have been reported for lumbar back muscles in CLBP survivors [19] leading to a decrease corticospinal drive to these muscles.

3. Clinical Implications of Neuroplastic Changes in CLBP

The clinical implications of an altered brain state are far from being understood [20]- [21]. Three important observations that have to be considered by the therapist in the management of CLBP are:

Altered Body Perception

Distortions of cortical representation of the body affect the body perception in CLBP [22] -[24]. Its difficult to the patients to identify letter that are traced on their back [22] , posess poor tactile acuity [25], difficult to delineate the outline of their back when asked to complete a drawing of how it feels [25]. Moreover, in some cases patients reported that they no longer considered their back as being part of them and can not be controlled automatically [26].

Psychological and Cognitive Effects

Chronic low back patients have impaired task designed to assess emotional decision making with performance negatively related to pain intensity [9]. Significant impairments in memory, language skills, mental flexibility and reduced ability to shift attention away from pictures of physical activities associated with the threat of back injury were seen in CLBP survivors [27]- [28]. Moreover, distraction increases pain tolerance and threshold in healthy controls compared with CLBP patients [29]. Psychological manifestations of CLBP are undoubtedly multifaceted and likely to be influenced by a variety of inputs, brain changes may need to be considered as an additional contributor to psychological dysfunction [29].

Increased Response to Noxious Stimuli

Chronic low back survivors exhibit sensitivity changes away from the back which implicate cortical rather than peripheral or spinal mechanisms [30]. The patients had lower mechanical pain thresholds over the lumbar spine, thumb nail and a combination of sites remote to the lumbar spine compared to healthy controls [13], [14], [30], [31]-[32].

Diffuse tenderness is considered to reflect disturbed nociceptive regulation rather than spinal pathology [32]. It is likely that part of the pain experience by CLBP survivors is mediated by sensitivity changes within the central nervous system due to neuronal plasticity [33]. This is important because a number of manual therapies are thought to mediate their analgesic effects via descending antinociception [33].

Effect of Transcranial Direct Current Stimulation in CLBP

Table 2.8 and 2.9 summarized the reviews of combine TDCS/TENS and TDCS in chronic pain. Significant improvement of pain when combine with cognitive behavioral therapy was seen in a study on the effect of anodal transcranial direct current stimulation of primary motor cortex in CLBP [34]. A similar finding was reported in patients with other chronic pain syndrome such as trigeminal neuralgia and poststroke pain [35]. Likewise, a similar findings was reported from an exploratory study [21] with limited sample size, which prevents the generalization of their result.

Comparative study of combine TDCS/TENS and TDCS revealed a significant reduction of pain among the subjects in the group that received combine TDCS/TENS stimulation compare to those in the TDCS group [36]. Negative finding was revealed in a study in which the patients received a single session of TDCS [37]. Base on the literature search for the present study there is paucity of a study that correlate the effect of combine TDCS/TENS and conventional therapy. Moreover, in most of the studies search, primary motor cortex is used as the primary site of electrode placement.

Table 1: Positive Findings Using Transcranial Direct Current Stimulations

Author's Name	Title of study	Technique	Year	Site of stimulation	Parameters of stimulation	N	cause of pain	Results	Type of study
Kerstin Luedtke, Alison Rushton Christine Wright, Tim P Juergens, Gerd Mueller and Arne May	*Effectiveness of anodal transcranial direct current stimulation in patients with chronic low back pain: Design, method and protocol for a randomised controlled trial*	TDCS and Congnitive behavioral therapy (CBT)	2011	PMC	20min, 2mA, 5days stimulation and 4, 12 and 24 week follow up for CBT	135	CLBP	Significant combine with CBT	double blind sham control trial
Antal A, Terney D, Kühnl S and Paulus W.	*Anodal transcranial direct current stimulation of the motor cortex ameliorates chronic pain and reduces short intracortical inhibition.*	TDCS	2010	PMC	20min, 2mA, 5dapys stimulation	12	Trigemnal neuralgia, poststroke pain syndrome, back pain and fibromyalgia	Significant	Exploratory study

Schabrun SM, Jones E, Elgueta Cancino EL and Hodges PW	*Targeting chronic recurrent low back pain from the top-down and the bottom-up: a combined transcranial direct current stimulation and peripheral electrical stimulation intervention.*	TDCS, TENS	2014	PMC	20min, 2mA, 3days stimulation	16	CLBP	Significant	Crossover design

Table 2: Negative Findings Using Transcranial Direct Current Stimulations

Author's Name	Title of study	echnique	Year	Site of stimulation	Parameters of stimulation	N	ause of pain	Results	Type of study
Kerstin Luedtke, Arne May and Tim P. Jurgens	No Effect of a Single Session of Transcranial Direct Current Stimulation on Experimentally Induced Pain in Patients with hronic Low Back Pain – An Exploratory Study	Single session of TDCS	2012	PMC	15min, 1mA	15	CLBP	No significant alteration due to nature of the treatment	Exploratory Study
Neil E. O'Connell, John Cossar, Louise Marston, Benedict M. Wand, David Bunce, Lorraine H. De Souza, David W. Maskill, MPhil, Andrew Sharp, and G. Lorimer Moseley	Transcranial Direct Current Stimulation of the Motor Cortex in the Treatment of Chronic Nonspecific Low Back Pain A Randomized, Double-blind Exploratory Study	TDCS	2013	PMC	20min, 2MA for 15days	8	CLBP	Significant but cannot be generalize due to small sample size	Exploratory Study

4. Conclusion

There have been evidence suggesting the effectiveness of non invasive brain stimulation in management of chronic pain, while in some cases proves more effective when combine with peripheral stimulation. TDCS is safe, cost effective, easy to blind compare to other non invasive brain stimulation technique. Therapist and researchers need to explored more in this area, looking at the burden and level disability associated with chronic low back pain.

5. Acknowledgment

Alhamdulillah, I wish to thank Kano state government for the courage and support in the smooth conduct of this review. Also to my able supervisor professor Nordin bn Simbak Dean Faculty of Medicine, Universiti Sultan Zainal Abidin, Kuala Terrengganu Malaysia for his kindly advice and corrections during the course of written this review.

References

[1] Neil, E.C., John, C., Louise, M., Benedict, M. W., David, B., Lorraine, H.D., David, W.M., Andrew, S., &Lorimer, M. (2013). "Transcranial direct current stimulation of the motor cortex in the treatment of chronic nonspecific low back pain: a randomized, double-blind exploratory study", J of Pain, 29 pp26-34.

[2] van Tulder, M. W., Koes, B., & Malmivaara, A (2006). "Outcome of non-invasive treatment modalities on back pain: an evidence-based review", European Spine Journal, 15 pp64-81.

[3] Quinette, A.L., Linzette, D.M., & Karen G. (2007). "The prevalence of low back pain in Africa: a systematic review", BMC Musculoskeletal Disorders, 105.

[4] . Larsson, B., Bjork, J., Borsbo, B., & Gerdle, B (2012). "A systematic review of risk factors associated with transitioning from regional musculoskeletal pain to chronic widespread pain", Eur J Pain, 16 pp1084–1093.

[5] Robinson, J.P., & Apkarian, A.V (2009). Low back pain. In: Mayer EA, Bushnell MC, editors. Functional pain syndromes: presentation and pathophysiology", Seattle IASP Press, pp23-53.

[6] Grachev, I.D., Fredrickson, B.E., & Apkarian, A.V (2000). "Abnormal brain chemistry in chronic back pain: an in vivo proton magnetic resonance spectroscopy study", Pain, 89 (1) pp7-18.

[7] Siddall, P.J., Stanwell, P., Woodhouse, A., Somorjai, R.L., Dolenko, B., & Nikulin, A (2006). "Magnetic resonance spectroscopy detects biochemical changes in the brain associated with chronic low back pain: a preliminary report", Anesthesia and Analgesia, 102(4) pp1164-8.

[8] Schmidt, W.T., Leinisch, E.,Ganssbauer, S., Draganski, B., Bogdahn, U., & Altmeppen, J (2006). "Affectivecomponents and intensity of pain correlate

with structural differencesin gray matter in chronic back pain patients", Pain, 125(12) pp89-97.

[9] Apkarian, A.V., Sosa, Y., Sonty, S., Levy, R.M., Harden, R.N., & Parrish, T.B (2004). "Chronic back pain is associated with decreased prefrontal and thalamic gray matter density", The Journal of Neuroscience, 24(46) pp10410-5.

[10] Antal, A., Kincses, T.Z., Nitsche, M.A., & Paulus, W (2003). "Manipulation of phosphene thresholds by transcranial direct current stimulation in man", Exp Brain Res, 150(3) pp375:378.

[11] Buckalew, N., Haut, M.W., Morrow, L., & Weiner, D (2008). "Chronic pain is associated with brain volume loss in older adults: preliminary evidence", Pain Medicine, 9(2) pp240-8.

[12] Gauthier, L.V., Taub, E., Perkins, C., Ortmann, M., Mark, V.W., & Uswatte, G (2008). "Remodeling the brain: plastic structural brain changes produced by different motor therapies after stroke", Stroke, 39(5); pp1520-5

[13] Flor, H., Braun, C., Elbert, T., Birbaumer, N (1997). "Extensive reorganization of primary somatosensory cortex in chronic back pain patients", Neuroscience Letters, 224(1) pp5-8.

[14] Giesecke, T., Gracely, R.H., Clauw, D.J., Nachemson, A., Duck, M.H., & Sabatowski, R (2006). "Central pain processing in chronic low back pain", Evidence for reduced pain inhibition, 20(5) pp411.

[15] Kobayashi, Y., Kurata, J., Sekiguchi, M., Kokubun, M., Akaishizawa, T., & Chiba, Y (2009). "Augmented cerebral activation by lumbar mechanical stimulus in chronic low back pain patients", Spine, 34(22) pp2431.

[16] Wolpert, D.M., Ghahramani, Z., Flanagan, J.R (2001). "Perspectives and problems in motor learning", Trends in Cognitive Sciences, 5(11) pp487-94.

[17] Tsao, H., Galea, M.P., & Hodges, P.W (2008). "Reorganization of the motor cortex is associated with postural control deficits in recurrent low back pain", Brain: A Journal of Neurology, 131(8) pp2161-71.

[18] Jacobs, J.V., Henry, S.M., Nagle, K.J (2010). "Low back pain associates with altered activity of the cerebral cortex prior to arm movements that require postural adjustment", Clinical Neurophysiology, 121(3); pp431-40.

[19] Strutton, P.H., Theodorou, S., Catley, M., McGregor, A.H., Davey, N.J (2005). "Corticospinal excitability in patients with chronic low back pain", Journal of Spinal Disorders &Techniques, 18(5) pp420-4.

[20] Apkarian, A.V., Baliki, M.N., & Geha, P.Y (2009). "Towards a theory of chronic pain", Progress in Neurobiology, 87(2) pp81-97.

[21] Benedict, M.W., Luke P., Neil, E.O., Connell, H.L., James, H. M., Michael T., & Moseley, L.G. (2011). "Cortical changes in chronic low back pain: Current state of the art and implications for clinical practice", Manual therapy.16, pp15-20.

[22] Gill, K.P., & Callaghan, M.J (1998). "The measurement of lumbar proprioception in individuals with and without low back pain" Spine, 23(3): pp371:7.

[23] Brumagne, S., Cordo, P., Lysens, R., Verschueren, S., Swinnen, S (2000). "The role of paraspinal muscle spindles in lumbosacral position sense in individuals with and without low back pain", Spine, 25(8);989-94.

[24] Taimela, S., Kankaanpaa, M., & Luoto, S (1999). "The effect of lumbar fatigue on the ability to sense a change in lumbar position. A controlled study". Spine, 24(13), pp1322-7.

[25] Diers, M., Koeppe, C., Diesch, E., Stolle, A.M., Holzl, R., & Schiltenwolf, M (2007). "Central processing of acute muscle pain in chronic low back pain patients: an EEG mapping study", Journal of Clinical Neurophysiology, 24(1); pp76-83.

[26] Wand, B.M., Di Pietro, F., George, P., & O'Connell, N.E (2010). "Tactile thresholds are preserved yet complex sensory function is impaired over the lumbar spine of chronic non-specific low back pain patients: a preliminary investigation", Physiotherapy, in press,doi:10.1016/j.physio.2010.02.005.

[27] Osborn, M., & Smith, J.A (2006). Living with a body separate from the self. "The experience of the body in chronic benign low back pain: an interpretative phenomenological analysis", Scandinavian Journal of Caring Sciences, 20(2) pp216-22.

[28] Weiner, D.K., Rudy, T.E., Morrow, L., Slaboda, J., & Lieber, S (2006). "The relationship between pain neuropsychological performance, and physical function in community-dwelling older adults with chronic low back pain", Pain Medicine, 7(1), pp60-70.

[29] Lourenco, J.L., Gerard, C., & Revel, M (2009). "Evidences of memory dysfunction and maladaptive coping in chronic low back pain and rheumatoid arthritis patients: challenges for rehabilitation", European Journal of Physical and Rehabilitation Medicine, 45(4) pp469:77.

[30] Johnson, M.H., & Petrie, S.M (1997). "The effects of distraction on exercise and cold pressor tolerance for chronic low back pain sufferers", Pain, 69(12) pp438.

[31] Giesbrecht, R.J.S., & Battie, M.C (2005). "A comparison of pressure pain detection thresholds in people with chronic low back pain and volunteers without pain", Physical Therapy, 85(10) pp1085.

[32] Clauw, D.J., Williams, D., Lauerman, W., Dahlman, M., Aslami, A., Nachemson, A.L, (1999). "Pain sensitivity as a correlate of clinical status in individuals with chronic low back pain", Spine, 24(19); pp2035-41.

[33] Ole Kudsk, J., Claus Vinther, N., & Kristian, S-P (2009). "Low back pain may be caused by disturbed pain regulation: a cross-sectional study in low back pain patients using tender point examination", European journal of pain, 14(5) pp514-22.

[34] Vicenzino, B., & Wright, A (2002). Managing pain: physical treatments. In: Strong J, Unruh AM, Wright A, Baxter GD, editors. Pain: a textbook for therapists. Edinburgh: Churchill Livingston; p. 187 :206.

[35] KerstiN, L., Alison, R.C.W., Tim, P.J., Gerd, M., & Arne, M. (2011). "Effectiveness of anodal transcranial direct current stimulation in patients with chronic low back pain: Design, method and protocol for a randomised controlled trial", BMC Musculoskeletal Disorder, pp12-290.

[36] Antal, A., Terney, D., Kuhnl, S., and Paulus, W. (2010). "Anodal transcranial direct current stimulation of the motor cortex ameliorates chronic pain and reduces short intracortical inhibition", J Pain Symptom Manage, 39(5) pp890-903.

[37] Schabrun, S.M., Jone, E., Elgueta, C.E.L., & Hodges, P.W. (2014). "Targeting chronic recurrent low back pain from the top-down and the bottom-up: a combined transcranial direct current stimulation and peripheral electrical stimulation intervention", Brain Stimul Subsets, 7(5) pp451-9.

[38] Kerstin, L., Arne, M., & Tim, P. J. (2012). "No effect of a single session of transcranial direct current stimulation on experimentally induced pain in patients with chronic low back pain – An Exploratory Study", PLoS one. 7(11).