

# Neuromodulation

TECHNOLOGY AT THE NEURAL INTERFACE

February 2025 ■ Volume 28 ■ Number 2 ■ Pages 191-370

## TABLE OF CONTENTS

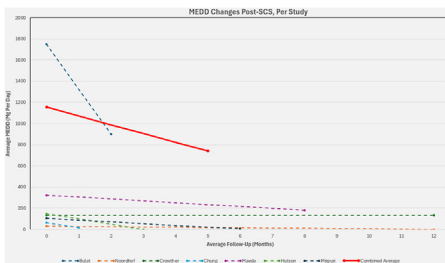
### NEUROSTIMULATION FOR PAIN

#### Review Articles

##### ★ Editor's Choice

#### 191 Neurostimulation for the Treatment of Cancer-Induced Pain: A Scoping Review

Peter D. Vu, MD; Steven Mach, MD; Saba Javed, MD



A comprehensive literature review was conducted using Medline, Embase, and Cochrane Library databases, focusing on studies from 2000 onwards. Inclusion criteria included interventional and observational studies reporting on SCS, DRGS, and PNS in cancer-induced pain. Data were extracted and evaluated using the Grades of Recommendation, Assessment, Development, and Evaluation (GRADE) system.

The search yielded 831 references, with 24 studies meeting the inclusion criteria. Sixteen studies focused on SCS, seven on PNS,

and two cases on DRGS. SCS showed significant pain reduction, with an average decrease in numeric rating scale (NRS) scores from 8.0 to 2.2 over an average 8.4 month follow-up period. PNS also demonstrated substantial pain relief, with NRS scores decreasing from 8.29 to 3.04 over an average 5.2 month follow-up period. DRGS, though less studied, showed a reduction in NRS scores from 6.0 to 1.0 over an average 6.0 month follow-up period. SCS was associated with a significant reduction in opioid use, with average reported morphine equivalent daily dose (MEDD) change from 1152.2 mg to 739.7 mg over an average 5.0 month period, while PNS and DRGS had limited impact on opioid consumption with no reported MEDD change.

#### 204 Cylindrical vs Paddle Leads in Spinal Cord Stimulation for the Long-term Treatment of Chronic Pain: A Systematic Review and Meta-analysis

Salim El Hadwe, MD; Filip Wronowski; Sara Rehman; Yaw Ofosu Ansong Snr; Damiano G. Barone, MD, PhD

#### 234 Noninfectious Complications of Dorsal Root Ganglion Stimulation: A Systematic Review and Meta-Analysis

Maarten Vanloon, MD; Tim Van Broeckhoven, MD; Vincent Raymaekers, MD; Dirk De Ridder, MD, PhD; Bart Billet, MD; Sacha Meeuws, MD; Tomas Menovsky, MD, PhD; Mark Plazier, MD, PhD

# Neuromodulation

TECHNOLOGY AT THE NEURAL INTERFACE

February 2025 ■ Volume 28 ■ Number 2 ■ Pages 191-370

*Contents continued*

## Basic Science

### 249 Pudendal Nerve Block by Adaptively Stepwise Increasing the Intensity of High-Frequency (10 kHz) Biphasic Stimulation

Jianan Jian, PhD; Jicheng Wang, PhD; Bing Shen, DVM; Zhijun Shen, MD; Khari Goosby, BS; Joseph Scolieri, BS; Jonathan Beckel, PhD; William C. de Groat, PhD; Changfeng Tai, PhD

## Clinical Science

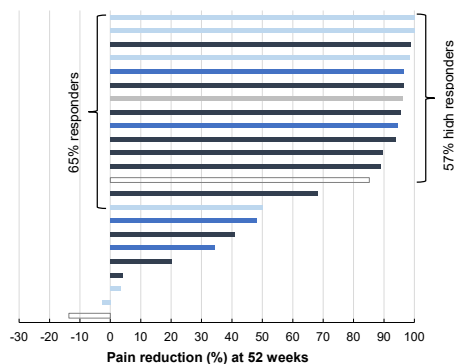
### 256 Effects of Pulsed Radiofrequency Duration in Patients With Chronic Lumbosacral Radicular Pain: A Randomized Double-Blind Study

Chan-Sik Kim, MD; Yujin Kim, MD; Doo-Hwan Kim, MD, PhD; Hyun-Jung Kwon, MD; Jin-Woo Shin, MD, PhD; Seong-Soo Choi, MD, PhD

### ★ *Editor's Choice*

### 263 Twelve-Month Clinical Trial Results of a Novel, Dorsal Horn Dendrite Stimulation Waveform for Chronic Neuropathic Low Back Pain

Marc A. Russo, MD; Willem Volschenk, MD; Dominic Bailey, MClintRes; Danielle M. Santarelli, PhD; Elizabeth Holliday, PhD; Daniel Barker, PhD; Jason Dizon, BMath, BCompSci; Brett Graham, PhD



Twenty-seven participants were implanted with a commercial SCS system. Devices were programmed to deliver the waveform (frequency 100 Hz, pulse width 1000  $\mu$ sec, T9/10 disk bipole) at descending stimulation perception threshold amplitudes (80%, 60%, then 40%) over a 14-week period. Participants were blinded to the program settings. Participants then received their preferred program for further evaluation at 26- and 52-weeks post-activation. Outcome measures included back pain score (visual analogue scale; VAS), Brief Pain Inventory (BPI), EQ-5D-5L, 36-Item Short Form Health Survey (SF-36), treatment satisfaction, and clinician global impression of change (CGIC).

At 52-weeks ( $n=24$ ), the responder rate ( $\geq 50\%$  pain relief) was 65.6%, and the high responder rate ( $\geq 80\%$  pain relief) was 56.5%. The mean change from baseline in pain VAS was  $-43.94$  mm (95% CI  $-57.89$ ,  $-30.00$ ;  $p<0.001$ ) and mean pain relief was  $64.69 \pm 39.43\%$ . BPI and SF-36 scores remained significantly improved ( $p\leq 0.001$ ). EQ-5D-5L index and EQ-VAS further improved, and 87.0% of participants met the minimum clinically important difference for EQ-5D-5L index. Treatment satisfaction was 83% and 91% of participants had a CGIC rating of "much improved" or above. No serious study-related adverse events were reported.

# Neuromodulation

TECHNOLOGY AT THE NEURAL INTERFACE

February 2025 ■ Volume 28 ■ Number 2 ■ Pages 191-370

*Contents continued*

## 274 Peripheral Nerve Stimulation Implantation Combining Ultrasound With Microendoscopy for Management of Chronic Neuropathic Pain: A Case Series Study

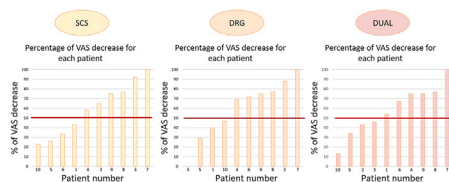
*Bénédicte Bouche, MD; Maxime Billot, PhD; Arthur Voratanouvong, MD; Amine Ounajim, PhD; Maarten Moens, MD, PhD; Lisa Goudman, PT, PhD; Sam Eldabe, MD; Denys Fontaine, MD, PhD; Manon Duraffourg, MD; Manuel Roulaud, MSc; Kévin Nivole, MSc; Mathilde Many, MSc; Sandrine Baron, RN; Bertille Lorgeoux, MSc; Lucie Lampert, MSc; Romain David, MD; Philippe Rigoard, MD, PhD*



### Editor's Choice

## 283 Comparison of Spinal Cord Stimulation, Dorsal Root Ganglion Stimulation, and Association of Both in Patients With Refractory Chronic Back and/or Lower Limb Neuropathic Pain: A Prospective, Randomized, Double-Blind, Cross-Over Trial (BOOST-DRG Study)

*Philippe Rigoard, MD, PhD; Amine Ounajim, PhD; Bénédicte Bouche, MD; Maarten Moens, MD, PhD; Lisa Goudman, PT, PhD; Sam Eldabe, MD; Manuel Roulaud, MSc; Bertille Lorgeoux, MSc; Sandrine Baron, RN; Kévin Nivole, MSc; Mathilde Many, MSc; Lucie Lampert, MSc; Romain David, MD; Maxime Billot, PhD*



This study aimed to compare the pain relief ( $\geq 50\%$ ) responder rates between SCS, DRGS, and SCS+DRGS (DUAL) through a 3-month randomized crossover trial in PPS-2 patients. Following the crossover period, stimulation programming was switched to Burst. Secondary objectives included evaluating the clinical efficacy at 3-, 4-, 6- and 12-month follow-ups, assessing pain

intensity, area of pain, area of paresthesia coverage, quality of life, functional disability, psychological distress, medication intake, and the Multidimensional Clinical Response Index (MCRI).

The responder rate of pain relief was similar between SCS, DRGS and DUAL (60%,  $p=0.84$ ) at the end of the crossover period, increasing to 80% with the ability to switch between stimulation possibilities. Burst programming did not provide additional pain relief at the 4-month follow-up ( $p=0.99$ ). Clinical outcomes significantly improved until 12-month follow-up compared to baseline. Considering a clinically significant increase of 1.05 of the MCRI, all patients were responders at 3-, 4-, 6- month follow-up, and 80% were responders at 12 months compared to baseline.

## 297 Restorative Neurostimulation of the Multifidus for Chronic Low Back Pain After Prior Lumbar Spinal Surgery: A Single-Center, Consecutive Case Series

*Ian R. Whittle, MBBS, MD, PhD; Derek Yull, MBBS, BSc; Allen Huang, MBBS; Sally Fish, DipCouns.; Dani Chene, MBBS; Michael Selby, MBBS; Kyle Craig, BA Sci, MClinExPhys.; Eleanor Clausen, BSc, RGN, Dip Prof Studies, ENB; Yun-Hom Yau, MBChB*

# Neuromodulation

TECHNOLOGY AT THE NEURAL INTERFACE

February 2025 ■ Volume 28 ■ Number 2 ■ Pages 191-370

## Contents continued



### Editor's Choice

#### **306** Preoperative Magnetic Resonance Imaging Modifies Percutaneous Spinal Cord Stimulator Trial Progression and Planning

David A. Provenzano, MD; Esha A. Vaidya, BA; Jason S. Kilgore, PhD

*A retrospective chart review of a single center identified patients who considered SCS percutaneous lead trials and had preprocedural MRIs. Patients' preprocedural MRIs were reviewed for spinal pathology and locations and severity of stenoses (mild, moderate and severe) based on qualitative analysis that may affect lead placement. Additionally, trial-related information and several demographic factors were analyzed with proportional analyses, logistic regressions, and relative risks (RR) to determine their association with stenosis.*

*Retrospective review identified 340 patients who considered an SCS trial with preprocedural MRIs. Preprocedural MRIs influenced SCS treatment for 7% (n = 25) of total patients. For these 25 patients, 60% (n = 15) had the trial technique altered, and 40% (n = 10) did not progress to trial due to an MRI finding. Preprocedural MRIs were more likely to influence SCS trials for cervical cases than thoracic/lumbar cases (RR = 4.6, 95% CI 2.2, 9.5, p < 0.001). Logistic regression analyses revealed age group to be significantly (p ≤ 0.02) associated with moderate/severe cervical spinal stenosis and lumbar spinal stenosis, while only age was significantly (p ≤ 0.04) associated with moderate/severe thoracic spinal stenosis.*

---

#### **315** Does Spinal Cord Stimulation Improve Sleep Disturbances Independently of Pain Relief in Patients With Chronic Pain? An Explorative, Observational Study

Emilia Nejatbakhsh, MD; Simon B. Kristensen, PhD; Christian Scherer, MD; Kaare Meier, MD, PhD; Morten Blichfeldt-Eckhardt, MD, PhD

#### **323** The Retrograde Approach of Surgical Paddle-Lead Placement for Spinal Cord Stimulation

Ahmed J. Awad, MD; Molly M. Murray, MD; Justin L. Morris, PA-C; Peter A. Pahapill, MD, PhD

#### **331** Implanted Pulse Generators in Lower Extremity Neuroprostheses: A 25-Year Review

Lizbeth A. Leapo, BS; Michael E. Miller, MS; Harry A. Hoyen, MD; Gilles C. Pinault, MD; Ronald J. Triolo, PhD

#### **341** Evaluating Spinal Cord Stimulation as a Therapeutic Strategy for Postmastectomy Pain Syndrome: A Retrospective Observational Study

Yun Li, MD; Yang Chen, MD; Guangfu Wei, MSc; Shengtao Wang, MSc; Tao Sun, MD; Xuli Zhao, MD

#### **348** Peripheral Nerve Stimulation for Pain Management: A Survey of Clinical Practice Patterns

Jay Karri, MD, MPH; Eellan Sivanesan, MD; Amitabh Gulati, MD; Vinita Singh, MD, MS; Soun Sheen, MD; Bhavana Yalamuru, MBBS; Eric J. Wang, MD; Saba Javed, MD; Matthew Chung, MD; Rohan Sohini; Nasir Hussain, MD; Ryan S. D'Souza, MD

# Neuromodulation

TECHNOLOGY AT THE NEURAL INTERFACE

February 2025 ■ Volume 28 ■ Number 2 ■ Pages 191-370

---

*Contents continued*

**362** The Opinion of Healthcare Professionals About a Proposed European Registry of Neuromodulation for Chronic Pain: An Online Survey

*Lisa Goudman, PhD, MSc; Philippe Rigoard, MD, PhD; Manuel Roulaud, MSc; Konstantin Slavin, MD; Marc Russo, MBBS; Maxime Billot, PhD; Maarten Moens, MD, PhD*

**Professional Development**

---

**369** Calendar of Events