International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Effect of Combine Cortical and Back Muscle Stimulation in Non Specific Chronic Low Back Pain

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Abstract: ***Objective: The purpose of this study is to determine the effect of combine cortical and back muscle stimulation in chronic non specific low back pain (CLBP). Design And Setting: within group clinical trial in the Physiotherapy Department of Sir Muhammad Sunusi Specialist Hospital, Kano, Nigeria. Methods: A total of Forty eight patients were recruited and assigned into four groups, which include group that received infrared therapy (IRT) and a session soft tissue massage (STM) only, combine dorsolateral prefrontal cortex (DLPFC) and Back muscle stimulation plus IRT and STM, combine primary motor cortex (PMC) and Back muscle stimulations plus IRT and STM and finally Williams flexion exercise plus IRT and STM. The primary outcome (level of pain intensity) was assessed using visual analogue scale (VAS) while bothersome questionnaire (secondary outcome) was used to assess the level of bothersome of the participants. Result: Statistical analysis revealed that all the interventions are significant at (P=0.002, Z=-3.16) combine PMC and back muscle stimulation, (P=0.007, Z=-2.71) combine DLPFC and Back muscle stimulation, (P=0.005, Z=-2.83) William flexion exercise and (P=0.005, Z=-2.83) control group respectively. Conclusion: It is concluded that combine brain and back muscle is effective in the treatment of non specific CLBP, and that combine PMC and back muscle stimulation is more effect in reduction of pain than combine DLPFC and Back muscle stimulation. This result cannot be generalized because of the small sample size and sampling technique used in grouping the participants.***

Keywords: Transcranial Direct Current Stimulation, Primary Motor Cortex, Dorsolateral Prefrontal Cortex and Chronic Low Back Pain

1. Introduction

Non Specific chronic low back pain (CLBP) is a heavy pain that worsened with exertion especially in the afternoon, and relieved with rest (Neil et al, 2013). It is not associated with tissue damage but serve as a major cause of medical expenses, absenteeism and disability in developed nations (Maurits et al, 2000), with average one year prevalence and lifetime prevalence of 33%, 50%, 36% and 62% among adolescents and adults in Africa respectively (Quinette et al, 2007). Neuroimaging studies revealed a neuroplastic changes in the brain of CLBP survivors which contribute to the development of chronic pain state (Apkarian et al., 2009; Tracey & Bushnell 2009). Moreover, it shows decreased cortical thickness in several regions of their brain including the left dorsolateral prefrontal cortex (DLPFC), left somatosensory cortex, and right anterior cingulated cortex (Seminowicz et al., 2011). Successful treatment was associated with increased cortical thickness mostly in left DLPFC. Thus, suggesting that structural changes in chronic pain are at least partially reversible in this region and irreversible in other area of the brain (Seminowicz et al 2011).

Noninvasive brain stimulation such as repetitive transcranial magnetic stimulation (rTMS) and transcranial direct current stimulation (TDCS) are seen to reduces pain and disability by altering the activity of brain neurons specific to the site of application and the parameters used (Lefaucheur, 2008). TDCS led to a decrease in the intracortical inhibition in a group of patients with CLBP and other painful conditions with mixed origin (Antal, Terney, Kuhnl & Paulus 2010). Pascual-Leone et al., (2010); Antal, Terney, Kuhnl and Paulus (2010) revealed from current systematic review of chronic pain that anodal TDCS had a pain reducing effect in patients with chronic pelvic pain, fibromalgia, spinal cord injury, CLBP and various chronic conditions.

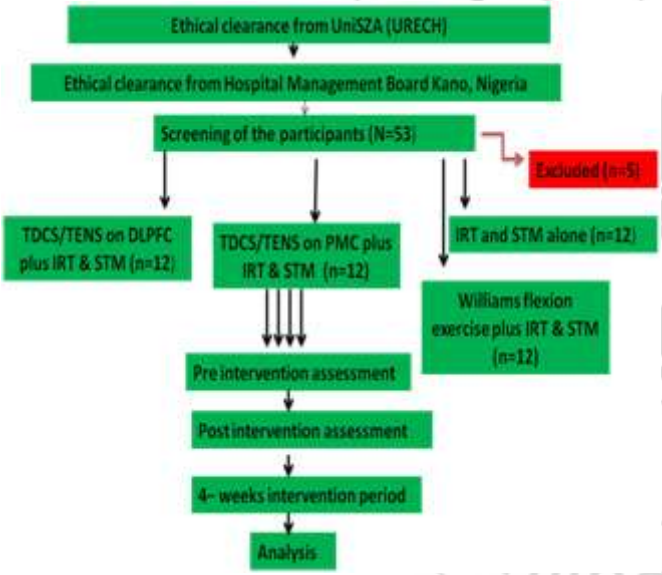
The advantage of TDCS over other noninvasive brain stimulation technique such as rTMS is that apart of being cost effective, pain free and safety, the sham treatment was indistinguishable from the active treatment during implementation (Gandiga, Hummel & Cohen 2006). Antal, Terney, Kuhnl and Paulus (2010) reported that TDCS modulate neural activities in the stimulated and interconnected regions compared with TMS which generate magnetic field that was associated with some adverse effect such as fainting, seizure, transient hearing loss and discomfort.

Transcutaneous electrical nerve stimulation (TENS) is another form of noninvasive therapy that is widely used in variety of pain syndrome (Carroll et al., 2002). High frequency and low intensity TENS proves to be more effective than low frequency and high intensity TENS in CLBP (Chesterton et al., 2002). APTA (1993); Barr (1999); Deyo (1990); Sluka (2003) revealed that TENS machine are capable of being self-administered and stimulate peripheral nerves via skin surface electrodes at well-tolerated intensities. Base on the literature search, study of combine effects of brain and back muscle stimulations in chronic low back pain seem to be scarce. Likewise, of the few studies that were available no comparison was made between the different cortical regions. Therefore this study aim to determine effects of combine TDCS and back muscle stimulations on two different cortical regions.

2. Methodology

Subjects

G- power software was used to calculate the sample size with α = 0.05 (5% chance of type I error), 1- β = 0.80 (power 80%), and effect size of δ = 1.21. This provided sample size of n = 48. The screening criteria was that, the subjects have to meet the following: age between 18-65 years, complaining of back pain for more than three months with baseline rating of 4 on VAS and Seeking care for low back pain, while those with an evidence of specific spinal pathology (fracture, neoplasm, deformity and spinal infections), history of spinal surgery, known neurological disease, used of pacemaker or metallic implant, identifiable psychotic illness or other mental illness, pregnancy, involvement in any other ongoing research project relating to low back pain was excluded from the study. The study included 3-days pre-intervention period of baseline assessment, followed by four week intervention period and 3-days follow-up period for the post intervention assessment. Detail of the study framework is summarized below:



The study was carried out at Sir Muhammad Sunusi Specialist Hospital Kano, Nigeria; after the ethical clearance for the conduct of the study was received from Universiti Sultan Zainal Abidin, Malaysia. A convenient sample technique was use to recruits and assigned the patients into one of the four groups: PMCS/TENS plus IRT & RSTM (n=12), DLPFCS/TENS plus IRT & RSTM (n=12), Williams's flexion exercise plus IRT & RSTM (n=12) and control (n=12). The study protocol was fully explained to all the participants, and a written consent form was signed after having understood the detail of the experiment.

3. Procedures and Instrumentation

Primary Outcome Parameter

The level pain intensity of all the participants was assess and serve as the primary outcome measure of the study. Visual analog scales (VAS) was used to assess the pain. Each subject was instructed to mark the intensity of his/her pain on a 10m stick without any gradation (Gould et al., 2001). Subjects marked the intensity as 0 points when they experienced no pain, and severe pain was given 10 points. The scores were presented as follows: 0-3 = mild pain, 4-6 = moderate pain, 7-10 = severe pain (Kelly, 2001). The inter-rater reliability of this tool is 0.55-0.97, and the reliability within each rater is 0.69-0.91 (Taddio et al, 2009).

Secondary Outcome Parameter

A global score of "bothersomeness" was used as the secondary outcome measure. This is a single question ("how bothersome is your pain today?") tool which is measure on a 5 point likert scale of 'not at all', 'slightly', 'moderately', 'very much' and 'extremely' bothered (Dunn and Croft, 2005).

Combine Stimulation

International 10-20% EEG system was applied to locate the position of PMC and DLPFC for all the participants (O'Connell et al, 2007) as indicated in the figure below. The TDCS machine has anodal and cathodal arm for both stimulatory and inhibitory function. In this study the anodal arm was used as the active electrode while the cathodal arm was used as the reference electrode.

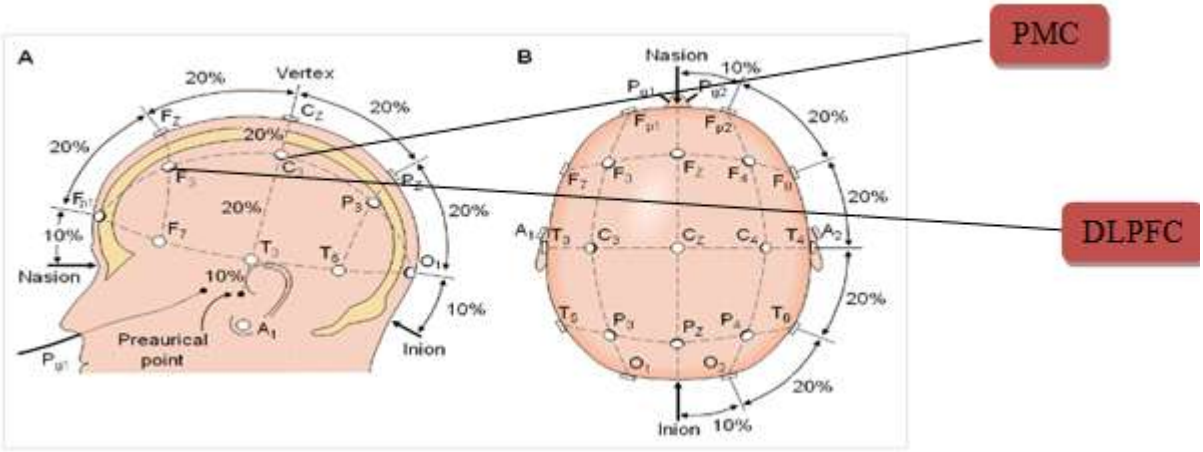


Figure A: location of PMN and DLPFC using 10/20 EEG system

Combine Primary Motor Cortex and Back Muscle Stimulation

Patients were told to assume seating position. The anode electrode was placed over the primary motor cortex of the patients, that is at a point 1 cm anterior and 4 cm lateral to the cortical vertex, which correspond to C3/C4 in EEG system (O'Connell et al, 2007). In the other hand, to complete the circuit the cathode electrode was attached over the contralateral supraorbital region. All the electrodes were secured with soft elastic straps.

Subjects whose pain is predominantly on one side of their back, the contralateral hemisphere was used to stimulate the primary motor cortex, while for those whose pain is dispersed, the hemisphere contralateral to the subject's self-nominated dominant hand was used. This is in consistent with previous clinical studies (Fregn et al., 2006; Gimenes et al., 2006). In addition high frequency and low intensity TENS electrode was placed at the painful site of the paravetebral muscle and both the stimulations lasted for 13min. The patients also received additional 15min of infrared therapy and a session of soft tissue massage (STM) after the stimulations.

Combine Dorsolateral Prefrontal Cortex and Back Muscle Stimulation

The subjects in this group also assume sitting position. The anode electrode was placed at the left cerebral cortex (F3) at 5cm anterior to PMC location (C3/C4) 10/20 EEG system. TENS electrode was also applied at the painful site of the back muscle followed by 15min IRT and RSTM after the stimulation.

The two other groups that serve as control are conventional physiotherapy group that received 15minute of IRT & RSTM alone and the William flexion exercise group that received both six set of William flexion exercise and 15minute of IRT & RSTM respectively. All the participants in each group received the treatment twice a week for period of four weeks.

4. Statistical Analysis

Wilcoxan signed rank test was used to determine the within group statistical difference of each of the intervention. The statistical analysis was conducted using the Statistical Package for the Social Sciences (SPSS) 20.0 version at p-value 0.05.

5. Ethical Aspects

The study has been approved by the ethics committee of the Kano state Hospital management board, Nigeria (responsible body for studies conducted on patients in the region of Kano). Ethical approval to start the study was provided by the university ethics committee at the Universiti Sultan Zainal Abidin, Malaysia.

6. Results

A total of 48 participants with chronic non specific low back pain participated in the study, out of which 12 participants were allocated to four different intervention groups. Findings from table 1 below revealed a statistical significant median difference of pain intensity in all the four groups. Likewise, statistical significant median difference of bothersome index was seen among the participants that received combine DLPFC and back muscle stimulation and control (IRT and STM alone) respectively.

Table 4.3: Effectiveness of the Studied Interventions

Interventions	*Median (IQR)*			
	Pre-test	*Post-test*	*Z-start*[a]	*P-value*
Pain intensity				
Williams flexion execise plus IRT & STM	-	1(3)	-2.83	**0.005**
PMC/Back muscle stimulation plus IRT & STM	4(0)	1(3)	-3.16	**0.002**
DLPFC/Back muscle stimulation plus IRT & STM	4(0)	1(3)	-2.71	**0.007**
Control	4(2)	4(3)	-2.83	**0.005**
Bothersome				
Williams flexion exercise plus IRT & STM	2.5(2)	2(1)	-0.97	0.331
PMC/Back muscle stimulation plus IRT & STM	2.5(1)	2(1)	-1.00	0.317
DLPFC/Back muscle stimulation plus IRT & STM	2.5(1)	2(2)	-2.11	**0.035**
Control	3.5(2)	3(2)	-2.11	**0.035**

[a]Wilcoxon signed rank test, IqR= interquatile range, PMC= primary motor cortex, DLPFC= Dorsolateral prefrontal cortex, IRT= infrared therapy, STM= soft tissue massage

7. Discussion

The small sample size used in this study was similar to that of the study conducted by Antal et al., (2010) on ameliorating effect of transcranial direct current stimulation in chronic low back pain. On the other hand it was in contrast with the study conducted by Neil et al., (2014) on the effect of TDCS in non specific chronic low back pain, which has very small sample size compare to this study.

Statistical significant median difference of pain intensity was revealed in all the interventions at (P=0.002, Z=-3.16) combine PMC and back muscle stimulation, (P=0.007, Z=-2.71) combine DLPFC and Back muscle stimulation,

(P=0.005, Z=-2.83) William flexion exercise and (P=0.005, Z=-2.83) control group respectively. The participants that received combine PMC and back muscle stimulation have much reduction of pain intensity compare to other groups. The result was similar with the study conducted by Schabrun et al, (2014) in which significant reduction was seen among the patients that received PMC/Back muscle stimulation. Participants in the combine DLPFC and Back muscle stimulation and the control group were reported to have statistical significant reduction of level of bothersome (P=0.035, Z=-2.11) compare to those that received combine PMC and back muscle stimulation. This could be attributed to individual perception of pain and that DLPFC mostly concerned with the perception aspect of pain.

8. Conclusion

The outcome of the study revealed that combine brain and peripheral stimulation has an impact on pain perception in CLBP. Moreover, both the combine DLPFC/back muscle stimulation and PMC/back muscle stimulation are effective in CLBP, with the later been more effective. The result cannot be generalize because of the small sample size and design used in this study.

9. Acknowledgment

Alhamdulillah, I wish to thank Kano State Government, my parent and my uncle for the courage and support in the smooth conduct of the study. I also like to extend my appreciation to the Dean Faculty of Medicine, Universiti Sultan Zainal Abidin in person of Professor Nordin bn Simbak, who happen to be my supervisor for his advice and corrections during the course of the study. Likewise, I wish to thank all the participants that were very active at all time during the course of the study.

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