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Effect of Spinal Cord Stimulation on Early Disability Pension in 198 Failed Back Surgery Syndrome Patients: Case-Control Study

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BACKGROUND: Spinal cord stimulation (SCS) has proven to be a cost-effective treatment for failed back surgery syndrome (FBSS). However, the effect on patients' working capability remains unclear.

OBJECTIVE: To evaluate the impact of SCS on working capability and to identify the factors behind permanent disability in FBSS patients.

METHODS: The study group consisted of 198 working-age patients with SCS trialed or implanted for FBSS in a single center between 1996 and 2014. For each patient, 3 living controls, matched by age, gender, and birthplace, were otherwise randomly selected by the Population Register Center. The data on working ability were obtained from the Social Insurance Institution. Patients were divided into 3 groups: SCS trial only, SCS implanted permanently, and SCS implanted but later explanted.

RESULTS: A rehabilitation subsidy was given to 68 patients and 8 controls for a mean of 5.2 (95% confidence interval [CI] 2.4-8.2) and 0.2 (95% CI 0.05-0.6) days per month ($P < .05$). At the end of follow-up, 16 (37%), 13 (33%), 25 (22%), and 27 (5%) subjects were on disability pension (DP) in the SCS trial, SCS explanted, SCS permanent, and control groups. Patients in the SCS trial-only group were significantly more often on DP than were patients with permanent SCS (odds ratio 2.6; 95% CI 1.2-5.9; $P = .02$)

CONCLUSION: Permanent SCS usage was associated with reduced sick leave and DP. Prospective study will be required to assess possible predictive value.

KEY WORDS: Disability pension, Failed back surgery syndrome, FBSS, Rehabilitation subsidy, SCS, Sickness allowance, Spinal cord stimulation

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One in 5 Europeans (19%) are estimated to suffer from chronic pain.¹ Chronic pain is an economic burden, causing many direct and indirect costs.^{2,3} In 2014 in Finland, backache diseases caused approximately 2 million daily sickness allowance (SA) days, resulting in SA costs of €117.9 million.⁴ At the end of 2013, nearly 27 000 out of 5.5 million people were retired in Finland due to backache

diseases, resulting in €346.6 million in disability pension (DP) costs.⁵

Neuropathic pain results from a lesion or disease affecting the somatosensory system at either the peripheral or central level.⁶ The most common neuropathic pain is pain radiating from the lower back to the lower extremities.⁷ Spinal cord stimulation (SCS) is an effective treatment that can be used for any neuropathic pain, but the most common indication is failed back surgery syndrome (FBSS).⁸ FBSS is defined as persistent or recurrent pain in the lower back or legs after technically and anatomically successful lumbosacral spine surgeries.⁹ SCS has been found to be a more effective treatment for FBSS than reoperations are.^{10,11} A prospective randomized controlled multicenter trial established that patients undergoing SCS had better outcomes at 2-yr follow-up than

ABBREVIATIONS: CI, confidence interval; DP, disability pension; FBSS, failed back surgery syndrome; ICD, international classification of diseases; IPG, internal pulse generator; NHI, National Health Insurance; OR, odds ratio; PRC, Population Register Center; RS, rehabilitation subsidy; SA, sickness allowance; SCS, spinal cord stimulation; SII, Social Insurance Institution

did their controls with conventional medical management alone.¹² Although short-term SCS implantation increases costs, several studies have found SCS treatment to be cost-effective over the long term in FBSS patients.¹³⁻¹⁶

The SCS database of Kuopio University Hospital (KUH) contains all SCS patients implanted for FBSS in KUH between 1996 and 2014. Socioeconomic outcome data from the Finnish national registries, including information on sickness benefits and pensions, have been linked to the database. For each patient, 3 living controls, matched by age, gender, and birthplace, were otherwise randomly selected by the Population Register Center (PRC) of Finland. Work ability and early retirement play an important role in evaluating the long-term efficacy of SCS. There is very little information about FBSS patients' transition to early retirement. Our aim was to evaluate the impact of SCS on working capability and identify the factors behind permanent disability. Finding the potential predictors for DP could improve patient selection and help treat patients more effectively to prevent premature incapacity.

METHODS

Data Collection

The medical charts of 230 FBSS patients who received SCS implantation at KUH Neurosurgery between January 1, 1996, and December 31, 2014 were retrospectively evaluated. A neurosurgeon, orthopedic surgeon, or pain physician set a diagnosis of FBSS and provided the primary treatment, such as physical therapy and oral analgesics. Patients suffered from radicular lower limb pain or combined lumbar pain after at least 1 lumbar disc or decompression operation. Untreated depression was a contraindication for SCS.

We limited our time for reviewing the ability to work to 4 yr (2 yr before and 2 yr after SCS implantation). During the follow-up period, patients who had reached the age of 63 yr ($n = 30$; the retirement age in Finland) or who had died ($n = 1$) were excluded from this study. One patient was excluded due to incomplete data.

A matched control cohort was created using the PRC for SCS patients to evaluate the effect of the treatment. With one exception (who received only 1 control), the PRC randomly selected 3 live controls for each patient in the study. The control group was matched by (1) age, (2) gender, and (3) place of birth; in addition, (4) both the patient and the control had to be alive on the index day. The index day for matching was the day of SCS implantation or explantation.

The Social Insurance Institution (SII) of Finland is an independent social security institution that runs the National Health Insurance (NHI) scheme. The NHI scheme is part of the Finnish social security system that covers all permanent residents of Finland. The SII of Finland maintains a nationwide registry of all patients who are receiving or have received SA or rehabilitation subsidy (RS, a fixed-term DP), or who are or have been retired. The data for SA, RS, and DP were derived from the register of the SII of Finland. Data included the start and end dates, as well as the International Classification of Diseases (ICD-10) diagnoses of each SA/RS/DP period. This information was collected for both the patients and the controls.

In Finland, the occupational health physician or physician responsible for the treatment assesses the patient's ability to work and, if necessary,

writes the sickness certificate. The applicability of SA/RS/DP is decided by the medical adviser/physician of the institution who is responsible for the payment of the sickness benefit or DP, in line with commonly agreed criteria. SII provides SA to compensate for a short-term disability lasting up to 300 d. In order to receive SA for the same illness, the recipient must have worked uninterrupted for at least 1 yr. If work disability continues for more than 1 yr and SA entitlement expires, it is possible to apply for RS or DP. During the period of RS (often during an SA period), the SII and the authorized pension provider clarify the possibilities of returning to work with the help of rehabilitation. Payment of RS begins after a year if the inability to work continues. If ability to work is not restored during treatment or rehabilitation, the recipient may be entitled to DP. In Finland, the retirement age was 63 yr until 2017.

The baseline characteristics included gender, age, location and duration of pain, previous lumbar procedures, level and reason for operation, spinal fusion, and type of electrode. SCS implantation procedures have been described previously.¹⁷

Patients were divided into 3 groups: SCS trial only, SCS permanent, and SCS explanted. The SCS trial-only group did not experience adequate pain relief and had their electrode removed after the trial period. The SCS permanent and SCS explanted patients received an internal pulse generator (IPG, Medtronic, Dublin, Ireland) after the trial period. The SCS permanent patients used the IPG throughout the follow-up, after which time it was explanted from the SCS explanted group due to inadequate pain relief.

Statistical Analysis

The demographic data were analyzed by calculating the means and standard deviations for normally distributed variables, as well as medians and ranges for the other variables. The statistical evaluation was performed with analysis of variance and nonparametric tests (Table 1). A cross-table analysis was used for the categorical outcome and the chi-square test for the statistical evaluation (Table 1). The significance between the groups during the SA and RS periods was assessed with the negative binomial regression model (Figure 1), and the results are shown by means. A logistic regression analysis was used for the multivariate analysis of variables associated with DP (Table 2). The analysis automatically rejected patients with missing data (Table 2). P values $< .05$ were considered significant. All statistical analyses were performed using SPSS 22.0 (IBM Corporation, Armonk, New York) for Windows.

Ethical Issues

Patients' privacy and self-determination were not compromised at any stage of the study. This is a retrospective register study; separate patient consent was therefore not required. The study protocol was approved by the Ethics Committee of KUH. Data fusion from the national registries was performed with approval from the Ministry of Social Affairs and Health of Finland and the SII.

RESULTS

Study Population

The median follow-up time for patients was 5 yr. The mean age of the 198 patients during the trial period was 45.5 yr (range 22-60) and 104 (53%) were male (Table 1). The median duration of pain was 6 yr (range 0-30), and 80 (40%) patients suffered from radicular pain alone. The median number of previous lumbar

TABLE 1. Demographics of 198 Consecutive Failed Back Surgery Syndrome Patients Treated With Spinal Cord Stimulation Collected in the Kuopio University Hospital in the Period of 1996 to 2014

	Trial only (n = 43)		Permanent SCS implanted (n = 155)				P
	All	%	SCS explanted (n = 40)		SCS in use at the end of follow-up (n = 115)		
			All	%	All	%	
Gender							.70
Female	18	42	20	50	56	49	
Male	25	58	20	50	59	51	
Age (mean ± SD)	45.1 ± 9.4		44.4 ± 8.6		46.1 ± 7.5		.47
Location of pain							.69
Extremity	19	44	14	35	47	41	
Extremity and back	24	56	26	65	68	59	
Duration of pain in years (median/range) n = 195	4.5/1-24 (n = 42)		6/0-30 (n = 39)		6/1-28 (n = 114)		.68
Number of previous operations before implantation (median/range) n = 197	2/1-3		2/1-8		2/1-8 (n = 114)		.22
Level of operation n = 192			n = 37		n = 112		.15
L4-5 and above	21	49	10	27	44	39	
L5-S1	8	18	12	32	38	34	
Multiple level	14	33	15	41	30	27	
Reason for operation n = 194	n = 42		n = 39		n = 113		.73
Disc herniation	23	55	23	59	60	53	
Stenosis	7	17	4	10	23	21	
Both	9	21	8	21	25	22	
Other	3	7	4	10	5	4	
Spinal fusion (n = 195)			n = 39		n = 113		.29
Yes	10	23	15	38	39	34	
No	33	77	24	62	74	66	
Type of electrode^a							.08
Symmix/Resume 1 × 4	39	91	34	85	87	76	
Specify 5-6-5/2 × 4	4	9	6	15	28	24	

SCS = spinal cord stimulation.

^aAll electrodes manufactured by Medtronic.

operations before implantation was 2 (range 1-9). The majority of patients had single-level surgery (n = 133, 69%) before SCS implantation, and disc herniation (n = 106, 55%) was the most common cause of operation. One-third (33%) of the patients had received instrumented fusion. (Table 1)

All 198 SCS patients underwent a 1- to 2-wk trial stimulation period, and if sufficient pain reduction was received, a permanent subcutaneous pulse generator was implanted: 155 (78%) patients received IPG after the trial period. The most used electrode was Symmix in 157 (79%) patients (all electrodes from Medtronic). Due to inadequate pain relief, the SCS device was explanted from 29 (15%) patients. Other reasons for the removal were infection (n = 1), hematoma (n = 1), electrode migration (n = 1), IPG battery depletion (n = 3), need of MRI (n = 1), unnecessary hardware (n = 3), and stimulation in the wrong region (n = 1).

Sickness Allowance

During the follow-up, 116 out of 198 FBSS patients and 181 out of 592 controls received SA (at least 1 d). In FBSS patients,

the mean SA was 3.5 (95% confidence interval [95% CI] 0.2-8.3) days per month during the follow-up period (2 yr before and 2 yr after the implantation) when it was 0.7 (95% CI 0.4-1.3) in the control group. FBSS patients had more SA days per month (mean 4.8-6.3; 95% CI 3.5-8.1) than did the control group (mean 0.6-0.9; 95% CI 0.4-1.3) during the follow-up before the implantation, with a P-value < .05 (Figure 1A).

Rehabilitation Subsidy

RS was given to 68 (34%) patients and 8 (1.4%) controls for a mean of 5.2 (95% CI 2.4-8.2) and 0.2 (95% CI 0.05-0.6) days per month (P < .05). Of 116 FBSS patients, 42 (36%) received RS after SA. During the follow-up (2 yr before and 2 yr after the implantation), RS was received by 31 (27%) of SCS permanent, 17 (43%) of SCS explanted, 20 (47%) of SCS trial-only, and 8 (1.4%) of control patients. Up to the time of implantation, SCS permanent and SCS explanted groups had the same amount of RS days per month. Six months before

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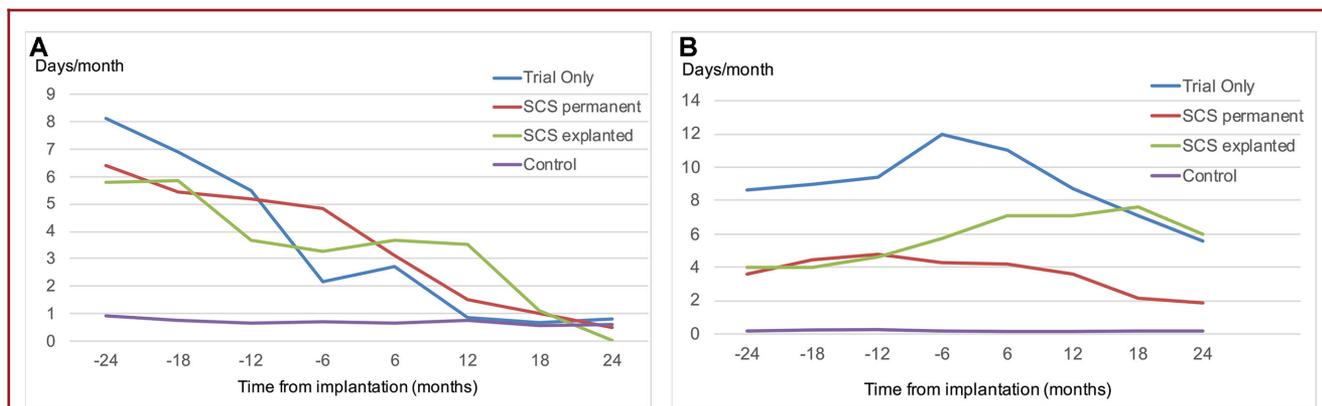


FIGURE 1. Sickness allowance and rehabilitation subsidy of 198 failed back surgery syndrome patients with spinal cord stimulation and their 592 controls during the follow-up (2 yr before and 2 yr after implantation) collected in the Kuopio University Hospital in the period of 1996 to 2014. **A.** Sickness allowance during the follow-up (2 yr before and 2 yr after implantation) in trial only, SCS permanent and SCS explanted groups, and their controls. Time points from implantation represent the mean of sickness allowance (days/month) for 6 m. For example, the time point -24 represents the mean sickness allowance (days/month) 24 to 18 mo before implantation. **B.** Rehabilitation subsidy during the follow-up (2 yr before and 2 yr after implantation) in trial only, SCS permanent and SCS explanted groups, and their controls. Each value represents the mean number of rehabilitation subsidy days per month during a 6-mo observation period. For example, the time point between -24 and -18 represents the mean number of rehabilitation subsidy days per month 24 to 18 mo before implantation.

TABLE 2. Independent Predictors of a Disability Pension in Failed Back Surgery Syndrome of 191 Patients Treated With Spinal Cord Stimulation in the Kuopio University Hospital between 1996 and 2014

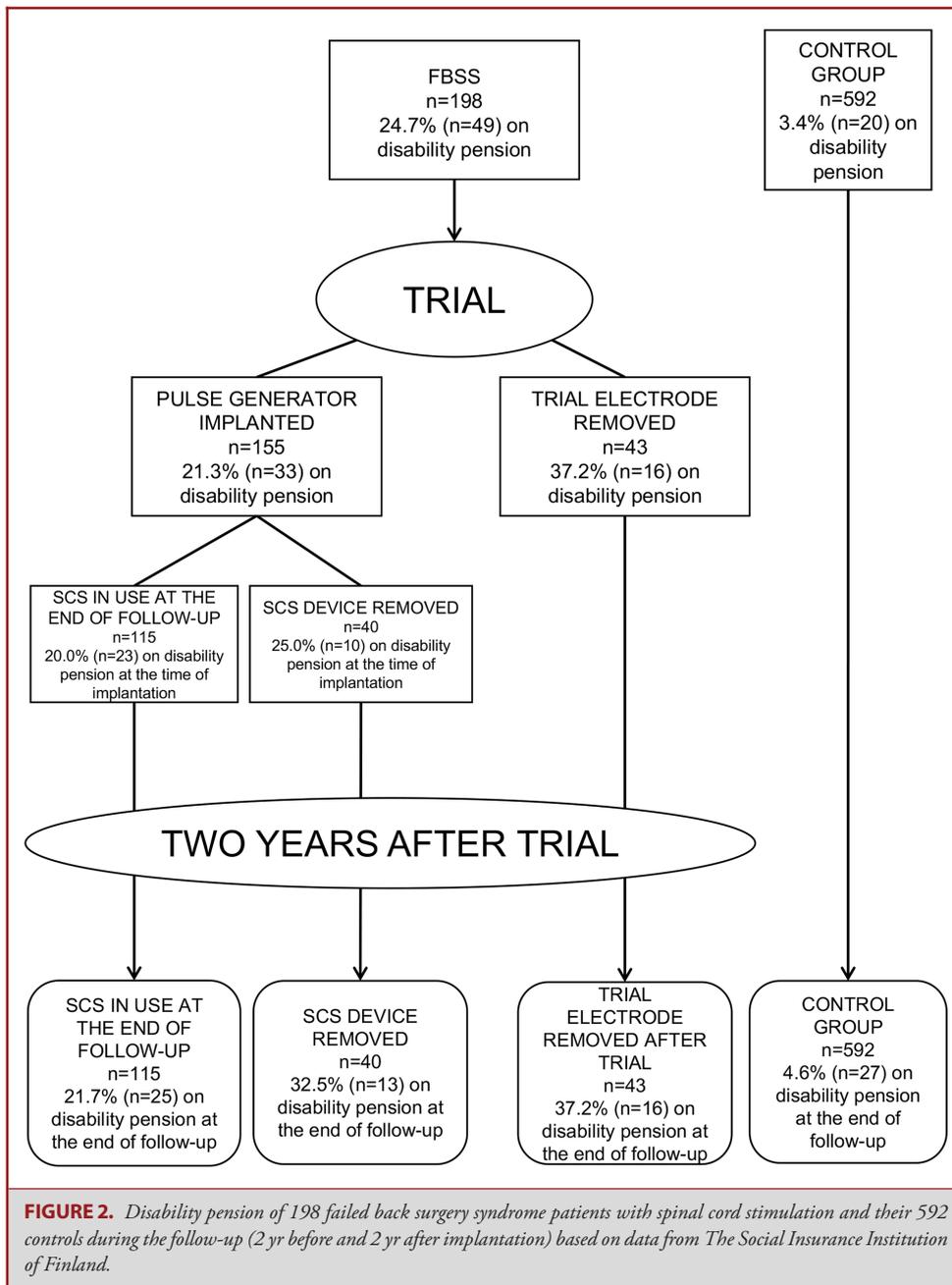
Variable (n = 191)	DP/All	%	OR	95% CI	P
Gender					
Male (ref.)	23/104	22.1			.06
Female	31/94	33.0	1.92	0.97-3.76	
Age		1.01	0.97-1.05	.67	
Group					
SCS in use at the end of follow-up (ref.)	25/115	21.7			.05*
SCS explanted during follow-up	13/40	32.5	1.80	0.76-4.27	.18
Trial only	16/43	37.2	2.64	1.18-5.89	.02*
Location of pain					
Extremity (ref.)	19/80	23.8			.30
Extremity and back	35/118	29.7	1.46	0.72-2.99	
Duration of pain in years		1.03	0.98-1.09	.29	
Number of previous operations before implantation		1.23	0.97-1.55	.09	
Spinal fusion					
Yes (ref.)	18/64	28.1			.83
No	35/131	26.7	1.09	0.50-2.34	

DP, disability pension; SCS, spinal cord stimulation.

*P < .05.

implantation in the explanted group, the RS days increased, while in the SCS permanent group it started to decline (Figure 1B). At the time points of 18 and 24 mo after implantation, the difference between the groups was significant (SCS permanent 95% CI 0.9-4.1; SCS explanted 95% CI 3.2-12.8; $P < .05$). The trial SCS group had significantly more ($P < .05$) RS days per month (mean 5.6-12.0; 95% CI 3.1-17.1) than did the SCS permanent

group (mean 1.9-4.8; 95% CI 0.9-7.2) throughout the follow-up. With the SCS permanent group, the amount of RS started to decline after the implantation, and this was a significant ($P < .05$) difference compared to time points 18 to 6 months before implantation (mean 4.3-4.8; 95% CI 2.9-7.2) and at time points 18 to 24 mo after implantation (mean 1.9-2.2; 95% CI 0.9-4.1; Figure 1B).



Disability Pension

Of the FBSS patients who received permanent DP, 28 (24%) had also been on SA during the follow-up: 49 (25%) of FBSS (n = 198) patients had retired before trial. After the trial period, 155 (78%) received IPG and 33 (21%) of them were retired by that time. In the SCS permanent group, 23 (20%) patients were retired before implantation and 25 (22%) by the end of the follow-up (2 yr after the implantation), while in the SCS explanted group, 10 (25%) of patients had retired before implan-

tation and 13 (33%) had retired at the end of the follow-up (Figure 2). Only 43 patients experienced the trial period, 16 (37%) of whom had retired before the trial and none of whom retired during the follow-up (Figure 2).

Predictors of DP

In the multivariate logistic regression analysis, membership of the trial group (odds ratio [OR] 2.64; 95% CI 1.18-5.89; P = .02) predicted DP (Table 2). Females retired almost twice

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TABLE 3. Disability Pension Diagnosis of 54 Failed Back Surgery Syndrome Patients With Spinal Cord Stimulation and 27 Controls During a Follow-up (Starting 2 Years Before and Ending 2 Years After Implantation) Based on Data From The Social Insurance Institution of Finland

Primary diagnosis (site diagnosis)	Trial only (n = 16)	Permanent SCS Implanted (n = 38)		Controls (n = 27)
		SCS Explanted (n = 13)	SCS in use at the end of follow-up (n = 25)	
C00-D48 Neoplasms		1		1 (1)
F00-F99 Mental and behavioral disorders	2 (3)	(2)	3 (6)	19 (6)
G00-G99 Diseases of the nervous system	1			(4)
I00-I99 Diseases of the circulatory system				1 (2)
J00-J99 Diseases of the respiratory system				(1)
K00-K93 Diseases of the digestive system				(1)
M00-M99 Diseases of the musculoskeletal system and connective tissue	13 (8)	12 (2)	22 (5)	4
S00-T98 Injury, poisoning and certain other consequences of external causes		(1)		2 (1)
Z00-99 Factors influencing health status and contact with health services				(1)

SCS = spinal cord stimulation; primary diagnosis = the main diagnosis of medical statement; site diagnosis = additional illnesses that are relevant to assessing work ability.

as often (OR 1.92) as males, but this difference did not become statistically significant ($P = .06$). Age, cause of operation, duration of pain, number of previous operations, pain distribution, and level of operation did not predict DP. Membership of the SCS permanent group appeared to be protective against DP (Table 2).

DP Diagnosis

In the FBSS, 38 (70%) out of 54 had DP as a result of deforming dorsopathies, spondylopathies, or other dorsopathies (Table 3). Other intervertebral dorsopathies (M51) were the main diagnosis for retirement in 14 (56%) SCS permanent, 8 (50%) trial-only, and 5 (38%) SCS explanted patients. In the FBSS group, the pension was granted for 5 (9%) patients on the basis of mood (affective) disorders (F30-F39). In the control group, the diagnoses were more disparate (Table 3). The most common reason for retirement in the control group was F20-F29 schizophrenia, schizotypal, and delusion disorders ($n = 5$, 19%), and F30-F39 mood (affective) disorders ($n = 7$, 26%).

DISCUSSION

This case-control study analyzed 198 working-age patients who had SCS implanted to treat FBSS with an extremely long follow-up period. We found that FBSS patients were more susceptible for DP than were the controls. During the follow-up period, patients in the SCS permanent group had fewer DP and RS than did patients in the explanted or trial groups. It may be possible to predict the outcome of SCS treatment by determining whether the patient is retired or on RS before the operation. In the multivariate logistic regression analysis, membership of the trial group predicted retirement. In the trial group, 16 (37%) patients had retired before the trial and no one retired during the 2-yr

follow-up. Is it possible that people who are already permanently retired do not benefit from SCS in the same way as people who are still working?

On the basis of a systematic review, the evidence suggested that SCS was effective in reducing the chronic neuropathic pain of FBSS.¹⁸ It has been shown previously that SCS efficacy decreases as the number of previous measures or the duration of pain increases.¹⁹ A recent study from the same population found that instrumented fusion and a smaller number of previous operations predicted a good outcome, and prolonged neuropathic pain did not worsen it.¹⁷ However, these factors did not affect the DP in this study. Several studies have shown SCS to be a cost-effective treatment for FBSS,^{13,14,16} while others find no evidence for greater effectiveness of SCS than alternative treatments in treating FBSS.²⁰ In recent research, the use of opioids has also been linked as a negative predictor of return to work after lumbar discectomy.²¹ This has not yet been studied in SCS-treated FBSS patients. On the basis of our results, the patients who received and benefited from a permanent stimulator were less likely to have a DP and that the only predictor of DP was membership of the trial group.

SCS has been recognized to have an impact as a part of rehabilitation of patients with FBSS.²² Other common indications of SCS include complex regional pain syndrome and refractory angina pectoris.²³ Some studies have also been made on the efficacy of SCS in other disabling diseases causing complicated functional impairment and social costs like the cerebral stroke and minimal consciousness disorders and vegetative state.²⁴⁻²⁷ In future research, these topics could be approached from the point of view of rehabilitation and pensions because these diseases also affect the working-age population and are responsible for strong working capability impairments. This leads to a question of what the role of reconstructive neurosurgery as a part of rehabilitation is in the future.²⁸

Sickness Allowance

In Finland, SA is a measure in response to a short-term disability. Previous studies have shown that, on average, SA days slowly increase when the DP threshold approaches.^{29,30} In our study, 28 (24%) of those FBSS patients who received permanent DP had also been under SA during the follow-up. A limited amount of SA explains the reduction in days at the end of the follow-up period (Figure 1A).

Rehabilitation Subsidy

The RS is a response to disability of more than 1 yr. One out of 3 FBSS patients received an RS after SA. In the SCS explanted group, the stimulator was removed from 50% of the patients within 2 yr of implantation. Monitoring in the neurosurgery unit ended with the removal of the SCS, and it is possible that the end of closer monitoring has an impact on disability. In this study, patients in the SCS permanent group had less RS than did other FBSS groups (Figure 1B).

Disability Pension

The DP is a response to permanent disability. In the trial group, 16 (37%) patients were retired before the trial, and there was no change throughout the follow-up period. Only 2% of those who received a permanent stimulator were retired during the follow-up, while it was 8% of those from which the stimulator was later removed. FBSS patients are far more likely to retire (27%) than are control group members (4.6%) (Figure 2). In this study, we did not find any other factors contributing to DP than membership of the trial group. Most (n = 49, 91%) of the FBSS patients were retired because of spine diseases. DP diagnoses for SCS permanent, SCS explanted, and trial-only groups were very similar (Table 3). Even before the trial, untreated depression was considered a contraindication for SCS treatment. It is therefore quite unlikely that mood factors would explain the differences between the groups. The factors causing disability are probably more complex and require further research.

Strengths and Limitations

This is a retrospective study with concomitant limitations. Structured questionnaires about functional ability or quality of life have not been used for this study population. Unfortunately, we did not have any information on the income categories or the socioeconomic status of the patients. This study did not take into account the part-time DP paid by the authorized pension provider because patients receiving it were still partially capable of working. We were able to investigate the number of sick leaves and pensions, but we do not know whether the rest of the patients are at work or, for example, unemployed job seekers. In our view, this fact does not have great significance, since in both cases the patients have been evaluated as fit for work by a treating physician (sick leave has not been given). This is a long-term follow-up study, and therefore most of the electrodes used were

surgical Symmix electrodes (Medtronic) according to the therapeutic practice in the past.

The strengths of our study are the homogenous study cohort of FBSS patients. The analysis was based on medical records and national registry data. A matched control cohort was created with PRC and, with one exception (who received only 1 control), 3 live controls were randomly selected for each patient in the study. We evaluated the patient's disability on the basis of information obtained from the SII of Finland. National registries provide reliable data of socioeconomic outcome, including information about sickness benefits, the start and end dates, and the ICD-10 diagnoses of each SA/RS/DP period.

Suggestions for Further Research

In assessing incapacity to work, the differences between groups are quite clear. However, in this study we did not find any explanation for the differences between the groups. In the future, it will be important to try to identify the differences between the groups and if there are any factors that might improve patient selection in the future. Additional research will also be needed to distinguish patients who would most likely benefit from the stimulator.

CONCLUSION

Permanent SCS usage was associated with reduced sick leave and DP. Prospective study will be required to assess possible predictive value.

Disclosures

Dr Nissen has received travel funding from Medtronic, Boston Scientific, and Abbott St Jude Medical. Tiina-Mari Ikäheimo has received travel funding from Medtronic and Abbott St Jude Medical and speaker honoraria from Abbot St Jude Medical. Dr von und zu Fraunberg has received travel funding from Medtronic and Abbot St Jude Medical and speaker honoraria from Abbot St Jude Medical. Dr Huttunen has received travel funding from Medtronic and Abbott St Jude Medical. The other authors have no personal, financial, or institutional interest in any of the drugs, materials, or devices described in this article.

REFERENCES

1. Brevik H, Collett B, Ventafridda V, Cohen R, Gallacher D. Survey of chronic pain in Europe: prevalence, impact on daily life, and treatment. *Eur J Pain*. 2006;10(4):287-333.
2. Maniadas N, Grey A. The economic burden of back pain in the UK. *Pain*. 2000;84(1):95-103.
3. van Zundert J, van Kleef M. Low back pain: From algorithm to cost-effectiveness? *Pain Practice*. 2005;5(3):179-189.
4. The Social Insurance Institution of Finland (KELA). The medical insurance statistics 2014 from the Social Insurance Institution of Finland (Kelan sairausvakuutus tilasto 2014). https://helda.helsinki.fi/bitstream/handle/10138/156398/Kelan_sairausvakuutus_tilasto_2014.pdf Accessed March 14, 2018.
5. Finnish Centre for Pensions (Eläketurvakeskus). Finnish Centre for pension statistics database 2014 (Eläketurvakeskuksen tilastotietokanta 2014). <http://tilastot.etk.fi/?lang=3>. Accessed March 14, 2018.
6. Haanpää M, Attal N, Backonja M, et al. NeuPSIG guidelines on neuropathic pain assessment. *Pain*. 2011;152(1):14-27.

7. Freyenhagen R, Baron R, Tolle T, et al. Screening of neuropathic pain components in patients with chronic back pain associated with nerve root compression: a prospective observational pilot study (MIPORT). *Curr Med Res Opin.* 2006;22(3):529-537.
8. Kumar K, North R, Taylor R, et al. Spinal cord stimulation vs. conventional medical management: a prospective, randomized, controlled, multicenter study of patients with failed back surgery syndrome (PROCESS study). *Neuromodulation.* 2005;8(4):213-218.
9. Leveque JC, Villavicencio AT, Bulsara KR, Rubin L, Gorecki JP. Spinal cord stimulation for failed back surgery syndrome. *Neuromodulation.* 2001;4(1):1-9.
10. North RB, Kidd DH, Farrokhi F, Piantadosi SA. Spinal cord stimulation versus repeated lumbosacral spine surgery for chronic pain: a randomized, controlled trial. *Neurosurgery.* 2005;56(1):98-107.
11. Lad SP, Babu R, Bagley JH, et al. Utilization of spinal cord stimulation in patients with failed back surgery syndrome. *Spine.* 2014;39(12):E719-E727.
12. Kumar K, Taylor RS, Jacques L, et al. The effects of spinal cord stimulation in neuropathic pain are sustained: 24-month follow-up of the prospective randomized controlled multicentre trial of the effectiveness of spinal cord stimulation. *Neurosurgery.* 2008;63(4):762-770.
13. Kumar K, Malik S, Demeria D. Treatment of chronic pain with spinal cord stimulation versus alternative therapies: cost-effectiveness analysis. *Neurosurgery.* 2002;51(1):106-116.
14. Zucco F, Ciampichini R, Lavano A, et al. Cost-effectiveness and cost-utility analysis of spinal cord stimulation in patients with failed back surgery syndrome: results from the PRECISE study. *Neuromodulation.* 2015;18(4):266-276.
15. Bala MM, Riemsma RP, Nixon J, Kleijnen J. Systematic review of the (cost-)effectiveness of spinal cord stimulation for people with failed back surgery syndrome. *Clin J Pain.* 2008;24(9):741-756.
16. Farber SH, Han JL, Elsamadicy AA, et al. Long-term cost utility of spinal cord stimulation in patients with failed back surgery syndrome. *Pain Physician.* 2017;20(6):797-805.
17. Nissen M, Ikäheimo T, Huttunen J, Leinonen V, Fraunberg M. Long-term outcome of spinal cord stimulation in failed back surgery syndrome: 20 years of experience with 224 consecutive patients. *Neurosurgery.* published online ahead of print: 2018 (doi: 10.1093/neuros/nyy194).
18. Simpson EL, Duenas A, Holmes MW, Papaioannou D, Chilcott J. Spinal cord stimulation for chronic pain of neuropathic or ischaemic origin: systematic review and economic evaluation. *Health Technol Assess.* 2009;13(17):1-154.
19. North R, Shipley J, Prager J, et al. Practice parameters for the use of spinal cord stimulation in the treatment of chronic neuropathic pain. *Pain Medicine.* 2007;8(4):S200-S275.
20. Turner JA, Hollingworth W, Comstock BA, Deyo RA. Spinal cord stimulation for failed back surgery syndrome: outcomes in a workers' compensation setting. *Pain.* 2010;148(1):14-25.
21. O'Donnell JA, Anderson JT, Haas AR, et al. Preoperative opioid use is a predictor of poor return to work in Workers' Compensation patients after lumbar discectomy. *Spine.* 2018;43(8):594-602.
22. Giugno A, Guli C, Basile L, et al. Spinal cord stimulation: an alternative concept of rehabilitation? *Acta Neurochir Suppl.* 2017;124:15-18.
23. Song JJ, Popescu A, Bell RL. Present and potential use of spinal cord stimulation to control chronic pain. *Pain Physician.* 2014;17(3):235-246.
24. Visocchi M, Cioni B, Pentimalli L, Meglio M. Increase of cerebral blood flow and improvement of brain motor control following spinal cord stimulation in ischemic spastic hemiparesis. *Stereotact Funct Neurosurg.* 1994;62(1-4):103-107.
25. Visocchi M, Giordano A, Calcagni M, Cioni B, Di Rocco C, Meglio M. Spinal cord stimulation and cerebral blood flow in stroke: personal experience. *Stereotact Funct Neurosurg.* 2001;76(3-4):262-268.
26. Visocchi M, della Pepa GM, Esposito G, et al. Spinal cord stimulation and cerebral hemodynamics: updated mechanism and therapeutic implications. *Stereotact Funct Neurosurg.* 2011;89(5):263-274.
27. Della Pepa GM, Fukaya C, La Rocca G, Zhong J, Visocchi M. Neuromodulation of vegetative state through spinal cord stimulation: where are we now and where are we going? *Stereotact Funct Neurosurg.* 2013;91(5):275-287.
28. Visocchi M. Reconstructive neurosurgery: a challenge. *Acta Neurochir Suppl.* 2017;124:1-4. doi: 10.1007/978-3-319-39546-3_1.
29. Wallman T, Wedel H, Palmer E, et al. Sick-leave track record and other potential predictors of a disability pension. A population based study of 8,218 men and women followed for 16 years. *BMC Public Health.* 2009;9:104. doi: 10.1186/1471-2458-9-104.
30. Laaksonen M, Blomgren J, Gould R. Sickness allowance trajectories preceding disability retirement: a register-based retrospective study. *Eur J Public Health.* 2016;26(6):1050-1055.