Open Access Article

Ann. Acad. Med. Siles. (online) 2024; 78: 104–107
eISSN 1734-025X
DOI: 10.18794/aams/176503
www.annales.sum.edu.pl

OPIS PRZYPADKU
CASE REPORT

Double spinal cord stimulators (SCS) with different types of stimulation implanted percutaneously – case report and literature review

Zastosowanie podwójnych stymulatorów rdzenia kręgowego (SCS) o różnym typie stymulacji implantowanych metodą przezskórną – opis przypadku i przegląd literatury

Wojciech T. Ślusarczyk[1], Maciej Laskowski[2], Marta A. Kwiatkowska[2], Agnieszka Koperczak[2]

[1]Department of Neurosurgery, Faculty of Medical Sciences in Katowice, Medical University of Silesia, Katowice, Poland
[2]Students' Scientific Club, Department of Neurosurgery, Faculty of Medical Sciences in Katowice, Medical University of Silesia, Katowice, Poland

ABSTRACT

INTRODUCTION: Spinal cord stimulation (SCS) has emerged as a prevalent therapy for chronic neuropathic pain and failed back surgery syndrome (FBSS) over the past three decades, offering various stimulation types differentiated primarily by frequency.
CASE REPORT: A 51-year-old male patient in 2016 underwent lumbar discectomy – L4/L5 due to symptomatic discopathy, which resulted in pain relief; however, the symptoms returned. In 2021 a Stimwave high-frequency (HF) SCS was placed epidurally at Th8–Th10. The patient reported substantial improvement after stimulation, nevertheless, after two weeks there was sudden exacerbation of his symptoms, especially in the lumbar region. Despite multiple attempts at program change and confirmation of the electrode location, there was no improvement. The HF stimulator was not removed owing to the risk of complications and 20% relief of pain in the right lower limb. After two years he was qualified for the implantation of newer generation of stimulators – BurstDR™ stimulation. An epidural electrode was implanted at Th8–Th10, followed by the placement of a BurstDR™ pulse generator. Currently, the patient has two active electrodes, one with HF stimulation, the other with BurstDR™ stimulation.
CONCLUSIONS: Our case report demonstrates that there is no need to abandon SCS after the first failed attempt and it is worth trying stimulation with a different modulation. Furthermore, according to our center's experience, the therapeutic effects of HF stimulation are quickly depleted and only after using burst stimulation was the expected result achieved. The reasons for this phenomenon are unknown and should be further researched.

KEYWORDS

low back pain, SCS, FBSS, spinal cord stimulation, failed back surgery syndrome, burst stimulation

Received: 25.06.2023 **Revised:** 31.10.2023 **Accepted:** 07.12.2023 **Published online:** 29.04.2024

Address for correspondence: dr n. med. Wojciech Ślusarczyk, Klinika Neurochirurgii Katedry Neurochirurgii, Uniwersyteckie Centrum Kliniczne im. prof. K. Gibińskiego SUM, ul. Medyków 14, 40-752 Katowice, tel. +48 32 789 45 01, e-mail: wslusarczyk@sum.edu.pl

Publisher: Medical University of Silesia, Katowice, Poland

STRESZCZENIE

WSTĘP: W ciągu ostatnich trzech dekad stymulacja rdzenia kręgowego (*spinal cord stimulation* – SCS) stała się powszechną metodą leczenia w przypadku przewlekłych neuropatycznych zespołów bólowych oraz problemów związanych z niepowodzeniem operacji kręgosłupa (*failed back surgery syndrome* – FBSS). Istnieje kilka rodzajów stymulacji, różniących się głównie częstotliwością prądu.

OPIS PRZYPADKU: 51-letniego pacjenta operowano w 2016 r. z powodu dyskopatii na poziomie L4/L5. Po zabiegu nastąpiła poprawa, jednak dolegliwości wróciły. Po nieudanym leczeniu zachowawczym pacjent został zakwalifikowany do implantacji SCS. W 2021 r. założono stymulator SCS do stymulacji o wysokiej częstotliwości (*high-frequency* – HF) na poziomie Th8–Th10. Pacjent zgłaszał znaczną poprawę podczas stymulacji, jednak po dwóch tygodniach nastąpił nagły powrót dolegliwości bólowych. Wielokrotnie próbowano zmiany programu stymulacji, jednak bez wyraźnych rezultatów. Dodatkowo wykluczono migrację elektrody. Zdecydowano nie usuwać stymulacji typu HF, gdyż wiąże się to z ryzykiem powikłań. Po dwóch latach pacjent został zakwalifikowany do wszczepienia nowszej generacji stymulatorów – stymulacji BurstDR™. W miejscu Th8–Th10 wszczepiono elektrodę zewnątrzoponową, następnie umieszczono generator impulsów BurstDR™. Po zastosowaniu nowego typu stymulacji dolegliwości bólowe znacznie się zmniejszyły. Obecnie pacjent ma dwie elektrody aktywne, jedną ze stymulacją HF, drugą ze stymulacją BurstDR™.

WNIOSKI: Opisany przypadek pokazuje, że nie należy rezygnować ze stymulacji rdzenia kręgowego przy pierwszym niepowodzeniu; warto podjąć próbę stymulacji w innej modulacji. Ponadto z doświadczeń naszego ośrodka wynika, że efekt terapeutyczny stymulacji typu HF szybko ulegał wyczerpaniu, a dopiero zastosowanie stymulacji BurstDR™ powodowało dużą poprawę w zmniejszeniu dolegliwości bólowych. Przyczyna tego zjawiska powinna stać się przedmiotem dalszych badań.

SŁOWA KLUCZOWE

bóle pleców, SCS, FBSS, stymulacja rdzenia kręgowego, zespoły bólowe po nieskutecznych operacjach kręgosłupa, stymulacja typu *burst*

INTRODUCTION

Spinal cord stimulation (SCS), a neuromodulation technique used since 1967 to treat persistent, drug-resistant neuropathic pain, was initially based on the gate control theory put forth by Melzack and Wall in 1965 [1]. It is based on the usage of an electric impulse to depolarize the large myelinated A fibers of the spinal cord's dorsal columns, which activates the inhibitory interneuron of the substantia gelatinosa. This stimulation causes paresthesia to appear over the painful area, which relieves the pain [2]. The initial electric waveform is called tonic and consists of steady stimulation with a frequency typically between 40 and 60 Hertz and an amplitude high enough to cause paresthesia over the painful area. Two types of no-paresthesia stimulation, BurstDR™ and 10 kHz high-frequency (HF) stimulators, demonstrated improvements for failed back surgery syndrome (FBSS) with predominant, refractory back pain and were superior to tonic stimulation [1,3].

CASE REPORT

A 51-year-old male patient admitted to the Department of Neurosurgery of the Medical University of Silesia in Katowice in 2016 reported pain accompanied by a tingling sensation in the lumbosacral region that radiated to the posterolateral part of his right buttock, thigh and calf reaching down to the first toe. He also complained of pain in his left buttock and difficulty with urination and defecation, which could be associated with opioid use.

On physical examination, a decrease in exteroceptive sensation covering both buttocks and posterolateral portion of the right lower limb was observed. There was no paresis. The patellar reflex was diminished on the right side and Achilles tendon reflexes were bilaterally weak. Furthermore Lasègue's sign was positive in both limbs – at 30 degrees in the right leg and at 15 in the left. The FABER test was also positive in the right hip joint. The patient's gait was correct and he did not limp when walking on heels and toes. The patient reported no pain on palpation in the lumbosacral region, however, there was a slight restriction of movement due to pain. Laboratory testing revealed no important abnormalities. The patient also suffered from inflammatory bowel disease (remission), sensorimotor polyneuropathy, hypogonadotropic hypogonadism and vitamin D deficiency.

The patient was diagnosed with discopathy and in 2016 underwent lumbar discectomy L4/L5 to treat symptomatic discopathy, which resulted in pain relief. Nonetheless, the symptoms returned after six months. There was pain in the lumbar region, radiating to the posterolateral side of the thigh and lower leg up to the first toe of the right foot. Generally, the pain was mostly on the right side. The MRI examination revealed progressive discopathy compared to the examination from 2016, thus he was diagnosed with recurring lumbar discopathy. The patient was then reoperated – widened refenestration L4/L5 from the right side, excision of adhesions and scar tissue, decompression of the meninges and spinal nerve with right-side

foraminotomy were performed. The surgery was followed by alleviation of the symptoms, which yet again recurred after two weeks.

Due to the characteristics and location of the pain, the patient was qualified for SCS treatment. In 2021 a Stimwave SCS for HF stimulation (Neuro Optimal) was placed epidurally at Th8–Th10. The patient reported substantial improvement after stimulation – the VAS (visual analog scale) in the lumbar region was 2, and the lower limb also 2 (pain reduction of 90%). After two weeks there was a sudden exacerbation of his symptoms, especially in the lumbar region (VAS in the lumbar region was 9, and lower limb 2). Over subsequent weeks there was a progressive decrease in the efficacy of the stimulation. Pain relief persisted at a level of 20% in the lumbar segment and 50% in the right lower limb. Despite multiple attempts at program change and confirmation of the electrode location by X-ray, there was no improvement. The patient described the efficiency of the stimulation in pain relief as 50% in the right lower limb and 10% in the lumbosacral region. The patient underwent treatment in a pain clinic for 2 years, during which time he took high doses of opioids and pregabalin.

In February 2023, after the decision of the council, he was qualified for the implantation of a BurstDR™ stimulator. SCS BurstDR™ implantation surgery can be divided into two main stages – electrode implantation with intraoperative stimulation and after 14 days of test stimulation with an external pulse generator, implantation of the final pulse generator which is placed under the skin of the lumbosacral region. During the first stage, the epidural electrode Octrode Abbot was implanted at Th8–Th10 and then connected to an external stimulator. After 14 days of stimulation, which resulted in a reduction in VAS scores (VAS in the lumbar region was 5, and the lower limb was 5), the proper SCS Proclaim XR Abbott was implanted, and the patient was discharged home. The patient had follow-up visits after 1 month, 3 months, and then 6 months after the second and final stage of burst SCS implantation. At each visit, the patient reported VAS values of 5–6 in the lumbosacral region (before BurstDR™ stimulation it was 9) and 0 in the right lower limb (before BurstDR™ stimulation it was 2). During the correction of the current text, the patient attended a scheduled follow-up appointment at the neurosurgical outpatient clinic where X-ray scans were performed (Figure 1).

Currently, the patient has completely discontinued HF. According to the patient, BurstDR™ stimulation has replaced the need for using HF stimulation entirely. It was decided, in consultation with the patient, to keep the HF stimulator in case of pain exacerbation and thus additional HF stimulation might be required. It is also worth noting that there was a 55% reduction in tramadol use, and the usage of pregabalin was completely discontinued.

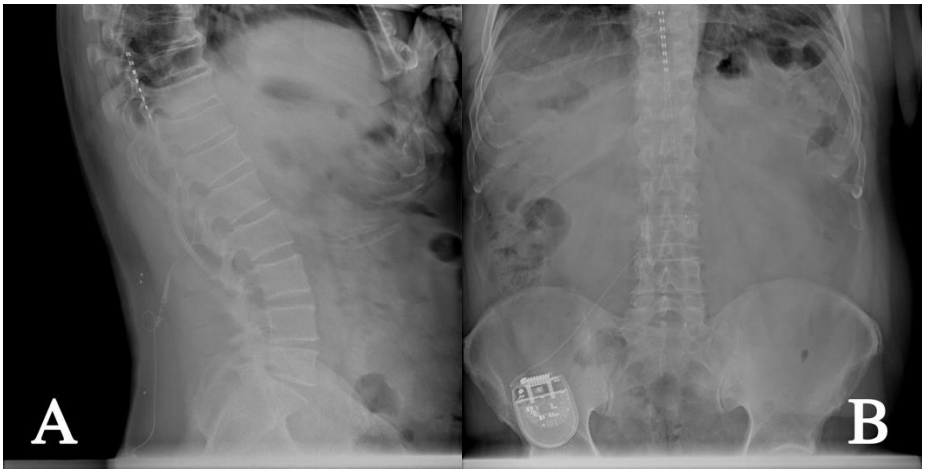

Fig. 1. X-ray image of thoracolumbar spine lateral view (A) and in anterior-posterior (B). Two electrodes parallel to each other are visible at Th8–Th10. The stimulator battery for BurstDR™ is also visible.

DISCUSSION

Burst and other/HF types of stimulation use different mechanisms to suppress pain. Patients may respond better to one particular stimulation mechanism, and the other can be ineffective. Tonic stimulation creates sodium ions spikes with potassium hyperpolarization. During BurstDR™ stimulation, the sodium spikes fire in groups, which are called bursts. They ride on the plateau of calcium depolarization, followed by periods of dormancy. Generally, according to the literature, BurstDR™ generates a stronger molecular nervous system response than other stimulations [4,5].

Moreover, it provides patients with relief not only from their physical discomfort but also significantly alleviates the emotional distress that often accompanies such pain [6].

In the case of our patient, better improvement in pain relief was noticed after implementing BurstDR™ stimulation than HF stimulation. The HF stimulation was effective only for 2 weeks, which can be seen in the VAS scores. We suspect that adaptation to HF stimulation occurred. There was no shift of electrode placement, which was confirmed by X-ray. A representative of the company performed extensive diagnostics to assess whether the pulse generator and electrode were working properly, but they reported no such malfunction.

It was decided that the HF simulator would not be removed because this procedure carries the risk of many complications caused by the presence of adhesions between the electrode and the dural sac. Additionally, the device is anchored to the fascia muscles. It is also worth mentioning that the patient experienced a 20% improvement in pain in his right lower limb which was the result of HF stimulation. The concept of changing stimulation waveform therapy is a generally applied procedure, which is also supported by various studies and reviews [7,8]. Moreover, when replacing the battery of a tonic stimulator from Abbott, the protocol typically involves upgrading the stimulation type from tonic to burst. This change is a consequence of advancements in newer generations of stimulators, which are considered improvements over their predecessors.

Considering the neurophysiological mechanism of BurstDR™ stimulation, it appears to have greater efficacy compared to other types of stimulation and is more frequently preferred by patients. BurstDR™ outperforms tonic stimulation, offering clinical superiority by modulating medial thalamo-cortical pathways, impacting both the analgesic and affective dimensions of pain. This evidence advocates the uniform outcome metrics in neuromodulation research, highlighting the therapeutic potential of burst SCSs [9].

Author's contribution

Study design – W.T. Ślusarczyk, M. Laskowski

Manuscript preparation – W.T. Ślusarczyk, M. Laskowski

Literature research – W.T. Ślusarczyk, M. Laskowski, M.A. Kwiatkowska, A. Koperczak

Final approval of the version to be published – W.T. Ślusarczyk, M. Laskowski

REFERENCES

1. Kirketeig T., Schultheis C., Zuidema X., Hunter C.W., Deer T. Burst spinal cord stimulation: A clinical review. Pain Med. 2019; 20(Suppl 1): S31–S40, doi: 10.1093/pm/pnz003.

2. Caylor J., Reddy R., Yin S., Cui C., Huang M., Huang C. et al. Spinal cord stimulation in chronic pain: evidence and theory for mechanisms of action. Bioelectron. Med. 2019; 5: 12, doi: 10.1186/s42234-019-0023-1.

3. Rapcan R., Mlaka J., Venglarcik M., Vinklerova V., Gajdos M., Illes R. High-frequency – spinal cord stimulation. Bratisl. Lek. Listy 2015; 116(6): 354–356, doi: 10.4149/bll_2015_067.

4. Swadlow H.A., Gusev A.G. The impact of 'bursting' thalamic impulses at a neocortical synapse. Nat. Neurosci. 2001; 4(4): 402–408, doi: 10.1038/86054.

5. Sherman S.M. A wake-up call from the thalamus. Nat. Neurosci. 2001; 4(4): 344–346, doi: 10.1038/85973.

6. Deer T., Slavin K.V., Amirdelfan K., North R.B., Burton A.W., Yearwood T.L. et al. Success Using Neuromodulation with BURST (SUNBURST) study: results from a prospective, randomized controlled trial using a novel burst waveform. Neuromodulation 2018; 21(1): 56–66, doi: 10.1111/ner.12698.

7. Sammak S.E., Mualem W., Michalopoulos G.D., Romero J.M., Ha C.T., Hunt C.L. et al. Rescue therapy with novel waveform spinal cord stimulation for patients with failed back surgery syndrome refractory to conventional stimulation: a systematic review and meta-analysis [online ahead of print]. J. Neurosurg. Spine 2022; 1–10, doi: 10.3171/2022.4.SPINE22331.

8. Piedade G.S., Gillner S., Slotty P.J., Vesper J. Combination of waveforms in modern spinal cord stimulation. Acta Neurochir. 2022; 164(4): 1187–1191, doi: 10.1007/s00701-021-05107-4.

9. Chakravarthy K., Malayil R., Kirketeig T., Deer T. Burst spinal cord stimulation: A systematic review and pooled analysis of real-world evidence and outcomes data. Pain Med. 2019; 20(Suppl 1): S47–S57, doi: 10.1093/pm/pnz046.