

Chiropractic treatment of chronic episodic tension type headache in male subjects: a case series analysis

Robert D Mootz, DC, DABCO¹

MSI Dhami, PhD²

Jennifer A Hess, DC³

Robert D Cook, DC⁴

David B Schorr, DC⁵

Objective: To assess effectiveness of chiropractic management, primarily cervical adjustment, in the treatment of chronic episodic muscle tension type headache in male patients.

Design: Prospective case series analysis with pre-treatment baseline. Sixteen sessions of chiropractic care were provided to each patient over an eight week period. Data was also collected during a two week no-treatment baseline period prior to initiation of care. The subjects took no pain medication or had any other treatment for the entire duration of the study.

Setting: A large chiropractic teaching clinic: Palmer College of Chiropractic-West Outpatient Clinic.

Participants: Eleven male outpatients between the ages of 18-40 years old with a self-reported history of chronic headache at least six months duration and an average of at least weekly headache episodes were recruited. There was one dropout due to moving out of the area before study completion.

Interventions: Primary: high velocity, short lever cervical adjustment (Diversified technique). Secondary: myofascial trigger point therapy using ischemic compression to the cervical and thoracic musculature; thoracic and lumbar adjustment if indicated (Diversified technique); moist hot packs to cervical and thoracic spine regions.

Outcome measures: Pain diary measuring frequency, duration, and intensity of head/neck pain; and McGill Pain Questionnaires.

Results: Mean pre-treatment to post-treatment headache frequency changed from 6.4 episodes per two week period to 3.1, a statistically significant change ($p < 0.01$). Mean pre-

Objectif : Vérifier l'efficacité des soins chiropratiques, principalement l'ajustement cervical, lors du traitement d'une céphalée due à une tension chronique épisodique, chez des hommes.

Contenu : Étude prospective de cas avec un standard pré-traitement. Seize sessions de soins chiropratiques ont été prodiguées à chaque patient sur une période de huit semaines. Les données ont aussi été amassées au cours des deux semaines précédant le début des soins. Au cours de cette période, aucun traitement n'a été prodigué. Les sujets n'ont pas pris d'analgésiques et n'ont reçu aucun autre traitement pendant l'étude.

Milieu : Une grande clinique chiropratique d'enseignement : la clinique externe du Collège Chiropratique Palmer West (Palmer College of Chiropractic-West Outpatient Clinic).

Participants : Onze patients externes, mâles, âgés de 18 à 40 ans présentant des antécédents de céphalées chroniques d'au moins six mois et ayant eu au moins un épisode de douleur par semaine ont été recrutés. Une personne a abandonné avant la fin de l'étude en raison d'un déménagement.

Interventions : primaire : ajustement cervical de haute vélocité, à levier court (technique diversifiée). Secondaire : thérapie myofasciale de points gachettes utilisant une compression ischémique de la musculature cervicale et dorsale; ajustement dorsal et lombaire au besoin (technique diversifiée); sacs de chaleur humide appliqués à la région cervicale et dorsale.

Mesures des résultats : le journal de la douleur mesurant la fréquence, la durée et l'intensité des céphalées et des douleurs au cou et le questionnaire de douleur McGill.

Résultats : La fréquence moyenne des céphalées pré et post-traitement est passée de 6,4 épisodes aux deux semaines à 3,1, un changement significatif du point de vue statistique ($r < 0,01$). La durée moyenne des céphalées pré et post-traitement est passée de 6,7 heures à 3,88 heures ce qui était significatif du point de vue statistique ($r < 0,05$). L'intensité moyenne de la douleur est passée de 5,05 à 3,37, valeur légèrement trop basse pour avoir une importance statistique ($r = 0,059$). Il n'y avait pas de changements significatifs dans les résultats du questionnaire de douleur McGill pré et post-traitement.

1 Associate Medical Director, Washington State Department of Labor and Industries, Olympia, Washington.

2 Professor, Palmer College of Chiropractic-West, San Jose, California.

3 Private Practice, Oak Harbor, Washington.

4 Clinical Professor, Palmer College of Chiropractic-West, San Jose, California.

5 Private Practice, Palo Alto, California.

Correspondence: Robert D. Mootz, DC, Associate Medical Director for Chiropractic, State of Washington Department of Labor and Industries, P.O. Box 44321, Olympia, Washington 98504-4321.

© JCCA 1994.

treatment to post-treatment headache duration changed from 6.7 hours per episode to 3.88 hours which was statistically significant ($p < 0.05$). Mean anchored pain scale intensity ratings changed from 5.05 to 3.37 but this was just beyond statistical significance ($p = 0.059$). There were no significant changes in any McGill pain questionnaire scores pre and post treatment.

Conclusions: In this case series analysis of episodic tension headache in 10 male patients, typical chiropractic interventions of adjusting, muscle work and moist heat significantly reduced self-reported frequency and duration of headache episodes following 12 treatments over an 8 week period. No significant effect was observed in self-reported pain intensity, however a trend of reduction may indicate that a larger sample size might show increased significance. The McGill Pain Questionnaire did not appear to provide any useful information in assessing change in this sample. This may lend support to the result that little or no effect is obtained in reducing intensity of individual headache episodes with this treatment approach. These findings are limited by the small sample size and suggest a need for a larger study population as well as specific treatment comparison studies. These results may further be limited in that all subjects were male.

(JCCA 1994; 38(3):152-159)

KEY WORDS : tension-type headache, muscle contraction headache, vertebrogenic headache, chiropractic, spinal manipulation.

Conclusions : dans cette étude de cas de céphalées dues à une tension épisodique auprès de dix hommes, les interventions typiques, c'est-à-dire les ajustements chiropratiques, le travail musculaire et la chaleur humide, ont réduit de façon significative la fréquence et la durée des épisodes de céphalées, tels que rapportés par les sujets, après douze traitements échelonnés sur une période de huit semaines. Aucun effet significatif n'a été observé en ce qui a trait à l'intensité de la douleur telle que rapportée par les sujets. Cependant, une tendance à la baisse de la douleur indiquerait qu'un plus grand échantillon de sujets pourrait amener une augmentation de la valeur significative. Le questionnaire de douleur McGill ne semblait pas divulguer de renseignements utiles à l'évaluation du changement dans cet échantillon. Ceci pourrait appuyer les résultats qui démontrent que peu ou pas d'effets sont obtenus en terme de réduction d'intensité d'épisodes individuels de céphalées avec cette approche thérapeutique. Ces résultats sont limités par un petit échantillon et motivent une étude comportant un plus grand nombre de sujets ainsi que des traitements comparatifs spécifiques. Ces résultats peuvent être limités étant donné que l'étude a seulement été menée auprès d'hommes.

(JCCA 1994; 38(3):152-159)

MOTS CLÉS : céphalée tension, céphalée musculaire, céphalée vertébrogène, chiropratique, manipulation vertébrale.

Introduction

This report results from a recent study evaluating changes in serum levels of beta-endorphin, melatonin, follicle stimulating hormones (FSH), and luteinizing hormone (LH) of male patients with chronic head and neck pain.¹ Earlier reports assessing the effects manipulation had on beta endorphins as well as other hormones have been conflicting.^{2,3} As a part of the data collection for the project, clinical information was also gathered to assess changes in patient symptomatology. Results on only the clinical variables of the first eleven chronic headache subjects from that study are presented here.

Headache is a frequent complaint in clinical practice and is commonly addressed by chiropractors.^{4,5} There is a small amount of experimental literature on headaches and manipulation/mobilization in general, and much of it suffers from limitations of statistical power and emphasis on short-term effects.⁶ It has been documented previously that mobilization and manipulation appear to be of value in the treatment of cervicogenic headache.^{7,8} A study on 33 chronic headache patients at a chiropractic college teaching clinic demonstrated a reduction in headache frequency in 84% of the subjects over the course of

care.⁷ A hospital based study on 100 chronic cervicogenic headache patients undergoing spinal manipulative therapy reported that 75% of the subjects reported fewer headaches with the treatment, with 65% maintaining a reduction at a six month follow up.

One descriptive study using resisted muscle contraction procedures in the cervical spine reported benefit on 134 patients with cervicogenic headache.⁹ Two hospital based randomized trials on apparent cervicogenic headache appear in the literature as well.^{10,11} One European study suggested a greater short-term reduction in visual analog scores in a group of subjects undergoing high velocity manipulation than in comparison groups undergoing mobilization, or a waiting list control.¹⁰ Another study reported decreased severity with osteopathic manipulation.¹¹ Both suffer from low statistical power and weak descriptions of experimental and clinical methods.⁶

A retrospective chart review of over 300 headache cases seen by manual practitioners suggested that 93% of the cases descriptively had a positive therapeutic outcome.¹² Another descriptive report of 200 patients with radiographic findings of cervical vertebral dysfunction noted that 90% had headache symptoms.

The report further noted that 80% of the headache sufferers received complete remission of symptoms with manipulation.¹³ A preliminary report of a randomized clinical trial on tension headache suggested benefit from manipulation at least equivalent to pharmaceutical management.¹⁴

In this project, episodic tension type headache with concurrent cervical mechanical dysfunction was studied. Headache with other causes were ruled out. This dysfunction had also been referred to as muscle contraction headache which has been characterized as follows:¹⁵

Minimal to severe, often bilateral, dull, persistent pain in the neck, occipital, vertex, temporal, and/or frontal areas that may vary in intensity, frequency, duration, and site. The pain or pressure may often be related to stress, activity, and/or prolonged position. Muscular spasm, tightness, and tenderness may be present. Various head, neck, shoulder, and upper extremity paresthesias may accompany episodes. Often there may be abnormal head and neck postures, asymmetrical shoulder elevations, and occasional nausea. The episodes should not be routinely disabling.

Objective – An objective of this project was to assess the effectiveness of chiropractic management, primarily high velocity, short amplitude chiropractic cervical adjusting in the treatment of chronic episodic tension type headache associated with cervical mechanical findings (muscle contraction headache, cervico-cranial syndrome, vertebrogenic headache) in male patients. This report is a sub-analysis of another study which examined several pituitary hormone levels necessitating evaluation of a single gender. As males experience less cyclical fluctuation of many of the hormones studied, they were the only gender available from the data pool in this study.

Methods

Subjects – Study subjects were recruited from two sources: the existing patient flow at the Palmer College of Chiropractic-West Outpatient Clinic in Sunnyvale, California, and through flyers posted at local community colleges. Only one subject came from recruitment by fliers with the remainder culled from existing new patient flow to the college clinic.

All new male patients presenting to the clinic were given a one page screening questionnaire designed to assess if a patient potentially met inclusion criteria for the study. The surveys were reviewed daily and any subjects appearing to meet study criteria were contacted before any treatment began. Due to the chronic nature of the patients being sought, clinic policy requires a complete physical examination by a chiropractic intern and review by clinic staff prior to initiation of any treatment. This typically required 1–2 days following intake, thus allowing study staff ample time to personally evaluate all potential subjects prior to any initiation of treatment.

Those subjects meeting inclusion criteria between the ages

18 to 40 years were oriented to the study and offered a chance to participate. Study subjects were allowed care without any charge and were paid a stipend following the conclusion of the study. All patients meeting inclusion criteria who were offered the chance to participate agreed to do so.

Inclusion criteria consisted of complaints of mild to severe head and/or neck pain of at least six months duration. Occurrences had to be of a frequency of at least four episodes per month. All subjects recruited into the study group exceeded this with an average headache frequency of 6.4 headache episodes during the two week pre-treatment period. Historically, all subjects stated that they regularly experienced headaches at their baseline frequencies. Findings of mechanical dysfunction in the cervical spine were also required in order to justify any manipulative intervention. Exclusion criteria included any concurrent illness or pathology, severe degenerative changes of the cervical spine, congenital cervical spine anomalies (such as hemi-vertebra) that could affect movement, moderate to severe osteoporosis as well as any associated upper extremity neurologic deficit, muscle weakness, or radiculitis. Patients who were unable or unwilling to avoid analgesic medication for the study duration were also excluded as were any individuals who presented with clinical contra-indications to spinal adjusting. Patients were also excluded if they had been to a manipulative provider during the six months prior to presentation. All subjects accepted into the study provided signed informed consent relative to these requirements for participation.

Interestingly, all potential subjects who routinely took pain medications (nine of the first eleven) were willing to give them up for the 10 week duration of the study. One subject had to drop out of the study after the third week of care due to a death in the family requiring him to move to another city. The remaining ten subjects completed the full course of the study.

Examiners and treaters – All patients were given complete physical examinations by chiropractic student interns under supervision of the study manager. Positive examination findings were re-checked by one of three experienced faculty chiropractors participating in the study and all patients were regionally re-examined in the cervical spine and head area by the study's principle investigator. In order to rule out subjects that may have exclusion criteria such as severe degenerative changes, congenital anomalies, or osteoporosis, subjects were radiographed (a minimum of an AP and lateral cervical series) by student interns. Films were reviewed by a faculty radiologist as well as the treating doctors.

In addition to complete physical examinations, subjects underwent mechanical assessments of the spine to evaluate muscle tone, global and segmental range of motion, comfort during motion, and tenderness to palpation. These factors were taken into account along with the quality of segmental end feel by the treating chiropractors in order to determine which spinal segments would undergo manipulation.

Treatment for all subjects was provided by three experienced

faculty clinicians who rehearsed manual assessment and treatment protocols before caring for any subjects. This helped insure a standardized regimen as well as complete coverage during all operating hours of the clinic independent of any one treater's schedule. All subjects exhibited findings of mechanical dysfunction in the cervical spine prior to initiation of treatment.

Treatment procedures – Primary treatment consisted of Diversified chiropractic adjustment of the cervical spine. Prior to each treatment, the cervical spine was palpated statically and dynamically to evaluate for muscle tightness, tenderness, decreased range of motion compared to the opposite directional vector, hard end feel, and overall aberrant quality of movement (i.e., crepitus, lack of fluidity). Spinal regions were determined to exhibit mechanical dysfunction where at least 3 out of 5 of these findings were identified by the treating doctors. If multiple adjacent segments exhibited such findings, the lower most segment was selected for contact, with the area reassessed prior to performing multiple manipulations in adjacent segments. Following any preparatory procedures (described below), high velocity, short lever manipulations were administered. All patients received this protocol throughout care.

Myofascial trigger point therapy using ischemic compression to tight cervical and thoracic musculature was also provided to each subject, especially during the first two weeks of care, prior to administration of a cervical adjustment. This work was considered preparatory to adjusting in order to relax muscles and assist the patient to relax during manipulation. This muscle work consisted of brief general longitudinal massage to the posterior cervical musculature and bilateral scalene groups. Any significant trigger points (localized twitch response) were addressed with direct ischemic compression to the area. The myofascial work to the cervical spine lasted approximately 5 minutes.

On those patients who were especially tight or sensitive in the cervical region, 5–10 minutes of moist heat was applied prior to the muscle work or adjusting. The preparatory work was up to clinician discretion and patient preference. Use of these procedures typically decreased over time with successful patient response. All patients were examined throughout the full spine and any additional areas of dysfunction or subluxation were addressed in a similar fashion. The most frequently involved region outside of the cervical spine was the mid-upper thoracic region which was symptomatic or provokable in eight of the ten subjects on intake. Four subjects had mechanical findings in the lumbar spine with one being slightly symptomatic in the area.

A minimum of twelve to a maximum of sixteen sessions of such care were provided to each patient over an eight week period. Twelve visits were scheduled over a period of eight weeks. Each subject was also allowed four discretionary visits throughout the study. This allowed patients to come in during a flare-up or episode of headache. None requested additional care beyond this amount during the course of the study. As patients agreed to forego any medication for the baseline and treatment

periods, discretionary care was considered an important option.

Study design and protocol – This study was a prospective case series analysis with a two week pre-treatment baseline period.^{16,17} Treatment was scheduled initially at three encounters weekly for the first 2–3 weeks, reducing in frequency thereafter according to patient response and clinician discretion. Complete clinical re-evaluations were made at two week intervals until eight weeks of care was completed. Arbitrarily, no more than sixteen treatments were scheduled within the eight week treatment in order to provide some relatively standardized comparison for treatment. All patients completed 16 treatments with the exception of the previously mentioned dropout.

Patients were given headache diaries and McGill pain questionnaires. They were instructed in their use and these were collected weekly. Research work assistants contacted the patients by telephone weekly to remind them about filling out diaries and surveys. In addition, the assistants met with the patients weekly during the course of care to collect and replace instruments as well as coordinate other aspects of the study for the patient. Although the clinician verbally asked the patient about progress, these instruments were not available for clinician review thereby providing blinding to the outcome measures.

Subjects were instructed to record headache information on a daily basis. Pain level was rated on an anchored 0–10 point scale. For the purpose of assessing frequency, a pain level rating of zero was considered no headache. Any episode rated 1–10 was considered a headache in terms of frequency. In addition, the duration of the episode was recorded in hours. If the patient perceived the headache as going away during part of the day and returning later, separated by at least 6 hours, the episode was recorded as two separate events, each rated and analyzed individually. If pain levels waxed and waned throughout a day without a six hour pain free interval, the episode was treated as a single event and the patient was asked to estimate an average pain level and track the number of hours the headache was symptomatic to calculate duration.

Analysis – Headache diary and McGill scores during the two week baseline period were compared to reported scores during the final two weeks of care. Total frequency was calculated by counting all diary entries that rated one or above according to the guidelines discussed previously. Mean pain intensity was calculated by averaging the pain level entries. Mean duration was also calculated for these time periods. McGill questionnaires were scored in the standard six categories (total score, number of words chosen, sensory, affective, evaluative, and miscellaneous) and the mean scores were analyzed.

Due to the small sample size, a one tailed paired sample t-test¹⁸ was used to compare two week pre-treatment mean baseline scores with mean scores from the last two weeks of care. This time period was chosen as it typically entailed the least amount of care combined with the longest period following onset of care.

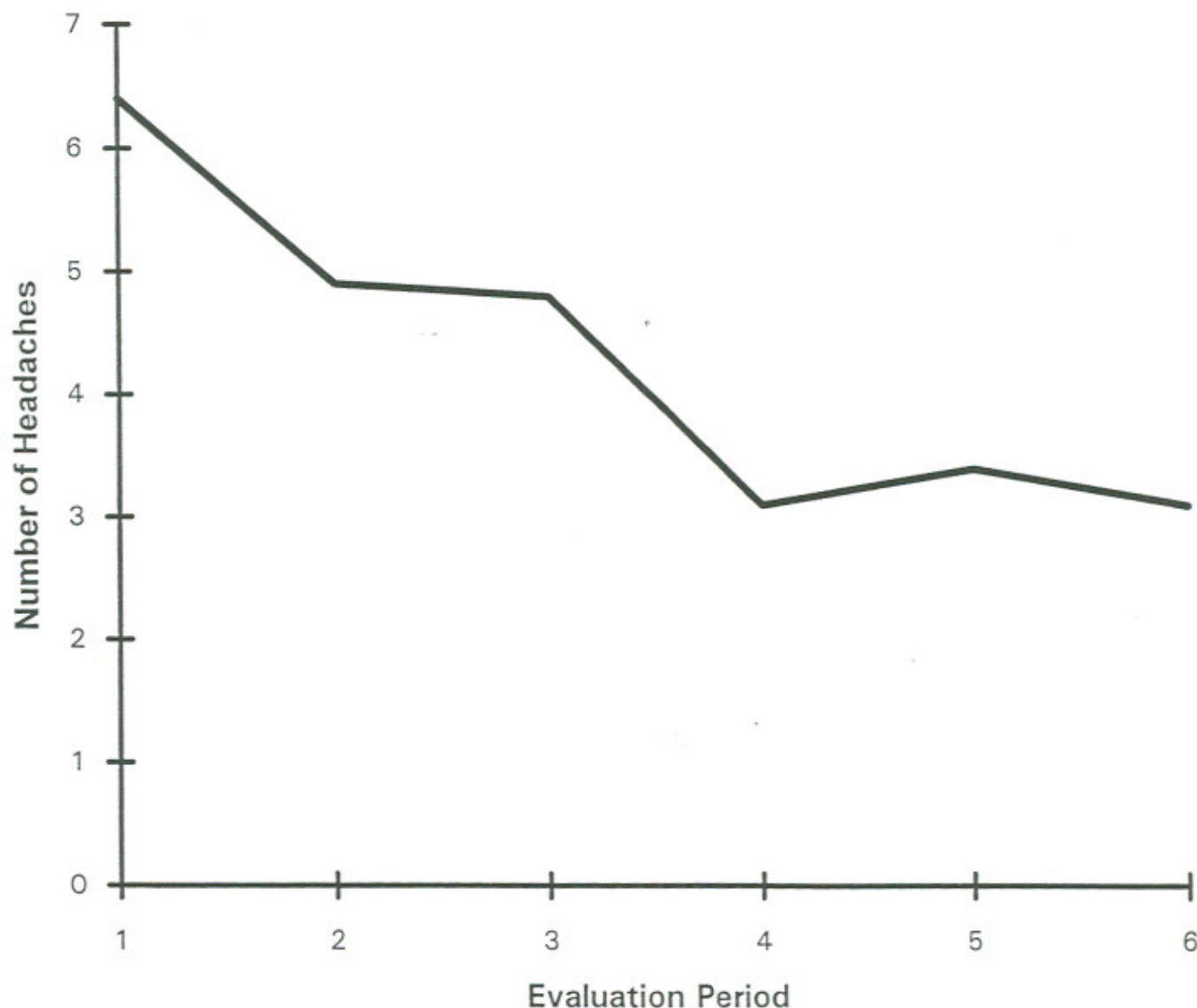


Figure 1 Average headache frequency: evaluation period 1 is the number of headaches during a two week no treatment baseline. Periods 2–5 represent the number of headaches during each two week period after initiation of care. Period 6 is the two week period following conclusion of care.

Results

Mean pre-treatment to final two-week headache frequency changed from 6.4 episodes per two week period to 3.1. This was statistically significant ($P < 0.01$) Figure 1 provides a graphical representation of changes in frequency during each two week period (baseline, and four two-week periods following initiation of care) with each evaluation point representing the mean scores from each two-week period.

Mean pre-treatment to final two-week headache duration changed from 6.7 hours per episode to 3.88 hours. This too was

statistically significant ($P < 0.05$) Figure 2 illustrates the mean duration scores over time.

Mean anchored pain scale intensity ratings changed from 5.05 to 3.37. This was slightly beyond significance ($P = 0.059$). Pain intensity scores are shown in Figure 3. There were no significant changes in any of the McGill pain questionnaire categories pre- and post-treatment.

Discussion

The results of this preliminary study offer a number of unique

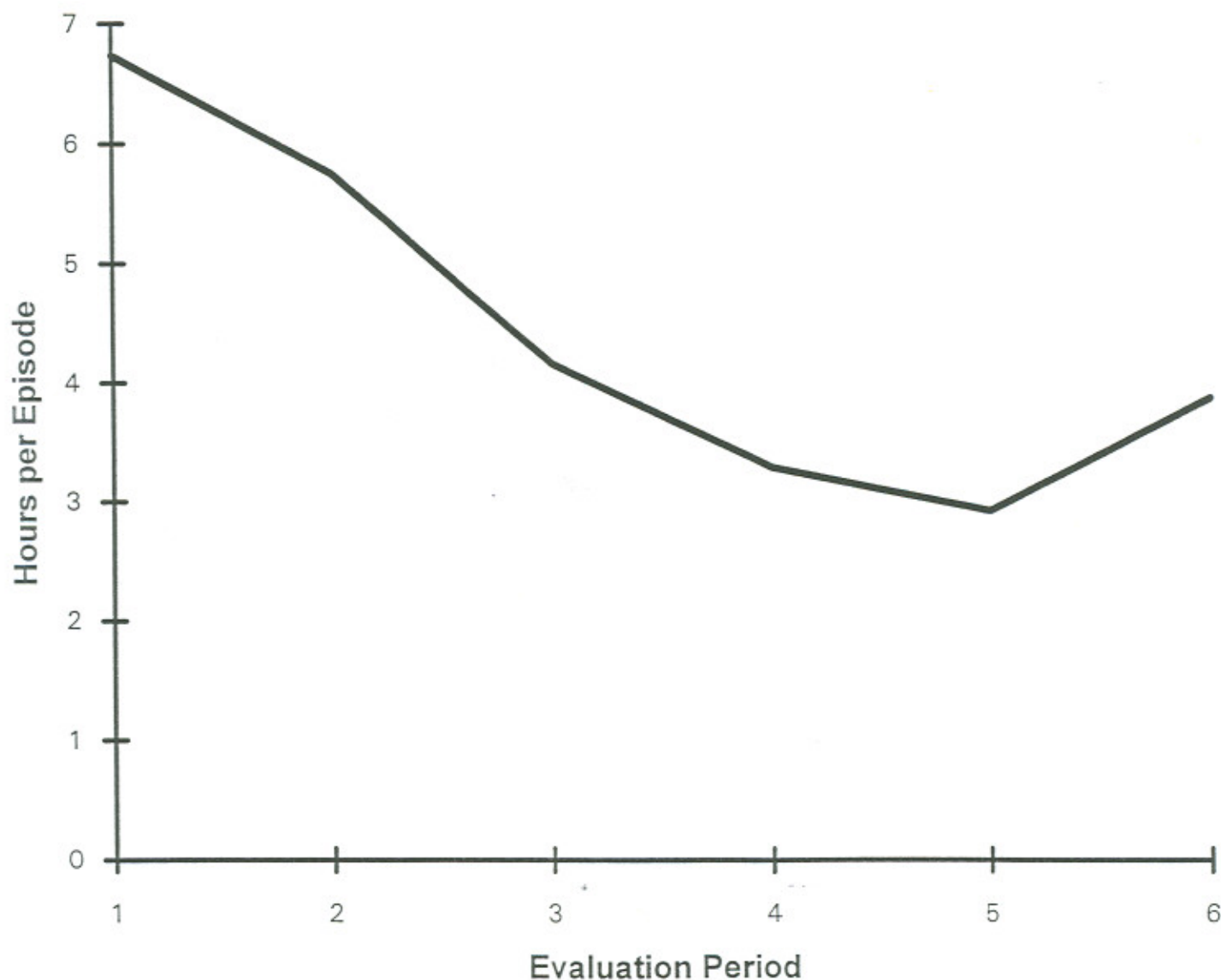


Figure 2 Average headache duration: evaluation period 1 represents the mean duration in hours for all headaches occurring during a two week no treatment baseline. Periods 2–5 represent mean duration of headache episodes during each two week period after initiation of care. Period 6 is the two week period following conclusion of care.

features as well as several substantial limitations. Of particular interest, this project looked at individuals who experienced a relatively common cervicogenic condition that is usually managed with over the counter medications. The subjects in this study were able to eliminate the use of medication for the ten week duration providing a unique opportunity to test manual care without a confounding secondary treatment. It should be noted that the intervention consisted of manipulation as well as preparatory work, therefore results are not readily attributed to manipulation in isolation. Such modalities as heat and muscle

work are common in chiropractic practice and contribute to external applicability of the management approach in general. In addition, the preparatory procedures used in this study were not extensive and were regionally focused to the area to be manipulated.

This management approach does not necessarily apply to other clinical situations. As these subjects were being additionally studied for serum levels of certain hormones subject to alteration by medication, much emphasis and ongoing communication regarding the importance of avoiding analgesics was

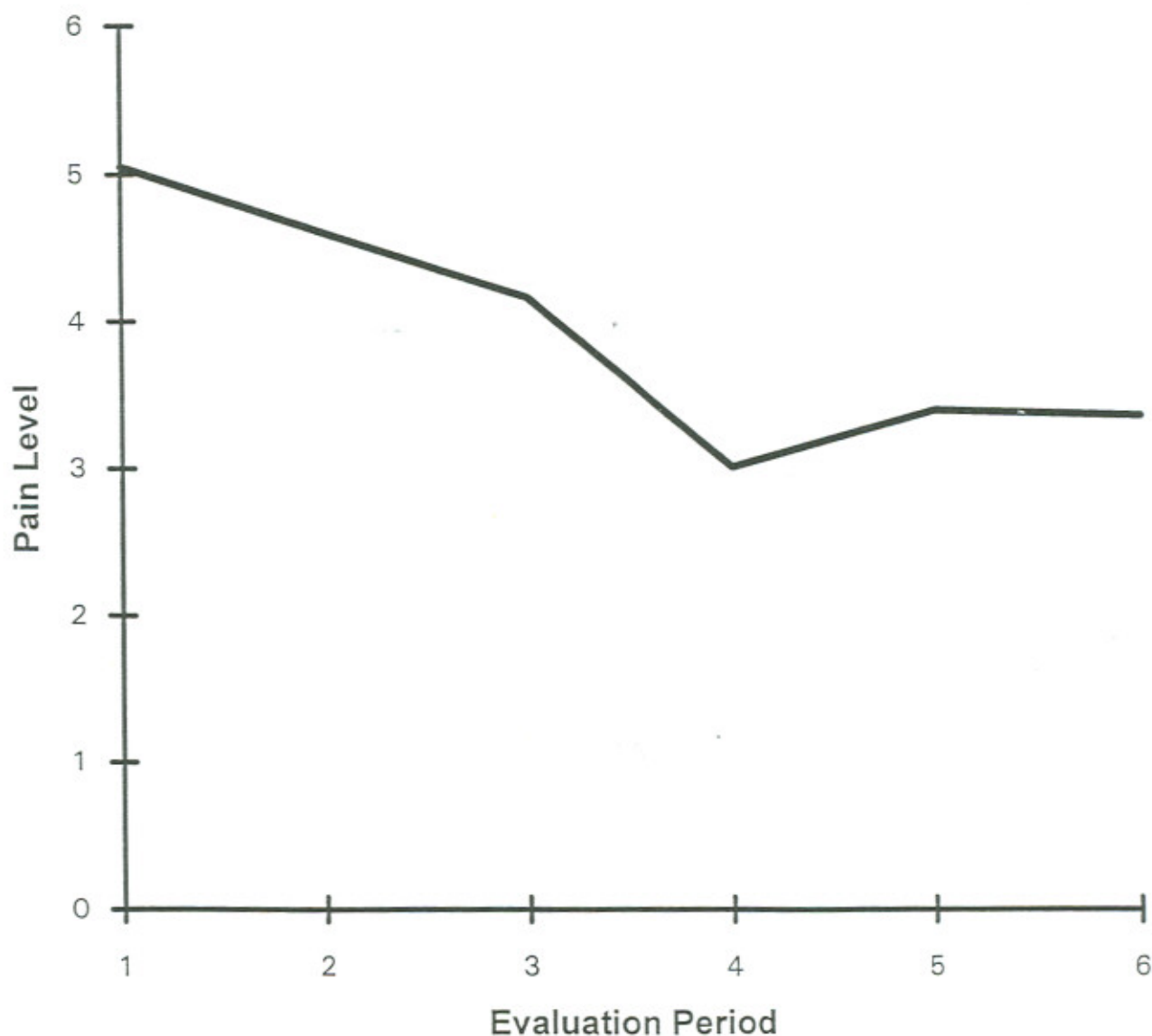


Figure 3 Average headache pain intensity: evaluation period 1 is the mean pain score on 10 point scale of all headache episodes occurring during the two week no treatment baseline. Periods 2–5 represent the average pain scores during each two week period after initiation care. Period 6 is the two week period following conclusion of care.

regularly discussed with the subjects. There was also a substantial stipend (\$120.00) serving as a motivator for completing the study without using medication. Further, care was free of charge eliminating another barrier to compliance. All but one of the subjects were presenting to the college clinic for this complaint expecting to pay for care. Two subjects reported previously being successively treated with chiropractic care for head and neck pain, but none had received care in the previous six months.

In these subjects, a reduction in the number of headaches per

week and a decrease in the duration of the headaches when they occurred appeared to be a substantial benefit, even though the intensity of a given episode may not have been significantly altered. At the conclusion of the study, all but two of the patients requested to have their charts returned to the general clinic pool so that they might return for future care if needed.

The sample size is quite small and warrants caution in extrapolation of the results. Interestingly the two tailed t-test maintains significance for a reduction in frequency ($P < 0.05$) but not for duration. The small number of subjects presented with a

wide variation in mean baseline scores for frequency (range 2–12 episodes), duration (1–12 hours per episode), and intensity (2.6–7 on a ten point scale). Such large variance may tend to confound the analysis. It should also be noted that one of the ten subjects experienced a series of headache episodes during the follow-up period that were of greater intensity, duration, and frequency than during the baseline period. This subject did otherwise experience reductions throughout the study period. Due to the small sample size, this occurrence impacted upon the overall outcome. Previous studies have reported results according to percentage of patients obtaining results.¹⁰

When compared to results of other studies on manipulation for cervicogenic tension headache, similar reductions in severity have been reported.^{4,6} Although previous studies also suffer from limited statistical power, such a trend warrants expanded research in this area. One earlier study also reported a reduction in headache frequency.⁷ Many of the earlier reports tended to be descriptive or retrospective in nature and quantitative comparisons are not readily obvious.^{4,6}

Clearly, a much larger study population, equal gender distribution, and other functional status outcomes such as patient satisfaction and impact on activities of daily living would enhance the applicability of such a study. It would appear that emphasis on other factors besides pain intensity may be fruitful for future research on manipulation for cervicogenic headache.

Lastly it needs to be noted that all but one of the recruited subjects were in the process of seeking chiropractic care for their headaches regardless of study participation. The possibility of selection bias cannot be ruled out.

Conclusions

In this case series analysis of chronic cervico-cranial syndrome (muscle contraction headache) in 10 males, typical chiropractic interventions of diversified adjusting, muscle work and moist heat significantly reduced self-reported frequency and duration of headache episodes during the last two weeks of care when compared to a two week pre-treatment baseline period.

No significant effect was observed in self-reported pain intensity, however a trend of reduction may indicate that a larger sample size might be worthy of study. The McGill Pain Questionnaire did not appear to provide any useful information in assessing change. This tends to collaborate with mean pain intensity scores supporting a conclusion that little or no effect is obtained in reducing intensity of individual headache episodes.

The results of this study are limited by small sample size, possible selection bias, a single gender sample, and contamination of treatment approaches. However, the trends and findings of the outcomes are consistent with previous reports and punctuate the need for additional investigations, especially randomized trials.

Acknowledgements

This study was part of a larger project made possible by a grant from the Foundation for Chiropractic Education and Research.

The authors wish to thank the following individuals for their contribution to the project: Drs. Ronald Henninger, Michelle Hamady, Megan Hodgson, Chris Goertz, Roland Noriat, and Kevin McCarthy.

References

- 1 Dhami MS, Mootz RD. Preliminary report of changes in serum melatonin and beta-endorphin levels in males following spinal manipulation. *Proceedings, World Federation of Chiropractic*, Toronto, 1991.
- 2 Vernon HT, Dhami MS, et al. Spinal manipulation and beta-endorphin: a controlled study on the effects of spinal manipulation and beta-endorphins in normal males. *J Manip Physiol Therap* 1986; 9:115–123.
- 3 Christian GF, Stanton GJ, Sissons D, How HY, Jameson J, Alder B, Fullerton M, Funder J. Immunoreactive ACTH, beta-endorphin, and cortisol levels in plasma following spinal manipulative therapy. *Spine* 1988; 13:1411–1417.
- 4 Vernon H. Vertebrogenic headache. In: Vernon H (ed). *Upper cervical syndrome: chiropractic diagnosis and treatment*. Baltimore: Williams & Wilkins, 1988; 170–174.
- 5 Nelson C, Boline P. A consensus on the assessment and treatment of headache. *Chiro Technique* 1991; 3:151–168.
- 6 Bronfort G. Effectiveness of spinal manipulation and adjustments. In: Haldeman S (ed). *Principle and practice of chiropractic* 2nd ed. Norwalk, 1992; 415–441.
- 7 Vernon HT. Spinal manipulation and headaches of cervical origin. *J Manip Physiol Therap* 1989; 12:455–468.
- 8 Turk Z, Ratkolb O. Mobilization of the cervical spine in chronic headaches. *Manual Med* 1987; 3:15–17.
- 9 Lewit K. Ligament pain and anteflexion headache. *Europ Neurol* 1971; 5:365–378.
- 10 Bitterli J, et al. Objective criteria for the evaluation of chiropractic treatment of spondylotic headaches. *Nervenarzt* 1977; 48:259–262.
- 11 Hoyt WH, et al. Osteopathic manipulation in the treatment of muscle contraction headache. *J Am Osteopathic Assoc* 1978; 78:322–325.
- 12 Droz JM, Crot F. Occipital headaches: statistical results in the treatment of vertebro-genous headache. *Swiss Annals of Chiropractic* 1985; VIII:127–136.
- 13 Jirout J. Comment regarding diagnosis and treatment of dysfunctions in the C2–3 segment. *Man Med* 1985; 2:16–17.
- 14 Boline P, Boline K. One year follow-up to the controlled clinical trial, "spinal adjustments and pharmaceutical therapy: a randomized clinical trial for the treatment of chronic muscle contraction headaches". *Proceedings of the International Conference on Spinal Manipulation, Foundation for Chiropractic Education and Research, Arlington*, 1993; 107.
- 15 Friedman AP, et al. Classification of headache. *J Am Med Assoc* 1962; 179:717–718.
- 16 Keating JC. *Toward a philosophy of the science of chiropractic: a primer for clinicians*. Stockton Foundation for Chiropractic Research, Stockton, 1992.
- 17 Barlow DH, Hayes SC, Nelson RO. *The scientist practitioner: research and accountability in clinical and educational settings*. New York: Pergamon, 1984.
- 18 Devore J, Peck R. *Statistics: the exploration and analysis of data*. New York: West Publishing Co., 1986; 373,417.