



Spinal Cord Stimulation Therapy: New Technological Advances in Treating Chronic Pain

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Editorial

During the last years remarkable advances in the field of Spinal Cord Stimulation (SCS) have been made. The aim has always been to provide a substantially improved relief by chronic pain patients. Targeting new anatomical targets, new frequencies and various field shapes are only some of the recent developments. Of utmost importance are considered the technological capabilities of new neurostimulators to provide simultaneously multiple stimulation paradigms in order to adjust the therapy to the specific needs of the patients and not *vice versa*.

It is true that during a SCS-trial or over time suboptimal results could be observed; inadequate coverage of the pain area or poor pain relief. Additionally, various device-related issues such as battery failure, physical discomfort due to the size of the battery or complex externals could lead to a decreased patient's satisfaction. To address these issues several significant steps toward personalization & simplification of the pain treatment have been taken:

a) Combination therapy: many studies have shown that when patients are given multiple options, the outcomes are superior [1]. These multiple options can be applied only in one pain area (back pain or leg pain) or usually in multiple areas (back and leg pain). Moreover, not only the issue of habituation could be potentially resolved by the sequential use of various therapies, but a faster pain relief could be also achieved (paresthesia-based stimulation offers a fast relief onset while sub perception stimulation offers a delayed one).

b) New stimulation algorithms (without paresthesia) can now easier identify the neural target and maintain the therapy overtime. This is accomplished by acting on multiple vertebral levels and not only on a specific anatomic level (by the conventional paresthesia-free bipole the stimulation is over the disc T9/T10). At the same time the stimulation field is calibrated to each patient's anatomy and lead variability. These new paradigms target the dorsal horns and not the dorsal columns, as is the case with the tonic stimulation.

c) Automation of waveforms: the new neurostimulators can automatically (without the involvement of the patients) rotate through different stimulation paradigms aiming at a longer pain relief. A program scheduling reduces the visits in the Outpatient Department and avoids mistakes, especially by elderly patients. In addition to that, the new systems provide program usage reports and the possibility for the patients to give real-time therapy ratings. These two characteristics allow physicians to quickly identify the best program/stimulation with the lowest energy consumption. At the same time, the hospitals and the insurance companies obtain a reliable and well structured documentation.

Of note, although the 2-year results seem very promising, a critical evaluation of the long term outcomes (>5 years) should be undertaken in the future. Despite all these advances, it still remains a challenge to get a small dimension SCS-system which can offer an adequate pain relief with minimal energy consumption, MRI compatibility without habituation problems (on the long run). Modification of the stimulation parameters (pulses, frequency, and pulse width) of the existing waveforms [2,3] or invention of new ones are some possible ways to maximize the good outcomes of the SCS therapy. With a strong commitment to research and innovation and keeping in mind that every patient is unique we can be convinced that a great future for all neuromodulation therapies lies ahead.

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