COVER LETTER

This is an original journal article and is not under consideration for publication in another pre-reviewed medium.

I intend to submit this journal article to the Health SA Gesondheid. It should be considered to be published. The study is titled "The Efficacy of Chiropractic Manipulation on Headaches in Migraine Sufferers".

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The Efficacy of Chiropractic Manipulation on Headaches in Migraine Sufferers

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ABSTRACT

Purpose: Headaches are a major problem, with migraine incidence ranking as the third most prevalent disorder in the global burden of disease survey. Studies show that migraines affect 6% of men and 18% of women with a reduction in quality of life more than that caused by osteoarthritis or diabetes. The aim of this study was to determine if cervical manipulative therapy had any effect on the frequency, intensity and/or duration of headaches in migraine sufferers.

Method: Twenty participants between the ages of 18 up to and including 40 years were recruited. Participants required a diagnosis of migraines with aura also known as the classical migraine. Participants were all placed into one group receiving chiropractic manipulative therapy to the cervical spine.

Procedure: The participants completed the treatment phase of the study over one month. Prior to the initiation of treatment, participants were required to complete a headache diary for one month. Furthermore participants were required to complete a headache diary during the month of treatment, and for the following two months after treatment was completed to assess if there were any long term effects from manipulative therapy. Subjective readings were recorded by completing the MIDAS questionnaire at the end of each of the four months.

Results: Intragroup analysis revealed statistically significant decreases in the level of disability caused by the headaches and migraines during the month of treatment. This also showed statistically significant decreases in the number of days participants experienced headaches and the severity of these headaches. Intra-group analysis tested one month after the treatment was completed revealed no statistical difference in headache and migraine disability, number of days participants experienced headaches or severity of the headaches. Finally, Intra-group analysis revealed that at a two month follow up after the treatment was administered, no statistical significance was found in the degree of disability caused by the headaches and migraines. However, the number of days with a headache and the severity of the headaches showed a statistical significance and indicated a further decline.

Conclusion: The findings of this study show that chiropractic manipulative therapy to the cervical spine decreased disability, intensity and frequency of the headaches, including the migraines, experienced by the participants. This effect was maintained at two months following completion of treatment and the intensity and frequency of the headaches showed further improvement in the long term.

Key Words:

Chiropractic, manipulation, migraines, headaches.

INTRODUCTION

Headaches can be broadly classified as being primary or secondary. Primary headaches refer to those headaches that do not have any underlying pathology or disease process and secondary headaches refer to those headaches that are caused by an underlying pathology or disease process. Primary headaches include: migraines; cluster headaches; tension type headaches; and cervicogenic headaches. Although these headaches are benign, the pain they present are often debilitating (Chapman-Smith, 1995).

A number of primary and secondary headache disorders can cause chronic daily headaches, among which migraine ranks the top. It has been shown that patients with daily headaches often exhibit medication overuse headaches and the majority of patients with this condition experience migraines as their underlying disorder (International Headache Society, 2013).

Migraines are referred to as a syndrome with a collection of symptoms arising from a common cause. These symptoms can occur either in a complete form, with the usually expected symptoms of a migraine; or may occur with only some symptoms in a less complete form. Usually expected symptoms include migraines with a unilateral location, moderate to severe in intensity and are of a pulsating quality. They are often aggravated by routine physical activity and may also include a host of neurological symptoms such as: photophobia; phonophobia; nausea and/or vomiting. Migraines can further be divided into those with aura symptoms which include a variety of cognitive, motor, autonomic, and emotional responses; and those without aura symptoms (International Headache Society, 2013). Over and above the symptoms of a migraine, migraines can overlap with other headaches. While most migraine sufferers may experience attacks once or twice a month, an estimated 14 million people may experience near-daily headaches (Migraine Research Foundation, 2015).

Headaches are not usually accompanied by these migraine symptoms, but patients who suffer with migraines are most likely to experience other forms of headaches and these can vary in their duration, intensity, cause and frequency (The Migraine Trust, 2015).

With 8% of the general population being sufferers (Nilsson, 1995), cervicogenic headaches are as common as migraine headaches. A cervicogenic headache is defined as being the referred pain felt in any area of the head where the actual cause emanates from a primary nociceptive source in the musculoskeletal tissues innervated by cranial nerves (Khoury, 2000). Confusion thus exists between migraines and cervicogenic headaches due to the pathophysiological overlap and similarity in symptoms and as such these two primary headache types can occur solely or simultaneously. Studies done by Fishbain, Cutler, Cole, Rosomoff, and Rosomoff (2001) at a pain facility indicated a total of 44% of patients having fulfilled the criteria for more than one headache diagnosis. In addition, more than 70% of patients who suffered from cervicogenic headaches fulfilled the diagnostic criteria for migraine. In addition, migraine and tension-type headache sufferers were found to show cervical spine

dysfunction similar to cervicogenic headache sufferers (Vernon, 1995). Therefore, although disagreements arise pertaining to the sub-classification of primary headaches, research is still required to resolve the distinct entity versus continuum debate (Chapman-Smith, 1995).

Anatomical Substrate of the Trigeminovascular Pain Pathway

Pain sensitivity in the skull depends mainly on the meningeal blood vessels that are richly innervated by nociceptive sensory afferent fibers from the ophthalmic division of the trigeminal nerve. Activation of these afferents has generally been seen to lead to headaches and migraines (Pietroban and Striessing, 2003).

The trigeminocervical nucleus is defined as cells in the upper cervical segments that receive a cervical as well as a trigeminal nerve input. Hence, the nociceptive nucleus — of the upper neck, head and throat, and any noxious stimuli arising from them — is mediated by the trigeminocervical nucleus (Biondi, 2000). This anatomical overlap between the trigeminal nerve and the upper cervical spinal nerves occurs via the nucleus cordalis where nociceptive afferents from the trigeminal system can synapse with those from the upper cervical spinal nerves. This is paramount because this convergence can cause pain to be referred to the trigeminal or upper cervical nerve dermatomal regions. Thus, a noxious stimulus perceived and carried via the upper cervical spinal nerves can cause a referral of pain along the dermatomal distribution of the trigeminal system. The same referral applies vice versa (Khoury, 2000), thus causing pain perceived as a headache.

In Bogduk (1992) it is discussed that the cervical spine cause for chronic headaches can be attributed to the abovementioned convergence that occurs in the trigeminocervical nucleus and as such any structures innervated by C1-C3 spinal nerve roots —such as the joints, ligaments, muscles, dura mater of the spinal cord, posterior cranial fossa and vertebral artery — are capable of causing headaches.

MATERIALS AND METHODS

Selection Criteria

This study involved twenty participants of either gender between the ages of 18 up to and including 40. Advertisements via the local radio station, local newspaper, as well as advertisements placed at the Chiropractic Day Clinic were used to recruit participants. Participants were also enlisted via word of mouth, including network marketing such as via advertisements on Blackberry Messenger.

Participants who were female or male between the ages of 18 up to and including 40; who were diagnosed with migraine headaches with aura; had cervical spine joint dysfunction of at least one cervical spine motion segment; and who suffered with other headaches within the same month not associated with auras were recruited into the study. Participants not meeting the diagnostic criteria for migraines with aura; in whom manipulation was contra-

indicated; who were undergoing other forms of treatment including other manipulative or physical therapies; or who were taking prophylactic medication for the duration of the study were excluded from the study.

Methodology

The study spanned over a period of four months. One month of baseline headache diary recording, one month of treatment involving five treatment sessions, and a further two months of headache diary recording.

Participants completed a headache diary for one month as well as a Migraine Disability Assessment (MIDAS) questionnaire before treatment began in order to determine a baseline level of disability caused by the headaches and/or migraines. Prior to the treatment, participants were required to sign the information and consent form which explained the purpose and all procedures related to the study. The researcher then completed a case history, physical examination and cervical spine regional examination. The participants then received cervical spine manipulation to any motion-restricted segments. A second headache diary was completed during the treatment month as well as a MIDAS questionnaire at the end of the treatment month. The participants then received another two headache diaries and MIDAS questionnaires to complete, for each of the two months post treatment.

RESULTS

The sample constituted of 90% female patients and 10% male. The patients were on average 29.85 years old. MIDAS results (Figure 1) indicate that three quarters of the participants (75%) had severe disabilities caused by their headaches before treatment. This was reduced to a third (30%) with severe disability at the two-month follow-up after treatment.

The Shapiro-Wilk test was used to conduct normality tests in order to ascertain the appropriate statistical techniques to be used for further analysis. Since it was found that some of the variables were not normally distributed, the rest of the analysis was conducted using non-parametric tests, namely, the Friedman test and Wilcoxon signed-rank test.

Intragroup Analysis

Disability Score

A Friedman test was conducted to assess whether the disability scores were different among the four time periods that is: before treatment (month 0), during treatment (month 1), a follow-up assessment one month after treatment (month 2) and two months after treatment was completed (month 3).

Results for the Friedman test (Table 1) indicate a P-value of 0.000. This implies that there is a statistically significant difference between at least two months among the disability scores over the four months. To assess where the differences occurred, Wilcoxon signed-rank tests were conducted. Results were as follows (Table 2);

Month 0 vs month 1: Wilcoxon signed-rank test results yielded a P-value of 0.000 indicating a significant decline in the disability score from the period before treatment (month 0) to the period of treatment (month 1). Thus, the treatment resulted in a reduction in the disability score during the treatment month.

Month 1 vs month 2: Wilcoxon signed-rank test results yielded a P-value greater than 0.05 thus there was no significant difference between the disability score during the month of treatment and one month later.

Month 2 vs month 3: Wilcoxon signed-rank test showed no significant difference between the disability score between the period one month after treatment and two months after treatment. This is because the P-value of the Wilcoxon signed-rank test was 0.079, which is greater than 0.05. This implies that when the disability score decreases during the month of treatment, it will remain so even two months after treatment.

Number of Days with a Headache

The Friedman test was conducted to assess whether the number of days on which the participant had a headache per month differed for the times before, during and after treatment. The Friedman test (Table 3) resulted in a P-value of 0.001. This implies that there is a statistically significant difference among the number of days with a headache per month between at least two months. To assess where the differences occured, Wilcoxon signed-rank tests were conducted. The results are shown below (Table 4);

Month 0 vs month 1: The results of the Wilcoxon signed-rank test show a significant decline in the number of days on which the participants experienced headaches per month from the period before treatment (month 0) to the period of treatment (month 1). This is indicated by a P-value of 0.000. Thus, the treatment resulted in a reduction in the number of days in which the participants experienced headaches per month during the treatment month.

Month 1 vs month 2: Wilcoxon signed-rank test showed no significant difference between the number of days on which the participants experienced headaches during the month of treatment and one month later. This is because the P-value was greater than 0.05.

Month 2 vs month 3: The Wilcoxon signed-rank test showed a significant difference between the number of days on which the participants experienced headaches between the period one month after treatment and two months after treatment. This is because the P-value of the Wilcoxon signed-ranks test was 0.038. Thus the number of days on which the participants experienced headaches further decreased when comparing one month after treatment to the period two months after treatment (month 3).

Severity of Headaches

The severity of the participants' headaches was measured on a scale from 1 to 10, with 10 being the worst headache the participants had ever experienced in their lives and 0 being no headaches. The Friedman test was conducted to assess whether the severity of headaches differ for the times before, during and after treatment.

Results indicate a P-value of 0.000 (Table 5). This implies that there is a statistically significant difference among the severity scores between at least two months. To assess where the differences occured, Wilcoxon signed-ranks tests were conducted. The results follow (Table 6);

Month 0 vs month 1: The results of the Wilcoxon signed-rank test show that there was a significant decline in the severity of the headaches from the period before treatment (month 0) to the period of treatment (month 1) indicated by a P-value of 0.005. Thus, the treatment resulted in a reduction in the severity of headaches per month during the treatment month.

Month 1 vs month 2: The Wilcoxon signed-rank test shows that the severity of headaches during the month of treatment was not statistically different from the severity of headaches a month after treatment, since the P-value was greater than 0.05 (P-value = 0.274).

Month 2 vs month 3: The Wilcoxon signed-rank test showed a significant difference between the severity of headaches experienced between the period one month after treatment and two months after treatment. This is indicated by a P-value of 0.020. This shows that the severity of headaches experienced declined when comparing one month after treatment to the period two months after treatment (month 3).

DISCUSSION

Primary headaches are usually benign, but the pain associated with them is incapacitating and causes major concern to many patients. Very little research is available on South African statistics of migraine incidence and prevalence, but an estimated 14% of the Canadian population suffers from migraines (Chapman-Smith, 1995). 40 – 66% of patients with severe or frequent migraines do not seek help from a physician (Dowson and Jagger, 1999), and, among those that do seek help, regular visits to the physician do not ensue (Soloman and Price, 1997).

25 – 27% of headache sufferers will seek therapy other than medical treatment and most of these will visit a chiropractor (Eisenberg, Kessler, Foster, Norlock, Calkins and Delbanco, 1993). Furthermore, chiropractic treatment has been reported to be the most common alternative treatment for migraine sufferers (Eisenburg *et al.*, 1993). Moderate evidence exists to support manipulative therapy being superior in the short-term to physical therapy and general practice medical care, causing an improved physical function after the experience of chronic pain (Lantz, 1998).

Because the aetiology of migraines remains so unclear, the most appropriate and best treatment course is often uncertain (Dowson, Lipscome and Sender, 2002). Previous aetiological theories were focused on vascular changes and extracranial vasodilation as the entities responsible for the cause of migraine attacks (Goadsby, Lipton and Ferrari, 2002). Other models focus on vascular changes being related to neurological changes and linked serotonergic disturbances (Goadsby, 1999). Now migraines should be, instead of considered a vascular disorder, considered a disease state arbitrated by the central nervous system (Schwedt and Dodick, 2009).

Some researchers believe that the cervical spine is not a contributing factor to migraines (Bogduk, 1994), while others believe evidence shows that the cervical spine can cause migraine pain because of intracranial vascular changes that could be affected by cervical dysfunction (Freitag, 1983; Nelson *et al.*1998; Seaman, 1997).

Migraines have also been reported to cause a hyperactive state of the trigeminal pathway via nociceptive input from the upper cervical spine and upper limb muscles (Serrao, Perotta, Bartolo, Fiermonte, Pauri, Rossi, Parisi, and Pierelli, 2005) and this provides the chiropractic link.

Spinal adjustments have been shown to be clinically effective (Bergmann and Peterson, 2011), and the effects of manipulation in reducing pain and disability have been well documented. In Bergmann and Peterson (2011), it is stated that degenerative disease or injury to an area can result in chronic pain, stiffness, contractures, hypomobility or impairments. Manual therapy interventions during the early stages of healing and repair aim to decrease inflammation and pain, prevent further injury from occurring, and to promote healing; all with the goal of restoring mobility and function. Therefore, manipulations are designed to assist in pain relief/management, joint-locking and muscle spasm.

Cervical spine adjustments have been documented to change sensorimotor integration, cause increased motor excitability and decrease the perception of pain (Haavik-Taylor and Murphy, 2007). In Bergmann and Peterson (2011), spinal manipulative therapy is hypothesized to remove sources of pain and stimulate analgesia.
Additionally, spinal manipulation has been hypothesized to increase pain tolerance or threshold levels after a manipulation (Bergmann and Peterson, 2011). In this way, it can alter the processing of noxious stimulation and reduce pain and disability.

If the cause of the headaches were of cervicogenic origin, then the initial reduction that occurred during the treatment month may have been due to the rapid analgesic effect of spinal manipulative therapy, which decreases nociceptive input into the trigeminal system and hence decreases perception of pain. It also activates the descending pain inhibitory system, further decreasing the perception of pain (Wright, 1995). As mentioned previously headache sufferers have been shown to experience more than one primary headache at a time with cervicogenic headaches showing an overlap with migraines and their symptamology. It is possible that participants displaying reductions in disability scores were as a result of relief from their cervicogenic headaches which they had been suffering from concurrently with the migraines, as evidenced by the tight neck musculature and cervical spine dysfunction observed during the treatment sessions. Thus, migraine sufferers may display a cervicogenic aspect to their headaches, and, since chiropractic treatment has been shown to reduce cervicogenic headaches (Khoury, 2000), this had a favourable effect on the results.

Manipulation also has the ability to remove sources of mechanical pain and inflammation, thus inducing stimulus-produced analgesia. Chiropractic manipulation is reported to produce sufficient force to allow for the stimulation

of superficial and deep mechanoreceptors, nociceptors and proprioceptors. This, in turn, provides a strong sensory input into the spinal cord that is sufficient enough to inhibit the central transmissions of pain into the central nervous system (Bergmann and Peterson, 2011). This is evidenced in this study by the greatest reduction in disability scores when comparing the month prior to treatment to the month of chiropractic treatment.
Manipulation also has mechanical effects on the spine by using distractive forces while adjusting to stimulate low-threshold mechanoreceptors and thus reduce pain. These forces, which stimulate mechanoreceptors, can cause enhanced proprioceptive activity and reflex activation and may enable clearance of pro-inflammatory mediators to restore normal motion in a joint (Gay, Bronford and Evans, 2005).

The further significant decrease in frequency and severity and non-significant stabilization in the migraine disability scores two months after the treatment was administered, indicates that spinal manipulation shows a short-term and a long-term increase in pain relief, and, hence, the improvement on patients' functional statuses. These results are supported by numerous other studies (Whittingham, Ellis and Molynuex, 1994; Chapman-Smith, 1996; and Brontford, Assendelft, Evans, Haas and Bouter, 2001).

Based on the results of this study, it can be deduced that cervical spine manipulation has a favourable effect on the trigeminal pathway by decreasing its hyperactive state. In addition, via the effects of manipulation and restoring normal joint function, it has been shown that spinal manipulative therapy can treat, and perhaps even eliminate, headaches experienced by migraine sufferers. Thus chiropractic manipulation of the cervical spine can greatly benefit patients in terms of frequency, severity, and disability caused by their headaches including their migraines in the short-term and also exhibits that at a two-month follow-up, the adjustment is still effective, as evidenced by the further improvement in reduction of number of days participants experienced a headache and the severity of the headaches.

CONCLUSION

Evidenced by this study, chiropractic manipulative therapy can successfully treat headaches in migraine sufferers. In addition, treatment can also have an effect on migraines. It can thus be theorized that migraines can stem from two origins: a vascular origin; and a cervicogenic origin, it is likely that chiropractic treatment would have more of an effect on cervicogenic origins.

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REFERENCES

Bergmann, T.F., and Peterson, T.F. (2011). *Chiropractic Technique: Principles and Procedures, 3rd Edition.* Mosby Inc, pp 18 - 20, 34 - 47, 105 - 120, 146, 233 - 237, 239, 240, 254, 257, 275.

Biondi, D.M. (2000). Cervicogenic headache: Mechanisms, evaluation, and treatment strategies. *The Journal of the American Osteopathic Association*, 100(9): 7 - 14.

Bogduk, N. (1992). The Anatomical Basis for Cervicogenic Headaches. *Journal of Manipulative and Physiological Therapies,* 15(1): 67 - 70.

Bogduk, N. (1994). Cervical causes if headache and dizziness. *Modern Manual Therapy of the Vertebral Column, 2nd Edition.* Edinburgh: Churchill Livingstone, pp 317 - 331.

Brontford, G., Assendelft, W.J.J., Evans, R., Haas, M., and Bouter, L. (2001). Efficacy of Spinal Manipulation for Chronic Headache: A Systematic Review. *Journal of Manipulative and Physical Therapy,* 24(7): 457 - 466.

Chapman-Smith, D. (1995). Primary headache and cervical spine dysfunction. *The Chiropractic Report,* 9(3): 108.

Chapman-Smith, D. (1996). RAND Report on Cervical Manipulation and Mobilization. *The Chiropractic Report,* 10(5): 3 and 5.

Dowson, A., and Jagger, S. (1999). The UK migraine patient survey: quality of life and treatment. *Current Medical Research and Opinion*, 15(4): 241 - 253.

Dowson, A.J., Lipscome, S., and Sender, J. (2002). New guidelines for the management of migraine in primary care. *Current Medical Research and Opinion*, 18: 414 - 439.

Eisenberg, D.M., Kessler, R.C., Foster, C., Norlock, F.E., Calkins, D.R., and Delbanco, T.L. (1993). Unconventional medicine in the United States: prevalence, costs and patterns of use. *New England Journal of Medicine,* 328: 246 - 252.

Fishbain, D., Cutler, R., Cole, B., Rosomoff, H.L., and Rosomoff, R.S. (2001). International Headache Society headache diagnostic patterns in pain facility patients. *The Clinical Journal of Pain,* 17(1): 78 - 93.

Freitag, F.G. (1983). Osteopathic manipulative treatment of migraines. *The Journal of Osteopathic Annals*, 11: 254 - 258.

Gay, R.E., Bronfort, G., and Evans, R.L. (2005). Distraction Manipulation of the Lumbar Spine: A Review of the Literature. *Journal of Manipulative and Physiological Therapeutics,* 28(4): 266 - 272.

Goadsby, P.J. (1999). The Scientific basis of medication choice in symptomatic migraine treatment. *The Canadian Journal of Neurological Sciences*, 26: 520 - 526.

Goadsby, P.J., Lipton, R.B., and Ferrari, M.D. (2002). Migraine-current understanding and treatment. *New England Journal of Medicine*, 346: 257 - 270.

Haavik-Taylor, H., and Murphy, B. (2007). Cervical spine manipulation alters sensorimotor integration: a somatosensory evoked potential study. *Clinical Neurophysiology*, 118(2): 391 - 402.

International Headache Society. (2013). The International classification of headache disorders, 3rd edition. *Cephalgia,* 33(9).

Khoury, M. (2000). *A comparative study to determine the most effective chiropractic treatment protocol in the management of cervicogenic headache with respect to correcting abnormal biomechanical function in the cervical spine and/or lumbar spine and pelvis.* Technikon Witwatersrand, Johannesburg, pp. 6 – 24.

Lantz, C.A. (1998). Immobilization degeneration and the hypothesis is chiropractic subluxation. *Chiropractic Research Journal*, 1(1): 1 - 6.

Migraine Research Foundation. Available at: www.migraineresearchfoundation.org/migraine%20in%20women.html. Accessed: 29 October 2015.

Nelson, C.F., Bronfort, G., Evans, R., Boline, P., Goldsmith, C., and Anderson, A.V. (1998). The efficacy of spinal manipulation, amitriptyline and the combination of both therapies for the prophylaxis of migraine headache. *Journal of Manipulative and Physiological Therapeutics,* 21(8): 511 - 519.

Nilsson, N. (1995). The Prevalence of Cervicogenic Headache in a Random Population Sample of 20 - 59 Year Olds. *Spine*, 20(17): 1884 - 1888.

Pietrobon, D., and Striessing, J. (2003). Neurobiology of migraine. Available at: www.nature.com/reviews/neuro. Accessed: 1 September 2015.

Schwedt, T.J., and Dodick, D.W. (2009). Advanced neuroimaging of migraine. *The Lancet Neurology*, 65: 491 - 498.

Seaman, D. (1997). Joint complex dysfunction, a novel term to replace subluxation/subluxation complex: etiological and treatment considerations. *Journal of Manipulative Physiological Therapy*, 20(9): 634 - 644.

Serrao, M., Perotta, A., Bartolo, M., Fiermonte, G., Pauri, F., Rossi, P., Parisi, L., and Pierelli, F. (2005). Enhanced Trigemino-Cervical-Spinal Reflex Recovery Cycle in Pain-Free Migraineurs. *Headache: The Journal of Head and Face Pain*, 45(8): 1061 - 1068.

Solomon, G.D., and Price, K.L. (1997). Burden of migraine. A review of its socioeconomic impact. *Pharmaeconomics,* 11:1-10.

The Migraine Trust. (2015). Migraine Fact Sheet. Available at: www.migrainetrust.org. Accessed: 30 October 2015.

Vernon, H.T. (1995). The effectiveness of chiropractic manipulation in the treatment of headache: an exploration in the literature. *Journal of Manipulative and Physical Therapy*, 18(9): 611 - 617.

Whittingham, W., Ellis, W.B., and Molynuex, T.P. (1994). The Effect of Manipulation (Toggle Recoil Technique) for Headaches with Upper Cervical Joint Dysfunction: A Pilot Study. *Journal of Manipulative and Physiological Therapeutics*, 17(6): 396 - 375.

Wright, A. (1995). Hypoalgesia post-manipulative therapy: a review of a potential neurophysiological mechanism. *Manual Therapy,* 1: 11 - 16.