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The effectiveness of electrical spinal-cord stimulation in type i complex regional pain syndrome. A literature review

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ABSTRACT

Introduction: Complex regional pain syndrome (CRPS I and CRPS II), also known as reflex sympathetic dystrophy and causalgia, is a disease characterized by the presence of severe pain, swelling and other changes that occur after an adverse trigger event. Spinal cord stimulation (SCS) is applied by the percutaneous placement of electrodes in the epidural space under fluoroscopy to produce electrical stimulation directly on the posterior spinal cords in order to inhibit the conduction of nociceptive stimuli.

Object: The aims of this study were focused on identifying the variables analysed in studies of patients with type I complex regional pain syndrome (CRPS I) treated with SCS and determining the effectiveness of the SCS in type I complex regional pain syndrome.

Material and methods: To meet the objectives proposed in the present study, a literature review was conducted in the following databases: MEDLINE, PEDro, LILACS, IBECS, SPORTDiscus, Academic search complete and CINAHL. In addition, publishing platforms such as ScienceDirect, SpringerLink, OVID, ProQuest and Elsevier were consulted. The most recent search among all documentary resources was conducted in June 2016. The studies to be included were those analysing the effects of SCS on CRPS I.

Results and conclusions: From 213 articles identified, 22 studies were selected to be part of this review (11 clinical trials and 11 case reports). The variables studied were pain, quality of life, functional status, trophic and vasomotor disturbances, temperature, patient satisfaction and treatment costs. The studies revealed a significant decrease in pain, which greatly enhanced the quality of life of patients with CRPS I in the short term. SCS also influenced the temperature and improved the trophic changes of the affected limb, although the effect on vasomotor disturbances and functional status is unclear.

Key words: Complex regional pain syndromes, reflex sympathetic dystrophy, electrical stimulation therapy, spinal cord stimulation.

RESUMEN

Introducción: El síndrome de dolor regional complejo (SDRC I y SDRC II), también conocido como distrofia simpático refleja y causalgia, es una enfermedad caracterizada por la presencia de dolor intenso, edema y otras alteraciones que aparecen tras un episodio nocivo desencadenante. La estimulación eléctrica medular (EEM) se aplica mediante la colocación percutánea de electrodos en el espacio epidural bajo control radioscópico, para producir la estimulación eléctrica directamente sobre los cordones medulares posteriores con el fin de inhibir la conducción de los estímulos nociceptivos.

Objetivos: Los objetivos de este estudio se centraron en identificar las variables analizadas en los estudios de pacientes con síndrome de dolor regional complejo tipo I (SDRC I) tratados con EEM y conocer la eficacia de la EEM en el síndrome de dolor regional complejo tipo I.

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Material y métodos: Para cubrir los objetivos propuestos en el presente estudio, se realizó una revisión bibliográfica en las bases de datos MEDLINE, PEDro, LILACS, IBECS, SPORTDiscus, Academic search complete y CINAHL. Además, se consultaron plataformas editoriales como ScienceDirect, Springerlink, OVID, Proquest y ELSEVIER. La última búsqueda en todos los recursos documentales se realizó en junio de 2016. Los estudios incluidos debían analizar los efectos de la EEM sobre el SDRC I.

Resultados y conclusiones: De los 213 artículos identificados, 22 estudios fueron seleccionados para formar parte de esta revisión (11 ensayos clínicos y 11 informes de casos). Las variables estudiadas fueron el dolor, la calidad de vida, el estado funcional, las alteraciones tróficas y vasomotoras, la temperatura, la satisfacción de los pacientes y los costes del tratamiento. Los estudios revelaron una disminución significativa del dolor, lo que permitió aumentar la calidad de vida de los pacientes con SDRC I a corto plazo. La EEM también influyó sobre la temperatura y mejoró las alteraciones tróficas del miembro afectado, aunque no queda claro el efecto sobre las alteraciones vasomotoras y el estado funcional.

Palabras clave: Síndromes de dolor regional complejo, distrofia simpático refleja, terapia de estimulación eléctrica, estimulación medular.

INTRODUCTION

Complex regional pain syndrome (CRPS) was defined in 1993 by the International Association for the Study of Pain (IASP) as "a variety of painful conditions following an injury which appear regionally, having a distal predominance of abnormal findings, exceeding in both magnitude and duration the expected clinical course of the inciting event, often resulting in significant impairment of motor function, and showing variable progression over time" (1-3).

Two types can be differentiated: type I complex regional pain syndrome (CRPS I), also known as reflex sympathetic dystrophy or Sudeck's atrophy, and type II (CRPS II), known as causalgia. Although etiology is similar in both cases, CRPS II requires the presence of partial or total nerve injury. This means that the incidence of CRPS II is less frequent than CRPS I (1,2,4).

CRPS is present in 1 out of every 2,000 traumas and, according to epidemiological studies carried out, the mean age at when it occurs is between 32 and 42 years old, with a prevalence among females of 60-80% (1-3,5-7).

As regards its topography, the upper limbs are involved most, as the most prone to injury because they let us interact with the environment around us (7). Although unilateral impairment is more frequent, there is no statistically significant prevalence of a specific laterality (1,2,7).

In the physiopathological mechanism, the initial injury causes a painful impulse that reaches the central nervous system (CNS) and from there to the sympathetic nervous system, causing a vascular spasm that gives rise to extravasation, edema and pain, thus commencing a vicious circle of edema and pain (1,5,7-10).

Clinically, evolution takes place in two periods: a pseudo-inflammatory or oedematous "warm" stage, and a "cold" stage, characterized by cutaneous fibrosis and amyotrophy associated with other trophic dysfunctions (8,11). However, its evolution is unpredictable, and it may lead to major functional deterioration and effects on quality of life (8).

Different therapeutic approaches exist, including medical and pharmacological treatment, psychological treatment, occupational therapy, rehabilitation treatment and, more recently, treatment with electrical spinal cord stimulation (SCS). Although the therapeutic approach to CRPS requires a multidisciplinary focus, the most important factor is for treatment to be early, individual, progressive and painless (1,2,5,8).

SCS is based on the gate control theory proposed by Melzack and Wall in 1965. Two years later, Shealey first applied SCS in human clinical treatment. However, the first studies did not obtain regular results, as no selection criteria was used for pathology or patient type. As a consequence, in 1998 the European group for the study of pain established selection criteria for implanting SCS (Table I) (4,5,12).

SCS equipment consists of electrodes which are implanted at spinal cord level, the generator, which is inserted at subcutaneous level and a programmer, which controls stimulation intensity (4,5,13,14).

Spinal cord stimulation is carried out in two stages: in the first stage, the electrodes are only implanted at the desired level and for one week the patient remains with a test stimulation. During this time, if the pain diminishes by more than 50%, the way is clear for the second stage, where the definitive system is implanted, and an external programmer is used to adapt stimulation intensity (4,5,9,12,14-16).

The objectives of this article are to identify SCS's parameters of intervention and the variables analyzed in the studies, and to verify the effectiveness of SCS in CRPS I.

MATERIAL AND METHODS

To achieve the objectives, a literature review was carried out. The databases and publishing platforms Pubmed, LILACS, IBECS, SPORTDiscus, Academicsearch complete, CINAHL, PEDro, Proquest, Elsevier, OVID, ScienceDirect and SpringerLink were consulted. The most recent search in all documentary resources was carried out in June 2016.

Keywords and strategies used can be seen in Table II. Only the databases EBSCO, PEDro and ScienceDirect specified that the keywords appeared in title and abstract.

TABLE I
SELECTION CRITERIA FOR IMPLANTING SCS

– It is preferably applied for chronic neurogenic or vascular pain
– For best results, integrity of the Central Nervous System is required
– Analgesia is more effective in the cases of localized pain, especially axial (in upper or lower limbs)
– It is essential to cover the painful area with paresthesia
– A test period is always carried out to assess the effectiveness of SCS
– Patients' collaboration and an appropriate psychological state is required
– Cases should be avoided where patients seek to make economic profit from their painful condition
– Psychological evaluation must be carried out by psychologists or psychiatrists trained in pain management.

Adapted from Gómez-García A, 2007 and Kunnumpurath S, 2009 (5,12)

Once all the articles were collected, a "fan-out" search was carried out on the basis of their bibliographical references.

The search was limited to studies published in the last 15 years. Clinical trials and case reports were included when the pathology studied was CRPS I and the treatment, of at least one group, included SCS.

The exclusion criteria applied were that the pathology studied was chronic or neuropathic pain, post-surgery syndrome (FBSS) and CRPS II; and that the treatment was based exclusively on stellate ganglion block, pharmacological treatment and non-spinal electrical stimulation (TENS, electro-acupunture, etc.). Articles were also excluded when patients presented complications with anesthesia and studies carried out on animals.

RESULTS AND DISCUSSION

22 studies were selected (Figure 1), of which 11 were clinical trials (8 randomized clinical trials and 3 uncontrolled clinical trials) and 11 case reports (5,10,14,15,17-34).

As shown in Table III, in general, samples were made up of more women than men, mean age was 33 years old in the clinical trials and 44 years old in the case reports, and the number of subjects with affected upper limbs was greater than the number of subjects with affected lower limbs.

In all the studies, at least one group of patients received SCS and only in 5 clinical trials and 1 case report SCS was applied in combination with physiotherapy (17,22,30,32-34). Furthermore, 5 clinical trials applied a physiotherapy program to the control group consisting of exercises to improve strength and mobility (17,22,32-34).

Variables and measurement tools

As regards variables, we should stress that all the articles focused on pain. Additionally, 8 studies analyzed the quality of life variable (14,17,21-24,30,33), 4 articles studied functional status (5,17,21,22), 3 studies analyzed trophic alterations (10,18,28) and 3 articles studied vasomotor alterations (18,20,25).

In relation to tools used to evaluate interventions, most of the articles analyzed pain with the visual analogue scale (VAS); 3 articles also used the McGill Pain Questionnaire (17,22,24), 2 studies used the Numerical Pain Rating Score (NRS-11) (21,31) and 1 article used the Multidimensional Pain Inventory and the Pain Experience Scale (26).

TABLE II
KEYWORDS AND SEARCH STRATEGIES

Keywords [Mesh] #1 "Complex Regional Pain Syndromes" [Mesh] #2 "Electric Stimulation Therapy" [Mesh] #3 "Spinal cord stimulation" [Mesh] #4 "Reflex Sympathetic Dystrophy" [Mesh]	*Natural language keywords* #5 "Complex Regional Pain Syndrome" #6 "Spinal cord stimulation" #7 "Complex Regional Pain"
Pubmed strategy #1 AND (#2 OR #3) #4 AND #3	*Other platforms strategy* (#5 OR #7) AND #6

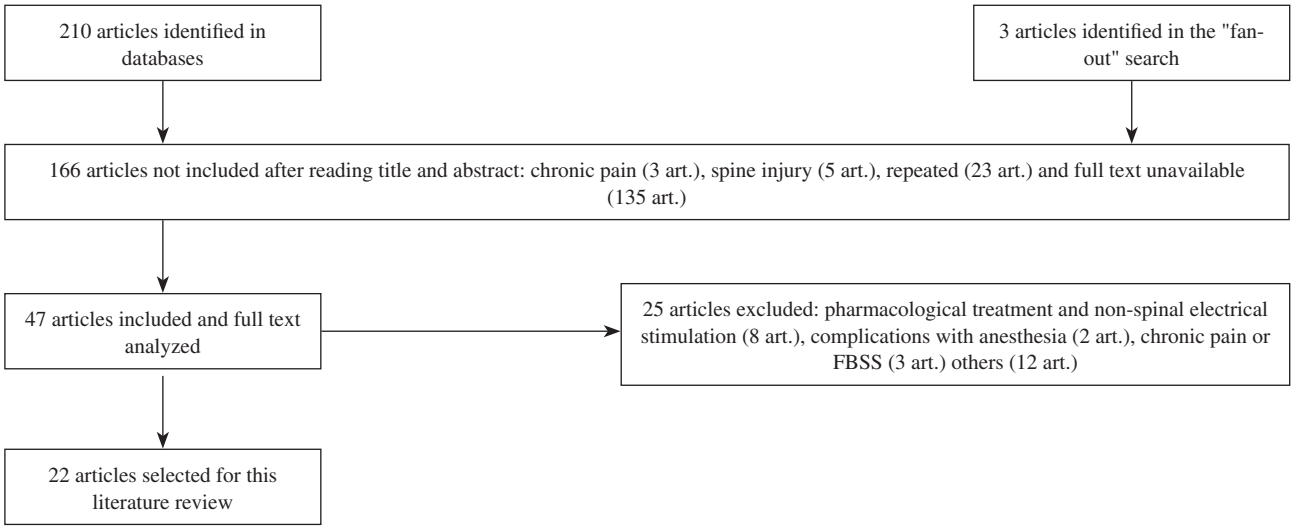

Fig. 1. Study identification and selection process.

To assess quality of life, 5 articles used the EuroQol-5 Dimensions (EQ-5D) (14,17,22,23,33), 2 articles used the Nottingham Health Profile and the Self Rating Depression Scale (17,22), the Sickness Impact Profile-68 (22,24), and the Oswestry Disability Questionnaire (24,26), 1 article used the SF-36 (21) and 3 studies used the Beck Depression Inventory, the Epidemiological Studies Depression Scale and the Global Perceived Effect (GPE) (14,24,26).

Functional status and vasomotor alterations were analyzed with tools such as the Walking Questionnaire (WQ), Questionnaire Rising And Sitting Down (QRS) and laser-doppler flowmetry, among others (20,21).

Also analyzed, though to a lesser extent, were temperature, patient satisfaction and treatment costs (25,31,33), using tools like Thermovision Scanner 900 SW-TE (TS900) or microcost analyses (25,33).

Effectiveness of SCS on pain

All the authors agreed that the application of SCS on subjects with type-I CRPS for whom the rest of treatments have failed, brings about a major reduction in pain (5,10,14,15,17-34).

7 clinical trials and 10 case reports analyzed the variation in pain before and after SCS. These studies observed that, prior to the implant, pain ranged from 6 to 10 points according to VAS and, Subsequently, after receiving SCS, scores dropped to a range of 0 to 5 points according to VAS (5,10,14,15,17-20,24-31,34).

Bennett et al. (1999) compared the variation in pain according to type of electrode implanted. In their study, the group that received stimulation with 2 tetrapolar electrodes obtained scores of 8 points according to pre-implant VAS; these fell by up to 4.26 points according to post-implant VAS. However, although there was a significant reduction in pain in both groups, the group that received stimulation with 2 octapolar electrodes obtained a greater reduction, falling from 8.17 points to 2.17 points according to VAS (15).

5 clinical trials also refer to the improvement in pain when SCS is combined with physiotherapy. Accordingly, individuals who received SCS together with physiotherapy experienced a reduction of 2 to 3 cm according to VAS (17,22,32,34), while in 3 of the 5 clinical trials, the group control that only received treatment with physiotherapy experienced a pain reduction of 0 to 1 cm according to VAS (32-34).

It is worth noting that in 2 clinical trials, pain worsened in the control group. The control group that was only treated with physiotherapy experienced a pain increase of 0 to 0.2 points according to VAS (17,22), as at certain times, especially in the disease's acute stage, physiotherapy can represent a harmful factor by increasing sympathetic tone (1,8).

Similarly, 5 clinical trials and 1 case report mention that the pain reduction is more significant in the short term (14,17,19,22,33,34), because as from 2 years of stimulation, the effects of SCS on pain began to fall off, though even so, the pain reduction obtained subsequently was significant.

Nevertheless, this depends on each patient, as 3 case reports defend the effectiveness of SCS on long-term pain, as in these articles, as from 2 years, the pain reduction continued to be so significant that patients even ended up disconnecting the device, from a few hours to the whole day (18,28,29).

TABLE III
CHARACTERISTICS OF STUDIES SELECTED

AUTHOR, YEAR	*ST. TYPE**	*N*	*AGE*	*ILL.*	*AFFECT. AREA*	*SCS PARAMETERS*	*INTERVENTION TYPE*	*CG*	*VARIABLES*	*TOOLS*	*RESULTS*
van Eijs, 2012 (21)	RCT	(n = 6) 6 W	35	CRPS I	LL	E. T10-T11 (80 Hz, 210 µseg, 0-10 V)	SCS	ND	Pain QL FS	NRS SF-36 WQ QRS	Pain <, QL (mental, physical improv. =) FS =
Kemler, 2006 (34)	RCT	ND	ND	CRPS I	ND	ND	SCS + Ph. (n = 31)	Ph. (n = 13)	Pain	VAS	Pain <
Kemler, 2004 (22)	RCT	ND	18-65	CRPS I	ND	ND	SCS + Ph. (n = 24)	Ph. (n = 30)	Pain FS QL	VAS NHP SIP-68 SRDS Mc Gill pain questionnaire EQ-5D	Pain < FS = QL>
Kemler, 2002 (33)	RCT	ND	ND	CRPS I	(n = 33) UL (n = 21) LL	ND	SCS + Ph. (n = 24)	Ph. (n = 30)	Pain QL Costs	VAS EQ-5D microcosts	Pain < QL > Short-term costs (SCS >, Conven. tr.>) Long-term costs (SCS <, Conven. tr.>)
Kemler, 2001 (32)	RCT	(n = 54) 37 W 17 M	21-65	CRPS I	(n = 33) UL (n = 21) LL	ND	SCS + Ph. (n = 24)	Ph. (n = 30)	Detection thr. Pain thr. Hyperalgesia	VAS SWPA TSA2001	Detection thr. = Pain thr.> Hiperalgesia <
Kemler, 2000 (20)	RCT	(n = 42) 28 W 14 M	18-65	CRPS I	(n = 24) UL (n = 18) LL	(85 Hz, 210 µseg, 0-10 V)	SCS (n = 22)	ND	Pain Microcirculation Vasoconstriction Sympathetic tone	VAS Laser doppler flowmetry	Pain < Microcirculation = Vasoconstriction < Sympathetic tone <
Kemler, 2000 (17)	RCT	ND	18-65	CRPS I	(n = 33) UL (n = 21) LL	E. (C4-MS, T12-MI) (85 Hz, 210 µsec, 0-10 V)	SCS + Ph. (n = 24)	Ph. (n = 30)	Pain FS QL	VAS NHP SRDS EQ-5D Jebsen Test	Pain < FS = QL>

(Continue in the next page)

TABLE III
CHARACTERISTICS OF STUDIES SELECTED

AUTHOR, YEAR	*ST. TYPE**	*N*	*AGE*	*ILL.*	*AFFECT. AREA*	*SCS PARAMETERS*	*INTERVENTION TYPE*	*CG*	*VARIABLES*	*TOOLS*	*RESULTS*
Oakley, 1999 (24)	RCT	(n = 19) 14 W 5 M	43	CRPS I	(n = 10) UL (n = 7) LL (n = 1) back and LL (n = 1) LLs	ND	SCS	ND	Pain QL	VAS SIP-68 ODQ BDI McGill pain rating index	Pain < QL >
Sears, 2011 (31)	CT	(n = 35) 9 W 9 M	47,8	CRPS I	(n = 6) UL (n = 4) back (n = 8) LL	ND	SCS	ND	Pain Satisfaction	VAS NRS-11	Pain < Satisfaction >
Forouzanfer, 2004 (14)	CT	(n = 36) G cervical (11 W-8 M) G lumbar (13 W-4 M)	G cervical (38) G lumbar (42)	CRPS I	ND	(85 Hz, 210 µseg, 0-10 V) G cervical (T3-T4) G lumbar (L3-L4)	SCS	ND	Pain QL	VAS GPE EQ-5D	Pain < QL >
Bennett, 1999 (15)	CT	(n = 101) G I (23 W-7 M) G II (40 W-31 M)	G I (26-80) G II (23-77)	CRPS I	UL and LL	UL E (C2-C6) LL (T10-T11).	SCS G-I (dual-tetrapolar) G-II (dual-octopolar)	ND	Pain	VAS	Pain <
Ito, 2013 (29)	CR	(n = 1) 1 W	30	CRPS I	LL	E T10-T11, **(18 Hz, 300 µseg, 3,1 V) (21 Hz, 450 µseg, 4,1 V)	SCS	ND	Pain	VAS	Pain <
Moriyama, 2012 (23)	CR	(n = 34) 18 W 16 M	25-80	CRPS I	ND	ND	SCS	ND	Pain QL	VAS EQ-5D	Pain < QL >
Canlas, 2010 (30)	CR	(n = 1) 1 W	24	CRPS I	UL der. LLs	E C2-C5 (60-1200 Hz, 150-387 µsec 2,7-6,7 mA) E T9-T10 (60-184 Hz, 287-387 µsec 5,4-7,3 mA)	SCS + Ph.	ND	Pain QL	ND	Pain < QL >

(Continue in the next page)

TABLE III
CHARACTERISTICS OF STUDIES SELECTED

AUTHOR, YEAR	*ST. TYPE**	*N*	*AGE*	*ILL.*	*AFFECT. AREA*	*SCS PARAMETERS*	*INTERVENTION TYPE*	*CG*	*VARIABLES*	*TOOLS*	*RESULTS*
Dam-Hieu, 2010 (28)	CR	(n = 2) 1 W 1 M	66 y 58	CRPS I	UL	Tetrapolar E C4-C5	SCS	ND	Pain Trophic alt.	ND	Pain < Trophic alt. <
Huh, 2010 (25)	CR	(n = 1) 1 M	39	CRPS I	LL	2 Octopolar E. T8	SCS	ND	Pain Tª microcirculation	VAS TS900	Pain < Temp.> microcirculation >
Rijkers, 2009 (10)	CR	(n = 1) 1 W	49	CRPS I	UL and LL	E C4-C5	SCS	ND	Pain Dystonia Trophic alt.	ND	Pain < Dystonia< Trophic alt. <
Williams, 2009 (18)	CR	(n = 1) 1 M	57	CRPS I	LL	E T9-T10	SCS	ND	Pain Edema Vasomotor alt.	ND	Pain < Edema < Vasomotor alt. <
Gómez-García, 2007 (5)	CR	(n = 5) 5 W	40	CRPS I	LL	Tetrapolar E T10-T12 3-12 h.	SCS	ND	Pain Analgesics FS	VAS	Pain < Analgesics < FS >
Atallah, 2007 (27)	CR	(n = 1) 1 M	59	CRPS I	LL and back	E T9-T12	SCS	ND	Pain	ND	Pain <
Ahmed, 2003 (19)	CR	(n = 1) 1 M	44	CRPS I	UL	E C3-T1	SCS	ND	Pain	ND	Pain <
Segal, 1999 (26)	CR	(n = 1) 1 W	30	CRPS I	UL	E C2-C3 (1 V, 180 µsec, 55 Hz) 24 h	SCS	ND	Pain Allodynia	MPI PES ESDS ODQ	Pain < Allodynia<

*Study type. RCT: Randomized clinical trial. CT: Uncontrolled clinical trial. CR: Case reports or clinical cases. N: sample size. W: woman. M: man. ND: Not described. G I and G II: intervention groups 1 and 2. UL: upper limb. LL: lower limb. C: cervical vertebrae. T: thoracic vertebrae. L: lumbar vertebrae. SCS: spinal cord stimulation. P: physiotherapy. CG: control group. T: threshold. QL: quality of life. FS: functional status. E: electrode. >: increase. <: decrease. =: no variation.
**SCS parameters before and during pregnancy. SWPA: The Semmes-Weinstein Pressure Aesthesiometer. TSA2001: Thermal Sensory Analyser. NHP: Nottingham Health Profile. SRDS: Self rating depression scale. SIP-68: Sickness Impact Profile 68. ODQ: Oswestry disability questionnaire. BDI: Beck depression inventory. NRS: Numerical pain rating score. SF-36: Short Form. WQ: Walking questionnaire. QRS: Questionnaire rising and sitting down. MPI: Multidimensional pain inventory. PES: Pain experience scale. ESDS: Epidemiological studies depression scale. GPE: Global Perceived Effect. TS900: Thermovision Scanner 900 SW-TE. VAS: Visual analogue scale of pain. EQ-5D: EuroQol 5 dimensions.

In short, in a general sense, pain improved both in the experimental group and in the control group, although the reduction was greater in the experimental group that received SCS. However, we should highlight the fact that in 2 clinical trials, pain increased in the control group that was only treated with physiotherapy (17,22).

Effectiveness of SCS on quality of life

This review included 6 clinical trials and 2 case reports that refer to quality of life (14,17,21-24,30,33).

In all the studies that measured patients' quality of life, a direct relationship was observed with the effect of SCS on pain, in such a way that in all cases there was an improvement in quality of life.

This idea is strengthened by studies like the one conducted by Kemler et al. (2000), where quality of life only improved in the experimental group, while in the control group, where pain worsened, quality of life did not improve (17).

It should be noted that Forouzanfer et al. (2004) compared the effectiveness of SCS on quality of life according to level of stimulation. In their study, they compared the results of stimulation at level T3-T4 with stimulation at level L3-L4. In both interventions, pain reduction and increased quality of life were obtained. There were no significant differences between the two groups (14).

Finally, in 2 case reports, the improvement was so significant that the patient could help with household tasks or even restart work (5,19).

Effectiveness of SCS on other variables

Regarding the relationship of pain with vasomotor alterations, William et al. (2009) and Kemler et al. (2000) agreed that vasoconstriction diminishes with SCS (18,20). Despite this, Kemler et al. (2000) did not find significant changes in microcirculation. This therefore suggests that the pain reduction brought about by SCS stems not from this treatment's influence on tissue microcirculation, but rather the pain reduction is due to inhibition of the sympathetic system, which causes vasoconstriction (20).

Although in the clinical trials, no changes in microcirculation were found, in the clinical case presented by Huh et al. (2010) increased microcirculation was observed. This seems to be related to the fact that, in this case, stimulation was applied by means of two octopolar electrodes (25).

Furthermore, CRPS causes multiple trophic alterations. These alterations greatly condition the lives of individuals who suffer them. Accordingly, 3 case reports focused their investigation on observing the effects of SCS on trophic alterations. As a result, after applying stimulation, the three studies concluded that SCS improves the alterations of tissue tropism, in some cases even leading to their complete disappearance (10,18,28).

As regards functional status, 3 clinical trials conclude that SCS does not bring about significant changes in functionality (17,21,22). However, a clinical case that studied 5 women with affected lower limbs concluded that SCS improved functional status, as it gave them 90% independence in everyday activities and 70% independence in walking (5).

Similarly, Canlas et al. (2010) studied the case of a woman with an affected upper limb and lower limb who had to use a wheelchair to move around. After stimulation, her functionality improved and she was able to walk with the aid of a crutch (30).

As regards temperature, 1 clinical trial focused its attention on studying the effects of SCS on heat and cold detection thresholds. After applying stimulation, no variation was observed in detection thresholds (32).

Additionally, the clinical case presented by Huh et al. (2010) studied the effects of SCS on the temperature of affected limbs. In this study, a temperature increase was observed in affected limbs due to increased microcirculation (25).

These results suggest that SCS can modify the temperature of affected limbs thanks to its vasoconstriction inhibiting effect, but it cannot modify the heat or cold threshold (25,32).

As regards treatment costs, 2 clinical trials and 1 case report stated that, as from the third year, costs of SCS treatment are lower than those for conventional treatment, as 83% of the expense in the first year referring to device implantation costs are no longer applicable (22,30,33).

Finally, one clinical trial gathered data on patient satisfaction in relation to benefits obtained with SCS. This study concludes that patients would use SCS again, as this is the only treatment that gives them a positive result in pain reduction once medical treatment and rehabilitation have failed (31).

In conclusion, spinal cord stimulation is effective in reducing pain and in improving the quality of life, especially in the short term. There also exist expectations regarding its long-term effectiveness.

Similarly, SCS influences temperature, improves trophic alterations and reduces treatment costs. However, the role of SCS in vasomotor alterations and patients' functional status is not clear.

CONFLICT OF INTEREST

The authors declare they have no conflicts of interest.

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