

High-frequency Spinal Cord Stimulation as a Palliative Treatment for Patients with Low Back and Lower Extremity Radiated Chronic Pain

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Abstract

Introduction: Since "Gate Control" theory was published, Spinal Cord Stimulation (SCS) has been used in palliative management of Low-back Pain (LBP) and lower extremity Radiated Pain (RP) and functionality in patients with Lumbar Stenosis (LS), Degenerative Scoliosis (DS) or Failed Back Surgery Syndrome (FBSS). Our aim is to describe our experience with High Frequency Spinal Cord Stimulation (HF-SCS).

Methods: Descriptive, retrospective study (n=30) between 2014-2017 with HF-SCS due to intractable LBP and RP. Mean age was 69 (45-87), mean Comorbidity Charlson Index (CCI) was 6; 80% female with minimum follow up of 12 months. Items reviewed were time to implantation, VAS for LBP and RP and Oswestry disability index (ODI), improvement in hungry, emotional status or sleeping; and personal satisfaction. Complications related to procedure were also recorded.

Results: HF-SCS was indicated in 25% patients because of LBP and LERP secondary to LS or not operable DS. Median time to surgery was 3 years (ICR 1-6). Pre and post-surgery mean (SD) values were VAS-LBP 8.63 (1.09) 4.43 (2.5); VAS-LERP 7.03 (2.84) 4.77 (2.49); and ODI 67.2 (11.9) 48.33 (16.93). All of these were statistically significant ($p < 0.01$); 60% improved in sleeping and mood. No patient presented lower limbs paraesthesia, but 13% had electrodes mobilization. 73% were finally satisfied with treatment received.

Conclusion: HF-SCS use for refractory LB and RP could be an effective tool to improve patient pain and functionality with high satisfaction. Especially in those who are not candidates for corrective surgery because of their age or comorbidities.

Keywords: Pain; Spinal cord stimulation; Neuromodulation; High-frequency

Level of Evidence

Level III-retrospective descriptive study.

Introduction

Low back pain (LBP) and lower extremity radiated pain (RP) are cause of chronic pain and dysfunction in more than 1.500 million people around the world. One out of four people will experience one or both of these conditions in a lifetime and will affect their daily life activities or their emotional or psychosocial spheres [1].

In case of refractory pain, recently Spinal Cord Stimulation (SCS) has proved superior results to re-surgery or non-operative management with pharmacology analgesic [2].

Neurophysiological principles, in which SCS sustains its functioning begin in 1965, when Melzack and Wall published their revolutionary "Gate control" theory. They affirm that one A myelin fibers stimulus in dorsal column, not only can an inhibit ascending pathway pain sensation vehicle by small C and A sensory fibers by the stimulus of monosynaptic inhibitory interneurons, but also,

stimulating the descending modulatory pain pathway, by stimulating the rostral central nuclei of the brainstem. The effect of these two actions results in a lower pain perception in cerebral cortex [3].

Opposite to conventional (low frequency) SCS, which generates electric pulses with lower frequency (50 Hz), longer lasting (300-600 sec) and higher amplitude (4-9 mA); new (high frequency) SCS (or HF-SCS), develops electric pulses with higher frequency (till 10000 Hz), shorter lasting (30 sec) and a lower amplitude (1-5 mA). All these changes have proved to be secure, effective and clinical beneficial without low extremity paresthesia [4], for at least 2 years

to lumbar stenosis (LS), degenerative scoliosis (DS) or FBSS with refractory pain.

Materials and Methods

A retrospective, descriptive study was carried out with a group of 30 patients treated at our institution (between November 2014 and June 2017) with a 10 kHz HF-SCS (Senza System; Nevro Corp, USA), with a diagnose of LS, DS or FBSS with refractory LBP associated or not RP to their low extremities. All patients had a minimum 12 months follow-up.

As inclusion criteria all the patients were older than 40-year-old, history of more than 6 months of LBP o RP to lower extremities with a

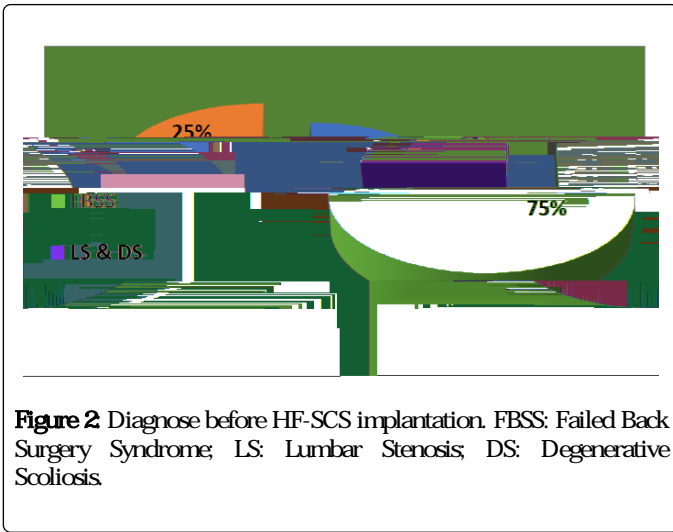


Figure 2 Diagnose before HF-SCS implantation. FBSS: Failed Back Surgery Syndrome; LS: Lumbar Stenosis; DS: Degenerative Scoliosis

	M ± SD	MSE
LBP-VAS PREOP	8.63 ± 1.098	0.200
LBP-VAS POSTOP	4.43 ± 2.582	0.471
RP-VAS PREOP	7.03 ± 2.846	0.520
RP-VAS POSTOP	4.77 ± 2.459	0.449
ODI PREOP	67.20 ± 11.900	2.173
ODI POSTOP	48.33 ± 16.939	3.093

years [9]. These results are also better with new HF-SCS which leads to higher pain control without associated paraesthesia with previous conventional low frequency SCS [9].

Pain is perceived after any thermic, chemical or mechanical stimuli activate our peripheral nociceptors. It unchains a nerve impulse which travels through neuronal axon till spinal dorsal root. From then it goes to the corresponding metameral dorsal horn where a new synapse is done activating a new fiber neuron that travels through lateral spinothalamic tract till brain stem where it synapses to rostral nuclei and thalamus, before finishing at cerebral cortex becoming conscious.

Last studies in chronic pain, give more importance to some neurons located at the spinal dorsal horn called Wide Dynamic Range (WDR) neurons. They belong to the thermoalgesic pathway which vehicles painful sensitivity. In chronic pain situations, WDR neurons experiment an abnormal cytoplasmic membrane ionic channels opening. It is called "wind-up" regulation, and leads into a neuronal hyperexcitation status due to an abnormal membrane depolarization (reduction of the activation threshold so neurons can be activated with lower stimuli and for a longer time). However, we also know that inhibitory descendent pathways from frontal cerebral cortex and brain stem can diminish pain perception by down regulation of this WDR neurons in the opposite way, by spinal and encephalic release of endorphins.

Conventional low frequency SCS, acts as painkiller by stimulating inhibitory GABA releaser interneurons which hyperpolarize WDR neurons. But also, stimulates neural proprioceptive and vibratory fibers in the dorsal column, causing paresthesia to lower limbs.

Opposite to this, HF-SCS, due to its high frequency pulses, in one hand penetrate deeper, directly to the inhibitory interneurons without stimulating dorsal column fibers, avoiding paresthesias. And in the other hand it is also able to give a major reduction of pain and longer in time [1].

Patients graded in ASA scale •3 or a CCI •6 (surviving probability •2,25% at 10 years), desirable surgery and its risk-benefit ratio can be unacceptable. Complications after spinal corrective surgery in people older than 65 y.o. are expected in 17,8% patients, even more in patients older than 80 y.o. However, complications requiring new surgeries after palliative positioning of SCS is expected between 6% as Kapural et al. [8] and 7% as Al-Kaisy et al. [2] reported, a little lower than our experience (13%), but substantially lower and less dangerous than corrective surgery alternatives.

Nowadays becomes very interesting not only calculate if there is any difference between therapeutic alternatives, but also if it is clinically relevant. It can be measured by minimally clinically important difference (MCID), which measures minimal variation in scales, which is perceived by patients as an improvement. MCID depends on pathology investigated and scale used. It is established as MCID in LBP and RP a descend of VAS value between 1,2 and 3,7 points; and in ODI a descend between 8,2 and 13,3 points [10].

According to these points, the result we experienced in our patients, of improvement of 4,2 and 2,26 points in LBP-VAS and RP-VAS values respectively, and 18,87 points for ODI, are clinically relevant and so SCS-HF can be recommended in elderly or with high comorbidity patients.

In addition, HF-SCS patient satisfaction in our experience (76%) according to others above 80% assured by Kapural et al. [5] and Al-

Kaisy et al. [11-14] is a really interesting issue, even more in patient unsatisfied with lots of previous treatments.

At last, we observed that all the patients who suffered from electrodes mobilization, were patients with cable electrodes. None of them had paddle electrodes. Despite the small incision and laminotomy needed to place paddle electrodes, the precision to assure the posterior and medial correct position in unique attempt, can influence in this circumstance. Besides, paddle electrodes seem to decrease pain and improve functionality versus cable electrodes. All of these results were exploratory and not our principal aim, and also, small paddle electrode group (n=4) compared to cable electrode group (n=26) make comparison imprecise. Prospective studies and equivalent groups with longer follow up are recommended in the future to confirm this observation [15-17].

Conclusions

HF-SCS could be an effective and clinically relevant palliative treatment for patients with refractory low back pain associated, or not, to lower extremities radiated pain. Especially in the elderly or those with high comorbidities with lumbar spinal stenosis, degenerative scoliosis or failed back surgery syndrome who are not candidates to surgery. It can lead into pain and functionality improvement, with high satisfaction but not exempt of complications.

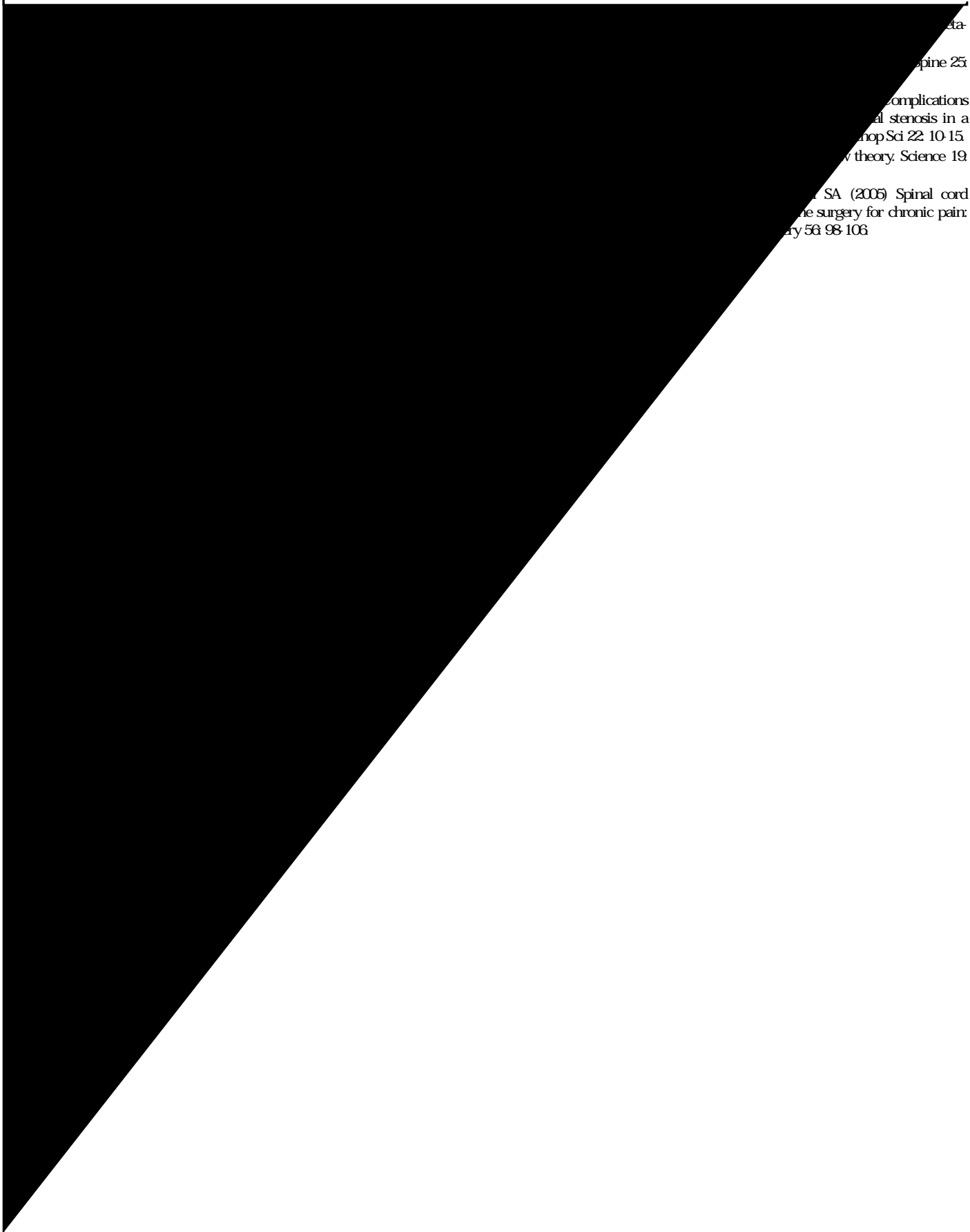
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