Posters

Top Posters Selected for 2017 19th Annual ASIPP Meeting

First Place Abstract Presentation
Dr. Richard North
Multicolumn Spinal Cord Stimulation for Predominant Back Pain in Failed Back Surgery Syndrom Patients: An International Multicenter Randomized Trial (PROMISE Study)

2nd Place Abstract Presentation
Gladstone C. McDowell, II MD
Effectiveness and Safety of Intrathecal Ziconotide as teh First Agent in Pump for Adult Patients with Severe Chronic Pain

Fellow Award
Christian Estrada
Performing a Transforaminal Epidural in a Patient with an Implanted DRG Nerve Stimulator

Resident Award
Ken Ehrhardt
New Treatment of Lower Back Pain with Matrix Metalloproteinases

Multicolumn spinal cord stimulation for predominant back pain in failed back surgery syndrome patients: an international multicenter randomized trial (PROMISE study)

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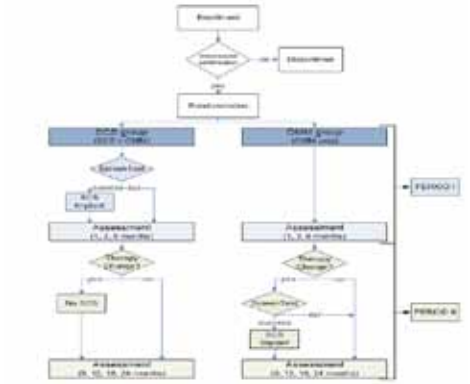
Background

Spinal cord stimulation (SCS) has been shown to be an effective treatment for failed back surgery syndrome (FBSS) with predominant radicular pain. Case series (Rigoard 2012 & 2014) support SCS for predominant low back pain (LBP), but until now we lacked randomized controlled trial (RCT) evidence in this population.

Objective

PROMISE, this multicenter, prospective, randomized, open-label, parallel-group study was designed to assess the clinical effectiveness of SCS in FBSS patients with predominant LBP.

Figure 1: Study Design



Methods

Eligible subjects were randomized 1:1 to optimal medical management alone (OMM group) or SCS plus OMM (SCS group). SCS group patients underwent trial stimulation, and if they achieved adequate LBP relief, a permanent system using a multicolumn surgical lead was implanted. Evaluations occurred at 1, 3, and 6 months, after which patients could change treatment groups and continue follow-up until 12 months.

The primary outcome was the proportion of subjects with ≥ 50% reduction in LBP (responder) based on a diary of numerical pain rating scale (NPRS) scores.

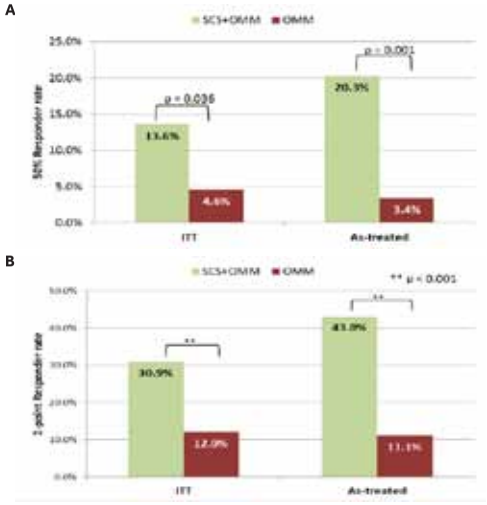
Secondary outcomes included change in LBP intensity, leg pain intensity, functional disability (Oswestry Disability Index, ODI) and health-related quality of life (Short-Form Health Survey, Physical Component Summary, SF-36-PCS).

Results

Of 278 participants enrolled in 28 centers in Canada, Colombia, Europe, and the United States, 218 were randomized (110 to SCS group and 118 to OMM group).

In intention to treat (ITT) analysis at 6 months, there were significantly more responders in the SCS group compared to the OMM group (15 participants, 13.6% versus 5, 4.6%, p=0.036, Figure 2). The SCS group responder rates varied from 0 to 50% across sites.

Figure 2: Low back pain (NPRS) responder rate at 6 months
A: 50% reduction; B: 2 point reduction



Secondary outcomes at 6-months improved significantly ($p<0.001$) for all measures in the SCS group, and the difference between groups was significant (all $p<0.001$) in favor of the SCS group (Figure 3). The OMM group did not improve by any measure at 6-months except the SF-36-PCS (p=0.03).

At 6 months, 2/80 (2.5%) of the SCS group opted to cease therapy, and 73/106 (68.9%) of OMM subjects requested crossover to SCS. Of the 68 continuing on SCS and with 12 months data, 18 (26.5%) were LBP responders.

Figure 3: Function (ODI, As-treated at 6 months)

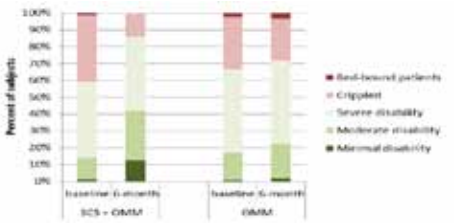
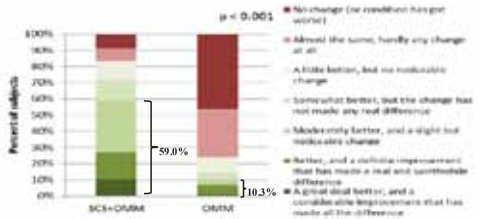


Figure 4: Patient's Global Impression of Change (As-treated at 6 months)



In the SCS group, 102 were trialed, of which 18 (17.6%) experienced device/therapy related complications through 6 months. Among these, 12 (11.8%) required surgical intervention.

Conclusion

In this international multicenter RCT, adding SCS with a multicolumn lead to OMM provided significant improvements in pain relief, health-related quality of life and function compared with OMM alone in a traditionally difficult to treat patient population of FBSS patients with predominant back pain. These improvements were sustained in the SCS group at 12 months.

Disclosures

MJJ, CV, YT: Medtronic employees. All others or their employers: industry consultancy, grants, and/or equity. Detailed disclosure on request.

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Effectiveness and Safety of Intrathecal Ziconotide as the First Agent in Pump for Adult Patients With Severe Chronic Pain: Primary and Secondary Outcomes

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Introduction

- Ziconotide is an intrathecally delivered, nonopioid analgesic agent approved in the United States for the management of severe chronic pain in adult patients for whom intrathecal (IT) therapy is warranted and who are intolerant of or refractory to other treatment, such as systemic analgesics, adjunctive therapies, or IT morphine[1,2]
- The efficacy of IT ziconotide for the treatment of severe chronic pain was established in randomized, double-blind, placebo-controlled trials[3–5]; however, few studies evaluating the effectiveness of IT ziconotide therapy have been conducted in clinical practice settings[6–8]
- In addition, it is recommended that patient-reported outcomes be considered in studies of chronic pain to assess patients' perceptions of the impact of treatment on health and functioning[9,10]

Objectives

- To evaluate the short-term and long-term effectiveness and long-term safety associated with IT ziconotide therapy in the management of patients with severe chronic pain

Methods

- The Patient Registry of Intrathecal Ziconotide Management (PRIZM) was a prospective, open-label, long-term, multicenter, observational study (registry) of IT ziconotide conducted in the clinical practice setting
  - The PRIZM study has closed as of March 2017
- The study population included adults aged ≥18 years with severe chronic pain (life expectancy >6 months) for whom IT therapy was warranted and who were intolerant of or refractory to other treatments, such as systemic analgesics, adjunctive therapies, or IT morphine, and initiated IT ziconotide as the sole agent in pump
- The primary efficacy outcome measure was change from baseline to week 12 in "average pain for the past 24 hours" as rated by patients on the 11-point Numeric Pain Rating Scale (NPRS) ranging from 0 (no pain) to 10 (pain as bad as the patient can imagine)
  - Secondary patient-reported outcomes included in PRIZM were the Patient Global Impression of Change (PGIC); Acute Short Form-36 Health Survey (SF-36), version 2; and Brief Pain Inventory Short Form (BPI-SF). PGIC results are reported here.
- Results through month 12 for the primary and secondary outcomes are presented for patients who have been treated with IT ziconotide and for whom data had been entered into the PRIZM database as of July 5, 2016 (all treated population)
  - Analysis included evaluation of IT ziconotide therapy in patients for whom ziconotide was the first versus second-or-later agent in pump
- IT ziconotide was administered via the Medtronic SynchroMed II Infusion System, which allows for an initial dose as low as 1.2 mcg/d using the undiluted 25 mcg/mL ziconotide formulation
  - According to the prescribing information, IT ziconotide should be initiated at no more than 2.4 mcg/d (0.1 mcg/h) and titrated by ≤2.4 mcg/d (0.1 mcg/h) at intervals of no more than 2 to 3 times per week, with a maximum recommended dose of 19.2 mcg/d (0.8 mcg/h)

Results

- As of July 5, 2016, 93 treated patients had data entered into the PRIZM database (the all treated population); enrollment closed at 93 patients
  - All 93 patients were enrolled ≥12 months prior to this interim analysis; 66 patients and 44 patients were still active in the study at months 6 and 12, respectively, of whom 77.3% (51/66) at month 6 and 59.1% (26/44) at month 12 remained on ziconotide monotherapy

Table 1: Patient Demographic and Baseline Characteristics (All Treated Population)

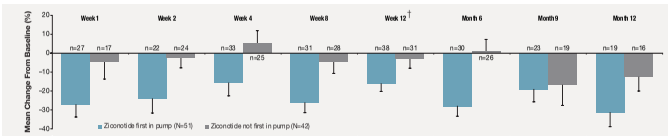
Characteristic	Ziconotide First in Pump (N=51)	Ziconotide Not First in Pump (N=42)
Female sex, n (%)	28 (54.9)	29 (69.0)
Age, y, mean (SD)	55.9 (12.5)	56.9 (14.2)
Race, n (%) White Black American Indian or Alaska Native	49 (96.1) 1 (2.0) 1 (2.0)	41 (97.6) 1 (2.4) 0
Pain etiology, n (%) Malignant Non-malignant	1 (2.0) 50 (98.0)	3 (7.1) 39 (92.9)
Pain classification, n (%) Neuropathic Nociceptive Mixed	25 (49.0) 3 (5.9) 23 (45.1)	22 (52.4) 2 (4.8) 18 (42.9)
Duration of pain, y Median (min, max)	9.0 (0.4, 43.0)	14.0 (2.0, 55.0)
Pain severity (NPRS scores)* Median (min, max) Mean (SD)	8 (0.0, 10.0) 7.4 (1.9)	8.0 (4.0, 10.0) 7.9 (1.6)

n=50 for ziconotide first in pump group; n=42 for ziconotide not first in pump group.
NPRS = Numeric Pain Rating Scale; SD = standard deviation.

- The most common prespecified primary diagnoses (≥5% of patients) were:
  - In patients with ziconotide first in pump: failed back surgery syndrome (17.6%), complex regional pain syndrome (11.8%), low back pain (11.8%), central pain syndrome (9.8%), and diabetic neuropathy (5.9%)
  - In patients with ziconotide not first in pump: failed back surgery syndrome (41.5%), low back pain (31.7%), and cancer pain (7.3%)
- The average initial ziconotide dose was similar in patients with ziconotide as first versus second-or-later agent in pump (1.6 vs 1.7 mcg/d, respectively)

Efficacy

Figure 1: Mean Percentage Change From Baseline in NPRS (All Treated Population)*

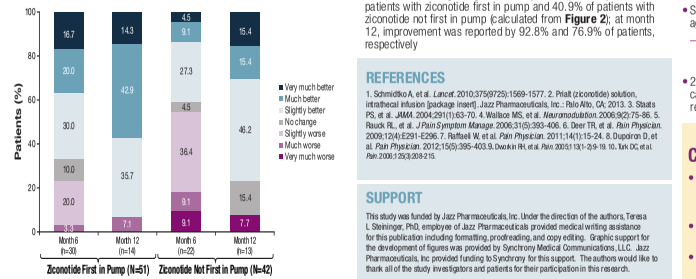


Mean Dose, mcg/d (SD)	Week 1	Week 2	Week 4	Week 8	Week 12	Month 6	Month 9	Month 12
First in pump	1.8 (1.4)	1.9 (1.1)	3.1 (2.5)	3.2 (3.0)	3.2 (3.2)	3.0 (2.2)	2.2 (2.0)	2.0 (1.7)
Not first in pump	2.3 (1.0)	2.4 (1.4)	3.2 (2.1)	3.6 (2.6)	3.0 (2.2)	3.0 (2.4)	3.9 (2.0)	3.8 (3.3)

Lower scores indicate improvement. Error bars represent 1 standard error of the mean. Sample sizes represent observed cases with an NPRS score at each assessment. *Mean doses for patients with ziconotide as first agent in pump and ziconotide not first agent in pump were 1.6 mcg/d and 1.7 mcg/d, respectively, at baseline. Mean dose is shown for each subgroup at each time point. Sample sizes for mean dose values vary slightly from sample sizes for NPRS scores; mean dose levels presented here are summaries of the dose the pump was programmed to deliver. NPRS = Numeric Pain Rating Scale; SD = standard deviation.
†The primary endpoint was mean percentage change from baseline to Week 12 in NPRS

- For treatment response defined as ≥2 unit reduction in NPRS score from baseline, 48.4% of patients with ziconotide first in pump and 23.1% of patients with ziconotide not first in pump were classified as treatment responders at month 6, and 63.2% and 37.5% of patients, respectively, were classified as treatment responders at month 12
- For treatment response defined as ≥30% reduction in NPRS score from baseline, 43.3% of patients with ziconotide first in pump and 15.4% of patients with ziconotide not first in pump were classified as treatment responders at month 6, and 52.6% and 31.3% of patients, respectively, were classified as treatment responders at month 12

Figure 2: Patient Global Impression of Change, Months 6 and 12 (All Treated Population)



Sample sizes represent observed cases with a PGIC score at each assessment.
PGIC = Patient Global Impression of Change

- At month 6, improvement in overall status (as measured by PGIC) since the beginning of the study was reported by 66.7% of patients with ziconotide first in pump and 40.9% of patients with ziconotide not first in pump (calculated from **Figure 2**); at month 12, improvement was reported by 92.8% and 76.9% of patients, respectively

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Safety

Adverse Events

Table 2: Adverse Events Occurring in ≥10% of Patients in Either Subgroup (All Treated Population)*

Adverse Event, n (%)	Ziconotide First in Pump (N=51)	Ziconotide Not First in Pump (N=42)
Any adverse event	51 (100.0)	36 (85.7)
Nausea	13 (25.5)	9 (21.4)
Auditory hallucination	9 (17.6)	5 (11.9)
Dizziness	9 (17.6)	7 (16.7)
Peripheral edema	9 (17.6)	2 (4.8)
Amnesia	8 (15.7)	4 (9.5)
Confusional state	8 (15.7)	9 (21.4)
Diarrhea	8 (15.7)	6 (14.3)
Memory impairment	7 (13.7)	5 (11.9)
Balance disorder	6 (11.8)	1 (2.4)
Constipation	6 (11.8)	3 (7.1)
Headache	6 (11.8)	5 (11.9)
Insomnia	6 (11.8)	2 (4.8)
Asthenia	5 (9.8)	7 (16.7)
Somnolence	4 (7.8)	7 (16.7)
Fatigue	3 (5.9)	5 (11.9)
Vomiting	2 (3.9)	5 (11.9)
Mental status changes	1 (2.0)	5 (11.9)

*This table includes adverse events that were coded using MedDRA (version 16.0) as of July 5, 2016.

- Serious adverse events (AEs) were experienced by 12 patients (23.5%) with ziconotide as the first agent in pump and 15 patients (35.7%) with ziconotide as the second-or-later agent in pump
  - 11 serious AEs were considered drug- or device-related (ziconotide first in pump: delusion, device inversion, pseudohyperkalemia, psychiatric disorders, suicidal ideation; ziconotide not first in pump: asthenia, mental status changes, paraplegia, vomiting)
- 2 patients died; one patient experienced a hypertensive fatal event, and the other died from cardiopulmonary arrest in the setting of septic shock; these deaths were not considered related to ziconotide by the study investigators

Conclusions

- In this interim PRIZM analysis, greater treatment response on the NPRS (primary efficacy measure) was observed when ziconotide was initiated as first in pump versus second-or-later agent in pump
- Improvement from baseline to 6 and 12 months on patient-reported outcomes was generally observed in both patient subgroups
- The most common AEs with ziconotide first in pump included nausea, auditory hallucination, dizziness, and peripheral edema; for patients with ziconotide not first in pump, nausea and confusional state were most common

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RUTGERS
New Jersey Medical School

Performing a Transforaminal Epidural in a Patient with an Implanted DRG Nerve Stimulator

Christian Estrada MD, Anant Parikh MD, Andrew Kaufman MD, Vanny Le MD, Antonios Mammis MD, Anthony Sifonios MD

Introduction

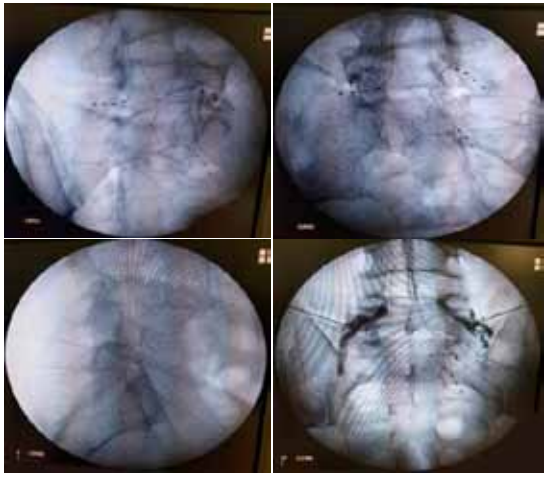
The dorsal root ganglion (DRG) is a nerve structure that processes and filters pain information from the periphery to the central nervous system. Stimulating the DRG is a type of neuromodulation that offers a meaningful option for patients suffering from chronic intractable pain in the lower limbs who are currently underserved by traditional spinal cord stimulation.

The ACCURATE study provided evidence of the safety and efficacy of DRG stimulation in CRPS patients[1]. As the number of patients with CRPS being treated with DRG stimulation rises, there will be a subset of patients with concurrent radicular low back pain.

Case

Patient is a 49-year-old man with a past medical history of chronic low back pain with radiculopathy and bilateral foot deformities s/p multiple surgeries secondary to a previous dancing career. He subsequently developed severe burning pain in the plantar aspect of both feet associated with a growing inability to walk, affecting his ADLs. Fulfilling the Budapest criteria, he was diagnosed with CRPS. After failing multiple conservative therapies, he underwent bilateral L5 and right S1 DRG stimulator implantation. Afterwards, the patient reported complete resolution of the burning sensation in the bottom of his feet.

Months later, the patient complained of sharp low back and radicular pain down bilateral legs posteriorly in an L5 nerve root distribution. This pain was not covered by the DRG stimulator. Due to a known displaced intervertebral disc causing bilateral neural foraminal stenosis at L5-S1, the decision was made to proceed with bilateral L5-S1 transforaminal epidural steroid injections with special care taken to avoid the radiopaque DRG leads.



Discussion

Our treatment plan was based on the idea that the DRG leads were irritating the nerve roots exiting an already stenotic foramen. Performing an epidural via the transforaminal approach in a patient with DRG leads at the same level can provide unique challenges. Before prepping the skin, we took several fluoroscopic images to map out the locations of the stimulator as well as the DRG leads. During the procedure, the ideal oblique angle of the fluoroscopic beam had to be readjusted because the DRG lead was in the way. This was particularly a problem when accessing the right foramen.

The needle placement was slightly more lateral than ideal. However, we were still able to access the epidural space safely.

Other options considered were an interlaminar epidural as well as a caudal approach. These two options are technically less difficult. However the location of the injectate would offer a less efficacious treatment given that the painful condition involved the nerve roots.

After a systematic review of the literature, we were unable to find other case reports where a transforaminal epidural was done at the same level as DRG leads. Contraindications to epidural injections from the manufacturer were not found. Close proximity of the needle to the leads would risk of direct lead damage. The manufacturer does warn of the use of radiofrequency (RF) ablation since it may cause interference with the stimulator[2]. Also, if the patient was wearing a trial neurostimulator, we would have postponed the epidural injection because the cleaning agents used to sterilize the skin may cause corrosion and affect the outcome of the trial.

Conclusion

DRG stimulation provides targeted pain relief in patients with debilitating CRPS. As this treatment modality gains popularity as an alternative to opioid therapy, there will be a larger subset of these patients with chronic radicular low back pain. Transforaminal epidural steroid injection remains a treatment option for radicular back pain in patients with implanted DRG leads. One however must consider the increased level of difficulty in placing the needles and risk of possible direct damage to the leads.

References

1. Levy R. Plenary presentation; Paper presented at: 19th Annual North American Neuromodulation Society (NANS); Las Vegas, NV. 2015.
2. Axium™ Neurostimulator System Patient Programmer User Manual Model MN10600-02, 2016.

New Treatment of Lower Back Pain with Matrix Metalloproteinases

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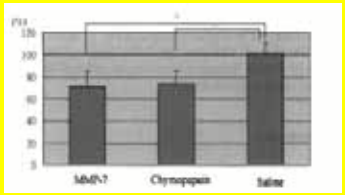
Background:
The prevalence of chronic lower back pain (CLBP) is increasing in today's society. Current treatment of lower back pain is effective in less than fifty percent of patients after one year. Matrix metalloproteinases (MMPs) are a family of proteolytic enzymes that participate in the degradation of matrix components such as glycoproteins, proteoglycans, and collagen. MMP-3 degrades the protein core of proteoglycans and small noncollagenous proteins. Their activity is inhibited by tissue inhibitors of metalloproteinases (TIMPs). It has been hypothesized that the dysbalance of MMPs and TIMPs leads to disc degeneration.

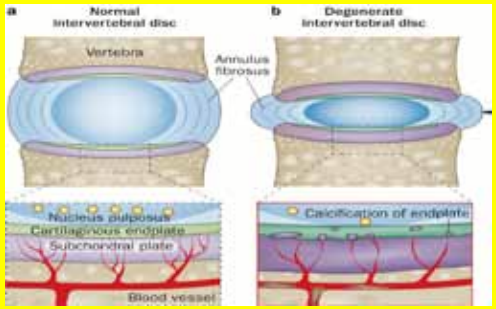
Objective:
This review investigates Matrix Metalloproteinases as a new treatment for lower back pain and disc herniation



Administration of MMP-7 and chymopapin into canine herniated discs had significant reduction of disc protrusion showed on MRI and myelography ($p<0.01$)

Methods:
An extensive literature search utilizing PUBMED, focused on matrix metalloproteinases as a treatment for CLBP.

Results:
Limited studies have been completed at present. Bachmeier et al. took 37 lumbar specimens obtained during surgical procedures, including lumbar discectomies and interbody fusions. A quantitative molecular analysis of the mRNA expression for MMPs and TIMPs was performed using RT-PCR. The researchers found that MMP-3 mRNA levels were consistently upregulated in samples with histological evidence for disc degeneration. Interestingly, TIMP-1 was also upregulated. The authors concluded that MMP-3 plays a key role in the degenerative cascade leading to symptomatic disc herniation. In another study, Haro et al. conducted an extensive study to examine the role of MMPs in the treatment of herniated discs. Administration of rh MMP-7 and chymopapain into canine herniated discs resulted in a decrease in protruded disc mass as seen by MRI and myelography. Histologically, rh MMP-7 destroyed the nucleus pulposus, but an intact nucleus area and annulus fibrosus remained. In contrast, chymopapain showed degradation though the NP and AF. The authors concluded that rh MMP-7 shows the greatest promise for the treatment of herniated discs.



Conclusion:
Further research and innovation is needed to implement these methods into practice and assess clinical significance. The current evidence suggests that matrix metalloproteinases are promising new agents for the treatment of CLBP and in particular herniated discs.

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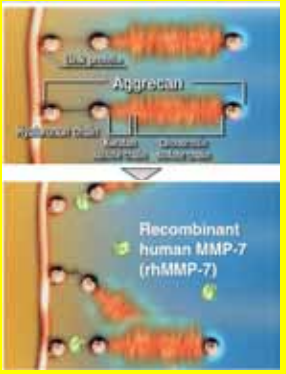


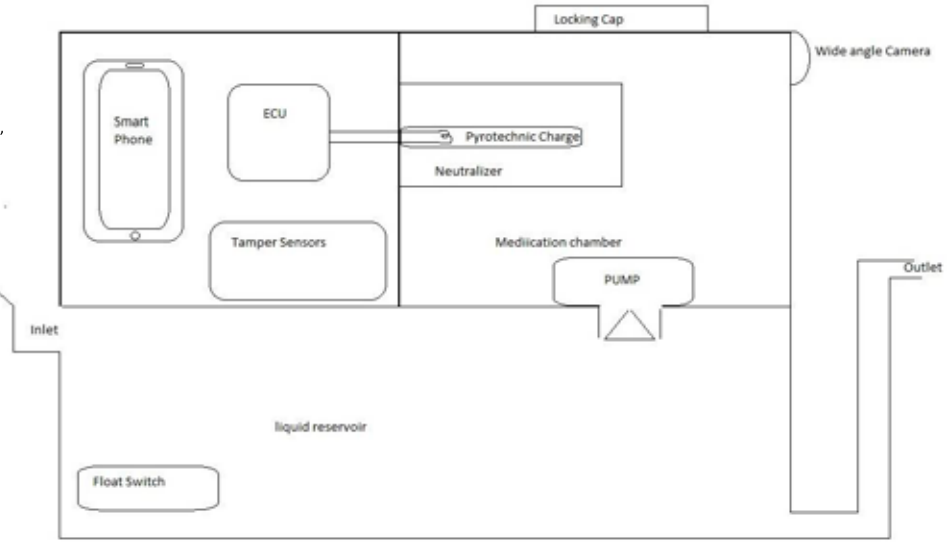
The future direction of prescription opioid abuse deterrent technologies

Amanpreet Sandhu MD / Ajay Singh MD

Opioid overdose causes up to 18000 deaths in the USA each year.
Once opioids are dispensed there are no checks or balances to prevent abuse. Abuse deterrent mechanisms can prevent iv or intranasal use but not oral ingestion (commonest form of abuse) of multiple doses or selling of opioids. Currently available medication dispensers allow for preprogrammed dispensing of medication doses at preprogrammed intervals however without actual monitoring of medication ingestion the patient can just remove one dose at a time, save all the pills in a bottle and then subsequently abuse or divert them all.
Goal is to develop of abuse resistant medication dispensers which
1) Allow the patient to access only one dose of medication at a fixed preprogrammed dosing interval
2) Allow electronic monitoring of actual ingestion of the drug by the patient
3) Are tamper resistant
4) Deter medication from being administered by any other route than prescribed
5) Prevent access to dispensed medications by anyone other than the patient
6) Allow for deactivation of the remaining unused medication once a specified interval has passed and the medication is no longer medically necessary
We describe a Medication dispenser which includes 3 main components
1) A portable battery operated, reusable tamper resistant medication dispenser that allows only a preprogrammed dose of the medication to be dispensed only at preprogrammed interval upon activation using biometric identification sensors.
2) a refillable liquid reservoir attached to the bottom off the medication dispenser into which the medication is dispensed
3) a smartphone and camera based monitoring system which records actual consumption of the medication infused liquid from the liquid reservoir by the patient
4) The mediation in pill, pellet or liquid form, is contained in the medication chamber, which is locked with accesses only to a pharmacist for medication refill and disposal.
A smart phone integrated with the device acts as the primary ECU. Tamper sensors including break/tripwire sensors, shock sensors, and temperature sensors detect any attempts at breaking, perforating or tampering.
The medication is in liquid form and an electronically controlled pump when activated allows for a fixed preprogrammed volume of the medication solution to be dispensed at the preprogrammed interval.
The medication can be specially formulated by addition of gelling and thickening agents to prevent intravenous administration of the dispensed medication. Also orally inactive opioid antagonists such as naloxone can be added to the opioid medication to prevent intravenous usage.
The medication is dispensed directly into a refillable liquid reservoir permanently attached to the bottom or side of the medication dispenser. This reservoir has float switches and has to be filled with at least a fixed predetermined volume of any potable opaque liquid such as milk, ensure, protein shake or nutritional supplement etc before the medication is dispensed into the reservoir and the patient drinks the liquid mixed with the medication directly by sucking from the outlet port of the liquid reservoir. The reservoir float switch monitors filling and emptying of the reservoir and prevents dispensing of the medicine into the reservoir until the reservoir is filled with a specified amount of liquid and subsequently emptied after the medication has been dispensed to prevent multiple doses of medication being dispensed into the reservoir.
When tampering is detected the medications are immediately rendered unfit for misuse or abuse by electronically activated pyrotechnic charge causing release of denaturing/ neutralizing chemicals into the medication chamber.

The tamper resistant medication dispenser can be programmed to activate the medication deactivating mechanisms at the end of a specified interval when the medical necessity for the prescribed medications is over, such as 2 weeks after surgery when severe pain should have resolved and the remaining unused medications in the medication chamber can be deactivated and rendered unfit for abuse and misuse.

The tamper proof medication dispenser is be equipped with wide angle camera to record pictures and video of the patient actually ingesting the medication infused liquid for later review of medication usage to prevent further misuse by diversion. Motion sensors or angle sensors and float switch information can be used to activate the camera. The smart phone can have cellular service to record and monitor medication usage by uploading pictures and video to central location where such pictures and video can be reviewed and also to allow for remote reprogramming of the medication dosing interval but only within fixed medically safe predefined parameters(to prevent overdose risk) such as if the patient has significant exacerbation of pain such as after sustaining a fall or injury and higher dosage of medication is needed and is approved by the prescribing physician with the dosing interval being changed remotely. This can also be used to allow for remote activation of the medication deactivation mechanism in the event of misuse or abuse noted upon review of recorded pictures or video from the medication dispenser or change in patient medical condition as determined by the prescribing physician.
The electronically activated medication deactivation system has a separate power supply and secondary ecu.
The pharmacist dispensing the medications and the physician prescribing them can review the camera images / video and also verify the integrity of the medication dispenser and monitor for any physical evidence of tampering with the medication dispenser.
If all controlled substances are dispensed using lockable portable battery-operated tamper resistant medication dispensers with preprogrammed medication doses and dispensing intervals along with technology to monitor actual ingestion of the medication by the patient it would substantially reduce the incidence of opioid and benzodiazepine related overdose and death.



REAL WORLD UTILIZATION OF MULTIPLE SPINAL CORD STIMULATION WAVEFORMS IN CHRONIC PAIN PATIENTS

Anthony Berg[1], Dat Huynh[2], Roshini Jain[2]

1. Spine Team Texas, Rockwall, TX USA 2. Boston Scientific Corporation, Valencia, CA USA

BACKGROUND

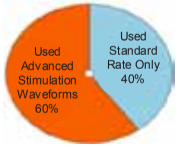
Chronic pain disorders can be inherently complex and significantly differ in presentation and etiology from patient to patient. Therefore, customizing spinal cord stimulation therapy offers the prospect of addressing patient variability by tailoring disease treatment to each patient. The recent availability of different treatment modalities in Spinal Cord Stimulation (SCS) such as standard rate, 1 kHz, burst, anode intensification, Multiple Independent Current Control (MICC), and anatomically-guided (3D) Neural Targeting SCS now allows for the potential real world, clinical application of highly customized SCS therapy. To begin to understand how patients utilize different modalities when empowered with different targeting and waveform options using a single SCS device, we first embarked on a device utilization study. In this specific analysis, the usage of multiple stimulation waveforms is examined in 250 chronic pain patients.

METHODS

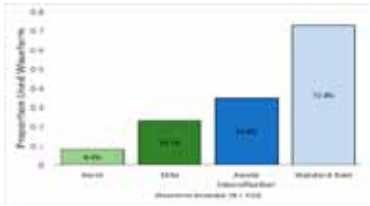
Study Design	Retrospective, multicenter, real-world device utilization
Study Device	Precision Spectra SCS system (Boston Scientific) equipped with MICC and Anatomically-Guided (3D) Neural Targeting and the following available waveform programming options: • Standard rate • 1 kHz • Burst stimulation • Anode Intensification • Combinations of all the above
Sample Size	250 patients with chronic pain
Analyzed Patients	Group 1: used standard rate programs exclusively Group 2: used advanced waveforms and field shapes either exclusively or in combination with standard rate programs

RESULTS

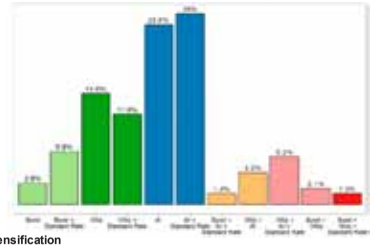
60% used advanced waveforms and field shapes, either exclusively or in combination with standard rate for ≥ 20% of total



Proportion showing usage of each waveform (based on ≥ 20% of total device usage)



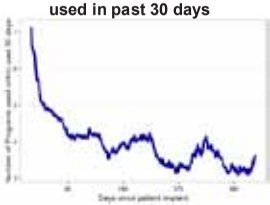
Distribution of waveform usage (N =144)



AI = Anode Intensification

Patients try ~6 different programs around the time of implant and will level to ~3-4 different programs after about 180 days

Mean number of programs used in past 30 days



CONCLUSIONS

- This analysis demonstrates patients used multiple waveforms/programs long-term and at different times each day.
- This strongly suggests the need for a device capable of providing several options to each patient based on their individual needs, thereby customizing SCS therapy.
- Future data, advanced analytics, and assessment of outcomes will drive further understanding of the impact of providing such options on patient lives.

Outpatient Thoracic Endoscopic Discectomy with or without foraminotomy- Case Series

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Background

- Surgical management of thoracic disc herniations is a challenge.
- Due to poor outcomes with thoracic laminectomy, posterolateral and lateral approaches have evolved.
- All approaches have high morbidity. Most approaches need hospitalization and extensive post-operative rehabilitation.
- With thecal sac adhesions, any approach medially carries risk of thecal sac injury or dural sac tears.
- Additionally, thoracic disc herniations at T6 level carries risk of "watershed area" of tenous blood supply rending neurologic complications common

Case 1 Thoracic Endoscopic Discectomy T12-L1 without foraminotomy

- 31 y/o white female with right sided thoracic pain after ski accident.
- MRI: T10-11 superiorly extruded component; T11-12 left sided disc herniation; T12-L1 right sided disc herniations with adhesions to thecal sac and mild flattening of cord.
- Initial surgical option anterior thoracic discectomy and fusion with thoracotomy.
- Failed conservative care, epidural injections, thoracic facet blocks and thoracic radiofrequency ablation.
- Thoracic discogram: concordant pain at T12-L1.
- Preoperative planning: Review of MRI and CT discogram and access planning (Figure 3).
- Endoscopic discectomy at T12-L1 via posterolateral approach on right side. 18 G 10 inch needle into disc (Figure 4), indigocarmine contrast into disc.
- Guidewire inserted, needle removed, a blunt dilator advanced under fluoroscopic control into posterolateral disc.
- Endoscope inserted through 9 mm sheath.
- Surgical decompression carried out with microforceps and radiofrequency ablation.
- Complete dissection carried out with good visualization of exiting nerve.

Case 2: Thoracic Endoscopic Discectomy T6-T7 with foraminotomy

- 34 y/o female, T6-7 disc herniation with failed conservative care and urinary urgency, discogram positive concordant pain
- 5 cm to right of midline incision, serial dilatation to inferior aspect of the foramen posterior to the rib and inferior aspect of the foramen and into the disc space.
- Second dilator passed, inner two stabilized.
- First of three trephines used to resect a portion of the superior articular process and initiate the foraminotomy. Trephine removed and third dilator passed.
- Cannula passed over the four dilators and discectomy initiated. Bipolar radiofrequency used to shrink disc.
- Pulsating perioperative fat noted indicating adequate decompression
- Patient released home same day, no chest tube needed, blood loss less than 150 ml

CASE 1: T12-L1 ENDOSCOPIC DISCECTOMY WITHOUT FORAMINOTOMY

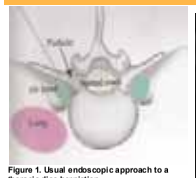

Figure 1. Usual endoscopic approach to a thoracic disc herniation

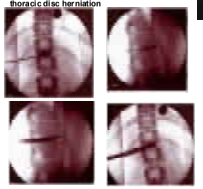

Figure 4 . (A and B) Discography with guide wire in position. C and D: Obturator advanced over the guide wire in AP and lateral views.

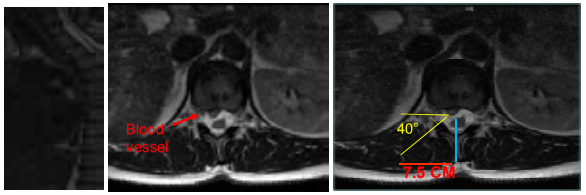

Figure 2. T12-L1 herniation to right. Soft herniation with thecal sac adhesions. Also note the blood vessel in the trajectory for the access. Modified approach planning to avoid medial approach and contact with the thecal sac. C. Preoperative planning identified an area 7.5 cm to the right of the midline and at an angle of 40 degrees to avoid the blood vessel and access the herniation, as well as avoid injury to the pleura.

Figure 5. After complete removal of the herniated disc fragment at T11-T12, the decompressed pulsating dura and PLL complex can be seen

CASE 2:T6-7 ENDOSCOPIC DISCECTOMY WITH FORAMINOTOMY

Figure 7. A) Sagital view showing the T6-7 herniation. **B) Axial view** : T6-7 right paracentral disc herniation with flattening of the hemicord

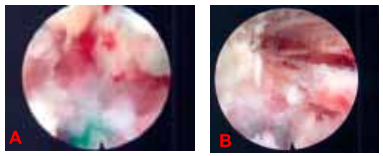

Figure 9. A) initiation of discectomy after foraminotomy. Indigocyanine stained disc at bottom of image **B) Completion of discectomy** with pulsating dura and PLL visible clearly

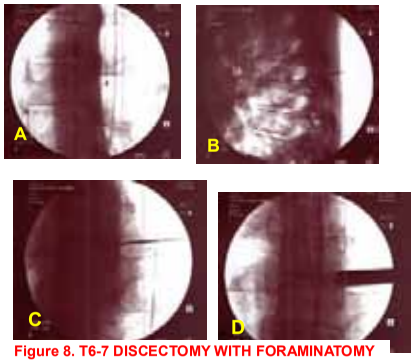

Figure 8. T6-7 DISCECTOMY WITH FORAMINATOMY STEPS: A. AP view. Needle placement 5 cm from midline B. Lateral View. C. Foraminotomy commencement with tube placement D. Endoscope working tube placed after foraminotomy

Discussion

- Anatomic features increasing complexity: Thoracic spine kyphotic, spinal cord runs close to posterior elements.
- Tethering of spinal cord by dentate ligaments limits mobilty of spinal cord to drift away from anterior impingement.
- The spinal cord diameter to canal diameter ratio is higher in thoracic area compared to lumbar and cervical area leaving less room for spinal cord in case of stenosis.
- Thoracic spinal cord vulnerable to ischemic injury ("watershed zone")
- Thoracic herniations frequently centrally located and calcify more easily.
- They may be adherent to and even erode over dural sac
- **Anterior approaches**: Conventional thoracotomy, mini-thoracotomy and thoracoscopy allow excellent visualization and direct decompression, however, pulmonary compromise is frequent.
- **Conventional posterior or posterolateral approaches**: Need dural retraction and more medial approach.
- ***All open approaches: need for hospitalization, possibility of perioperative complications (bleeding) and insertion of chest tubes or drains.***

Review of literature

- Natural history not well defined. Thus, indications and optimal type of surgery controversial. 75% occur below T8 and commonest level is T11-12.
- Approaches include laminectomy, transpedicular (with or without endoscopy), mini-open transpedicular, transfacet pedicle sparing approaches, costotransversectomy, transthoracic transpleural approach
- Recently reported(2011, Diverin et al): Minimal invasive anterolateral Transthoracic Transpleural approach. 12 patients, avg follow up 28 months, average hospital stay 5 days; VAS from 9 to 3 post-op. 1 patient had pleural effusion and 1 patient had intercostal neuralgia.
- Anand and Reagan (2002): Video assisted thoracoscopic surgery- 100 patients with minimal 2 year follow up: 21% complication rate; 15% pulmonary.
- McAfee et al (1995): VATS anterior approach in 78 patients- intercostal neuralgia (8%) and atelactasis (6%) sufficient to delay discharge.
- Jho et al (1999): Endoscopic transpedicular thoracic approach.
- Thoracic Microendoscopic discectomy: medial approach- dural tears
- Transfacet pedicle sparing approach (Stillerman et al 1995)
- Choi et al (2010): Transforaminal Endoscopic Thoracic Discectomy: 14 patients; foraminoplasty in all cases. Mean follow up of 60 months.
- Other reported complications: Hemothorax, chylothorax, paraplegia.

Thoracic Endoscopic Discectomy "Pearls"

•Thoracic discogram absolutely essentially planning level of surgery.
•Review of MRI and CT discogram to identify ideal access point. Identified a window between 5 and 9 cm from midline as ideal access point
•**Case 1**:Segmental blood vessel on intended area of access- therefore initial access with guide wire performed very carefully.
•Due to dural adhesions, prudent to consider "inside out" decompression instead of a direct access to disc with potential dural compromise.
•Available Ellman and Laser probe to address bleeding under direct vision.
•**Case 2**: Herniation higher up in spine, resection and enlargement of foramen essential
•Incision 5 cm from midline
•Foraminotomy allowed access to more medial disc herniation
•**BOTH CASES**: No drains or chest tubes inserted, outpatient procedure, no retraction of the spinal cord necessary.
•Case 1- 5 years follow up; Case 2 – 2 year follow up- no further surgery needed

Conclusion

- **Thoracic discectomy endoscopic approach feasible in an outpatient setting with proper planning.**
- **Thoughtful planning necessary for good outcomes.**
- **Endoscopic approach to thoracic herniations can be performed with or without foraminotomy**
- **. Better access tools availability and knowledge will lead to use of this approach more in the future. .**
- **Long term follow up result great with neither cases needing fusion / stabilization.**

A MULTICENTER, PROSPECTIVE, CLINICAL TRIAL OF HIGH FREQUENCY SPINAL CORD STIMULATION (HF-SCS) AT 10 kHz IN THE TREATMENT OF CHRONIC UPPER LIMB AND NECK PAIN

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Background

Disorders of the cervical spine are frequently disabling and costly[1,2]. When patients do not improve with conservative care, surgical procedures including anterior cervical discectomy with or without fusion are often employed. In a randomized comparison trial of various surgical techniques in patients with cervical radiculopathy secondary to single level pathology, the incidence of arm pain and neck pain was 0-8% and 17-27% respectively at 24 months[3].

Upper limb and neck pain remain difficult-to-treat areas of pain. Traditional SCS has been successfully used to treat upper limb and neck pain[4,5,6]. However, variability in the distribution and intensity of the induced paresthesias as well as obtaining effective coverage of axial neck pain remain limitations. High frequency SCS (HF-SCS) at 10 kHz is a paresthesia-independent therapy that has demonstrated long-term safety and effectiveness in the treatment of chronic, intractable back and leg pain[7,8]. The lack of paresthesia may reduce the positional variation that can compromise neck and upper limb pain relief. The goal of this study is to assess the safety and effectiveness of HF-SCS in the treatment of upper limb and neck pain.

Methods

- Prospective, multi-center study (ClinicalTrials.gov identifier: NCT02385201)
- Subjects with chronic, intractable neck and/or upper limb pain of ≥5 cm (on a 0-10 cm visual analog scale [VAS]) enrolled
- Major exclusion criteria: Mechanical instability of the spine, cervical stenosis, significant epidural scarring or symptoms of myelopathy
- Investigative device exemption (IDE) obtained from the US Food and Drug Administration, followed by Institutional Review Board approval
- Each subject implanted with two epidural leads spanning C2-C6 vertebral bodies (Figure 1)
- Subjects with successful trial stimulation (≥40% pain relief) implanted with a Senza system (Nevro Corp., Redwood City, CA)
- Primary safety and effectiveness endpoints (≥50% pain relief) assessed at 3 months post-implant
- Results are presented as mean ± standard error of the mean
- **Preliminary results at 3 months presented: 38 at baseline and 20 at 3 months**

Figure 1: Anterior-posterior and lateral views of cervical lead placements.

Results: Etiologies

Pain Etiology	N
Chronic intractable upper limb and neck pain	26
Chronic intractable neck pain only	12

Diagnosis	N
Radiculopathy	29
Degenerative disc disease	28
Failed cervical spine surgery syndrome	22
Spondylosis	19
Other chronic pain	14
Mild/moderate spinal stenosis	12
Neuropathic pain	5
Internal disc disruption/annular tear	4
Spondylolisthesis	2

Results: Safety

- No neurological deficits
- None of the subjects reported experiencing paresthesia
- Two device-related adverse events
  - Muscle spasm in neck/shoulder
  - Malaise
  - Both resolved with reprogramming

Conclusions

Preliminary results from a multicenter, prospective study using high frequency spinal cord stimulation at 10 kHz to treat upper limb and neck pain are promising with outcomes similar to SENZA-RCT results for back and leg pain.

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9. Soer et al. (2012) *Spine*.

Results: Responder Rates

Subjects	Trial†	3 Months (Primary) ††
All	36/38 (95%)	15/20 (75%)
With Neck Pain	36/38 (95%)	15/20 (75%)
With Upper Limb Pain	18/19 (95%)	10/12 (83%)

Note: Interim results not including 6 subjects at this time

†Defined as ≥ 40% pain relief
††Defined as ≥ 50% pain relief

Results: Pain Scores and Percentage Pain Relief

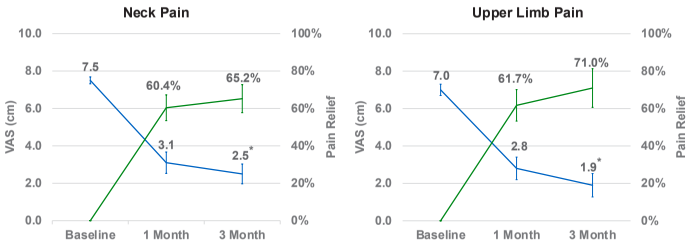
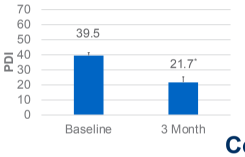


Figure 2: Neck (left) and upper limb (right) pain as a function of time. VAS scores shown in blue, percentage pain relief shown green. *p<0.001.

Results: Disability



- Disability assessed by Pain Disability Index (PDI) (Range: 0-70)
- Lower index score = less disability
- Minimal clinically important difference (MCID): 8.5-9.5[9]
- **Proportion of subjects reporting ≥ MCID: 66.7%**

Conflict of Interest

KA: Personal fees from Nevro Corp., Saluda Medical, Medtronic, and St. Jude Medical. Grants from Nevro Corp., Mesoblast, and St. Jude Medical. Scientific advisory board member of Nevro Corp., Mesoblast, Nalu Medical, Biotronik; CY: Personal fees from Boston Scientific, Medtronic, and St. Jude Medical; RV: Grants from Nevro Corp. and Boston Scientific and personal fees from Nevro Corp. and Boston Scientific; RB (Coastal Orthopedics and Pain Medicine): Personal fees (speaking engagements) and research grants from Nevro Corp; TLY: Research grants from Boston Scientific, Nevro Corp., and St. Jude Medical; Consulting agreements with Boston Scientific, Nevro Corp., St. Jude Medical and Neuronano; Officer in Meagan Medical (Chief Medical Officer) and Algos Clinical Development (Director); RB (Millennium Pain Center): Consulting agreement with Medtronic; Research grants and personal fees from Medtronic, Boston Scientific, St. Jude Medical and Nevro Corp.

Valve Gated Pump Used in Intrathecal Drug Delivery System Shows Reduced Dosage Escalation as Compared to Peristaltic-based Systems: A 24-Month Retrospective Study

Daniel R. Kloster, M.D., Interventional Pain Management Specialist, LLC, Overland Park, KS

Introduction

Minimizing dose escalation observed in chronic intractable pain patients implanted with programmable intrathecal (IT) drug delivery systems (IDDS) is critical for therapy efficacy. Dose escalation can be managed by dosing algorithms including micro-dosing and low-dose drug delivery, as clinical data suggests. Current implantable drug delivery platforms rely on either peristaltic- or valve gated-based systems. Thus, it was of interest to determine what difference in dose escalation, if any, existed between these two platforms in this patient population. Our retrospective analysis of patient records from a single center evaluated type of IDDS and drug dosage, as well as change in medication. Since bupivacaine, hydromorphone, and morphine were the most common analgesics recorded, their IT dosages were of particular interest. Available data were evaluated at 3, 6, 12, and 24 months post-implant.

Inclusion Criteria

Inclusion Criteria for Analysis

Age	≥18 yrs
Pain Condition & Restrictions	Chronic intractable pain who were nonsurgical candidates and/or experienced intolerable side effects to oral analgesics
IDDS	Implanted with either peristaltic or valve gated pump
IDDS Implant Date	June 2009 to June 2016

Results[1]

Demographics	Total	Male	Female
Enrolled – n (%)	40	17 (42.5)	23 (57.5)
Age – mean ±SD	60 ±11.9	55 ±8.8	64 ±12.5
Peristaltic Pump			
Enrolled – n (%)	20	8 (40)	12 (60)
Age – mean ±SD	59 ±13.9	52 ±7.4	64 ±15.2
Valve Gated Pump			
Enrolled – n (%)	20	9 (45)	11 (54)
Age – mean ±SD	63 ±10.4	50 ±22.7	64 ±9.7

Results

Medications Administered Over 24 Months

Medication	(%)	Peristaltic	Valve Gated
Baclofen	(10)	N	Y
Bupivacaine	(95)	Y	Y
Clonidine	(75)	Y	Y
Hydromorphone	(48)	Y	Y
Droperidol	(5)	Y	N
Fentanyl	(8)	Y	Y
Morphine	(43)	Y	Y
Prialt	(3)	Y	N

Total Mean Dosage Administered (mg) Over 24 Months

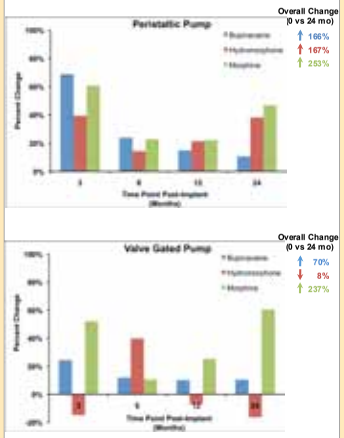
	Peristaltic	Valve Gated
Baclofen	--	0.12
Bupivacaine	5.80	5.57
Clonidine	0.14	0.22
Hydromorphone	1.61	2.38
Droperidol	0.05	--
Fentanyl	0.04	0.11
Morphine	1.85	1.35
Prialt	0.01	--

Mean Dosage (mg ±SD) Over Time

Perist	Months 0	3	6	12	24
Bupi.	2.95 ±0.79	4.98 ±2.35	6.17 ±3.41	7.09 ±3.12	7.85 ±3.34
Hydr.	0.92 ±0.68	1.28 ±1.33	1.47 ±1.44	1.78 ±1.48	2.46 ±1.30
Morp.	0.91 ±0.60	1.46 ±0.83	1.79 ±1.25	2.18 ±1.87	3.20 ±3.05
Valve Gated	Months 0	3	6	12	24
Bupi.	4.08 ±2.67	5.08 ±2.74	5.68 ±3.13	6.09 ±3.43	6.92 ±3.00
Hydr.	2.20 ±1.62	1.88 ±1.61	2.62 ±1.64	2.44 ±1.55	2.04 ±1.52
Morp.	0.72 ±0.47	1.09 ±1.11	1.21 ±1.19	1.52 ±1.50	2.43 ±2.05

Results

Post-Implant Mean Percent Change in Dosage From Previous Month



Discussion

This retrospective review of real world cases has demonstrated over a two-fold and twenty-fold percent decrease in use of bupivacaine and hydromorphone respectively, with a concomitant lower average dosage (24%) of morphine delivered after a 24-month period via a valve gated-based drug infusion system versus a peristaltic drug infusion system. Though four patients from the valve-gated group have not completed the 24-month post-implant period, the overall trend suggests a lower IT dosage to alleviate nociception, particularly after 3 months post-implant.

Discussion

Dose escalation observed in the peristaltic pump may be due to patients worsening pain as they approach the refill date. The peristaltic system decreases delivery of the medication as pressure diminishes with lower volumes. This results in a clinical picture of worsening pain, and decisions are made to escalate the pump. Conversely, the valve gated system allows constant delivery of the medication even as the volume diminishes toward the refill date. We believe this results in fewer upward adjustments in the pump because the patient's pain score is stable regardless of the volume of medication in the pump.

IT pharmacotherapy with a valve gated IDDS may be a safe and effective option for this population upon further evaluation of the therapy in a prospective clinical trial of appropriately powered sample size.

Conclusion

This benefit of overall low dose IT bupivacaine, hydromorphone, and morphine with decreased variability is achieved by the valve gated system minimal pressure requirements, which is in contrast to the environment sensitive (temperature and pressure) peristaltic-based drug infusion system that can contribute to known delivery fluctuations.

Acknowledgements

This study was supported (partially) by Flowonix, Inc.

1 - The content of this poster includes data from the abstract as well as additional data analyzed post abstract submission.

Epidural Steroid Injection with Racz Catheter Placement for Cervical Radiculopathy, is that Contrast in the Vertebral Artery: A Case Series

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Background

Two patients with history of anterior cervical discectomy and fusion with a bone graft at C5-6 level were seen in the office five years after the original surgery. They presented with radicular signs and symptoms and new disc herniation at C2-3/C3-4 above the fusion.

Case Description

Cervical epidural steroid injection with a Racz catheter was performed in order to reach the disc levels above the fusion and to lyse potential adhesions. Catheter was placed at the C6-7 level under live fluoroscopic guidance and brought to the C2-3/ C3-4 where contrast was injected.

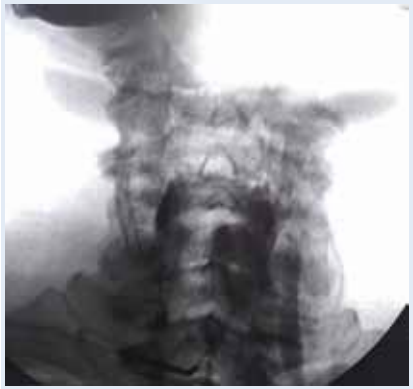
Case (continued)

The contrast spread pattern showed vertebral artery spread, however it persisted and did not disappear as typical vascular flow. It appeared to be outlining the vertebral artery, likely due to the catheter tip being in the vertebral foramen. To minimize any complications the catheter was repositioned and after confirmation with new contrast spread injections were performed.

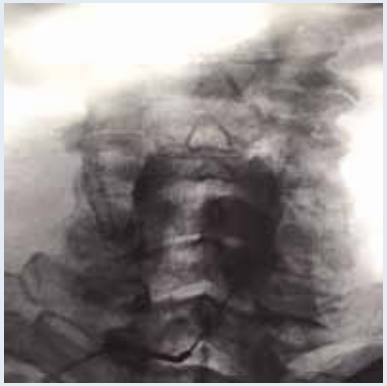
Discussion

Cervical epidural steroid injection (ESI) is a widely used treatment for both cervical radiculopathy and failed spine syndrome. The two major types of cervical ESI are intralaminar and transforaminal. Intralaminar is utilized to address diffuse symptoms and is deemed a fairly safe approach. Transforaminal is performed to directly treat a single nerve root; however it is associated with increased complications due to proximity of vascular structures in the cervical spine.

Images



Patient 1 Racz vertebral foramen contrast spread



Patient 2 Racz vertebral foramen contrast spread

Discussion (continued)

Epidural injections with catheter placement are considered by some to be more effective than nonselective ESI. They can produce adhesiolysis of scar tissue and provide selective block in the epidural space closer to the dorsal root ganglion.

Conclusion

These two cases demonstrate that during Racz procedure the contrast spread pattern can mimic arterial uptake, while actually outlining the vessel foramen. This is likely due to technique and catheter placement, along with contrast flow to the path of least resistance. It is important to be aware of this potential effect and determine type of vascular spread prior to injection.

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Scrambler Therapy for Chemotherapy Induced Peripheral Neuropathy – A Case Series

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Introduction

Chemotherapy induced peripheral neuropathy (CIPN) is a common and disabling side effect that impacts many patients undergoing treatment with antineoplastic agents. The incidence of CIPN has been reported as high as 90% with some chemotherapeutic drugs (2). The development of CIPN may prompt dose reduction or even chemotherapy cessation thereby increasing cancer related morbidity and mortality (1). CIPN is predominantly a sensory neuropathy, associated with decreased sensation and pain but it can also cause motor and autonomic nerve dysfunction. It frequently results in impairments in activities of daily living, and compromises quality of life (3).

The pain associated with CIPN is difficult to manage and many clinical trials of commonly used pharmacologic therapies have failed to demonstrate a significant treatment effect (1). Further, patients may be unable to take analgesics due to intolerance of side effects or limitations due to their disease (e.g. impaired kidney function). Non-pharmacologic pain treatment, such as neuromodulation, may be a viable treatment alternative. Scrambler Therapy (ST), a relatively novel, non-invasive neuromodulatory technique that utilizes electrocutaneous stimulation to relieve pain by replacing pain information with "nonpain" information, may enhance treatment outcomes and improve quality of life for this patient population.

Objective

Our objective in this case series was to evaluate the impact of Scrambler Therapy on health outcomes for patients who experience pain associated with chemotherapy induced peripheral neuropathy.

Methods

After obtaining approval from the Institutional Review Board at the University of Texas MD Anderson Cancer Center (PA16-0712), we evaluated the medical records of patients (n=5) with a cancer diagnosis and associated chemotherapy induced peripheral neuropathy. The patients underwent Scrambler Therapy at our comprehensive cancer center outpatient pain clinic. Each patient underwent 7-10 treatment sessions (45 minutes). At each session 8-10x electrodes were utilized through 4-5x channels, and applied to areas of normal sensation (nonpainful) adjacent to areas of pain. The level of stimulation was adjusted based on patients comfort and level of pain relief. Electrode placement and stimulation was optimized to provide maximum pain relief (ideally, eliminate pain altogether). Treatment response was measured at baseline, during treatment and post-treatment using the following pain-related health outcomes: pain score via a numeric pain rating scale (NRS; 0 = no pain, 10 = worse pain imaginable), and the following self-reported variables: changes in activity level, quality of sleep and medication use.

Table

Table 1. Clinical characteristics and outcomes

Patient	Cancer	Cancer treatment	Duration CIPN	Baseline NRS	NRS prior to last treatment	Sensation improvement	Medication use	Increased activity level	Quality of sleep
59 y/o male	Nasopharyngeal	Chemo, RRT, surgery	20+ years	4/10	1-2/10	Yes, significant	Decreased Methadone	Yes	Improved
79 y/o male	Chronic lymphocytic leukemia	Chemo	10 years	9-10/10 (at night)	0/10 (at night)	Yes, significant	Decreased hydrocodone	Yes	Improved
47 y/o male	Acute myeloid leukemia	Chemo, stem cell transplant	4 years	6-8/10	2/10	Yes	Decreased oxycodone	Yes	Improved
76 y/o female	Breast	Chemo, surgery	16 years	4/10	0/10	Yes, significant	Decreased tramadol	Yes	Improved
66 y/o female	Multiple myeloma	Chemo, stem cell transplant	13 years	7/10	2/10	Yes, significant	No change	Yes	Improved

Chemo = chemotherapy, RRT = Radiation therapy

Figures

Figure 1. Mean NRS at baseline and prior to latest treatment session

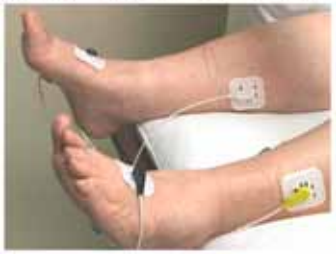
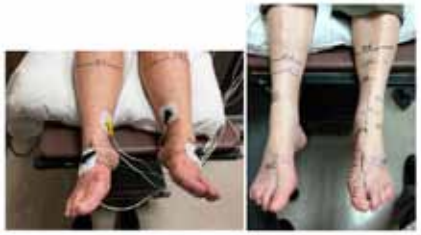


Figure 3a and 3b. Change in sensation from baseline (0/10) to treatment day 5 (5/10)



Results

The mean baseline pain score was 6.3, the mean pain score prior to the last treatment session was 1.1 (Figure 1). Two out of five patients had a post treatment NRS of 0 at all sessions. All five patient obtained >50% pain relief at post-treatment.

All patients reported improvements in the quality of their sleep. All reported increased in the level of activity they were able to tolerate. For example, one patient reported improved ambulation and balance, and expressed great excitement in being able to cook a thanksgiving meal. Four patients were able to decrease their medication use. Remarkably, all patients demonstrated improved sensation to light touch on physical examination (Figure 3a,b). No patients suffered from an adverse event. Clinical characteristics and outcomes from all patients are summarized in Table 1.

Discussion

As demonstrated by the results of our case series, Scrambler Therapy is a viable option for the treatment of CIPN. We demonstrated marked improvement in pain in our small group of patients. Our results are inline with previous studies of Scrambler Therapy (4).

Additionally, we have noted truly remarkable results from the treatment beyond improvement in pain. Patients reported feelings of "getting my life back", and expressed elation at being able to sleep through the night without awakening. All of the patients had been suffering with pain for a significant amount of time from 4 to 20+ years and the treatment success was beyond their expectations. The decrease in medication use represents an important benefit, as the side-effects from long term analgesic use are well recognized. The increased level of activity is key for patients to improve their quality of life and regain function lost due to CIPN. Further, we noted improvement in sensation to light touch in all patients, not an expected or easily explained outcome. Future study of Scrambler Therapy would certainly benefit from evaluation of patient's sensory function through qualitative sensory testing (QST).

Conclusions

Scrambler Therapy is an effective and non-invasive technique for the treatment of pain associated with chemotherapy related peripheral neuropathy. Although we demonstrated substantial pain reduction and improved function in our sample, further study with large, randomized, placebo control multicenter trial is warranted.

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Time to First Response With Intrathecal Ziconotide Treatment in Patients With Severe Chronic Pain

American Society of Interventional Pain Physicians
April 20-22, 2017 • Las Vegas, NV

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Introduction

- Ziconotide is an intrathecally delivered, nonopioid analgesic agent approved in the United States for the management of severe chronic pain in adult patients for whom intrathecal (IT) therapy is warranted and who are intolerant of or refractory to other treatment, such as systemic analgesics, adjunctive therapies, or IT morphine[1,2]
  - The efficacy of IT ziconotide for the treatment of severe chronic pain was established in randomized, double-blind, placebo-controlled trials[3-5]
- The Patient Registry of Intrathecal Ziconotide Management (PRIZM) evaluates efficacy and safety associated with IT ziconotide therapy in current clinical practice

Objectives

- To evaluate the time to first response during treatment with IT ziconotide

Methods

- PRIZM was a prospective, open-label, long-term, multicenter, observational study (registry) of IT ziconotide conducted in the clinical practice setting
- The study population included adults aged ≥18 years with severe chronic pain (life expectancy >6 months) for whom IT therapy was warranted and who were intolerant of or refractory to other treatments, such as systemic analgesics, adjunctive therapies, or IT morphine, and initiated IT ziconotide as the sole agent in pump
  - Patients were followed for up to 18 months as long as they continued to receive IT ziconotide
- The primary efficacy outcome measure for PRIZM was the 11-point Numeric Pain Rating Scale (which is reported separately); secondary patient-reported outcomes included the Patient Global Impression of Change (PGIC)
- This interim analysis, which includes data as of July 5, 2016, reports the time to treatment response based on PGIC score
  - PGIC assessments were scheduled for 3, 6, 9, 12, 15, and 18 months after the start of treatment
  - Response to IT ziconotide treatment was defined as improvement of at least "slightly better" on the PGIC, a 7-point categorical scale that includes the ratings "very much worse," "much worse," "slightly worse," "no change," "slightly better," "much better," or "very much better"
  - The analysis population included patients who completed at least 12 weeks of treatment with IT ziconotide (evaluable patients)
- IT ziconotide is administered via the Medtronic SynchroMed II Infusion System, which allows for an initial dose as low as 1.2 mcg/d using the undiluted 25 mcg/mL ziconotide formulation
  - According to the prescribing information, IT ziconotide should be initiated at no more than 2.4 mcg/d (0.1 mcg/h) and titrated by ≤2.4 mcg/d (0.1 mcg/h) at intervals of no more than 2 to 3 times per week, with a maximum recommended dose of 19.2 mcg/d (0.8 mcg/h)

Results

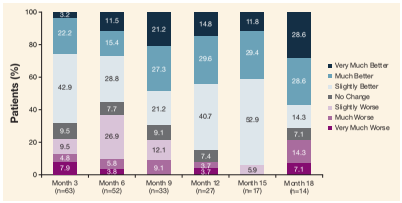
- As of July 5, 2016, 93 treated patients had data entered into the PRIZM database (the all treated population); enrollment has closed at 93 patients
- This analysis included 75 evaluable patients (those with ≥12 weeks of treatment)
  - At the time of this interim analysis, 35 patients with PGIC data had completed 12 months of treatment and 20 patients had completed the full 18 months

Table 1: Patient Demographic and Baseline Characteristics

Characteristic	Evaluable Population (N=75)
Female sex, n (%)	45 (60.0)
Age, y, mean (SD)	56.1 (13.9)
Race, n (%) White Black American Indian or Alaska Native	 72 (96.0) 2 (2.7) 1 (1.3)
Pain etiology, n (%) Malignant Non-malignant	 4 (5.3) 71 (94.7)
Pain classification, n (%) Neuropathic Nociceptive Mixed	 35 (46.7) 4 (5.3) 36 (48.0)
Duration of pain, y Median (min, max)	 10.0 (0.4, 55.0)
Pain severity (NPRS scores) Median (min, max) Mean (SD)	 8.0 (0.0, 10.0) 7.7 (1.7)
Starting dose of ziconotide, mcg/d Median (min, max) Mean (SD)	 1.2 (0.3, 5.5) 1.6 (1.0)

NPRS = Numeric Pain Rating Scale; SD = standard deviation.

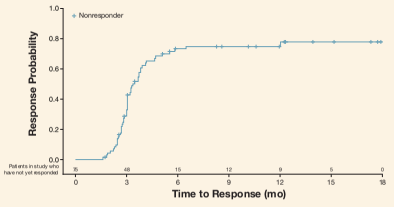
Figure 1: Patient Global Impression of Change (Evaluable Population)



Sample sizes represent observed cases with a PGIC score at each assessment.
PGIC = Patient Global Impression of Change.

- Improvement in overall status (at least "slightly better" on PGIC) was reported by 68.3% of patients at month 3, 55.8% of patients at month 6, 69.7% of patients at month 9, 85.2% of patients at month 12, 94.1% of patients at month 15, and 71.4% of patients at month 18

Figure 2: Time to Response on the Patient Global Impression of Change (Evaluable Population)



Treatment response defined as improvement of at least "slightly better" on the PGIC.
PGIC = Patient Global Impression of Change.

- Median time to first response was 3.5 months (95% confidence interval, 3.0-3.9)

Table 2: Adverse Events Occurring in ≥10% of Patients*

Adverse Event, n (%)	Evaluable Population (N=75)
Any adverse event	70 (93.3)
Nausea	19 (25.3)
Confusional state	15 (20.0)
Auditory hallucination	14 (18.7)
Dizziness	14 (18.7)
Amnesia	11 (14.7)
Asthenia	11 (14.7)
Diarrhea	11 (14.7)
Headache	11 (14.7)
Memory impairment	11 (14.7)
Peripheral edema	10 (13.3)
Somnolence	10 (13.3)
Pruritus	9 (12.0)
Constipation	8 (10.7)
Insomnia	8 (10.7)

*This table includes adverse events that were coded using MedDRA (version 16.0) as of July 5, 2016.

Conclusions

- In this interim PRIZM analysis, median time to first response, as assessed by the PGIC, was 3.5 months
  - However, the first PGIC assessment occurred at the month 3 visit, potentially missing improvement that occurred earlier in treatment
- On the PGIC, a positive response to ziconotide treatment was reported by 55.8% of patients at month 6 and 85.2% of patients at month 12
- The most common adverse events were nausea, confusional state, auditory hallucination, and dizziness

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Comparison of Single-level and Multilevel Transforaminal Epidural Steroid Injections Utilizing PROMIS Outcomes Data

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Background

Patient reported outcomes (PROs) are becoming increasingly important to determine the value delivered in patient care. PROMIS has been well validated in the spine literature. It assesses independent domains utilizing computer adaptive testing (CAT) and item-response theory (IRT), with outcomes reported as t-scores. Single-level and multilevel transforaminal epidural injections (TFESIs) have not previously been compared using PROMIS outcome measures.

Objective

To compare single-level and multilevel TFESI outcomes utilizing the PROMIS domains: Physical Function, Pain Interference, and Depression.

Methods

A single-center prospectively collected database was searched by CPT codes 64483 and 64484 to identify patients who underwent single-level or multilevel TFESIs respectively. Patients who had follow-up between 91-150 days since the date of their final injection were selected. The MCID was calculated for both single-level and multilevel injections for each PROMIS domain using the distributive method, defined as ½ the standard deviation of the change. The single-level (SL) and multilevel (ML) groups were then compared using PROMIS domain scores for Physical Function (PF), Pain Interference (PI), and Depression (D).

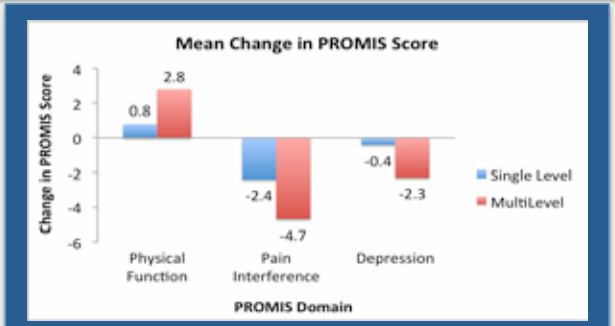

Figure 1. Comparison of mean change in PROMIS domain scores for single and multilevel TFESIs.

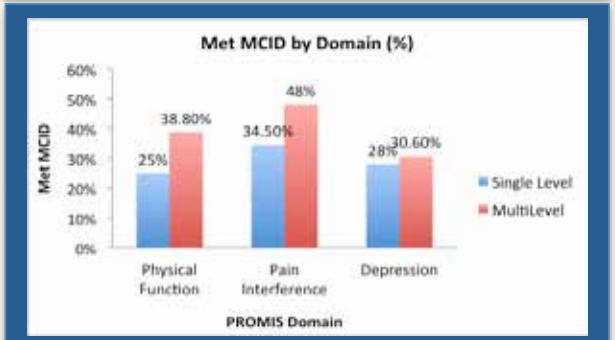

Figure 2. Comparison of percentage of patients who met MCID by PROMIS domain for single and multilevel TFESIs.

Conclusion

At 3-5 month follow-up, multilevel TFESIs demonstrated significantly greater improvement in PROMIS Physical Function and Pain Interference domains compared to single-level injections. Additionally, multilevel injections had a greater proportion of patients who achieved MCID for both Physical Function and Pain Interference domains.

Results

A total of 266 patients were identified (168 SL, 98 ML). There were 126 male (78 SL, 48 ML), 140 female (90 SL, 50 ML), p=0.688. The mean age (years) was 54.6 (SL), 58.1 (ML), p=0.066. The mean follow-up was 117 days (SL), 121 days (ML), p=0.076.

The baseline PROMIS scores were: PF 36.3 (SL), 37.5 (ML), p=0.111; PI 65.4 (SL), 64.5 (ML), p=0.244; D 52.3 (SL), 51.9 (ML), p=0.723. The change in PROMIS scores were: PF 0.8 (SL), 2.8 (ML), p=0.037; PI -2.4 (SL), -4.7 (ML), p=0.041; D -0.4 (SL), -2.3 (ML), p=0.061. The PROMIS MCID values were: PF 3.6 (SL), 3.8 (ML); PI -4.4 (SL), -4.0 (ML); D -4.2 (SL), -3.9 (ML). The percentage of patients who met MCID were: PF 25.0% (SL), 38.8% (ML), p=0.018; PI 34.5% (SL), 48.0% (ML), p=0.031; D 28.0% (SL), 30.6% (ML), p=0.647.

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Tracking Morphine Equivalent Dose Calculations on Patients in the Acute Rehabilitation Setting Decreases Opioid Utilization

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Mike Reed, RPh (Faculty), Byron Milton, MD (Faculty), and Dale Strasser, MD (Faculty)
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Background

- Opiates are important for pain management during acute rehabilitation stays and have an effect on participation in therapy, but they are potentially overprescribed and have many adverse effects.
- Due to the increased use of opioids in our nation and the risks associated with opioid use, this study aims to decrease the opioid burden among patients admitted to Emory Rehab Hospital

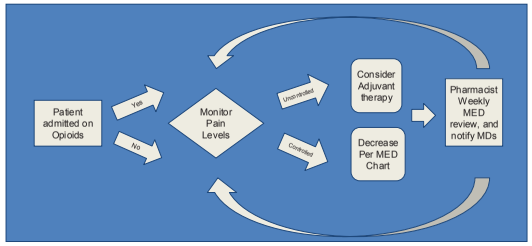
Methods

- Pre-intervention: We reviewed patients admitted to ERH in March-April 2016, and calculated the Morphine Equivalent Dose (MED) based on admission med reconciliation and again at discharge.
- The following interventions were done at the start of April, and we repeated the MED calculations in April-May 2016:
  - Informational lecture delivered to house staff/attendings how to use MEDs
  - Posted MED charts of common orders in clinical work areas

	Percocet 10q4hr	Fentanyl 25mcg q72h	Tramadol 50q6h	Tylenol #4, 60mg q6hr	Lortab 5q4	Tylenol #3 30mg q4hr	Percocet 2.5mgq6h
MME/day	90	60	40	36	30	28	15

- Pharmacist calculated MEDs weekly and emailed medical team to show weekly trends.

Room	MED
302	27 (135)
306	60
308-1	30
308-2	45 (60)
320	30
324	90
334	142.5
338	90 (90)



Outcome measures

- Primary outcome: Number of patients with MED at discharge less than or equal to 50.
- Secondary outcome: Change in MED from admission to discharge

Results

Demographics

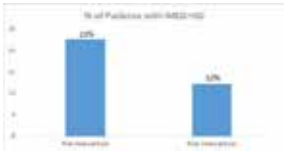
	Pre-Intervention	Post-intervention
Male	38	53
Female	37	34
Age (±SD)	59.3 ± 16.2	59.6 ± 15
LOS (±SD)	13.6 ± 6	11.9 ± 5.3 (↓ 1.7days, p=0.03)
BMI (±SD)	29.1 ± 8.9	27.5 ± 6.6
Admitting Diagnoses:		
Stroke	20	31
Brain Injury	10	11
SCI	7	11
Amputation	4	3
Debility	2	6
Other Ortho	11	7

Morphine Equivalent Dose

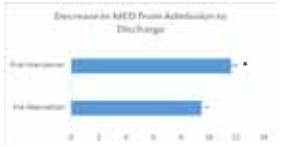
	Pre-intervention	Post-intervention
Avg Admission MED	32.6	41.2
Avg Discharge MED	26.7	29.6
Change	9.5	11.6 (p<0.001)

Results

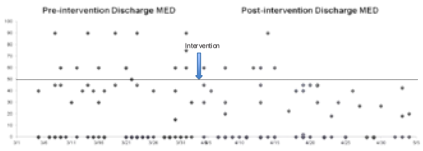
Previously, almost a quarter of patients were discharged with MED>50.



After our intervention, only 12% were discharged with MED>50.



Decrease in MED from admission to discharge was significantly greater in the post-intervention group. (p<0.001)



Summary and Conclusions

Opiate burdens can be significantly decreased in the acute rehabilitation setting by following the MED calculations throughout the length of stay and with periodic reminders from the pharmacist.

Given these results, we recommend the use of MED calculation as a patient care tool.

Future directions could include implementing automatic MED calculations into the EMR, and utilizing MED in other clinical settings.

Thank you to ERH and Select Medical

Establishing PROMIS Minimal Clinically Important Difference (MCID) Values after Single-level and Multilevel Transforaminal Epidural Steroid Injections

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Background

Patient reported outcomes (PROs) are becoming increasingly important to determine the value delivered in patient care. PROMIS has been well validated across the orthopaedic and spine literature. It assesses independent domains utilizing computer adaptive testing (CAT) and item-response theory (IRT), with outcomes reported as t-scores. There remains an absence of published minimal clinically important difference (MCID) values for use after interventional spine procedures.

Objective

To establish PROMIS MCID values for single-level and multilevel transforaminal epidural steroid injections (TFESIs) at 1-3, 3-5, and 5-7 month follow-up time periods.

Results

Single-Level - Demographics

Group (months)	Total Patients	Men	Women	Mean Age (years)	Mean Follow-up (days)
1-3	305	145	160	57.8	56
3-5	168	78	90	54.6	117
5-7	87	36	51	54.6	178

Table 1: Baseline demographics for single–level TFESIs separated into groups by time of follow-up

Multilevel- Demographics

Group (months)	Total Patients	Men	Women	Mean Age (years)	Mean Follow-up (days)
1-3	161	82	79	58.6	60
3-5	98	48	50	58.1	121
5-7	45	27	18	55.2	179

Table 2: Baseline demographics for multilevel TFESIs separated into groups by time of follow-up

Single Level Group- Outcomes

	Baseline PROMIS Score			Mean PROMIS Change			MCID			% Met MCID		
Group (mo)	PF	PI	D	PF	PI	D	PF	PI	D	PF	PI	D
1-3	36.2	65.3	51.7	1.37	-2.48	-1.31	3.7	-3.7	-4.2	26.2	37.7	30.5
3-5	36.3	65.4	52.3	0.84	-2.45	-0.38	3.6	-4.4	-4.2	25.0	34.5	28.0
5-7	36.8	64.9	50.8	1.14	-2.28	-0.36	3.6	-3.7	-3.4	24.1	29.9	23.0

Table 3: PROMIS Domain Scores, MCID values, and % patients who met MCID for single-level TFESIs separated into groups by time of follow-up. Positive PF values show greater function. Negative PI and D values reflect less pain and depression.

Multilevel Group- Outcomes

	Baseline PROMIS Score			Mean PROMIS Change			MCID			% Met MCID		
Group (mo)	PF	PI	D	PF	PI	D	PF	PI	D	PF	PI	D
1-3	36.2	65.1	51.6	2.44	-2.98	-1.74	3.9	-3.9	-4.2	29.2	37.9	31.1
3-5	37.5	64.5	51.9	2.78	-4.66	-2.33	3.8	-4.0	-3.9	38.8	48.0	30.6
5-7	37.8	65.1	53.2	1.36	-2.56	-1.78	4.2	-3.9	-4.6	26.7	35.6	33.3

Table 4: PROMIS Domain Scores, MCID values, and % patients who met MCID for multilevel TFESIs separated into groups by time of follow-up. Positive PF values show greater function. Negative PI and D values reflect less pain and depression.

Methods

A single-center prospectively collected database was searched by CPT code 64483 “single level injection”. Patients with the additional CPT code 64484 “multilevel injection”, were then separated, which resulted in the two cohorts of: single-level only injections and multilevel injections. Patients were further subdivided into three groups: 30-90, 91-150, and 151-210 day follow-up since the date of their last injection. Baseline PROMIS scores: Physical Function (PF), Pain Interference (PI), Depression (D) were compared to PROMIS scores at final follow-up. The MCID was calculated for each PROMIS domain by the distributive method as ½ of the standard deviation of the change. The percentage of patients who achieved the MCID in each PROMIS domain was then calculated

Conclusion

MCID values were calculated for PROMIS domains (PF, PI, D) following single-level and multilevel TFESIs at 1-3, 3-5, and 5-7 month follow-up. Combined results after TFESIs indicated the PROMIS MCID for Physical Function ranged between 3.6 and 4.2, Pain Interference between -3.7 and -4.4, Depression between -3.4 and -4.6. This analysis provides a benchmark to understand what is meaningful improvement when using PROMIS as a patient reported outcome measure following interventional spine procedures.

Resources

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Management of Cerebrospinal Fluid Leak After Implantation of Dorsal Root Ganglion Stimulator

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Introduction

Spinal cord stimulation (SCS) has been a treatment modality for chronic pain management since 1967. Neuromodulation has evolved significantly over the last 50 years in terms of targets, equipment, and therapy. During the last five years, the dorsal root ganglion (DRG) has emerged as a viable target.

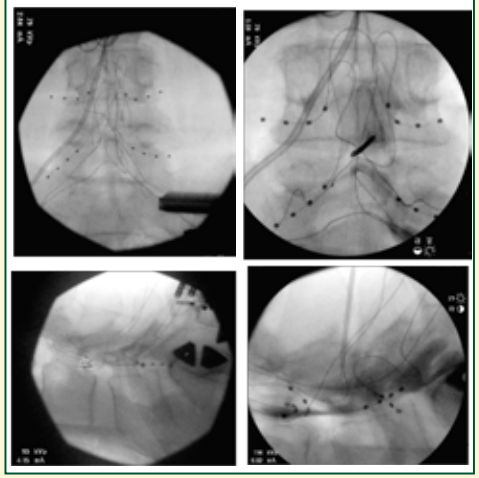
DRG stimulation has become an effective treatment modality for chronic pain of areas that are difficult to cover with conventional SCS. As with any procedure, this therapy has unique risks and potential complications. Management of DRG related complications can be compared to those experienced during conventional SCS. Dural puncture and cerebrospinal fluid (CSF) leak are rare complications of SCS. The incidence and management of such complications in DRG stimulation is not well studied.

Case Presentation

A 56 year old woman presented with 10 year history of neuropathic pain of bilateral lower extremities which was biopsy proven to be small fiber neuropathy. She had sub-optimal results with conservative therapy and expressed strong dislike for opioid medications. She had failed a course of epidural injections, underwent a successful trial of conventional SCS, and proceeded to permanent implantation. However, over the next year, she developed worsening pain of bilateral feet and was deemed an appropriate candidate for DRG stimulation. She underwent successful trial followed by permanent implantation of St. Jude Medical 4 contact leads at bilateral L4 and L5. In the recovery room she exhibited left foot weakness which was attributed to difficulty with lead placement in left L5 foramen. She was administered intravenous dexamethasone and was discharged without issue. On post-operative day three, the patient showed interval resolution of her weakness.

Then, nine days following implantation, she reported positional headache, generator site tenderness, and generator site swelling which fluctuated with position. She was advised to go to the emergency room where evaluation revealed a tense pocket. Oral antibiotics were initiated, blood cultures obtained, and sterile aspiration produced 80 mL of CSF. Two days later, she underwent epidural blood patch under fluoroscopic guidance with administration of 15 mL autologous blood which resulted in immediate relief of symptoms. She was advised to remain flat until her next follow up where she reported continued resolution of symptoms.

Epidural blood patch under fluoroscopic guidance:



Top left: Four electrodes in bilateral L4 and L5 foramen. AP view. Bottom left: Lateral view.

Top right: Epidural blood patch with 17 gauge Tuohy needle at L4-L5 interspace. AP view. Bottom right: Lateral view.

Conclusion:

The technical aspects of the DRG stimulator implantation and management of complications parallel conventional SCS. Dural puncture and CSF leak is a known but infrequent complication of SCS implantation. In this patient, difficulty with placing leads during trial and permanent implantation with subsequent transient post-procedural motor weakness may have prompted greater suspicion for dural injury and CSF leak. Due to similarity in mechanisms of injury, it is not surprising that the patient responded to epidural blood patch.

There is a fair amount of literature regarding management of this complication following SCS implantation, but there is a lack of such literature for DRG implantation. As DRG stimulation becomes more popular, there should be continued effort to track the incidence of complications and their respective management.

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Spinal Cord Stimulation (SCS) Trial Outcomes after Conversion to a Multiple Waveform SCS System

Nameer Haider[1], Nathan Miller[2], Christopher Gilmore[3], Gregory Moore[4], Rick Paicius[5], Eduardo Garcia[6], Kirk E. Harum[7], Dwight Ligham[8], Kristen Lechleiter[9], Amarpreet Bains[9], Roshini Jain[9]

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BACKGROUND

SCS trial outcomes can have a significant effect on patients' decision to proceed with permanent implantation. SCS trial failures can result sometimes from inadequate optimization of programming and/or lead placement. Enabling patients to experience multiple stimulation frequencies and waveforms using a single device (Multiple Waveform SCS) within a trial thus offers the potential for a more definitive identification of neurostimulative approaches optimally suited to each individual, which in turn may allow for better trial outcomes and successful permanent implantation. We therefore chose to investigate the effect of utilizing a system capable of providing multiple waveforms during a trial. We describe, here, the outcomes of an on-going study of a cohort of patients who, after enduring a trial failure using a system designed to achieve pain relief with stimulation held constant at 10 kHz only, were switched to an SCS system capable of delivering multiple stimulation waveforms.

METHODS

Study Design	Multicenter, observational study
Study Device (Trial Neurostimulator): Available Programs/ Waveforms	Senza (Nevro Corporation): • 10 kHz subperception Precision Spectra (Boston Scientific): • Anatomically-guided (3D) Neural Targeting algorithm • Multiple Independent Current Control (MICC) • Standard rate • 1 kHz • Anode intensification • Burst stimulation • Combinations of all the above
Sample size	N = 20 (14 with NRS or % pain relief scores)
Follow-up	SCS Trial Phase Only
Key Inclusion	Failed Trial Using Trial Neurostimulator at 10 kHz

RESULTS

Patient Demographics

Gender (F)	12 (20)
Age (Range)	33 - 81 yrs.
Baseline NRS [Mean (SD)]	8.00 (2.28)
Pain Location (%)	Low back and Legs (60%)
	Low Back only (40%)

Previous Back Surgeries

Number of Surgeries*	Percent of Cohort
0	20%
1	40%
2	25%
3	15%

*FBSS is counted as 1 surgery

65% of Patients preferred Multiple Waveform SCS

Figure 2: Patient Preference (n = 20)

50% of Patients Converted to Higher Pain Relief Categories

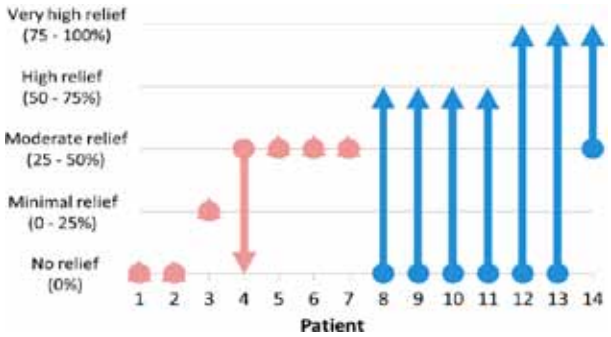

Figure 1: Patient Outcomes following SCS trials (Percent Pain Relief)

Circles (o) represent 10 kHz trial outcomes. Arrowheads (Δ) represent Multiple Waveform SCS trial outcomes. Pain Percent Relief scores were available for n = 14 patients only.

CONCLUSIONS

- In 14 patients who failed an SCS trial using 10 kHz *and* had NRS or Percent Pain Relief (PPR) scores available, 50% (n = 7) reported ≥50% improvement in pain relief as measured by PPR using a Multiple Waveform SCS System (Fig. 1).
  - Of the 6 patients where NRS or PPR scores were not available, 3 patients preferred Multiple Waveform SCS and 3 did not have a preference
- Of all 20 patients in cohort, 65% (n=13) who failed a trial with 10 kHz stimulation preferred Multiple Waveform SCS (Fig. 2).
  - Of the 7 patients who achieved ≥ 50% pain relief, one patient did not show a preference, while one patient who maintained moderate pain relief chose Multiple Waveform SCS.
- These preliminary data support the concept that a system capable of multiple SCS waveforms offers the potential to salvage failed 10 kHz trials and achieve positive outcomes. Further study is needed.

Longitudinal Study of Pain Area Changes and Paresthesia Coverage in Neuropathic Pain Patients

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Boston Scientific Corporation, Valencia, CA USA.

PROJECT FUNDING: BOSTON SCIENTIFIC

BACKGROUND

Spinal cord stimulation (SCS) often loses effectiveness in chronic pain treatment over time (Hayek et al., 2015; Kemler et al., 2006; Kumar et al., 1998; Sears et al., 2011). This may be partially driven by the appearance of new pain areas that are not covered by paresthesia. However, high-resolution assessment of pain area locations is limited by the fact that many different locations are often grouped in the same category. For instance, "low back pain" may refer to many different points or regions within the lower back. Here, we sought to quantify the extent to which pain patterns change over time at a finer resolution. In addition, as a metric of therapy effectiveness, we evaluated paresthesia coverage of these changing pain patterns.

METHODS

Study Design	Multicenter, observational
Study Device	Any commercially approved Boston Scientific SCS system
Sample Size	71 implanted patients from Baseline to 6 Months; 51 implanted patients from 6 to 12 Months
Number of Sites	72 sites
Follow Up Duration	Up to 12 months after trial implant
Key Inclusion	• Pain in lower body (low back or legs, including regions 15-23 or 36-47 in Figure 1) • Additional pain could occur elsewhere
Study Assessments	• Pain drawings at Baseline, 6 and 12 Months, showing pain with stimulator off • Paresthesia drawings at 6 and 12 Months • Overlap across time points of highlighted pain pixels (after correction for imprecision in highlighted locations) • Overlap of pain and treatment-induced paresthesia at 6 and 12 Months (again with correction)

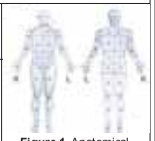

Figure 1. Anatomical regions used for analysis

RESULTS

Appearance and Disappearance of Pain Over Time

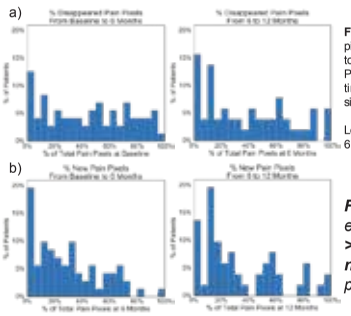

Figure 2. a) Percent of pain pixels that disappeared from first to second time point. b) Percent of pain pixels at second time point that newly appeared since first time point.

Left: Baseline to 6 Months. Right: 6 to 12 Months.

***For 50% of patients** at each follow-up time point, **>24% of their pain was new** since previous time point*

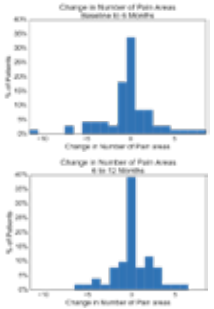

Figure 3. Change in number of discrete pain areas from Baseline to 6 Months (top) or 6 to 12 Months (bottom)

***66.2% of patients showed a change in the number of pain areas** from Baseline to 6 months*

***60.8% of patients showed a change in the number of pain areas** from 6 to 12 months*

Individual Patients: Appearance and Disappearance of Pain Over Time

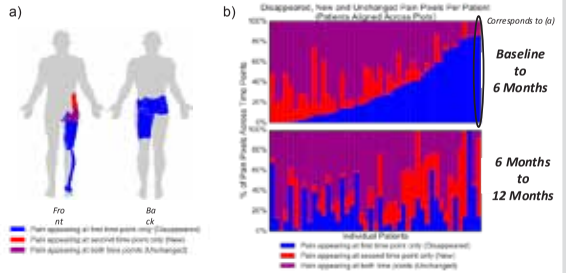

Figure 4. a) Analysis of one patient from Baseline to 6 Months. Blue: pain appearing at first time point that disappeared by second time point. Red: pain that newly appeared at second time point. Purple: unchanged pain present at both time points. b) Data for patients with pain drawings at all time points, analyzed as in (a). A vertical bar (continuing across both plots) represents a patient, from Baseline to 6 (top) and 6 to 12 Months (bottom).

RESULTS

Paresthesia Coverage of New Pain in Lower Body

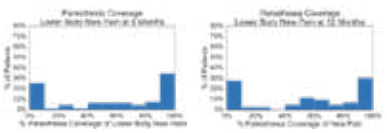

Figure 5. Paresthesia coverage of new pain developed in the lower body by 6 Months (left) or 12 Months (right). Pain was assessed with stimulator off.

***50% of patients had >64% coverage** of new pain pixels in the lower body (indicated for SCS) at 6 or 12 Months*

CONCLUSIONS

- Pain patterns change considerably over time after implantation of an SCS system
- Areas of pain change size over time: amount of new pain was not equal to amount of disappeared pain from either Baseline to 6 Months or 6 to 12 Months
- 64% (median) of new pain in lower body was covered with paresthesia at follow-up time points
- These data support the clinical relevance of adaptable SCS systems that can effectively address changing pain patterns, warranting further study

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A Prospective Clinical Trial to Assess the Feasibility of High Frequency Spinal Cord Stimulation (HF-SCS) at 10 kHz in the Treatment of Chronic Intractable Pain from Peripheral Polyneuropathy

Vincent Galan MD, MBA[1]; Sean Li MD[2]; Paul Chang MD[1]; James Scowcroft MD[3]; Peter Staats MD, MBA[2]

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Introduction

Peripheral neuropathy is caused by damage to peripheral nerves, resulting in pain, numbness, and/or weakness. Damage may affect small (myelinated Aδ and unmyelinated C) fibers along with injury to large myelinated fibers. Traditional SCS has been used to treat pain from peripheral polyneuropathy with limited long-term success[1-5]. Patients describe paresthesia-elicited sensations as "annoying" and "irritating"[4]. High frequency SCS (HF-SCS) at 10 kHz stimulation is a paresthesia-independent therapy that has demonstrated long-term safety and effectiveness in the treatment of chronic, intractable back and leg pain[6,7]. The goal of this prospective, multi-center study is to assess the safety and effectiveness of the Senza system in the treatment of chronic intractable pain from peripheral polyneuropathy.

Methods

Key Inclusion/Exclusion Criteria

- Inclusion: Subjects with chronic, intractable pain of ≥5 cm (on a 0-10 cm visual analog scale [VAS]) of the upper or the lower limb from peripheral polyneuropathy
- Exclusion: Subjects with mononeuropathies, significant stenosis, epidural scarring or symptoms of myelopathy

Trial and Implant

- Subjects trialed with two epidural leads spanning C2-C6 or T8-T11 vertebral bodies for upper limb pain and lower limb pain, respectively (Figure 1)
- After successful trial stimulation (≥40% pain relief) implanted with a Senza system (Nevro Corp., Redwood City, CA)
- Primary safety and effectiveness endpoints (≥50% pain relief) at 3 months post-implant
- Stimulation: 10 kHz, 30 µs, individualized current amplitude

Statistics

- Data reported for 26 (Baseline) and 16 subjects (1 months)
- Mean ± standard deviation
- Significance assessed at p<0.05
- Permanent implant data reported

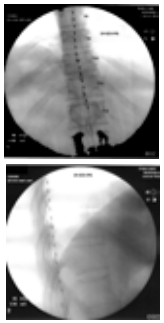

Figure 1: AP (top) and lateral (bottom) fluoroscopic images of lead placement to treat lower limb neuropathy

Results

Safety

- Three procedure-related AEs
  - Implant site infection (1) and implant site extravasation (2)
  - All AEs resolved

- Neurological assessment: **12 subjects had improvement at end of trial**
  - 11 – Sensory improvement
  - 1 – Motor improvement
  - 1 – Reflex improvement

- Enrolled: 28
- Failed screening: 2
- Trialed: 26
- Diagnoses: Idiopathic polyneuropathy (n=16), painful diabetic neuropathy (n=9)
- Responder Rate:
  - Trial: 21/26 (81%)†
  - 1 month: 13/16 (81%)††

†Defined as ≥40% pain relief
††Defined as ≥ 50% pain relief

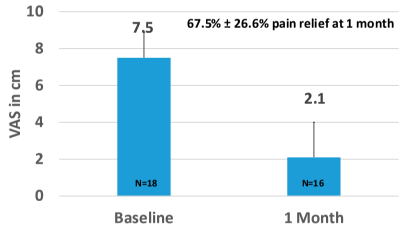

Figure 2: Average VAS scores showed meaningful pain relief at 1 month follow-up

Conclusions:

The trial-to-implant ratio of 84% is similar to, if not better than, the reported values in the literature (63%-82%)[1-3]. However, preliminary results for HF-SCS at 1 month follow-up demonstrate better outcomes than that reported with traditional SCS. Preliminary results from a multicenter, prospective study using high frequency spinal cord stimulation at 10 kHz to treat chronic intractable pain from peripheral polyneuropathy are promising with outcomes similar to SENZA-RCT results for chronic back and leg pain.

References:

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