

Effects of osteopathic manipulative treatment in patients with cervicothoracic pain: Pilot study using thermography

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To provide information on how cervicothoracic pain responds to osteopathic manipulative treatment, five subjects with acute or chronic pain received appropriate medication and three osteopathic manipulative treatments by the principal investigator using thrust and nonthrust techniques. The mean number of findings by both investigators on structural examination decreased considerably immediately after each of the three treatments. The number of findings increased in week 2 and decreased in week 3. The principal investigator observed a further decrease by the final session, but the coinvestigator reported an increase. The pain scale score improved an average of nearly 30%. Thermography showed cooling of the cervicothoracic region in all subjects and conversion to a normal pattern in four. Osteopathic manipulative treatment should be considered for patients with acute or chronic cervicothoracic pain. The use of thermographic analysis in clinical osteopathic research seems warranted.

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Cervicothoracic pain is frequently encountered in a family physician's practice. Various treatment approaches have been outlined elsewhere.¹⁻⁷ Manipulative treatment is currently one method of treating patients with painful musculoskeletal conditions.

Information obtained from clinical research on low-back pain to date is inconclusive. Favorable results with manipulation have been reported in some studies,⁸⁻¹⁸ but others have not identified a difference in results between manipulative treatment and other interventions.¹⁹⁻²¹ The research designs of many of these studies have been questioned.²²⁻²⁴ Problems encountered in these studies included trial design, standardization of therapy, the issue of placebo manipulation, lack of an accurate diagnosis, and the assessment of outcome.²²⁻²⁴ In addition, the manipulative treatments used in some of these studies are not comparable to the treatments patients typically receive from an osteopathic physician.^{19,20}

The number of studies on low-back pain cited exceed the few that have been conducted on cervicothoracic pain.²⁵⁻³⁰ An investigation to provide more information on the response of cervicothoracic pain to osteopathic manipulative treatment (OMT) was therefore planned. A pilot study was arranged and approved by the coinvestigator, the outpatient clinic administrator, and the Chicago College of Osteopathic Medicine Institutional Review Board.

Subjects with cervicothoracic pain were recruited from the Family Medicine Clinic at the Olympia Fields (Illinois) Osteopathic Medical Center. The objective of the study was to determine the effect of a course of OMT administered to subjects with cervicothoracic pain. Attention was given to duration of such an effect, the time to maximum effect, and the pattern of change over time. In addition, this study compared the effect of OMT on subjects with long-term pain with the effect on subjects with more recently acquired pain.

Semiquantitative and quantitative data improve a clinician's decision-making process. An improved decision-making process allows for better selection of interventions and more effective intervention. In this preliminary study, thermography was evaluated as a quantitative measurement of circulatory changes.

Materials and methods

Subjects were selected from the coinvestigator's (C.J.) practice at an ambulatory care clinic. The patients included in the study came to the clinic because of cervicothoracic pain. Their pain was musculoskeletal, had a known onset, and was present for at least 6 weeks before the start of the study.

Initially this study was designed to compare the difference in results between subjects undergoing non-manipulative treatment and subjects receiving OMT. However, because all the patients seeking care at this clinic requested OMT, it was deemed unethical to withhold treatment. Therefore, each subject in this study received OMT. This pilot study then became a description of the effect of such treatment on subjects with cervicothoracic pain.

Patients selected as candidates were at least 18 years of age. All had undergone a thorough physical examination by their family physician at least 6 months before the start of the study.

Candidates were excluded from the study if they had a history of strong response to medication for their pain, if they required hospitalization, or if they were using opiate-based medications. Also excluded were those patients with spastic or flaccid paralysis of the upper extremities, muscle wasting in the cervicothoracic region or upper extremities, or any gross structural deformities. Candidates were eliminated if they had received routine manipulative treatments (defined as weekly OMT for 2 months or 14 manipulative treatments in the preceding 12 months) or had had OMT within 1 week before the start of the study.

After informed consent was obtained, subjects were placed on a medication regimen appropriate for their condition; this regimen usually consisted of their current analgesic medications. They were asked to be seen on four occasions spaced 1 week apart. The principal investigator administered a total of three manipulative treat-

ments, one at each of the first three sessions. In addition, a questionnaire about pain, thermography, and structural examinations were administered at each session.

At the first session, subjects completed an initial questionnaire for baseline data. Included in the questionnaire was a 10-point pain scale. A thermographic recording of each subject's cervicothoracic region was obtained by use of the Agema T870 system (AGEMA, Secaucus, NJ), which was calibrated daily. Thermograms were obtained in a draft-free room maintained at a constant temperature of 25°C. The CATS software program version 1.01 (AGEMA, Secaucus, NJ) was used for thermographic analysis. The boundary of the cervicothoracic region was established as being from the hairline to the T-5 level on the posterior aspect.

Separate structural examinations were performed by both investigators before and just after OMT. Results of these examinations were recorded on a standardized form (*Figure 1*). The physicians recorded their findings, which included general somatic characteristics as well as the following:

- Tissue texture changes, both acute and chronic, detected by palpation using light touch and pressure. Acute changes are characterized by vasodilation, edema, tenderness, and muscular contraction. Chronic changes are characterized by tenderness, itching, fibrosis, paresthesias, and contracture.
- Restrictions in range of motion.
- Areas of tenderness.
- Severity of tenderness, scored from 1 to 3, with 1 denoting mild tenderness, and 3 denoting enough tenderness to produce a loud response from the patient on palpation.

Examiners were not permitted to review previous examination forms. Interexaminer discussion of the results of examinations also was not allowed.

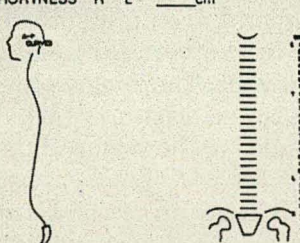
Osteopathic manipulative treatments were administered by the principal investigator using both thrust and nonthrust methods.

Thrust techniques consisted of a high-velocity, low-amplitude force to improve segmental range of motion. Nonthrust techniques included soft-tissue muscle stretching, myofascial release, spontaneous release by positioning (counterstrain), and articulatory techniques, whereby a joint is moved through its entire range of motion. Manipulation was not restricted to the cervicothoracic region.

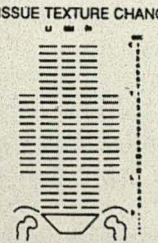
After the OMT, an additional thermogram was obtained, and separate structural examinations were again performed by both investigators. The investigators were blinded as to each other's findings. The coinvestigator did not have knowledge of the manipulative techniques used nor the segments treated. Questionnaires were completed before and after each treatment session. This protocol was repeated on each subject's second and third sessions. The fourth session consisted of questionnaire completion, thermography, and one set of structural examinations, whereupon the data collection was complete.

PHYSICAL EXAMINATION

GAIT: NORMAL ☐ ABNORMAL ☐ (EXPLAIN) _____
 BODY TYPE: ENDO MESO ECTO _____
 POSTURE: EXCELLENT ☐ FAIR ☐ POOR ☐ _____
 APPARENT LEG SHORTNESS R L _____ cm

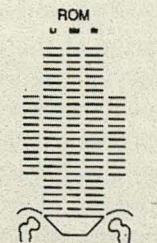


TISSUE TEXTURE CHANGES



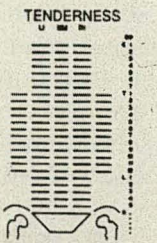
LEGEND: "A" IS ACUTE
"C" IS CHRONIC

ROM



R L F E ROT SB
EL DEP

TENDERNESS



1 SEVERE
2 MODERATE
3 MINIMAL

EXTREMITIES: NOTE TISSUE TEXTURE CHANGES, ROM, TENDERNESS.

ADDITIONAL FINDINGS: _____

Figure 1. Standardized form for recording investigators' structural examination results. Examiners were asked to indicate abnormalities of anteroposterior and lateral spinal curves in upper section and segmental findings in lower section.

Results

This study was conducted from September to October 1989. Five women aged 26 to 50 years (mean, 37.2 years) participated in the study. These subjects spent an average of 34 hours per week at work and averaged 13.6 years of schooling. Only one subject had legal action pending. Two of the subjects had the onset of pain 2 months before the start of the study; the other three had had pain persisting for years.

In *Figure 2*, the mean of the subjects' scores on a pain scale is plotted over time. The scores on the pain scale could range from 0 to 10, with 0 being no pain and 10 being the most severe pain they had ever experienced. The average amount of pain the subjects typically experienced before starting the study was rated 5. Their pain scores averaged 4.8 at the start of the study and decreased to an average of 3.4 at completion of the study ($P < .01$). All five subjects had a decrease in pain by the study's end.

When asked if they thought that the OMT improved their painful condition, 80% responded

"yes." However, only 60% of the subjects responded "yes" when asked if they thought that the medications alleviated their pain.

Subjects answered questions regarding their perception of the response they experienced from the manipulative treatments. Of the questions answered, 67% indicated a favorable response to the OMT. In addition, the two subjects who initially indicated radicular symptoms reported improvement by the end of the study.

Figure 3 shows the mean temperature of the subjects' cervicothoracic regions plotted over time. Over the course of the study, this mean temperature decreased an average of 0.98°C , with a range of 0.6°C to 1.4°C ($P < .001$). All five subjects had a decrease in the mean cervicothoracic temperature. Most of the decrement in temperature occurred by the third treatment session, with only a minimal decrease thereafter.

Initial thermograms of all five subjects showed asymmetries of skin temperature patterns. By the final session, four of the five subjects' thermograms converted to a normal pattern with elimination or reduction of asymmetry.

Figure 4 demonstrates how a normal thermogram of the cervicothoracic region should appear.

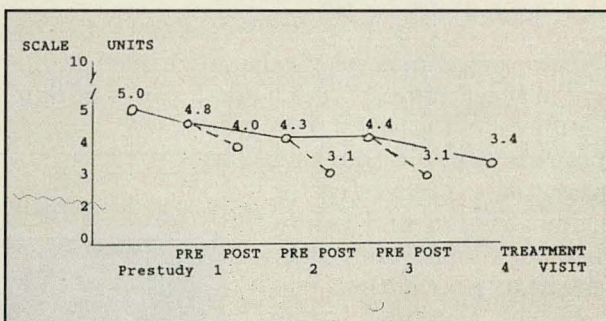


Figure 2. Mean of subjects' scores on a pain scale at each treatment session before and after treatment.

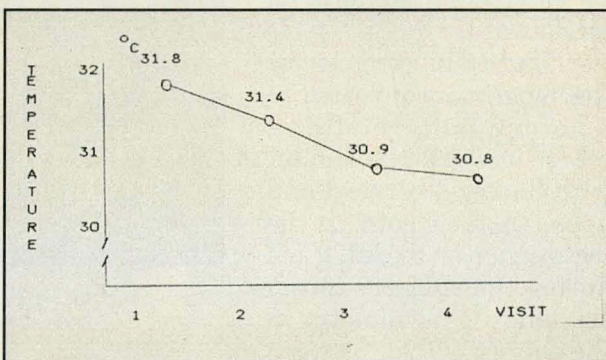


Figure 3. Average of mean temperature of subjects' cervicothoracic regions at each treatment session just before treatment.

Row	Lt5	Lt4	Lt3	Lt2	Lt1	M	Rt1	Rt2	Rt3	Rt4	Rt5	Mean	Gradient
1	311	312	319	325	326	322	324	325	321	314	311	319	2
2	312	318	324	326	325	323	324	326	323	318	313	321	2
3	317	323	327	327	325	323	325	326	325	323	316	323	1
4	320	326	328	327	326	325	326	327	328	326	323	324	2
5	323	327	328	327	326	325	326	327	328	326	323	326	2
6	326	327	328	328	327	326	326	328	328	326	323	327	1
7	326	326	327	328	327	327	327	328	328	326	323	326	1
8	327	326	327	327	327	327	327	328	328	326	322	326	0+
9	323	325	327	327	327	327	327	328	327	325	322	326	0+
10	323	325	326	327	327	327	327	327	327	325	322	326	0+
11	322	321	326	327	327	327	326	327	327	324	322	325	1
12	322	324	325	326	327	328	326	326	326	324	321	325	0
13	322	324	325	326	326	327	326	326	326	323	321	325	0+
14	321	323	325	326	327	326	326	326	326	323	321	325	0+
15	320	322	324	325	325	327	326	324	323	321	320	324	1
16	321	323	325	327	327	327	326	324	323	320	319	323	1
17	321	323	324	326	326	327	325	324	321	319	316	322	1
18	320	322	324	326	326	327	325	324	321	319	318	322	0+
19	321	323	326	326	326	326	324	323	320	318	317	321	1
20	321	323	325	325	325	325	323	322	320	318	316	321	0+
21	321	322	325	325	325	326	323	322	320	317	315	321	0+
22	320	322	325	325	325	326	323	321	320	317	315	320	1
23	321	325	325	325	325	325	323	320	317	317	317	320	0
24	321	325	325	325	325	325	322	320	319	317	317	320	1
25	321	324	325	325	325	325	322	320	318	316	316	319	0+
26	321	324	325	325	325	325	322	319	317	315	315	319	0+
27	321	324	325	325	325	325	321	318	316	316	316	318	1
28	321	324	325	325	325	325	321	318	316	316	316	318	0+
29	321	324	325	325	325	325	320	317	315	315	315	317	1
30	321	324	325	325	325	325	320	315	315	315	315	316	1
31	321	324	325	325	325	325	318	315	315	315	315	315	0+
32	321	324	325	325	325	325	319	315	315	315	315	315	0+
33	321	324	325	325	325	325	319	315	315	315	315	315	1
34	321	324	325	325	325	325	316	315	315	315	315	314	0
35	321	324	325	325	325	325	316	315	315	315	315	314	0
36	320	323	325	325	325	325	314	314	314	314	314	313	1
37	320	323	325	325	325	325	313	313	313	313	313	312	1
38	321	324	325	325	325	325	313	313	313	313	313	313	1
39	321	324	325	325	325	325	312	312	312	312	312	312	0+
40	321	324	325	325	325	325	312	312	312	312	312	312	0+
Mean	316	318	320	322	325	325	323	321	319	317	315	320	
Gradient	2	2	2	3	0+	2	2	2	2	2	2	2	

Figure 4. Tsk (temperature of skin) averages from thermograms of adults without major structural health problems. Pixel value is degrees centigrade $\times 10$, averaged for eight measurements. Row 12 is caudal to the C-7 marker and row 40 extends to or just below T-12. Each pixel is about 4×8 mm.

The thermogram is color coded, with each gradation of black representing a small range of temperatures. In the actual thermogram, purple (darkest gradation in Figure 4) is the coolest region and yellow (lightest gradation), the warmest. In a normal pattern, the warmest region roughly corresponds to the shape of the trapezius muscle with cooling laterally and caudalward.

Figure 5 illustrates how thermograms converted to a normal pattern after a course of OMT in a subject with bilateral cervical and upper thoracic pain. In the thermogram on the left, taken during the subject's initial session, the asymmetry in the pattern of color between the right and left sides of the subject's cervicothoracic

region is apparent. The average temperature of the right side of the cervicothoracic region was 0.5°C greater than on the left. In the thermogram on the right, from the same subject 1 week after a manipulative treatment, the two sides of the cervicothoracic region have an identical mean temperature. The cervicothoracic region appears more symmetric as well. Thermographic analysis of two subjects showed areas in which the pain pattern corresponded to the region of thermographic asymmetry.

Figure 6 is a graph of the total number of reported findings of both investigators, session by session. Each recording of tissue texture changes, restrictions in range of motion, or areas of tenderness counted as one finding, but the severity of tenderness component counted as 1, 2, or 3, depending on the rating. Osteopathic manipulative treatment was administered between examinations 1 and 2, 3 and 4, and 5 and 6.

Both examiners reported a large decrease in the number of findings immediately after treatment ($P < .001$). This decrease reflected improvement in range of motion, tenderness, and tissue texture. The number of findings increased in week 2 and decreased in week 3. The principal investigator observed a further decrease by the final session ($P < .001$), but the coinvestigator reported an increase. The objective data support agreement in six of the seven examinations with a significant decrease in findings immediately after OMT.

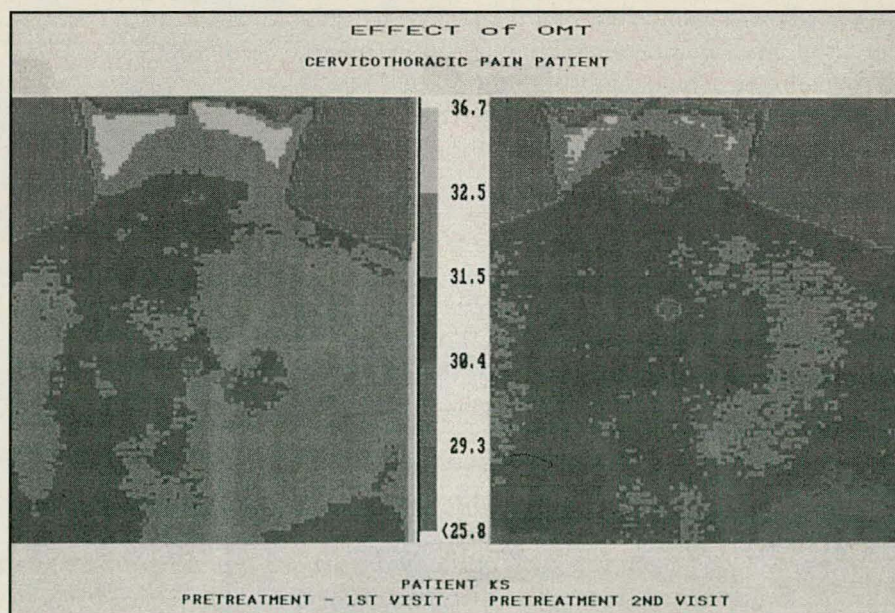


Figure 5. Two thermograms taken of cervicothoracic region in patient with bilateral cervical and upper thoracic pain. Thermogram on left was taken at initial session before treatment; thermogram on right was taken 1 week after one treatment.

Figure 7 illustrates the frequency of all findings, reported by both investigators, by segmental level. The findings increased most in the cervicothoracic region, with a decrease in the lower part of the vertebral column. This observation demonstrates a correlation between the subjects' complaints of cervicothoracic pain and the examiners' findings.

Subjects with long-standing painful disorders tended to have more diffuse somatic dysfunction and tissue texture changes. These subjects also tended to have findings more distant from their painful regions. In contrast, subjects with recently acquired painful disorders had a more concentrated area of findings that tended to coincide with their region of discomfort.

Discussion

The difficulty with clinical trials showing the role of manipulation in treating painful disorders has been discussed previously.²²⁻²⁴ In a pilot study by Beal and coworkers,²⁵ muscle activity of the cervical region was recorded by electromyography in patients with chronic cervical pain. After a course of OMT, the electrical muscle activity in the patients' cervical regions approximated that observed in asymptomatic patients.

In studies by Mealy,²⁶ Howe,²⁷ and Brodin²⁸ and their associates, manipulation provided more relief than a cervical collar and rest²⁶; analgesics²⁷; and massage, traction, and electrical stimulation,²⁸ respectively, in patients with cervical pain. In contrast, Nordema and Thörner²⁹ found transcutaneous nerve stimulation to be slightly more effective in pain reduction than mobilization therapy in patients with cervical pain. Sloop and associates³⁰ found that a single manipulative treatment with the patient under the influence of intravenously injected diazepam was no more effective than intravenously injected diazepam alone in patients with cervical spondylosis or nonspecific neck pain.

The subjects in our study all reported alleviation of pain, with the average improvement in pain scale score, nearly 30%. The two subjects with radicular symptoms reported improvement in arm and hand symptoms by the end of the study. The subjects thought that OMT was responsible for the relief of their pain.

Thermographic analysis indicated a cooling by nearly 1°C of each subject's cervicothoracic region after a course of OMT. This cooling represents large decreases in temperature in areas of regional temperature asymmetry and slight cooling in more thermographically normal regions.

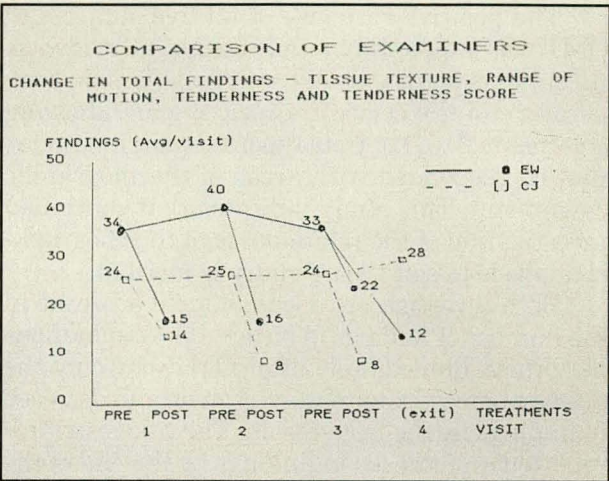


Figure 6. Average number of reported findings (by both investigators) of all subjects, session by session, both before and after treatment. Findings include number of segments with tissue texture changes, number of segments with decreased range of motion, number of segments with tender areas, and total score of severity of tenderness, with 1 as minimal tenderness, 2 as moderate, and 3 as severe. Upper curve shows principal investigator's findings, and lower curve reflects findings of the coinvestigator.

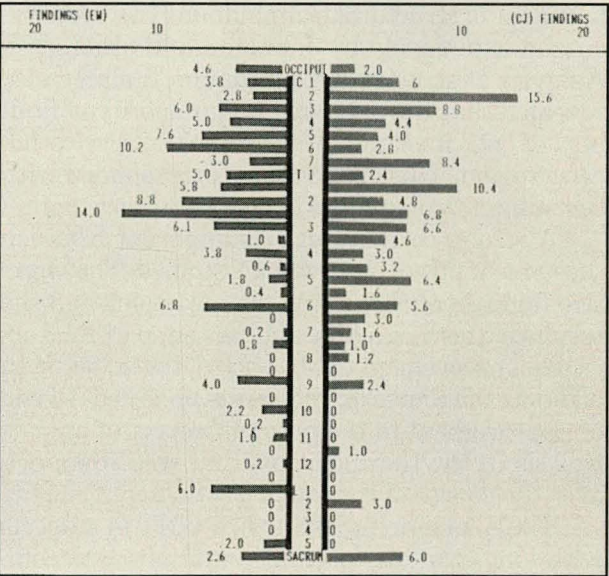


Figure 7. Average total number of findings of each subject by segment. Bar below each labelled thoracic segment represents corresponding rib findings. Principal investigator's findings are on left; the coinvestigator's findings, on right.

Most of the cooling occurred after only two treatments. Cooling may have represented a decrease in muscle tension in the dorsal cervicothoracic muscles or perhaps a change in the hydrational state of the underlying epidermis.³¹

After a course of OMT, thermograms converted to a normal pattern. This conversion occurred in four of the five subjects.

The positive response of all five subjects to OMT was supported by thermographic evidence. All subjects demonstrated a decrease in skin temperature of the cervicothoracic region following treatment. Two subjects reported pain in regions that corresponded with areas of thermographic asymmetry. This study indicates that continued investigation of the relationship of thermographic analysis to soft-tissue injury is merited.

Both investigators documented a decrease in the number of findings in structural examinations performed immediately after OMT, but only the principal investigator observed an overall decrease in findings by the last session. The coinvestigator reported an increase in findings by the end of the study. The investigators' difference in background and philosophy, as well as the coinvestigator's blinding as to regions treated, may have led to this discrepancy. Perhaps the biggest factor causing the discrepancy between examiners was the absence of a formal training session to instruct the examiners on performing a standard structural examination. Interexaminer agreement on the performance of structural examinations has been discussed extensively by Johnston and others.³²⁻³⁵ Analysis of structural examination findings also revealed that the overwhelming majority of findings of both investigators were in the cervicothoracic region. This observation corresponded with the subjects' complaints of cervicothoracic pain.

A strong correlation was apparent between the three kinds of observations studied. The objective findings on structural examinations and the results of thermographic analysis support the subjective improvement felt by each of the subjects. In addition, the course of treatments produced a trend of improvement in the patients' report of pain as well as in the thermograms that was sustained over the course of the study.

The alleviation of pain with OMT in subjects with long-standing painful conditions was comparable to the relief experienced by subjects with a more recent onset of pain. This result lends support to the view that OMT works as effectively on patients with chronic disorders as it does on patients with acute conditions.

Comment

Osteopathic manipulative treatment produced a beneficial effect for each of the five subjects with cervicothoracic pain. Osteopathic manipulative treatment was equally effective in subjects with long-standing and recently acquired painful conditions.

The results of this study suggest that thermography may be considered in clinical research on OMT and somatic dysfunction. The results further suggest that OMT should be considered when managing patients with cervicothoracic pain.

Future research providing more quantitative data would enhance physicians' decision-making processes. It would greatly improve the effectiveness of OMT for cervicothoracic pain as well as other painful disorders managed by the osteopathic physician.

Acknowledgment

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References

1. Wood GW: Lower back pain and disorders of intervertebral disc, in Crenshaw AH (ed): *Campbell's Operative Orthopaedics*, ed 7. St Louis, Mo, CV Mosby Co, 1987, vol 4, pp 3278-3288.
2. Nakano KK: Neck pain, in Kelley WN, Harris ED Jr, Ruddy S, et al: *Textbook of Rheumatology*. Philadelphia, Pa, WB Saunders Co, 1989, pp 471-490.
3. Phull PS: Management of cervical pain, in DeLisa JA (ed): *Rehabilitation Medicine: Principles and Practice*. Philadelphia, Pa, JB Lippincott, 1988, pp 749-764.
4. Branch WT Jr: Pain in the shoulder, neck, and arm, in Branch WT: *Office Practice of Medicine*, ed 2. Philadelphia, Pa, WB Saunders Co, 1987, pp 904-922.
5. Turek SL: The cervical spine, in Turek SL: *Orthopaedics: Principles and Their Application*, ed 4. Philadelphia, Pa, JB Lippincott, 1984, vol 2, pp 829-889.
6. Gore DR, Sepic SB, Gardner GM, et al: Neck pain: A long-term follow-up of 205 patients. *Spine* 1987;12:1-5.
7. England RW: The cervical spine: Some clinical and practical considerations. *JAOA* 1971;71:1-18.
8. Nwuga VCB: Relative therapeutic efficacy of vertebral manipulation and conventional treatment in back pain management. *Am J Phys Med* 1982;61:273-278.
9. Farrell JP, Twomey LT: Acute low back pain: Comparison of two conservative treatment approaches. *Med J Aust* 1982;1:160-164.
10. MacDonald RS, Bell CMJ: An open controlled assessment of osteopathic manipulation in nonspecific low-back pain. *Spine* 1990;15:364-370.
11. Evans DP, Burke MS, Lloyd KN, et al: Lumbar spinal manipulation on trial. Part 1—Clinical assessment. *Rheumatol Rehabil* 1978;17:46-53.
12. Hadler NM, Curtis P, Gillings DB, et al: A benefit of spinal manipulation as adjunctive therapy for acute low-back pain: A stratified controlled trial. *Spine* 1987;12:703-706.
13. Jayson MIV, Sims-Williams H, Young S, et al: Mobilization and manipulation for low-back pain. *Spine* 1981;6:409-416.

14. Hoehler FK, Tobis JS, Buerger AA: Spinal manipulation for low back pain. *JAMA* 1981;245:1835-1838.
15. Matthews JA, Mills SB, Jenkins VM, et al: Back pain and sciatica: Controlled trials of manipulation, traction, sclerosant and epidural injections. *Br J Rheumatol* 1987;26:416-423.
16. Coxhead CE, Inskip H, Meade TW, et al: Multicentre trial of physiotherapy in the management of sciatic symptoms. *Lancet* 1981;1:1065-1068.
17. Meade TW, Dyer S, Browne W, et al: Low back pain of mechanical origin: Randomised comparison of chiropractic and hospital outpatient treatment. *Br Med J* 1990;300:1431-1437.
18. Ongley MJ, Klein RG, Dorman TA, et al: A new approach to the treatment of chronic low back pain. *Lancet* 1987;2:143-146.
19. Godfrey CM, Morgan PP, Schatzker J: A randomized trial of manipulation for low-back pain in a medical setting. *Spine* 1984;9:301-304.
20. Zybergold RS, Piper MC: Lumbar disc disease: Comparative analysis of physical therapy treatments. *Arch Phys Med Rehabil* 1981;62:176-179.
21. Gibson T, Grahame R, Harkness J, et al: Controlled comparison of short-wave diathermy treatment with osteopathic treatment in non-specific low back pain. *Lancet* 1985;1:1258-1261.
22. Koes BW, Assendelft WJK, van der Heijden GJ MG, et al: Spinal manipulation and mobilisation for back and neck pain: A blinded review. *Br Med J* 1991;303:1298-1303.
23. Ottenbacher K, Difabio RP: Efficacy of spinal manipulation/mobilization therapy. A meta-analysis. *Spine* 1985;10:833-837.
24. Grahame R: Clinical trials in low back pain. *Clin Rheum Dis* 1980;6:143-156.
25. Beal MC, Vorro J, Johnston WL: Chronic cervical dysfunction: Correlation of myoelectric findings with clinical progress. *JAOA* 1989;89:891-900.
26. Mealy K, Brennan H, Fenelon GCC: Early mobilisation of acute whiplash injuries. *Br Med J* 1986;292:656-657.
27. Howe DH, Newcombe R, Wade MT: Manipulation of the cervical spine—a pilot study. *J R Coll Gen Pract* 1983;33:574-579.
28. Brodin H: Cervical pain and mobilization. *Acta Belg Med Phys* 1983;6:67-72.
29. Nordemar R, Thörner C: Treatment of acute cervical pain—a comparative group study. *Pain* 1981;10:93-101.
30. Sloop PR, Smith DS, Goldenberg E, et al: Manipulation for chronic neck pain: A double-blind controlled study. *Spine* 1982;7:532-535.
31. Adams T, Steinmetz MA, Heisey SR, et al: Physiologic basis for skin properties in palpatory physical diagnosis. *JAOA* 1982;81:366-377.
32. Johnston WL, Elkiss ML, Marino RV, et al: Passive gross motion testing: Part II. A study of interexaminer agreement. *JAOA* 1982;81:304-308.
33. Johnston WL, Beal MC, Blum GA, et al: Passive gross motion testing: Part III. Examiner agreement on selected subjects. *JAOA* 1982;81:309-313.
34. Johnston WL: Interexaminer reliability studies: Spanning a gap in medical research—Louisa Burns Memorial Lecture. *JAOA* 1982;81:819-829.
35. Johnston WL, Hill JL, Elkiss ML, et al: Identification of stable somatic findings in hypertensive subjects by trained examiners using palpatory examination. *JAOA* 1982;81:830-836.