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Bilateral L2 dorsal root ganglion-stimulation suppresses lower limb spasticity following chronic motor complete Spinal Cord Injury: A case report

Dear Editor,

We present the case of a 48-year old male patient with chronic motor complete SCI, who benefited from a 5-day period of bilateral L2-level DRG-stimulation by experiencing suppression of transfer-evoked spasticity problems and of chronic lower back pain. To the best of our knowledge, this is the first case describing the successful application of DRG-stimulation for spasticity depression in patients with chronic SCI.

Clinical presentation

A 48 year-old male patient with a 25-year history of a Th8 motor complete (AIS B) Spinal Cord Injury (SCI) after a bullet injury was enrolled in our clinical case series (MEC2017-037) in the Erasmus Medical Center, Rotterdam, The Netherlands. The primary aim of the study was to evoke motor responses in the corresponding muscles (i.e. *m. quadriceps femoris*) using DRG-stimulation. Extensive medical anamnesis and neurological examination by a Physical and Rehabilitation Medicine physician (*RO*), revealed a history of stable, transfer-evoked spasticity, commencing directly after the trauma. Triggers for spasticity attacks included moving in the wheelchair after longer durations of sitting (e.g., behind the computer), riding over obstacles and moving from sitting to supine position. These spastic attacks in supine position always involved involuntary flexion of the right hip with extension of the right knee, accompanied by flexion in the left hip and knee, lasting 10–15 seconds. The patient rated the average perceived severity of spasticity as '8' on the Numeric Rating Scale (NRS, ranging from '0' (*no spasticity*) to '10' (*worst spasticity imaginable*)). Additionally, he scored his spasms on the self-reported Penn Spasm Frequency Scale (PSFS) [1], with a score of '2' (*infrequent full spasms occurring less than once per hour*) in the spasm frequency domain and a score of '3' (*Severe*) in the domain of spasm severity. The patient reported a history of unsuccessful symptomatic treatment with oral baclofen use (20 mg, 3/day), which was stopped 8 years prior to inclusion. Concerning other medication, he used Imatinib (400 mg, 1/day) for his history of chronic myeloid leukemia (CML), which was diagnosed 7 years prior to inclusion and oxybutynin (5 mg, 3/day) for bladder hyperreflexia. Additionally, the patient complained of chronic pain problems bilaterally in the lower back, described as burning and stinging sensations, worsening during spastic attacks, accompanied by non-painful, but continuous paresthesias in the feet. The patient reported an '8' on the NRS for pain perception.

The patient received conventional DRG-leads (Abbott, Plano, Texas) as used for chronic pain treatment on spinal level L2 bilaterally using a minimally invasive surgical technique under local anesthesia, as described earlier by our group (Fig. 1A and B) [2]. Leads were left externalized and connected to a pulse generator (Proclaim™ DRG). Leads were left in situ over a period of 5 days (Fig. 1C), during which the patient was continuously bilaterally stimulated with a motor-subthreshold protocol (0,1 mA, 4 Hz, 1000 μs) at home. The patient was asked to keep a patient diary during DRG-stimulation (day 1–5), as well as after the stimulation period (day 6–13); the diary included questions concerning 1) potential changes in severity and/or frequency of spasticity (PSFS, NRS), 2) potential (changes in) pain sensations (NRS), and 3) signs of other side-effects. Additionally, we assessed the clinical status using the Modified Ashworth Scale (MAS), the Spinal Cord Assessment Tool for Spasticity (SCATS), and general measurements of reflexes [3] during, as well as directly (on day 5) and 1-week (day 13) after stimulation.

From day 2 up to day 6 (one day post-stimulation), the patient reported a reduced severity and frequency of his spasticity (PSFS, NRS) and lower back pain (NRS), both of which disappeared completely in the post-stimulation period (Fig. 1D). However, on day 13 the patient reported return of spasticity with a severity and frequency close to baseline. Clinical measurements on day 5 and 13 revealed less obvious improvements, with only the SCATS showing a slight reduction in extensor spasm post-stimulation (**supplement 1**).

Discussion

Spasticity is a complicated and heterogenous complex of symptoms, which can severely affect patients with upper motor neuron disease. Close to 70% of all patients with chronic SCI are affected by these involuntary muscle activations [4] which are thought to result from the interplay between hyperexcitability of interneurons in the spinal cord and decrease of post-synaptic inhibition [5]. Currently available clinical treatments such as surgical interventions and intrathecal drug administration leave room for

Abbreviations: AIS, American Spinal Injury Association Impairment Scale; CML, Chronic Myeloid Leukemia; PSFS, Penn Spasm Frequency Scale; SCATS, Spinal Cord Assessment Tool for Spasticity; SCI, Spinal Cord Injury; NRS, Numeric Rating Scale.

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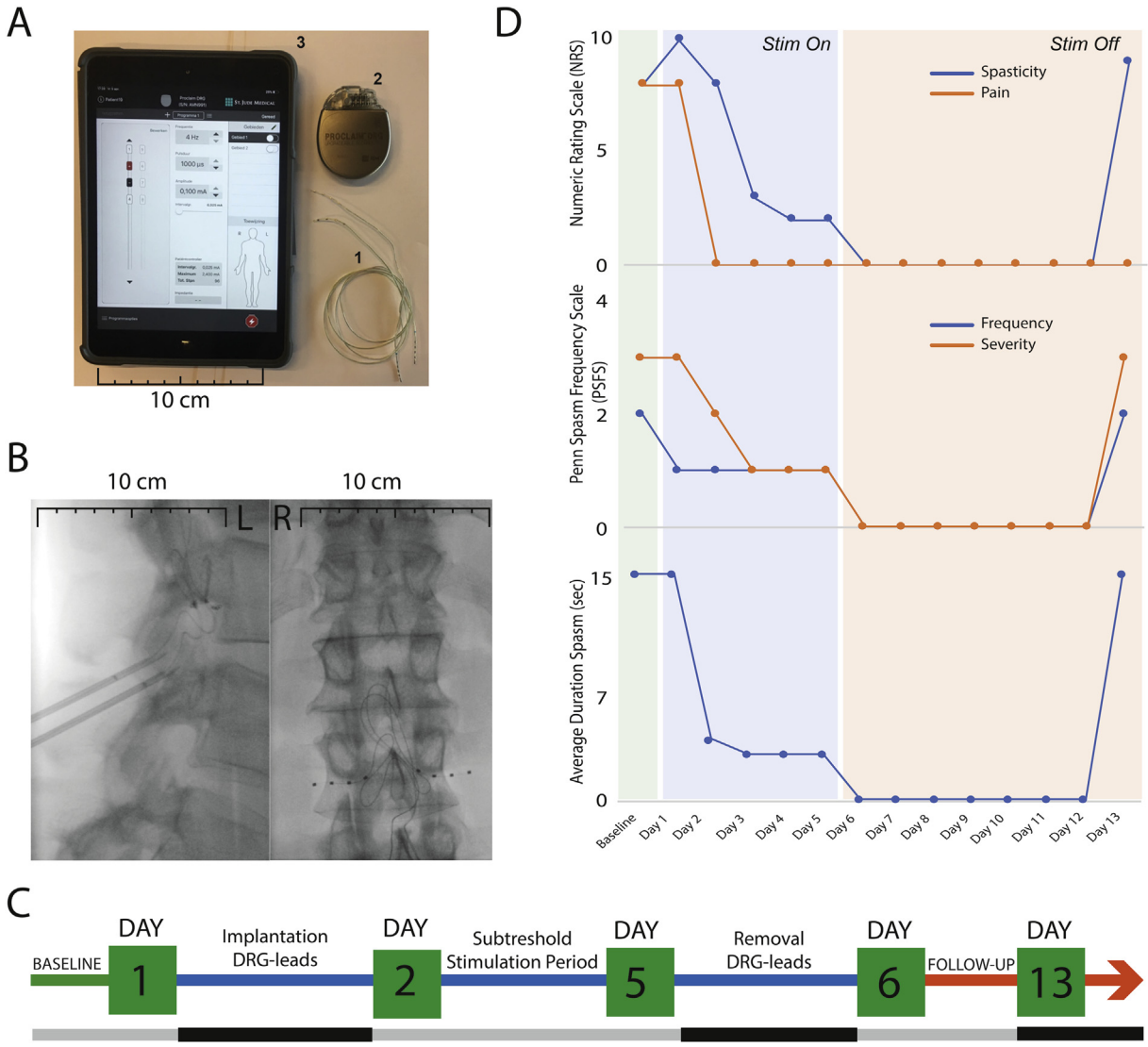

Fig. 1. Overview of the case report as presented in this paper. A) The patient was implanted with conventional DRG-leads (1) as used for chronic pain treatment, connected to a pulse generator (2), which could be controlled with a clinician's programmer (3). B) Intra-operative X-ray images from a lateral (*Left*) and frontal (*Right*) view, showing the bilateral placement of the DRG-leads on the L2-level. C) Overview of the study design, with 2 EMG-measurements (day 1 and day 5), and a subthreshold stimulation period in between (0,1 mA, 4 Hz, 1000 μs). Between day 6–13, the patient was followed-up. The grey line indicates the continuous self-reported measurements as collected daily. Clinical measurements were performed with the subthreshold stimulation on and the stimulation off (<30 min. on day 5 and 1-week post-stim on day 13), indicated by the black areas. D) Overview of the self-reported measurements (NRS, PSFS and average duration of spasm) from the baseline to day 13.

improvement in terms of treatment efficacy, as well as reduction of side-effects such as loss of muscle force [6].

So far, experimental neuromodulatory research for spasticity seems to focus mostly on spinal cord stimulation, either epidurally [7] or transcutaneously [5], but with limited to moderate success [5,7]. The DRG as a successful target for spasticity has been reported before in radiofrequency studies [8], in which potential underlying mechanisms are thought to include long-term depression of synaptic transmission and decrease of afferent excitatory input [8]. Interestingly, the use of DRG-neuromodulation rather than DRG-radiofrequency or other clinically available treatments such as intrathecal baclofen pumps, introduces unique benefits such as safe and dynamic patient-tailored targeting of the DRG without severe side-effects such as dizziness, muscle weakness and sedation [9], warranting further investigation.

Our patient also reported a significant decrease in chronic lower back pain during and >7 days post-stimulation. DRG-stimulation, being in origin a treatment for chronic pain, is known to result in effective pain relief in the lower back when implanted on L2-L3 DRGs [10]. It would be worthwhile to focus future efforts on pinpointing which SCI patient profiles might benefit most from DGR-neuromodulation for pain treatment.

Conclusion

Currently presented results spark interest for further investigation into the potential beneficial role of DRG-stimulation in spasticity and chronic pain in patients with SCI. However, our case report also reinstates the difficulty of objectively and conclusively studying treatment strategies for spasticity and pain as such, which will require special care in future study designs.

Author contributions

All authors were involved in the study design. FJPM was involved in the surgical lead implantation. SS, RO, JDdR, and BSH were involved in the data collection. SS was involved in the data analysis and drafting of the manuscript, with critical input of all authors.

Declaration of competing interest

FJPMH is a member of the executive advisory board of Abbott and has received unrestricted educational grants from Saluda and Medtronic. In addition, he has received investigator-initiated research grants from Spinal Modulation and St Jude (nowadays Abbott). FJPMH and BSH have applied for a patent in relation to the present work. The authors report no other financial conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.brs.2020.02.005.

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