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Subcutaneous Stimulation as an Additional Therapy to Spinal Cord Stimulation for the Treatment of Low Back Pain and Leg Pain in Failed Back Surgery Syndrome: Four-Year Follow-Up

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Objective: The objective of this study is to investigate the efficacy of long-term follow-up of subcutaneous stimulation (SubQ) as an additional therapy for patients with failed back surgery syndrome (FBSS) with chronic refractory pain, for whom spinal cord stimulation (SCS) alone was unsuccessful in treating low back pain.

Study Design: Prospective case series.

Materials and Methods: FBSS patients with leg and/or low back pain whose conventional therapies had failed, received a combination of SCS (8-contact Octad lead, 3877-45 cm, Medtronic, Minneapolis, MN, USA) and/or SubQ (4-contact Quad Plus lead (s), 2888-28 cm, Medtronic). Initially, an Octad lead was placed in the epidural space for SCS for a trial stimulation to assess the suppression of leg and/or low back pain. Where SCS alone was insufficient in treating low back pain, lead(s) were placed superficially in the subcutaneous tissue of the lower back, exactly in the middle of the pain area. A pulse generator (Prime Advanced, 37702, Medtronic) was implanted if the patient reported more than 50% pain relief during the trial period. We investigated the long-term effect of neuromodulation on pain with the visual analog scale (VAS), and disability using the Quebec Pain Disability Scale. The results after 46 months are presented.

Results: Eleven patients, five men and six women (age 51 ± 8 years, mean ± SD) were included in the pilot study. In nine cases, SCS was used in combination with SubQ leads. Two patients received only SubQ leads. In one patient, the SCS + SubQ system was removed after nine months and these results were not taken into account for the analysis. Baseline scores for leg ($N = 8$) and low back pain ($N = 10$) were VASbl: 59 ± 15 and VASbl: 63 ± 14, respectively. The long-term follow-up period was 46 ± 4 months. SCS significantly reduced leg pain after 12 months (VAS12: 20 ± 11, p12 = 0.001) and 46 months (VAS46: 37 ± 17, p46 = 0.027). Similarly, SubQ significantly reduced back pain after 12 months(VAS12: 33 ± 16, p12 = 0.001) and 46 months (VAS46: 40 ± 21, p46 = 0.013). At 12 months, the Quebec Pain Disability Scale (QPDS) was 49 ± 12 and after 46 months, 53 ± 15. Both at 12 and 46 months, the QPDS values were statistically significantly better (p12 = 0.001, p46 = 0.04) compared with baseline values (QPDSbl: 61 ± 15). In one patient, the pain suppressive effect of SCS/SubQ had disappeared completely over time and the pain scores returned to prestimulation values. In four, patients back pain scores increased over time due to new issues (SI-joint problems, degenerative spine problems, disc problems, and hip pain) unrelated to FBSS and for which SCS/SubQ was not targeted or a reason for implantation at the start of the pilot study.

Discussion: This is the first prospective report on the combined use of SCS and SubQ with a follow-up period of four years. These data show that SCS and/or SubQ provide persistent long-term pain relief for leg and back pain in patients with FBSS. One should also take into account that new back/leg pain problems may evolve over time and increase the pain score which impact overall pain treatment.

Conclusion: SCS combined with SubQ can be considered an effective long term treatment for low back pain in patients with FBSS for whom SCS alone is insufficient in alleviating their pain symptoms.

Keywords: Chronic pain, failed back surgery syndrome, low back pain, peripheral nerve field stimulation, subcutaneous stimulation

Conflict of Interest: The authors declare no conflicts of interest.

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INTRODUCTION

Several studies have shown that spinal cord stimulation (SCS) is effective for neuropathic pain due to failed back surgery syndrome (FBSS) (1–6). Clinicians have reported a greater success in radicular leg pain than with axial low back pain (7,8).

Efforts to relieve low back pain with SCS have benefited from the development of programmable multicontact electrodes and improved techniques and strategies (9–11).

Subcutaneous stimulation (SubQ) or peripheral nerve field stimulation (PNFS) appears to have potential as a therapeutic modality in the treatment of chronic pain (12–23). With the combination of SCS and SubQ, it is possible to treat FBSS patients with chronic leg and back pain.

In SCS, a lead is placed in the epidural space, connected to a neurostimulator, and electrical stimulation is applied to the large myelinated fibers of the dorsal column. In contrast, SubQ leads are placed subcutaneously in the middle of the pain area to stimulate the region of the affected nerves: cutaneous afferents, or the dermatomal distribution of these nerves, which converge back to the spinal cord (24).

The mechanism of action of SubQ is believed to be based on the activation of the large afferent (A-beta) nerve fibers which modulate the pain transmission through the A-delta and C-fibers in their afferent output according to the gate control theory (Melzack and Wall).

Besides the segmental pain-modulating mechanisms of the spinal cord, it may also influence on the descending pain modulation mechanism through the supraspinal loop by activating the subcutaneous leads. It is assumed that this results in an anti-inflammatory and a membrane depolarizing effect on the nerve fibers innervating the skin (25–27).

In 2008, our group conducted a pilot study to investigate the effect of SubQ as adjunctive therapy for SCS in patients with chronic back and leg pain due to FBSS (28). The aim of this paper is to report the long-term follow-up in this patient group.

A prospective case series was performed in patients with chronic leg and/or low back pain. Patients were selected, according to the inclusion criteria set by the Dutch Neuromodulation Association (VvNN) for SCS.

Patient Selection

The major selection criteria were:

1. Diagnosis of FBSS (after herniated disc surgery, laminectomy, or spondylodesis) with considerable disabling chronic leg and low back pain which existed for at least six months.
2. Mean intensity leg and low back pain score of 50 or higher measured on a 100-point visual analog scale (VAS).
3. Failure to respond to other conservative treatments (including medication, psychological therapy, rehabilitation, and pain management programs).
4. Psychological clearance (including drug addictions, major depression, and similar severe disorders which could have a negative influence on successful treatment).
5. No coexisting chronic pain problems or neurological diseases.
6. No coexisting conditions that would increase procedural risk (e.g., sepsis, coagulopathy).
7. Willing to provide informed consent.

Patients visited the outpatient clinic after implantation at 3, 6, and 12 months follow-up. Thereafter, yearly visits were scheduled. During each follow-up visit, VAS, Quebec Pain Disability Scale (QPDS) and pain medication, stimulation parameters, and adverse events (AEs) were recorded.

DEMOGRAPHICS

Eleven patients, 5 men and 6 women, were included. The mean age at inclusion was 51 ± 8 years (range 38–62 years). Low back pain component was on average 65% of all pain (leg + low back pain together).

MATERIALS AND METHODS

Details of the prospective pilot study are described in an earlier publication (27).

History

In nine cases, SubQ was used in combination with SCS. Patients started neuromodulation therapy with an epidural placed 8-contact lead. In case of a pain reduction score of more than 50% for leg pain and less than 50% pain reduction for back pain, two leads were placed subcutaneously in the middle of the pain area. Simultaneously, the pulse generator was implanted in the left lower abdomen.

In two patients without leg pain, only SubQ leads were used.

The first patient with severe buttock pain radiating to the back was included, although she did not have significant leg pain. SCS was unsuccessful to cover the pain area. Her physical and psychological history were carefully evaluated. All previous treatments had failed, resulting in a poor quality of life. She was unable to sit because of the pain she experienced 24 hours a day. With this in mind, she was included in the pilot study despite the absence of significant leg pain. The second patient started with SCS for leg and back pain. During the procedure, we were not able to get paresthesia coverage of the painful area in the leg, therefore we removed the epidural lead. During the follow-up visit at six months, the patient reported that the leg pain had disappeared spontaneously but that he still suffered from severe low back pain. Although we could not explain this phenomenon, we decided to treat the low back pain with placement of two leads subcutaneously in the middle of the painful area of the low back.

Programming

Several programming options were available for optimal treatment.

Three programs were eventually used and interchanged to optimize pain suppression, patient comfort, and prevention of neurostimulation tolerance (28,29).

1. Flow stimulation in which current between the two subcutaneous leads is set. This programming was described by Falco et al. (29) as the crossover technique.
2. Field stimulation, which was established for both sides of the back.
3. Triangular programming, in which the SCS lead is programmed as anode and subcutaneous leads are programmed as cathode (30).

RESULTS

Ten of the original 11 patients still receive SCS/SubQ. In one patient, the neuromodulation system was removed nine months

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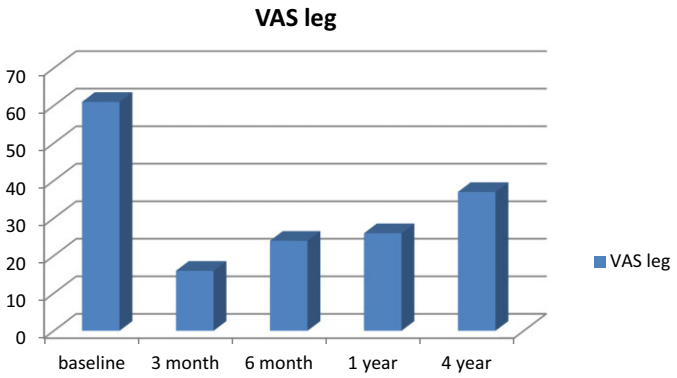

Figure 1. VAS leg. VAS, visual analog scale.

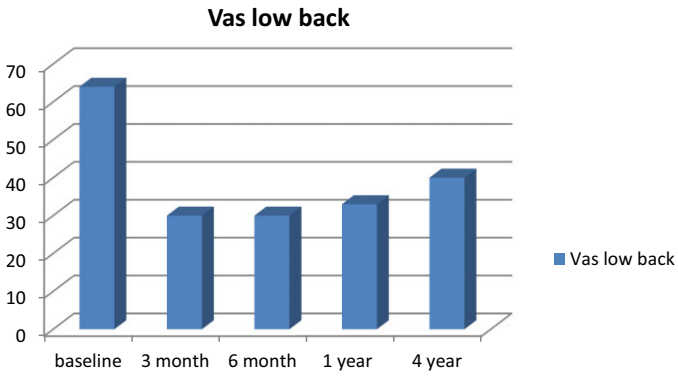

Figure 2. VAS low back. VAS, visual analog scale.

Table 1. VAS Leg and Low Back.

	Baseline	1 year	4 years
VAS leg	59 ± 15	20 ± 11	37 ± 17
VAS low back	63 ± 14	33 ± 16	40 ± 21
Leg		$p = 0.001$	$p = 0.027$
Low back		$p = 0.001$	$p = 0.013$

VAS, visual analog scale.

after implantation due to lack of efficacy, despite stimulation parameter optimization.

Pain

The results of SCS and SubQ on back and leg pain after long-term follow-up are shown in Figures 1 and 2. Both graphs show that the pain scores, after the initial period of neuromodulation, slowly increased, although the long-term results are still statistically significantly improved compared with baseline (Table 1). Over time, a number of patients experienced additional other spine (disc) or joint (hip) problems or pain as a result of a progressive degenerative spine.

Disability

At 12 months, the QPDS was 49 ± 12, and after 46 months, 53 ± 15, which is statistically significantly better than the score at baseline (P46 = 0.013).

From the two patients who returned to paid work, one is still at work. Six patients do volunteer work.

Medication

After four years, SCS/SubQ patients use more pain medication than at one year of follow-up (Table 2). Compared with one year follow-up, six patients do not use analgetics. In the other patients, we see an increase in use of paracetamol ($N = 3$), nonsteroidal anti-inflammatory drugs (NSAIDs) ($N = 2$), co-analgesics ($N = 2$), weak opioid ($N = 1$), strong opioid ($N = 3$). This kind of medication is generally used for nociceptive pain pathology because of increased mobility.

Safety

The first year, we reported on a total of 14 AEs (27). Subsequently in the three years thereafter, 12 more AEs were recorded: replacement of the epidural lead ($N = 2$), connector problem of the SubQ leads with the extension cable ($N = 1$), pain at the connector site due to too superficial placement ($N = 1$), pain due to the anchor of the subcutaneous lead ($N = 1$), reposition of the implanted pulse generator due to tilting which causes a continuous pain ($N = 3$), recharging problems of the implanted pulse generator ($N = 3$), partial loss of function of the right leg after RF treatment of the sacroiliac (SI) joint ($N = 1$). It is unclear if these were related to the neuromodulation therapy.

DISCUSSION

In this prospective case series, we investigated the four-year follow-up on the impact of SubQ stimulation as an add-on therapy to SCS on chronic leg and low back pain in patients who had insufficient pain relief with SCS alone. These results show for the first time the long-term effect of this combination therapy. In addition, these results demonstrated the sustained improvement of disability.

The decrease of effect of the neuromodulation may have been caused by new developing pain symptoms of different origin (e.g., facet joint, SI joint, disc problems/hip problems). This most likely also explained partly the pain medication increase over time. Probably the increased daily activity of the patient may also influence this phenomenon.

In the long-term follow-up, we have seen relatively few complications. To prevent technical problems, one should be aware that the amount of implanted material (connectors, anchors, and [bifurcated] extension cable) can cause discomfort to the patient. Therefore, the implant procedure should be well planned ahead of surgery. One should place the material in such a way that in case of reintervention, the existing leads are not being damaged.

In these cases, patients could benefit from a rechargeable pulse generator because of high energy consumption in three implanted active leads.

LIMITATIONS

The limitation of this study are the small patient sample size and the lack of a comparative group of patients.

Randomized controlled trials investigating the effect of the SubQ stimulation on treatment of back pain are needed. At present, two of these studies are ongoing.

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Table 2. Medication.

Patient	Medication		
	Baseline	1 year	4 years ±
1	Durogesic 25 mcg Paracetamol 4 × 500 mg	No analgesics	Lyrica 2 × 150 mg Diclofenac 3 × 50 mg
2	Paracetamol 1 × 500 mg Ibuprofen 1 × 600 mg	No analgesics	No analgesics
3	Lyrica 2 × 300 mg	No analgesics	Lyrica 2 × 150 mg Oxycontin 2 × 10 mg
4	No analgesics	No analgesics	No analgetic
5	Celebrex Oxycontin	Celebrex	Celebrex Oxycontin
6	Lyrica 2 × 150 mg Diazepam 1 × 5 mg Fentanyl 75 mcg	Paracetamol	Paracetamol 3 × 1 g
7	Morphine 2 × 10 mg Diclofenac 2 × 50 mg Paracetamol 1 × 1 g	System removed	Out of the pilot study
8	Ibuprofen Lyrica	Ibuprofen	Arcoxia 1 × 90 mg BuTrans 10 mcg
9	Durogesic 50 mcg	Tramadol 3 × 50 mg	Tramadol 3 × 50 mg
10	No analgesics	No analgesics	Panadol 3 × 1 g
11	Diclofenac Paracetamol Diazepam	Diclofenac	Paracetamol 4 × 500 mg Diazepam 1 × 10 mg Palexia 2 × 200 mg

Medication at baseline, one-year follow-up, and four-year follow up.

CONCLUSION

SubQ as add-on therapy to SCS seems an effective and safe long-term treatment option for patients with chronic low back pain.

Authorship Statements

Mrs. Hamm-Faber, Dr. Gültuna, and Dr. Aukes designed and conducted the study. Mrs. Hamm-Faber, Dr. Gültuna, Dr. Aukes, and Dr. van Gorp selected the patients, and collected and analyzed the data. Mrs. Hamm-Faber prepared the manuscript draft with intellectual input from Drs. Gültuna, Aukes, and van Gorp. All authors had complete access to the study data and they approved the final manuscript.

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