magnetic resonance guided focused ultrasound MRgFUS, especially those techniques are not easily accessible in developing countries with limited resources. Most of our patient's pathology was associated with neurological deficit in the form of weakness, none of them had any surgery related complications or increase in their neurological morbidity, which provides some evidence of safety of radiofrequency ablation in comparison to even noninvasive procedures which are still with some reported risks. [1, 2, 14]

Failure rate of pharmacotherapy in control of central neuropathic is not uncommon and patients with chronic central neuropathic pain would be candidates for surgical intervention at some time of their disease progress. [6] The reports of the central ablative procedures in literature started since 1950s, however with the recent advances of neuromodulation there was scarcity of reports on ablative central procedures, in the last decade with the advances in ablative techniques which included gamma knife and MRI guided focused ultrasound techniques central cranial ablative procedures was highlighted in the literature. [3–5, 7, 15] This fact supports the concept of destructive (ablative) neurosurgical central procedure as one of highly effective option in comparison to neuromodulation techniques. Also, multiple recent studies on central electrical neuromodulation techniques or more appropriately deep brain stimulation (DBS) have failed to provide enough evidence for effectiveness or superiority over central ablative procedures for management of chronic central neuropathic pain. In developing countries with limited resources, it is unwise to consider highly expensive devices as deep brain stimulation for central management of neuropathic pain with such lack of significant evidence. Of note DBS is not a covered technology by insurance or Medicare in the united states. [1]

Thalamotomy, mesencephalotomy, and cingulotomy is considered the most frequently performed ablative procedures for central management of neuropathic pain. However, thalamotomy provides less surgical and neurological morbidity. [8, 12]

Historically thalamic lesion target was described at the lateral sensory nucleus and shifted to medial CM nucleus due to undesirable effects, also lesioning of the posterior part of the central lateral nucleus was described with promising results. Up to date no definite guidelines can be described for target selection in ablative surgery for neuropathic pain. [5, 6, 11] We used the centromedian parafasscicular (CM/Pf)

as a target for ablative thalamotomy for our patients and all our patient's reported improvement of their pain and disability index, however with our limited number of patients and diversity of the pathological cause of pain we cannot suggest a specific preference for target selection.

Gamma knife stereotactic radiosurgical ablation of medial thalamus has been well described although benign minimal or non-invasive, some rare complications are reported radiation-related necrosis and malignancies. Some studies also reported 1-2 % complications rate with gamma knife treatment of neuropathic pain, however, they used higher than usual treatment doses. [3, 4, 15] In our study we haven't reported any surgery related complications, using radiofrequency ablation, with the advantage of immediate relief of pain associated with the thermal ablative technique in comparison to GKRS technique. [4, 15] Beside this, the GKRS procedure lacks any physiological guidance for lesion creation in comparison with Radiofrequency ablation and Magnetic resonance guided Focused Ultrasound MRgFUS

Recently the MRgFUS has been recently described as an ablative incision-less cranial technique for management of different central functional neurosurgical disorder, [5, 7] however it is still not available in most of neurosurgical centers worldwide and was not accessible for patients in our region to be consider as an alternative technique at our institute. Further research is recommended on the surgical management of central neuropathic pain. Stereotactic radiofrequency thalamotomy ablation (being an affordable and relatively safe technique) can be considered as one of the acceptable surgical options for patients with intractable neuropathic pain.

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