Journal of Bodywork & Movement Therapies 23 (2019) 678–682

Contents lists available at ScienceDirect

Journal of Bodywork & Movement Therapies

journal homepage: www.elsevier.com/jbmt

PREVENTION & REHABILITATION: Randomised Study

Effect of one session of tDCS on the severity of pain in women with chronic pelvic pain

Nahid Divandari [a], Farideh Dehghan Manshadi [a, *], Nasim Shokouhi [b], Mahdi Vakili [c], Shapour Jaberzadeh [d]

[a] Physiotherapy Department, School of Rehabilitation, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[b] Yas Women Hospital, Tehran University of Medical Sciences, Tehran, Iran
[c] School of Medicine, Semnan University of Medical Sciences, Semnan, Iran
[d] Physiotherapy Department, School of Primary Health Care, Faculty of Medicine, Nursing and Health Sciences, Monash University, Melbourne, Australia

ARTICLE INFO

Article history:
Received 3 August 2017
Received in revised form
25 November 2017
Accepted 17 December 2017

Keywords:
Chronic pelvic pain
Transcranial direct current stimulation
Pain intensity
Quality of life

ABSTRACT

Aim: The present study aimed to investigate the effects of tDCS on pain score in women with Chronic Pelvic Pain (CPP).
Materials & methods: A total of 16 women with CPP participated in the present double-blind sham-controlled cross-over study. Each participant received a 20-min 0.3 MA of trans Cranial Direct Stimulation (tDCS) with a current density of 0.1 mA/cm^2. In addition to the pain intensity, the Quality of Life (QOL), disability, and depression statuses were assessed prior to and one week after the treatment. Shapiro-Wilks goodness-of-fit test for normality, dependent *t*-Test, and Wilcoxon Signed- Rank Test were used for data analysis. Values of $p < .05$ were considered statistically significant.
Findings: Active tDCS treatment was effective in the reduction of pain ($p = .0001$), improving QOL ($208.938 > 193.313$, $P = .025$), and the disability ($22.375 < 30.375$, $P = .025$). The results showed no effect of active or sham treatment on the depression ($p \geq .05$).
Conclusion: The positive effects of active tDCS on CPP suggest the need to study the effect of this method on other types of chronic pain.

1. Introduction

Chronic Pelvic Pain (CPP) is described as any pelvic pain with no relevance to pregnancy, menstruation, and intercourse that lasts for six months or more. The etiology is often unclear; it may result from complex interactions between the gastrointestinal, urinary, gynecologic, musculoskeletal, neurologic and endocrine systems, as well as the influence of psychological and socio-cultural factors (Zondervan et al., 2001; Howard, 2003; Sedighimehr et al., 2017). CPP has an adverse impact on women's Quality of Life (QOL), daily activities (Arnold et al., 2006; Whitaker et al., 2016; Harvey et al., 2017), and general well-being (Latthe et al., 2006; Savidge and Slade, 1997), which can cause a drastic increase in anxiety and depression rate (Arnstein, P.et al.; Brawn, J. 2014). It has an alarming prevalence rate ranging from 1.2%–39% in different countries varying the characteristics of the studied population and research methodology (Latthe et al., 2006; Ahangari, 2014). The prevalence of CPP has previously been estimated in Iran in two cross-sectional studies at 10.2% (Dehghan et al., 2009) and 17.7% (Dehghan et al., 2014).

In spite of billions of dollars being spent on diagnosis and treatment of CPP, there are few evidence-based treatment protocols. Therefore, both patients and health professionals feel disappointed when dealing with conventional treatments (Engeler et al., 2013; Simis et al., 2015).

Recent studies have reported that dysfunction of the limbic system and hypothalamic-pituitary-adrenal axis dysfunction may be responsible for the CPP (Fenton et al., 2009; Brawn, J. 2014; Simis et al., 2015). They hypothesized that CPP is associated with central sensitization as well as functional and structural changes in the brain (Brawn et al., 2014; Kaya et al., 2013). It seems as if treatment procedures which focus on the pelvic organs are not effective in

* Corresponding author. Damavand Ave., Imam Hussein SQ, 1616913111, Tehran, Iran.
E-mail addresses: divandarinahid@yahoo.com (N. Divandari), manshadi@sbmu.ac.ir (F.D. Manshadi), nshokouhi@sina.tums.ac.ir (N. Shokouhi), vakilimahdi333@yahoo.com (M. Vakili), shapour.jaberzadeh@monash.edu (S. Jaberzadeh).

https://doi.org/10.1016/j.jbmt.2017.12.014
1360-8592/© 2017 Published by Elsevier Ltd.

producing long-lasting management of the limbic dysfunction. Therefore, during recent years, non-invasive brain stimulation methods in term of Transcranial Direct Current Stimulation (tDCS) and Trans cranial Magnetic Stimulation (TMS) are proposed (Zaghi et al., 2009; Simis et al., 2015). Generally, tDCS is more affordable and effective than TMS; it is also cheaper, with fewer complications and side effects. (Zaghi et al., 2009). Transcranial direct current stimulation (tDCS), as a form of noninvasive brain stimulation, has been proven to be very promising in treating chronic pain conditions. This direct electrical current, with low doses delivered to the brain via electrodes placed directly on the scalp, induces changes in the neuronal activity of the cortex by increasing excitability in the areas under the anode and decreasing it in the areasunder the cathode (Rostami et al., 2015).

Recent studies have shown the positive effects of tDCS on the central nervous system function (Giordano et al., 2017; Sankarasubramanian et al., 2017) and the reduction of chronic pain (Vaseghi et al., 2014; Silva et al., 2017; Kanotkova, 2017).

Determining the proper parameters of tDCS to increase cortical excitability are one of the issues that need to be addressed (O'Connell et al., 2010). One of these important parameters is applying tDCS over M1 and DLPFC. It is claimed that the simultaneous stimulation of these two regions increase the excitability of the motor cortex up to three times as compared with the conventional one; therefore, speeds up the process of pain relief (Vaseghi et al., 2015a,b). The present study aimed to investigate the potential effect of a one-session of a-tDCS $_{\mathrm{UHCDS}}$ (M1 and DLPFC) on pain intensity, QOL, disability, and depression status of women with CPP.

2. Materials & methods

Between October 2016 and January 2017, from among the patients who referred to a pelvic floor clinic in Yas Hospital, affiliated to Tehran University of Medical Sciences, 25 patients were assessed for eligibility and 16 non-postmenopausal women with CPP were recruited. The sample size was estimated with a 95% confidence interval and a test power of 80% (Fenton et al., 2009). The selection and referral of the CPP patients was conducted by a team specialised in Female Pelvic Medicine and Reconstructive Surgery, according to the definition provided by American College of Obstetrician and Gynecologists (ACOG Practice Bulletins, 2004).

Exclusion criteria included: genitourinary diseases, neurologic bladder dysfunction, self-reported alcohol or drug abuse over the past six months, taking medications like Carbamazepine, severe depression, neurological disorders, history of head injury resulting in temporary unconsciousness, and medication for pain reduction (Vaseghi et al., 2015a,b). The age range of participants was 21–50 years and BMI ranged between 19.72 and 45.79 (31.7 ± 7.27) kg/cm^2. To stimulate the dominant hemisphere, only right-handed subjects were selected (Vaseghi et al., 2015a,b).

Before starting the study, all patients completed the written consent form.

The study was approved by the Research Ethics Committee of Shahid Beheshti University of Medical Sciences, Tehran, Iran.

After collecting demographic information, the following reliable and valid instruments were used to measure the outcomes: VAS pain score, WHOQOL-BREFE Questionnaire to assess QOL (Nedjat et al., 2008), Oswestry Disability Index (Baradaran et al., 2016; Mousavi et al., 2006), and the short form of Beck Depression Inventory (Hojat et al., 1986; Dadfar and Kalibatseva, 2016). The tDCS device used in the study was from the Active Dose Company, Thailand.

After selection and referral of patients, the study was carried out in two main phases with a one-week interval between them. Both phases consisted of three parts: pretreatment assessment of all outcome measures, a treatment phase, and a post treatment assessment (Vaseghi et al., 2015a,b). All participants were their own controls and randomly received both active and sham treatment (Fenton et al., 2009; Vaseghi et al., 2015a,b). Randomization was performed by a blinded therapist using a sealed envelope for each woman. All participants and assessors were blinded to the intervention group. The following flowchart shows the stages of the study (See Fig. 1).

Completion of questionnaires and tDCS treatment was performed by an experienced physiotherapist, who had already passed the tDCS course.

2.1. tDCS

A direct current was applied over the M1 and DLPFC concurrently through two active saline-soaked surface sponge electrodes (1.5×2 cm). The small size of the electrodes produced a highly focused direct current over the target areas (Vaseghi et al., 2015a,b). Two reference electrodes (2×6 cm) were placed over the contralateral supraorbital area (Vaseghi et al., 2015a,b). The size of the reference electrodes was four times that of the active electrode, and this reduced their neuromodulator effects (Vaseghi et al., 2015a,b). The t-DCS simulators were set to deliver a 0.3 MA direct current for a period of 20 min. The required current intensity (0.3 MA) allowed the use of small active electrodes (Vaseghi et al., 2015a,b). The location of the electrodes is shown in Fig. 2.

To maintain safety, the current density was kept in a safe range (0.1 mA/cm^2) (Poreisz et al., 2007; Vaseghi et al., 2015a,b; Brunoni et al., 2011). Two tDCS devices were used for stimulation of the target areas in a-tDCS UHCDS conditions.

The international 10–20 system was followed to determine the target spots for stimulation. In the current study, the anode electrodes were placed over C3 and F3, the locations of left M1 and DLPFC respectively (Fig. 2) (Vaseghi et al., 2015a,b). In the sham group, only 30 s of stimulation was applied to mimic the itching associated with actual stimulation (Mungee et al., 2016). Then, the device remains silent on the patient's head until the end of the 20-min treatment (Vaseghi et al., 2015a,b). Participants were informed they could leave the study at any stage, but none of the patients left the trial due to side effects in either active or sham treatment.

Adverse effects were monitored immediately after each treatment and one week after the treatment. The most frequent reported side effects were mild tingling and itching without any sense of burning and pain beneath the anode electrodes after active or sham treatment only immediately after treatment, compared with one week later. Two patients perceived that one session of their treatment was sham, whereas others could not distinguish between the sessions.

Data were analyzed using SPSS statistical software (v. 21). Shapiro-Wilks goodness-of-fit test was used to assess the distribution of quantitative variables. Based on the results of this test, the matched *t*-test or Wilcoxon Signed- Rank Test was used to compare variables before and after sham or active intervention. A significant level was considered as $p < .05$ with a power of 80%.

2.2. Findings

Table 1 presents the values of the outcomes before and after the intervention (See Table 1).

Table 2 shows the results of the comparison of the averages before and after the intervention (See Table 2).

As seen in Table 2, there was a reduction of 2.94 (49%) points in the mean pain intensity for the active stimulation while this value was 0.56 (0.001%) for the sham treatment. Also, active treatment resulted in a significant decrease of 31.67% in the mean level of

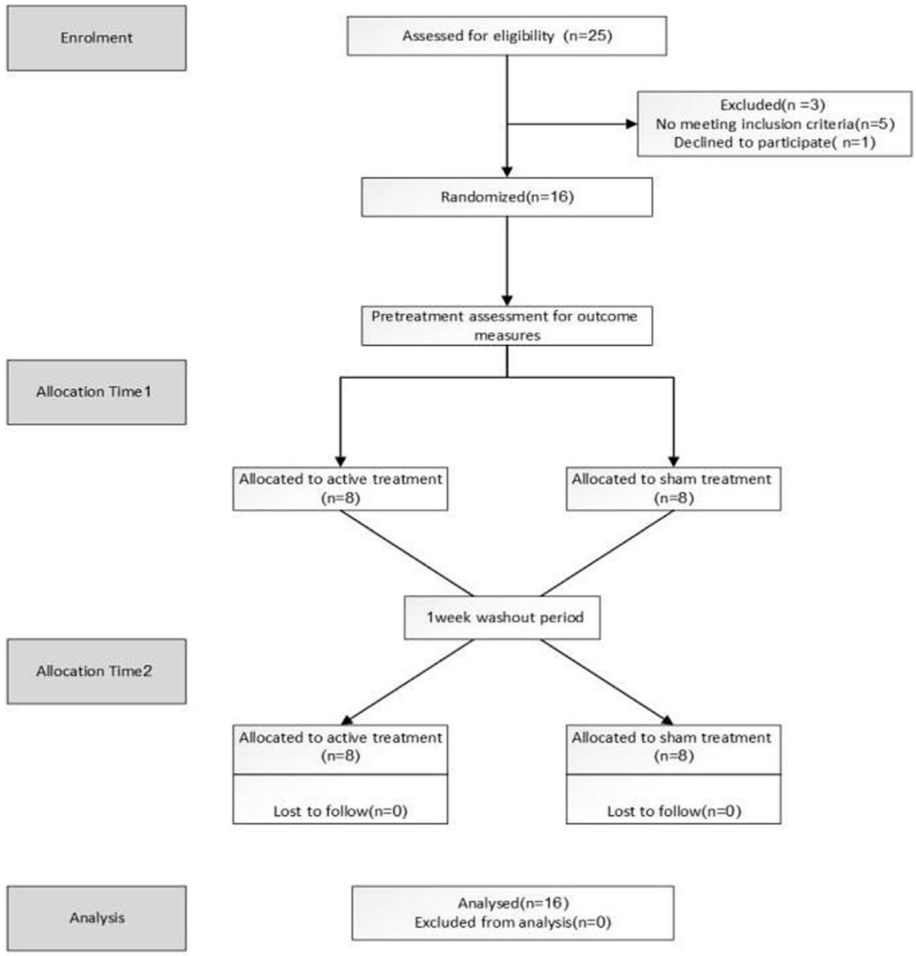

Fig. 1. Steps followed in the present research.

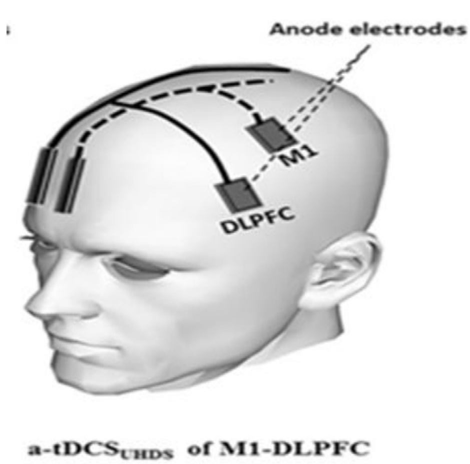

Fig. 2. Locations of electrodes (Vaseghi et al., 2015a,b).

disability, while the sham treatment showed no significant change ($p > 0.05$). Moreover, there was no significant difference between the two treatment conditions in terms of the depression level ($p > 0.05$).

3. Discussion

The present study showed that the Active-DLPFC-M_1 a-tDCS (UHCDs) technique, compared to the sham technique, decreases pain severity and improves the QOL and disability status in women with CPP.

The reduction in pain intensity was consistent with some previous studies (Cecilio et al., 2008; Fenton et al., 2009; Vaseghi et al., 2015a,b, b; Silva et al., 2017; Kanotkova, 2017, Rostami et al., 2015). In these studies commonly the tDCS (M1) technique was used but in the study by Cecilio et al, in addition to the M1, the S1 region was also stimulated unintentionally. Contrary to the previous studies in which the number of treatment sessions was 2–10 or more (Cecilio et al., 2008; Fenton et al., 2009; Vaseghi et al., 2015a,b; Silva et al., 2017; Kanotkova, 2017; Rostami et al., 2015), in the current study only the effects of one session were investigated.

Vaseghi et al. (2014) reported that a-tDCS on the DLPFC region had a greater effect than a-tDCS on M1 (Vaseghi et al., 2015a,b). In another study, authors suggested that simultaneous stimulation of these two regions would increase the excitability of the motor cortex, which is an important factor in reducing pain (Vaseghi et al., 2015a,b).

In the present study, simultaneous stimulation was performed on both of these areas and perhaps this was a factor influencing the effectiveness of a single treatment session. A-tDCS M1 leads to

Table 1
Average Values of clinical data before and after the intervention.

Group	Pre-test		Post-test	
Variables	Active	Sham	Active	Sham
number	16	16	16	16
Pain Score	6.12 ± 2.15	4.93 ± 3.043	3.06 ± 1.95	4.37 ± 2.52
QOL	193.3 ± 87.49	206.7 ± 80.43	208.93 ± 89.24	200.93 ± 78.70
Depression	10.43 ± 8.06	8.62 ± 8.21	10.06 ± 9.14	8.75 ± 7.96
Disability Status	30.37 ± 19.18	26.12 ± 13.99	22.37 ± 13.10	25 ± 12.81

Table 2
Between groups differences in main outcomes before and after interventions

Groups	Active		Sham	
Variables	Mean ± SD	P value	Mean ± SD	P value
pain Score	3.06 ± 1.69	0.0001*	0.56 ± 1.26	.95
QOL	−15.62 ± 20.4	.02*	.81 ± 38.51	.55
Depression	0.37 ± 3.8	.7	−0.12 ± 2.15	.8
Disability Status	8 ± 12.7	.02*	1.12 ± 9.58	.64

inhibition of pain by increasing the irritability of the M1, inhibiting external thalamic activity, controlling the somatosensory cortex, and increasing the level of opioids (Maeoka et al., 2012; Lauro et al., 2014; Parker et al., 2016; Cortese et al., 2017). Because of the relationship between the peripheral cortex of the left hemisphere and limbic structures, it could be effective in controlling the emotional aspect of pain. (Maeoka et al., 2012; Cortese et al., 2017). Anatomical based studies have also shown that the posterior part of the peripheral cortex passes a message to the M1 and the spinal cord receives input from the DLPFC (Kaya et al., 2013; Brawn et al., 2014).

Compared to the M1 stimulation, accompanying of the M1 and DLPFC (a-tDCS UHCDS M1 & DLPFC) stimulations may activate the DLPFC-premotor-primary motor path, increase M1 excitability and also reduce the GABAergic interneurons inhibitory function (Vaseghi et al., 2014; Vaseghi et al., 2015a,b; Silva et al., 2017; Kaya et al., 2013).

However, one study suggested that using both tDCS and TENS did not show a significant difference compared to TENS alone on pain score in patients with CPP or abdominal pain (Harvey et al., 2017). It is likely that the low number of samples and lack of a sham group are the possible reasons for this difference. Nevertheless, the recently published guidelines emphasizes caution in extensive use of this therapeutic method (Lefaucheur et al., 2017).

Similar to a previous study, our study revealed that one treatment session of the a-tDCS _UHCDC (M_1-DLPFC) improved the QOL in patients with CPP (Rostami et al., 2015). According to one study, the use of a-tDCS resulted in decreasing pain and improving QOL in people with fibromyalgia syndrome (Lefaucheur et al., 2017). This finding is compatible with those of other studies (Rostami et al., 2015; Mendonca et al., 2016; Mori et al., 2010). This has probably been the result of the effect of the treatment on the patients' pain level (Simis et al., 2015). However, Simis et al. reported no significant effect on the QOL among their CPP patients.

The severity of pain is closely associated with disability (Tripoli et al., 2011; Romão et al., 2009; Arnstein et al., 1999). Therefore, the application of a-tDCS $_{\mathrm{UHCDS}}$ (M1 and DLPFC) can result in a decrease in the pain level and improves the disability status.

There was no significant difference between the depression index between two shams and active treatment groups. This finding confirms the previous studies (Fenton et al., 2009). Since there are changes in the brain in the event of depression over time, there may be a need for more therapeutic sessions. (Liu et al., 2016).

The lack of using functional MRI to assess possible changes in the brain and long-term follow-up were the main limitations of the present study. More trials are needed to compare the potential effects of the present method with that of conventional tDCS. In conclusion, one session of the -tDCS $_{\mathrm{UHCDS}}$ (M1 and DLPFC) has a significant effect on pain score in patients suffering from CPP. Also, the stimulation of M1 and DLPFC of the same hemisphere with two separated tDCS devices seems a safe method for the management of CPP.

Funding

The present study was financially supported by the School of Rehabilitation, Shahid Beheshti University of Medical Sciences, Tehran, Iran. Grant Number: 10010.

Acknowledgments

The authors would like to express their thanks to the women who participated in the study.

References

ACOG Committee on Practice Bulletins-Gynecology, 2004. ACOG Practice Bulletin No. 51. Chronic pelvic pain. Obstet. Gynecol. 103 (3), 589–605.
Ahangari, A., 2014. Prevalence of chronic pelvic pain among women: an updated review. Pain Physician 17, E141eE147.
Arnold, L.D., Bachmann, G.A., Kelly, S., Rosen, R., Rhoads, G.G., 2006. Vulvodynia: characteristics and associations with co-morbidities and quality of life. Obstet. Gynecol. 107 (3), 617.
Arnstein, P., Caudill, M., Mandle, C.L., Norris, A., Beasley, R., 1999. Self-efficacy as a mediator of the relationship between pain intensity, disability and depression in chronic pain patients. Pain 80 (3), 483–491.
Baradaran, A., Ebrahimzadeh, M.H., Birjandinejad, A., Kachooei, A.R., 2016. Cross-cultural adaptation, validation, and reliability testing of the Modified Oswestry Disability Questionnaire in Persian population with low back pain. Anim. Sci. J. 10 (2), 215–219.
Brawn, J., Morotti, M., Zondervan, K.T., Becker, C.M., Vincent, K., 2014. Central changes associated with chronic pelvic pain and endometriosis. Hum. Reprod. Update 20 (5), 737–747.
Brunoni, A.R., Ferrucci, R., Bortolomasi, M., Vergari, M., Tadini, L., Boggio, P.S., Giacopuzzi, M., Barbieri, S., Priori, A., 2011. Transcranial direct current stimulation (tDCS) in unipolar vs. bipolar depressive disorder. Prog. Neuro Psychopharmacol. Biol. Psychiatr. 35 (1), 96–101.
Cecilio, S.B., Zaghi, S., Cecilio, L.B., Correa, C.F., Fregni, F., 2008. Exploring a novel therapeutic approach with noninvasive cortical stimulation for vulvodynia. Am. J. Obstet. Gynecol. 199 (6), e6–e7.
Cortese, A.M., de Heredia, L.L., Belci, M., 2017. Effects of transcranial direct current stimulation (tDCS) on chronic pain in spinal cord injured patients. Skin Res. 3 (1).
Dadfar, M., Kalibatseva, Z., 2016. Psychometric properties of the Persian version of the short beck depression inventory with Iranian psychiatric outpatients. Sci. Tech. Rep. 2016.
Dehghan, F.M., Ghanbari, Z., Frootan, M., Moshtaghi, Z., 2009. Chronic Pelvic Pain frequency among a group of Iranian employed women. (in Persian)Tehran University of Medical Sciences 66 (10).
Dehghan, F.M., Miri, E.A., Roostaie, M.M., Ghanbari, Z., Akbarzadeh, A., 2014. Chronic pelvic pain in women attending the pelvic floor clinic at Imam Khomeini Hospital (in Persian). Behzisti Univ. Rehabil. J 15, 42e50.
Engeler, D.S., Baranowski, A.P., Dinis-Oliveira, P., Elneil, S., Hughes, J., Messelink, E.J., van Ophoven, A., Williams, A.C., 2013. The 2013 EAU guidelines on chronic pelvic pain: is management of chronic pelvic pain a habit, a philosophy, or a science? 10 years of development. Eur. Urol. 64 (3), 431–439.
Fenton, B.W., Palmieri, P.A., Boggio, P., Fanning, J., Fregni, F., 2009. A preliminary study of transcranial direct current stimulation for the treatment of refractory

chronic pelvic pain. Brain Sci. 2 (2), 103–107.
Giordano, J., Bikson, M., Kappenman, E.S., Clark, V.P., Coslett, H.B., Hamblin, M.R., Hamilton, R., Jankord, R., Kozumbo, W.J., McKinley, R.A., Nitsche, M.A., 2017. Mechanisms and effects of transcranial direct current stimulation. Dose-Response 15 (1), 1559325816685467.
Harvey, M.P., Watier, A., Rouleau, É.D., Léonard, G., 2017. Non-invasive stimulation techniques to relieve abdominal/pelvic pain: is more always better? World J. Gastroenterol. 23 (20), 3758.
Hojat, M., Shapurian, R., Mehryar, A.H., 1986. Psychometric properties of a Persian version of the short form of the Beck Depression Inventory for Iranian college students. Psychol. Rep. 59 (1), 331–338.
Howard, F.M., 2003. Chronic pelvic pain. Obstet. Gynecol. 101, 594–611.
Kanotkova, H., 2017. Evidence-based review of transcranial direct current stimulation (tDCS) for chronic pain syndromes. Brain Sci.: Basic, Translational, and Clinical Research in Neuromodulation 10, 403.
Kaya, S., Hermans, L., Willems, T., Roussel, N., Meeus, M., 2013. Central sensitization in urogynecological chronic pelvic pain: a systematic literature review. Pain Physician 16 (4), 291–308.
Latthe, P., Latthe, M., Say, L., Gülmezoglu, M., Khan, K.S., 2006. WHO systematic review of prevalence of chronic pelvic pain: neglected reproductive health morbidity. BMC Publ. Health 6 (1), 177.
Lauro, L.J.R., Rosanova, M., Mattavelli, G., Convento, S., Pisoni, A., Opitz, A., Bolognini, N., Vallar, G., 2014. TDCS increases cortical excitability: direct evidence from TMS–EEG. Cortex 58, 99–111.
Lefaucheur, J.P., Antal, A., Ayache, S.S., Benninger, D.H., Brunelin, J., Cogiamanian, F., Cotelli, M., De Ridder, D., Ferrucci, R., Langguth, B., Marangolo, P., 2017. Evidence-based guidelines on the therapeutic use of transcranial direct current stimulation (tDCS). Clin. Neurophysiol. 128 (1), 56–92.
Liu, A., Bryant, A., Jefferson, A., Friedman, D., Minhas, P., Barnard, S., Barr, W., Thesen, T., O'Connor, M., Shafi, M., Herman, S., 2016. Exploring the efficacy of a 5-day course of transcranial direct current stimulation (TDCS) on depression and memory function in patients with well-controlled temporal lobe epilepsy. Epilepsy Behav. 55, 11–20.
Maeoka, H., Matsuo, A., Hiyamizu, M., Morioka, S., Ando, H., 2012. Influence of transcranial direct current stimulation of the dorsolateral prefrontal cortex on pain related emotions: a study using electroencephalographic power spectrum analysis. Neurosci. Lett. 512 (1), 12–16.
Mendonca, M.E., Simis, M., Grecco, L.C., Battistella, L.R., Baptista, A.F., Fregni, F., 2016. Transcranial direct current stimulation combined with aerobic exercise to optimize analgesic responses in fibromyalgia: a randomized placebo-controlled clinical trial. Front. Hum. Neurosci. 10, 68.
Mori, F., Codecà, C., Kusayanagi, H., Monteleone, F., Buttari, F., Fiore, S., Bernardi, G., Koch, G., Centonze, D., 2010. Effects of anodal transcranial direct current stimulation on chronic neuropathic pain in patients with multiple sclerosis. J. Pain 11 (5), 436–442.
Mousavi, S.J., Parnianpour, M., Mehdian, H., Montazeri, A., Mobini, B., 2006. The Oswestry disability index, the Roland-Morris disability questionnaire, and the Quebec back pain disability scale: translation and validation studies of the Iranian versions. Spine 31 (14), E454–E459.
Mungee, A., Burger, M., Bajbouj, M., 2016. No effect of cathodal transcranial direct current stimulation on fear memory in healthy human subjects. Brain Sci. 6 (4), 55.
Nedjat, S., Montazeri, A., Holakouie, K., Mohammad, K., Majdzadeh, R., 2008. Psychometric properties of the iranian interview-administered version of the world health Organization's quality of life questionnaire (WHOQOL-BREF): a population-based study. BMC Health Serv. Res. 8 (1), 61.
O'Connell, N.E., Wand, B.M., Marston, L., Spencer, S., DeSouza, L.H., 2010. Non-invasive brain stimulation techniques for chronic pain. Cochrane Database Syst. Rev. 9.
Parker, R.S., Lewis, G.N., Rice, D.A., McNair, P.J., 2016. Is motor cortical excitability altered in people with chronic pain? A systematic review and meta-analysis. Brain Sci. 9 (4), 488–500.
Poreisz, C., Boros, K., Antal, A., Paulus, W., 2007. Safety aspects of transcranial direct current stimulation concerning healthy subjects and patients. Brain Res. Bull. 72 (4), 208–214.
Rostami, R., Badran, B.W., Kazemi, R., Habibnezhad, M., George, M.S., 2015. Long-lasting analgesic effect of transcranial direct current stimulation in treatment of chronic endometriosis pain. J. Obstet. Gynaecol. Res. 41 (12), 1998–2001.
Romão, A.P.M.S., Gorayeb, R., Romao, G.S., Poli-Neto, O.B., Dos Reis, F.J.C., Rosa-e-Silva, J.C., Nogueira, A.A., 2009. High levels of anxiety and depression have a negative effect on quality of life of women with chronic pelvic pain. Int. J. Clin. Pract. 63 (5), 707–711.
Sankarasubramanian, V., Cunningham, D.A., Potter-Baker, K.A., Beall, E.B., Roelle, S.M., Varnerin, N.M., Machado, A.G., Jones, S.E., Lowe, M.J., Plow, E.B., 2017. Transcranial direct current stimulation targeting primary motor versus dorsolateral prefrontal cortices: proof-of-concept study investigating functional connectivity of thalamocortical networks specific to sensory-affective information processing. Brain Connect. 7 (3), 182–196.
Savidge, C.J., Slade, P., 1997. Psychological aspects of chronic pelvic pain. J. Psychosom. Res. 42 (5), 433–444.
Sedighimehr, N., Manshadi, F.D., Shokouhi, N., Baghban, A.A., 2017. Pelvic musculoskeletal dysfunctions in women with and without chronic pelvic pain. J. Bodyw. Mov. Ther. https://doi.org/10.1016/j.jbmt.2017.05.001.
Silva, A.F., Zortea, M., Carvalho, S., Leite, J., da Silva Torres, I.L., Fregni, F., Caumo, W., 2017. Anodal transcranial direct current stimulation over the left dorsolateral prefrontal cortex modulates attention and pain in fibromyalgia: randomized clinical trial. Sci. Rep. 7.
Simis, M., Reidler, J.S., Duarte Macea, D., Moreno Duarte, I., Wang, X., Lenkinski, R., Petrozza, J.C., Fregni, F., 2015. Investigation of central nervous system dysfunction in chronic pelvic pain using magnetic resonance spectroscopy and noninvasive brain stimulation. Pain Pract. 15 (5), 423–432.
Tripoli, T.M., Sato, H., Sartori, M.G., de Araujo, F.F., Girão, M.J., Schor, E., 2011. Evaluation of quality of life and sexual satisfaction in women suffering from chronic pelvic pain with or without endometriosis. J. Sex. Med. 8 (2), 497–503.
Vaseghi, B., Zoghi, M., Jaberzadeh, S., 2014. Does anodal transcranial direct current stimulation modulate sensory perception and pain? A meta-analysis study. Clin. Neurophysiol. 125 (9), 1847–1858.
Vaseghi, B., Zoghi, M., Jaberzadeh, S., 2015a. A meta-analysis of site-specific effects of cathodal transcranial direct current stimulation on sensory perception and pain. PLoS One 10 (5), e0123873.
Vaseghi, B., Zoghi, M., Jaberzadeh, S., 2015b. The effects of anodal-tDCS on corticospinal excitability enhancement and its after-effects: conventional vs. unihemispheric concurrent dual-site stimulation. Front. Hum. Neurosci. 9, 533.
Whitaker, L.H., Reid, J., Choa, A., McFee, S., Seretny, M., Wilson, J., Elton, R.A., Vincent, K., Horne, A.W., 2016. An exploratory study into objective and reported characteristics of neuropathic pain in women with chronic pelvic pain. PLoS One 11 (4), e0151950.
Zaghi, S., Heine, N., Fregni, F., 2009. Brain stimulation for the treatment of pain: a review of costs, clinical effects, and mechanisms of treatment for three different central neuromodulatory approaches. J. Pensions Manag. 2 (3), 339.
Zondervan, K.T., Yudkin, P.L., Vessey, M.P., Jenkinson, C.P., Dawes, M.G., Barlow, D.H., Kennedy, S.H., 2001. Chronic pelvic pain in the community—symptoms, investigations, and diagnoses. Am. J. Obstet. Gynecol. 184 (6), 1149–1155.