Professional Perspective

Manipulation of the Cervical Spine: Risks and Benefits

Manipulation of the cervical spine (MCS) is used in the treatment of people with neck pain and muscle-tension headache. The purposes of this article are to review previously reported cases in which injuries were attributed to MCS, to identify cases of injury involving treatment by physical therapists, and to describe the risks and benefits of MCS. One hundred seventy-seven published cases of injury reported in 116 articles were reviewed. The cases were published between 1925 and 1997. The most frequently reported injuries involved arterial dissection or spasm, and lesions of the brain stem. Death occurred in 32 (18%) of the cases. Physical therapists were involved in less than 2% of the cases, and no deaths have been attributed to MCS provided by physical therapists. Although the risk of injury associated with MCS appears to be small, this type of therapy has the potential to expose patients to vertebral artery damage that can be avoided with the use of mobilization (nonthrust passive movements). The literature does not demonstrate that the benefits of MCS outweigh the risks. Several recommendations for future studies and for the practice of MCS are discussed. [Di Fabio RP. Manipulation of the cervical spine: risks and benefits. *Phys Ther.* 1999;79:50–65.]

Key Words: *Effectiveness, Physical therapy, Risk, Spinal manipulation, Vertebrobasilar accident.*

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Manipulation and mobilization may be important aspects of the care provided to patients with cervical impairments.

Manipulation of the spine (MTS) is a form of manual therapy that is used in an effort to reduce pain and improve range of motion.[1] The use of manipulation of the spine to treat patients with pain involves a high-velocity thrust that is exerted through either a long or short lever-arm.[2–6] The "long-lever" techniques move many vertebral articulations simultaneously (eg, rotary manipulation of the thoracolumbar spine),[7–9] whereas the "short-lever" techniques involve a low-amplitude thrust that is directed at a specific level of the vertebral column. Manipulation of the spine differs from mobilization of the spine because, theoretically, during manipulation of the spine, the rate of vertebral joint displacement does not allow the patient to prevent joint movement.[10] Mobilization of the cervical spine involves low-velocity (nonthrust) passive motion that can be stopped by the patient.[10] The speed of the technique (not necessarily the amount of force), therefore, differentiates manipulation from mobilization.

Manipulation of the spine has been used in the treatment of patients with head and neck disorders, including neck pain and stiffness, muscle-tension headache, and migraine.[11] Because of the proximity of the vertebral artery to the lateral cervical articulations, caution must be used during manipulation of the cervical spine (MCS). It is thought that stroke can be induced as a result of MCS by mechanical compression or excessive stretching of arterial walls,[12] but the pathogenesis of ischemia is unknown.[13] Leboeuf-Yde et al[14] maintain that some vascular injuries that occur after MCS may have happened, in any case, as a natural consequence of some underlying medical condition. Ladermann has raised questions about the link between MCS and cerebrovascular accidents and claimed that in some cases "there is barely a temporal coincidence between the manipulation and the onset of brain-stem syndrome."[15(p63)]

Frisoni and Anzola[13] proposed a theory that accounted for the delay in symptoms that is sometimes reported following MCS. They suggested that vertebrobasilar ischemia after neck manipulation might begin with subclinical damage to the tunica intima or tunica media. Progressive or delayed symptoms are possible when a thrombus or slowly progressive dissection forms and propagates to the basilar, internal carotid, or posterior cerebral arteries.[13,16] Based on a review of injuries related to MCS, Frisoni and Anzola[13] also suggested that acute arterial dissection could result unexpectedly, even after repeated successful cervical manipulations. Their theory is supported by the observation that young individuals without known systemic or vascular pathology who receive MCS sometimes have subsequent brain infarctions in the vertebrobasilar artery distribution.[17,18]

The purposes of my study were to review previously reported cases of injury attributed to MCS, to identify cases of injury involving treatment by physical therapists, and to describe the risks and benefits of MCS. Before analyzing the case reports, I will discuss the effectiveness of screening examinations for patients with cervical impairments and describe the current use of MCS by physical therapists. Following the analysis of injuries attributed to MCS, I will propose several recommendations for practice and research related to MCS.

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Screening Examinations

Manipulation of the cervical spine is not the only cause of vertebrobasilar vascular accidents.[19] There have been reports of spontaneous vertebral artery dissections[20] (and Mas et al[21] [cases 8 and 11]), self-inflicted vertebral artery obstruction (ie, caused by self-manipulation)[22–25] (and Katirji et al[26] [cases 2 and 4] and Easton and Sherman[27] [case 1]), and occlusion related to exercise[28] or bony abnormalities such as osteoarthritic spurs[29] and atlanto-occipital fusion.[30]

Clinical screening examinations that might detect some of these conditions have been advocated as a way of preventing injury from MCS.[31–36] The central features of the screening examinations involve patient history and provocation of symptoms by testing for signs of vertebral artery compression (reviewed by Grant,[31] Terrett and Webb,[33] Rivett,[35] Cote et al,[37] and Ladermann[38]). The detection of congenital bony deviations, spinal instability, and inflammatory or degenerative joint disease may also require plain radiographs and imaging during functional movements.[39] There are sex-specific factors that are considered contraindications to MCS (eg, women immediately postpartum or taking oral contraceptives are thought to experience hormone-mediated ligament laxity that might reduce the protective stability in intervertebral articulations).[32] Terrett[32] noted that factors in the patient history can be used to identify "warning" signs related to osseous, vascular, and neurologic factors (eg, osteophytes, previous neck trauma, hypertension, previous stroke, visual disorders), but there is not wide agreement that these conditions are absolute contraindications for MCS.[38]

Although the use of screening examinations seems prudent, the sensitivity and specificity of "warning signs" obtained from the patient history and from the symptom provocation tests of vertebral artery function have not been established. Several authors have reviewed cases of subjects without known pathology who experienced vertebrobasilar ischemia following MCS,[13,17,18] and it has been suggested that the population at risk cannot be identified a priori.[13] Patients who have none of the "warning signs" that would otherwise alert clinicians to some assumed contraindication for MCS may still experience injury following MCS.

Several tests have been used to assess the vulnerability of the vertebral artery to movement-induced pressure,[33,37,40] and all of these maneuvers place the neck in an extended position with rotation. One procedure requires the clinician to maintain the patient's head in this position for 30 to 40 seconds. The clinician then looks for signs of brain-stem ischemia (ie, vertigo, nystagmus, nausea, or sensory disturbance). The absence of positive findings for the vertebral artery tests, however, does not necessarily indicate that the vertebral arteries will remain patent during MCS.[40]

Cote et al[37] found that the sensitivity of the vertebral artery test for increasing impedance to blood flow was zero. Their results were based on a secondary analysis of earlier work that measured vascular impedance to blood flow using Doppler ultrasonography during the vertebral artery test in subjects with and without clinical signs and symptoms of suspected vertebrobasilar insufficiency.[41] Haynes[42] reported that only 5% of the arteries tested in 148 patients had Doppler signals that stopped during contralateral rotation of the neck. Ladermann[15] acknowledged the limitations of screening patients to prevent MCS-induced injury and even suggested that placing the head in the sustained posture required for the vertebral artery test exposed the patient to a greater risk than the brief thrust of a manipulation. In addition, Grant[31] noted that the rapid thrust component of MCS is not simulated during vertebral artery testing, and this limitation might contribute to the lack of test sensitivity. Several modifications in the Australian Physiotherapy Association premanipulative vertebral artery testing protocol[34] have been suggested by Rivett[35] (eg, the addition of sustained traction, oscillations of the cervical spine at the end-range of motion), but there is no evidence that these modifications improve the sensitivity for identifying patients with vertebrobasilar insufficiency.

Symptom provocation testing and functional radiographs might help identify vascular and mechanical problems in some patients. Clinicians need to be aware, however, that negative (normal) findings for these tests do not mean that MCS will be safe. Symptom provocation tests might even cause injury in some patients.

Methods of Assessment of Injuries Associated With Cervical Manipulation

I identified descriptions of cases and case reports involving injuries attributed to MCS using a search of the *Index Medicus* database for the years 1966 to 1997. The BIOETHICSLINE database (1973–1997), the *Cumulative Index to Nursing and Allied Health* (CINAHL) database (1982–1997), and the *Current Contents* database (1994–1997) were also used. The search was initiated using the key words "chiropractic," "cervical vertebrae," "neck pain," and "physical therapy." Additional references were identified from the bibliographies of published articles that were construed to be relevant to the topic of cervical manipulation injuries. Several recent reviews provided the majority of reference citations.[11,13,43–50] Case reports of spontaneous vertebral artery dissections[20,51] (and Mas et al[21] [except cases 8 and 11]), self-inflicted injuries related to neck motion[22–25] (and Katirji et al[26] [cases 2 and 4] and Easton and Sherman[27] [case 1]), injury due to trauma,[52–56] and bony malforma-

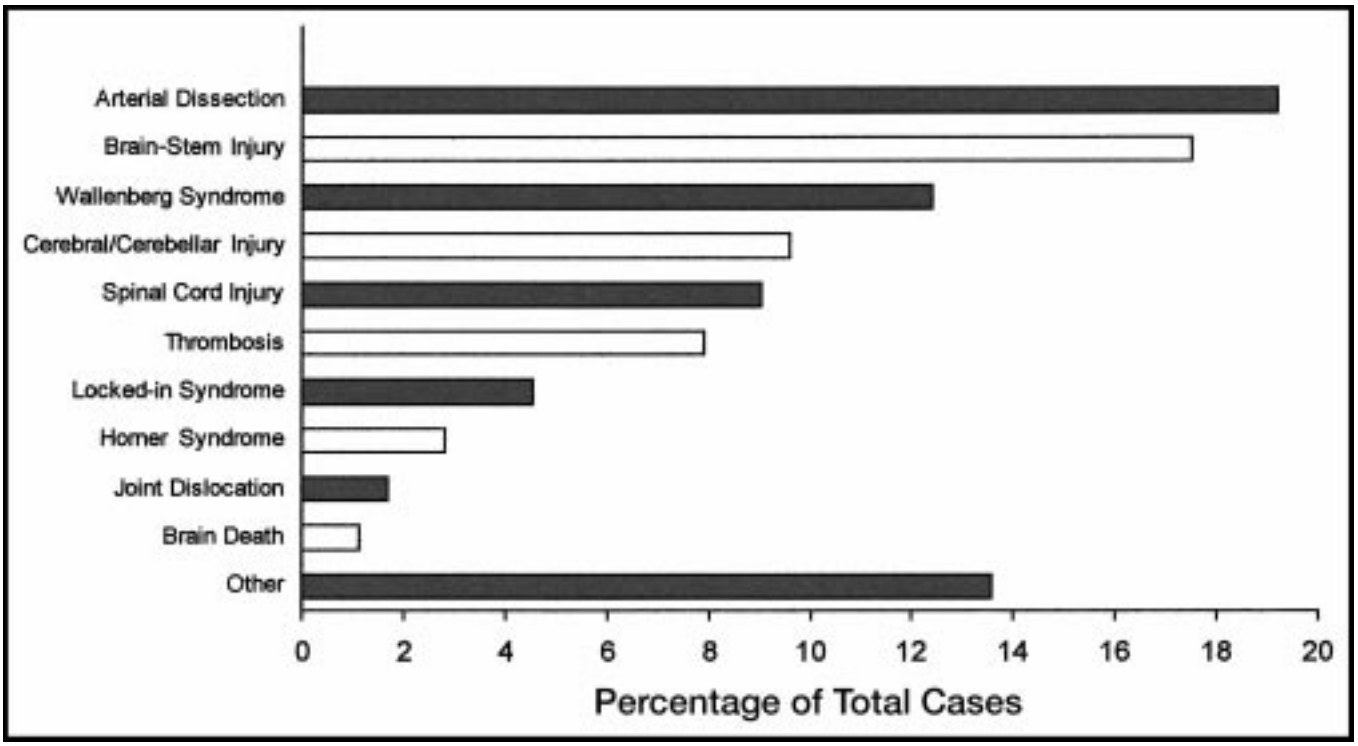

Figure 1.
Injuries attributed to manipulation of the cervical spine. The category "Arterial Dissection" included pseudoaneurysm, arterial spasm, and rupture. The "Brain-Stem Injury" and "Cerebral/Cerebellar Injury" categories indicate cases of infarct in these areas of the brain. The "Other" category included visual deficits, hearing loss, balance deficits, and phrenic nerve injury.

tions or congenital vascular malformations (Bladin and Merory[54] [case 3]) were not analyzed. Accounts of manipulation-related injuries that appeared in newspapers and magazines[55] were not included.

Information from each case report was entered into a spreadsheet. The database included patient age and sex, the practitioner administering the manipulation, the type of injury sustained from the manipulation, whether the outcome was death, presence of previous medical complications, the type of manipulation, and whether the patient received other manipulative treatments prior to the incident. Terrett[55] reported numerous cases in the literature where the practitioner responsible for the injury induced by MCS was incorrectly labeled as a "chiropractor." Terrett[55] suggested that future discussions regarding the safety of MCS be based on a "corrected" description of the practitioner (provided to him through correspondence and discussions with the authors of reports containing supposedly inaccurate descriptions of the practitioner performing MCS). The analysis of the data, therefore, was repeated using Terrett's "corrections" for practitioners. These "corrections" were done by simply changing the type of practitioner that provided manipulation from "chiropractor" to some other type of practitioner (eg, physician, physical therapist) so that the "corrected" data would be consistent with Terrett's findings.

Articles not in the English language were included and were evaluated based on the interpretation from secondary sources or from an English abstract. There were several instances where the same case was reported multiple times in the literature. An attempt was made to identify instances of multiple reporting where the original case report was not referenced in subsequent articles.[27,56–64] Redundant data were removed from the database prior to analysis. The number of redundant cases could only be estimated, however, because there was a reliance on secondary sources for extracting some information. Descriptive statistics were obtained using Statistica* (version 5.1) for each variable in the database.

Results of Assessment of Injuries Associated With Cervical Manipulation

One hundred seventy-seven cases were reported in 116 articles.† The case reports were published between 1925 and 1997. Secondary sources were used to extract data in 17% (n=30) of the cases. The patients described in these case reports were 80 males and 90 females (the patient's sex was not reported in 7 case reports). The mean age of the patients was 39.6 years (SD=13 years, range=4 months to 87 years).

* Stat Soft Inc, 2300 E 14th St, Tulsa, OK 74104.
† References 13, 16–18, 21, 26, 27, 45, 46, 48, 54, 56, 60, 61, 64–165.

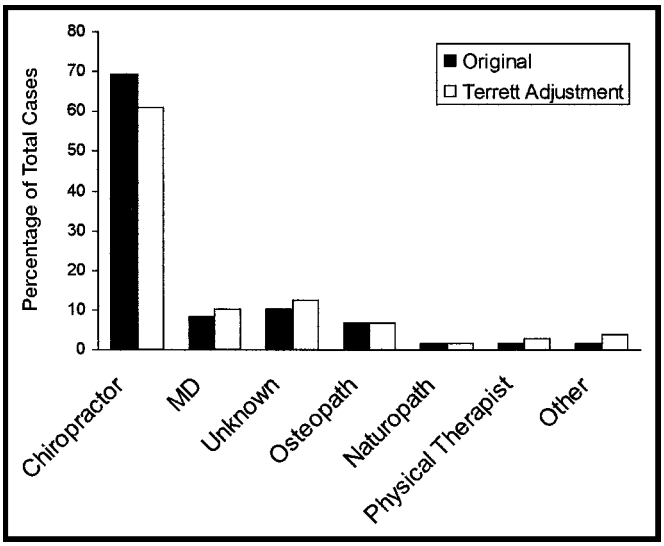

Figure 2.
Practitioners providing manipulation of the cervical spine that resulted in injury. For the purpose of comparison, the type of practitioner was adjusted according to the findings by Terrett.[55]

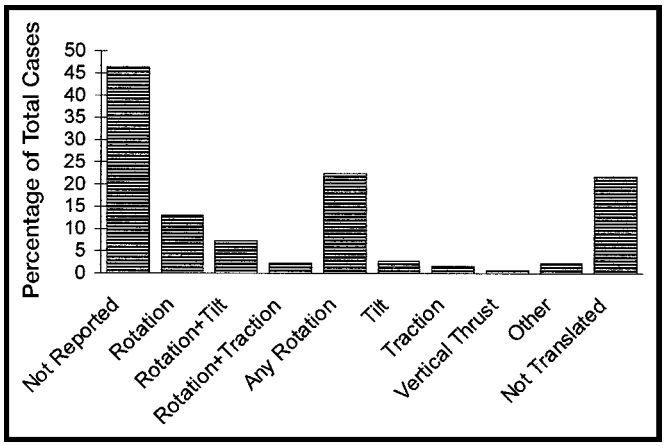

Figure 3.
The type of manipulation of the cervical spine attributed to injury. "Not Reported" means that the information was not included in the case report. "Not Translated" means that the description of manipulation could have been in an original non-English language article, but was missing from the secondary source interpretation of the article or from the English-language abstract.

The most frequently reported injuries involved arterial dissection or spasm, lesions of the brain stem, and Wallenberg syndrome (Fig. 1). The "other" category included visual deficits, hearing loss, balance deficits, and phrenic nerve injury (Fig. 1). Death occurred in 18% of the cases (n=32). Twenty percent of the patients (n=36) were described as "healthy" prior to the incident, but health status prior to injury was not reported for 32% of the cases (n=57). The medical histories of the remaining patients indicated that some patients were smokers, were overweight, had hypertension, were taking oral contraceptives, had osteoarthritis or osteoporosis, had chest pain, or had a previous incident involving trauma to the head and neck.

The majority of injuries were attributed to manipulation by chiropractors (Fig. 2). Physical therapists were involved in less than 2% of the cases. Some authors,[43,47,166] however, have reported incidents (in aggregate form) that were attributed to physical therapists using MCS (Tab. 1). A retrospective survey of physical therapists showed one minor transient incident for every 1,573 manipulations.[166] In a prospective analysis of MCS involving manipulative physical therapists in New Zealand, Rivett and Milburn[43] found 1 incident (usually an exacerbation of neck pain) per every 476 cervical manipulations.

When the type of practitioner (noted in the original studies included in this review) was determined using Terrett's[55] modifications, the number of chiropractors involved in cases of MCS injury decreased slightly, and the numbers of cases attributed to physicians, physical therapists, and other individuals (ie, a barber, a kung-fu practitioner, and a masseur) increased (Fig. 2). In addition, the number of cases where the practitioner was later reported (by the original authors of the case report) to be unknown increased slightly (Fig. 2). The overall pattern of practitioners involved in MCS-related injuries, however, did not change with Terrett's[55] adjustments.

The specific type of manipulation was not described in 46% (n=82) of the cases. When the type of manipulation was identified, manual procedures that involved rotational thrust had the largest representation (23%) (Fig. 3). I was unable to determine the type of manipulation in 24% (n=42) of the cases, primarily because the original articles were not published in the English language. Although the description of manipulation could have been in the original non-English article, it was missing from the secondary source interpretation of the case or from the English-language abstract. I, therefore, classified the type of manipulation in these cases as "not translated" (Fig. 3).

Cervical manipulation was not a new treatment for nearly half of the patients. Forty-one percent (n=73) of the patients had at least one other manipulation prior to the incident, and only 10% of the patients were identified as experiencing their first manipulation. The history of previous MCS was not reported for 24% (n=43) of the cases, and data regarding previous manipulations could not be extracted from 24% (n=43) of the cases.

Discussion

Risks of Injury Due to Cervical Manipulation

The risk of injury due to MCS is not known. The frequency of complications among patients receiving

Table 1.
Complications of Cervical Manipulations Attributed to Physical Therapists

Primary Reference	Information Obtained From Secondary Source	Article Type	Patient	Manipulation Type	Injury	Outcome
Parkin et al[107] (1978)	No	Case report	23-year-old woman	Traction-rotation	Brain-stem infarction	Residual ataxia, paralysis, and sensory changes
Nielsen[125] (1984)	Terrett[45] (1987)	Case report	44-year-old woman	Unavailable	Balance dysfunction, vomiting, memory loss	No improvement
Fritz et al[123] (1984)	No	Case report	63-year-old man	Hyperextension and side bending	Brain-stem infarction	Minor residual hemiparesis, dysarthria, dizziness
Frisoni and Anzola[13] (1991)	Terrett[55] (1995)	Review	39-year-old woman	Not reported	Vertebrobasilar stroke	Good recovery, with residual balance deficit
			49-year-old woman	Not reported	Vertebrobasilar stroke	Full recovery
Patijn[47] (1991)[a]	No	Review	6 of 129 cases (<5%) attributed to physical therapist manipulation	Not reported	Not reported	Not reported
Michaeli[36] (1993)	No	Survey	1 case	Mobilization[b]	Cerebrovascular accident	Not reported
			4 cases		Brachialgia	Partial recovery for 2 cases; no improvement for 2 cases
Michaeli[166] (1991)	No	Survey	48 incidents/75,500 manipulations	Unavailable	Minor transient reactions	Full recovery implied
Accident Rehabilitation and Compensation Insurance Corporation	Rivett and Milburn[43] (1996)	Personal communication	2 patients with "marked neurovascular complications"	Unavailable	Unavailable	Not reported (stroke implied)
Rivett and Milburn[43] (1996)	No	Prospective study	1 incident/476 manipulations	Not reported	Minor exacerbation of neck pain	Full recovery implied

[a] Includes cases described by Parkin et al[107] and Fritz et al[123] and also includes cases involving low back manipulations.
[b] This case was attributed to nonthrust techniques.

cervical manipulation can only be estimated because the actual number of manipulations and caseload of patients receiving MCS are not known. The lack of data concerning the practice of manipulation has led to a wide variation of estimates. Rivett and Milburn[43] reported that the incidence of severe neurovascular compromise was estimated to be within the rather wide range of 1 in 50,000 to 1 in 5 million manipulations. Coulter et al[11] used data from a community-based study of chiropractic services[167] and estimated that complications for cervical spine manipulation occur 1.46 times per 1 million manipulations. They also estimated the rate of serious complications (6.39 per 10 million manipulations) and death (2.68 times per 10 million manipulations) from manipulation of the cervical spine.[11] Klougart et al[168] surveyed 99% of all chiropractors practicing in Denmark and estimated that one case of cerebrovascular accident occurred for every 1.3 million cervical treatment sessions. The occurrence increased to one in every 0.9 million treatment sessions for upper cervical manipulations, and they noted that techniques using rotational thrusts were overrepresented in the frequency of injury. Other estimates of complications following chiropractic manipulation of the cervical spine have been in the range of 1 in 200,000 manipulations[52] to 1 in 3 million manipulations.[169]

In order to put the risk of cervical manipulation in perspective, some authors have compared the estimated rate of occurrence of manipulation-induced injury to other treatments for cervical impairments. Dabbs and Lauretti[170] suggested that the risk of complications (eg, gastrointestinal ulcers, hemorrhage) or death from the use of nonsteroidal anti-inflammatory drugs (NSAIDs) is 100 to 400 times greater than for the use of cervical manipulation. Hurwitz et al[44] reported that the incidence of a "serious gastrointestinal event" associated with NSAID use was 1 in 1,000 patients compared with 5 to 10 cases of complication per 10 million cervical manipulations. Cervical spine surgery, by comparison, had 15.6 cases of complication per 1,000 surgeries.[44]

Although most of these estimates indicate that the incidence of complications due to MCS is rare, some authors[13,43,47,48,171,172] have suggested that the reliance on published cases will produce an underestimation of the injuries associated with these procedures. Lee et al[172] surveyed 177 neurologists practicing in California and reported 55 incidences of stroke presumed to be related to MCS, but the validity of the claim that MCS caused the strokes was not established. Robertson[171] cited a survey of the Stroke Council of the American Heart Association that identified 360 unpublished cases of extracranial arterial injury, but the clinical details of these cases were not published. There have also been cases reported in newspapers and magazines that have not appeared as case reports in the medical or chiropractic literature.[55] In addition to problems caused by the potential mismatch between published case reports and actual injuries, I believe that evaluating the complications following MCS in a retrospective fashion is problematic. Ladermann stated, "It is impossible to know from most descriptions what manipulation was performed, what the qualification of the practitioner was, what force was applied, the number of treatments and their frequency."[46(p183)]

Prospective surveys involving physical therapists in New Zealand[43] and chiropractors in Norway[173] who perform manipulation of the cervical spine have shown that it is not uncommon for patients to experience mild transient reactions to MCS (eg, an exacerbation of neck pain or headache). The incidence rate for minor exacerbation of neck pain per physical therapist manipulation in New Zealand, reported prospectively, was 0.21% (1 in 476 manipulations).[43] Only 11% of the reactions to chiropractic manipulation (including lumbar manipulation) were characterized as preventing the patients from performing their daily activities.[173] There were no permanent complications attributed to MCS in either study.[43,173]

Another approach to evaluating the risks and benefits of MCS is to summarize the opinions of experts in the field of manual therapy. The RAND group evaluated the risks and benefits of MCS by assessing the clinical opinions of a 9-member panel that consisted of 4 chiropractors, a primary care physician, a neurosurgeon, an orthopedic surgeon, and 2 neurologists.[11,174,175] Ratings were made on a 9-point ordinal scale (1=inappropriate application of MCS, 9=apropriate application of MCS). For 736 "clinical scenarios," the panel indicated that only 11.1% of the scenarios were appropriate for the application of MCS, whereas 57.6% of the scenarios were ranked as inappropriate.[174] Coulter[174] noted that for almost all the scenarios evaluated, the use of mobilization was rated more favorably than manipulation.

The decision to use a thrust technique on the cervical spine must be weighed in terms of risks and benefits. The relatively high proportion of injuries linked to manipulation causing rotation (Fig. 3) has prompted some authors[45,49,50,168] to recommend that upper cervical rotation procedures be abandoned in favor of thrust methods that do not require rotation. Other authors[13,18,48,152,176] have suggested (or reviewed evidence that implies) that thrust techniques should be abandoned altogether or that other treatments such as low-velocity spinal mobilization be used in place of MCS. Grant[31] cited the Australian Physiotherapy Association protocol for premanipulative testing of the cervical spine as a basis for recommending that generalized rotary

Table 2.
Reviews of Randomized Trials Comparing Groups Receiving Cervical Manipulation With Placebo Control or Comparison Groups

Reference	Primary Complaint Analyzed	Randomized Controlled Trials Reviewed	Intervention: (Thrust=t, Nonthrust=nt)	Method	Results	Authors' Conclusions
Koes et al[179] (1991)	Neck pain	Sloop et al[184] (1982)	t	Blinded, descriptive review	All trials had methods scores of <50 (100 maximum; best)	Manipulation is not consistently better than other therapies, and methodology scores for all studies were low
		Nordemar and Thorner[185] (1980)	nt			
		Brodin[186] (1985)	nt			
		Howe and Newcombe[187] (1983)	t			
		Mealy et al[188] (1986)	nt			
Hurwitz et al[44] (1996)	Subacute, chronic neck pain	Sloop et al[184] (1982)	t	Pooled estimate of effect size for 3 selected studies	Effect size=0.42 favoring manipulation (95% CI[b]=0.005 to 0.85)	Manipulation is slightly more effective than mobilization for achieving short-term relief of symptoms
		Howe and Newcombe[187] (1983)	t			
		Koes et al[189–192,a] (1992–1993)	t+nt			
		Cassidy et al[193] (1992 and 1993)	t vs nt[c]			
		Vernon et al[194] (1990)	t vs nt			
	Muscle-tension headache (nonmigraine)[d]	Boline et al[195] (1995)	t	Data across studies not pooled due to differences in treatment	Not evaluated quantitatively	Manipulation or mobilization may be beneficial
		Jensen et al[196] (1990)	t+nt			
		Hoyt et al[197] (1979)	t+nt			
Coulter et al[11] (1996)	Same data as Hurwitz et al[44] (1996)					
Vernon[180] (1995)	Muscle-tension headache (nonmigraine)[d]	Jensen et al[196] (1990)	t+nt	Descriptive traditional review	Studies that were designed as case series were combined with randomized controlled trials to suggest that "manipulation seems better" than mobilization or no treatment	No definitive support for manipulation efficacy in randomized controlled trials
		Boline et al[195] (1995)	t			
Aker et al[177] (1996)	"Neck disorders" (including neck pain)	Sloop et al[184] (1982)	t	Pooled estimate of effect size for 5 studies that used manual therapy in combination with other treatments	Effect size=−0.6 (95% CI=−0.9 to −0.4)	Preliminary support for manual therapy in combination with other treatments for short-term relief of neck pain (but efficacy could not be adequately assessed with the studies included in the review)
		Nordemar and Thorner[185] (1980)	nt			
		Brodin[186] (1983)	nt			
		Mealy et al[188] (1986)	nt			
		Koes et al[191] (1992)	t+nt			
		Jensen et al[196] (1990)	t+nt			
		Cassidy et al[193] (1992 and 1993)	t vs nt[c]			
		Vernon et al[194] (1990)	t vs nt[c]			
		McKinney et al[198] (1989)	nt			
Gross et al[178] (1996)	Same as Aker et al[177] (1996)					

[a] A series of 4 studies from the same database (Koes et al[189–192]) were evaluated as one study "unit," and the series combined manipulation and mobilization under the category of "manual therapy."
[b] CI=confidence interval.
[c] Manipulation (thrust) compared with mobilization (nonthrust).
[d] One study was reviewed that addressed migraine headaches, but was not included in this summary.

manipulation and vigorous traction not be used and that only a single manipulation be given during each treatment session. In addition, Grant[31] and Terrett[32] recommended that vertebral artery testing be done during each patient visit prior to MCS and that informed consent be given by the patient prior to each manipulation.

Benefits of Cervical Manipulation

Although the risk of serious injury might be reduced by modifying the manipulative technique, this course of action does not address the effectiveness of MCS compared with other forms of manual therapy. Several literature reviews[11,44,177–180] have addressed the efficacy of cervical manipulation and mobilization. In order to interpret the results of these literature reviews, I considered any manual technique that utilized a thrust at the end of the available range of cervical motion to be a manipulation. Mobilization was considered to be any nonthrust technique (eg, the "Maitland" technique,[181] "muscle energy" techniques[182]).

Quantitative reviews used statistical procedures to calculate pooled effect sizes[183] by combining data from studies that were deemed to be similar in terms of the types of patients or treatment procedures described in the primary studies of MCS.[44,177] Cohen[183] provided a guide that can be used to evaluate to the magnitude of the effect size. Cohen defined an effect size with an absolute value of 0 to 0.19 as negligible, one with an absolute value of 0.20 to 0.50 as small, one with an absolute value of 0.51 to 0.80 as medium, and one with an absolute value greater than 0.80 as large. In addition, some quantitative reviews[44,177] transformed pain ratings to a standard scale so than the magnitude of clinical improvement, in terms of pain reduction, could be estimated.

With the redundant publications eliminated in 4 reviews,[44,177,179,180] a total of 12[‡] nonoverlapping randomized controlled trials[184–198] were identified that evaluated the efficacy of MCS for the treatment of patients with neck pain and headache (Tab. 2). The types of manual therapy intervention for each study (thrust versus nonthrust) are summarized in Table 2. Patients in the "intervention" groups received manipulation or mobilization, or both types of manual therapy. The comparison groups included patients receiving analgesics, rest, spinal mobilization, or modality therapy.

The quantitative reviews produced small to medium effect sizes (absolute effect size values ranged from 0.42 to 0.60), showing that mobilization and manipulation were slightly better than control or comparison interventions (Tab. 2). The effect sizes, however, were based on subsets of articles (3–5 articles) selected by the authors of each quantitative review.[44,177] Aker et al[177] acknowledged that the small number of studies used in the subgroup analysis were unlikely to have sufficient power for meaningful results. Hurwitz et al[44] included studies that used thrust or nonthrust techniques under a category that they labeled "manipulation randomized controlled trials" (Tab. 2). Their conclusion that manipulation is slightly better than mobilization for the treatment of patients with subacute and chronic neck pain, therefore, is confounded by studies using a mixture of treatment types.

The pooled index of pain change on a 100-point pain scale showed that from 1 to 4 weeks following the initiation of therapy, there was an expected difference of 13 to 16 points.[44,177] This finding indicates that the overall decrease in pain attributed to manual therapy was on the order of 13% to 16%.

The literature reviewed indicates that manual therapy may provide a short-term improvement in pain associated with head and neck disorders, but there is no evidence to support the idea that manipulation of the cervical spine achieves better clinical outcomes than does mobilization. Only 2 studies[193,194] cited in the review articles (Tab. 2) compared mobilization with manipulation of the cervical spine. Cassidy et al[193] found no difference in pain intensity ratings immediately after a single cervical spine manipulation, compared with mobilization of the cervical spine, for 2 groups of approximately 50 patients with unilateral neck pain. Vernon et al[194] reported that manipulation into rotation immediately increased the pressure-pain threshold of 5 subjects with chronic mechanical neck pain compared with 4 subjects who received gentle mobilization into rotation. Follow-up beyond the day of treatment was not done in either study. The results, therefore, cannot be generalized to long-term effects. A study[199] published after the reviews summarized in Table 2 showed that MCS was no better than massage for improving cervical range of motion for patients with headache (approximately 20 patients per group and both groups showed improvement in range of motion).

Limitations

Several limitations were encountered when analyzing data for this article. Published cases were difficult to find. Some articles describing injuries related to MCS were indexed in *Index Medicus* without any statement that the article actually contained a case report. It is not possible, therefore, to determine whether my review was exhaustive. In addition, there were large blocks of data (eg, health history prior to incident, type of manipulation used) that were not reported in the published studies. For some articles originally published in foreign

[‡] Four studies by Koes and colleagues evaluated different aspects of the same database and were considered as one study (Tab. 2).

languages, only incomplete data were available because the author of the secondary analysis did not extract all of the information needed in the present review. The use of ambiguous terminology or labels that possibly misrepresented practitioners was also a factor that complicated the extraction of data from case reports and the randomized controlled trials that addressed MCS.[55,200] For example, "chiropractic manipulation" was not always done by a chiropractor,[55] or patient outcomes were compared for physical therapy versus manual therapy (when manual therapy is practiced by physical therapists).[200] Regardless of these limitations, several preliminary recommendations can be made regarding the practice and study of MCS.

Recommendations

Mobilization should be used as an alternative to MCS. There have been injuries attributed to mobilization of the cervical spine (Tab. 1),[36] but the preponderance of cases reported in the literature suggest that more complications are associated with MCS. Although the risk of injury with either type of manual therapy is thought to be rare, the efficacy of MCS has not been shown to be better than that of mobilization for treating patients with neck pain and muscle-tension headache.[§] The largest number of injury cases have involved thrust techniques applied by chiropractors (Fig. 2), but it should also be noted that chiropractors perform the largest number of manipulations of any practitioner group.[11] One could presume that if physical therapists utilize more treatments involving MCS, the prevalence of MCS-related injury may also rise. The recommendation to use mobilization as an alternative to MCS for cervical impairment, in my opinion, should apply to all practitioners of manual therapy, regardless of their professional training or license.

If MCS is used to treat patients with cervical impairments, then clinicians should not, in my opinion, apply long lever-arm techniques that use rotational thrust or short lever-arm ("local") rotational thrust techniques in the upper cervical spine. This recommendation is made with the caveat that there may be a bias for the use of rotary manipulative procedures in the populations of practitioners studied.[201] That is, many practitioners may simply select rotary techniques, and it is difficult to determine whether rotary thrust—or any thrust technique—places the patient at risk for vertebrobasilar injury. In addition, it is not clear at this time whether clinicians should avoid rotational thrust techniques in the lower cervical spine. The literature rarely differentiated between manipulation applied to the upper cervical (craniocervical) spine from the rest of the cervical spine. The risks and effectiveness of MCS may depend on the cervical level being moved. Future research should make a distinction between upper cervical and other cervical manipulations.

Studies in the future need to be designed to determine whether sensitive and specific premanipulative screening protocols can be developed. The occurrence of injury in individuals without known pathology following MCS and the possibility of cumulative subclinical damage to the vertebral arteries are factors that need to be considered when using MCS. These factors complicate the assessment of sensitivity and specificity of premanipulative screening protocols. The screening protocols[32,34] have not yet been shown to be sensitive and specific for identifying persons who are at risk for injury following MCS. There is no compelling evidence that supports the use of symptom provocation testing, Doppler ultrasound, brain imaging, or arteriography as valid clinical screening tools to identify patients who are at risk of injury from MCS.[201]

Risk factors need to be identified. McGregor et al[201] pointed out that there is little agreement or confirmation in the literature concerning the association of presumed "risk factors" (eg, a person's sex, smoking, use of oral contraceptives, history of migraine, osteoarthritic spurs, high blood pressure) and vertebrobasilar vascular compromise. Whether it is even possible to identify risk factors (patient characteristics or a particular health history with a clear association to vertebrobasilar injury) needs to be determined.

Case reports should provide more details (eg, response to premanipulative testing and to previous manipulations, health status prior to injury, predisposing factors that might have increased the risk of injury, specific type of manipulative procedures used to treat the patient). The large blocks of missing data in the database derived from case reports and the possibility that injuries related to MCS are often not reported in perspective with comorbid factors, previous manipulation exposure, and the "dose" of therapy complicate the assessment of risks and benefits associated with MCS.

Prospective reporting systems should be implemented so that potential bias regarding the assessment of complications following MCS can be reduced. Powell et al[48] suggested that most of the injuries due to MTS were related to misdiagnosis, failure to recognize the onset or progression of neurological signs and symptoms, improper technique, or the use of MTS in the presence of coagulation disorders or herniated intervertebral disk. The data derived from prospective reporting systems might be useful for evaluating the prevalence of these (and other as yet unknown) injury "factors." In

[§] *Muscle-tension headache* is defined as a constant, "viselike," referred ache frequently involving the frontal or suboccipital region of the head that is thought to be caused by sustained contraction of the scalp and neck muscles.[197]

addition, the systematic assessment of clinical outcome may ultimately provide specific profiles of patients that distinguish those patients who are at greatest risk for injury from those patients who are most likely to benefit from MCS.

Summary and Conclusions

Manipulation and mobilization may be important aspects of the care provided to patients with cervical impairments, but there are few randomized controlled trials that have evaluated the efficacy of these procedures. Premanipulative screening protocols have not been shown to be sensitive and specific for identifying individuals who are at risk for injury following MCS. It is difficult, therefore, to determine who should receive MCS.

The review of published cases involving injury attributed to MCS showed that the most frequently reported injuries involved arterial dissection or spasm, lesions of the brain stem, and Wallenberg syndrome. Twenty percent (n=36) of the patients were described as "healthy" prior to the incident. Death occurred in 18% (n=32) of the cases. Physical therapists were involved in less than 2% of the cases, and the most serious injury sustained by patients receiving MCS from physical therapists was stroke in the vertebrobasilar artery distribution. Cervical manipulation was not a new treatment for nearly half of the patients. Forty-one percent (n=73) of the patients had at least one other manipulation prior to the incident. The type of manipulation was not described in 46% (n=82) of the cases. When the type of manipulation was identified, manual procedures that involved rotational thrust had the largest representation (23% [n=40]). Quantitative reviews reported small to medium effect sizes, showing that mobilization and manipulation were slightly better than control or comparison interventions, but there was no compelling evidence to show that manipulation achieved better clinical outcomes compared with mobilization. The occurrence of injury following MCS in patients without known systemic or vascular pathology and the absence of serious neurovascular accident during the first exposures to MCS might provide indirect support for the theory that cumulative subclinical damage to the vertebral arteries occurs following MCS.

Some preliminary recommendations regarding the use and study of MCS have been presented. Until more is known about the effectiveness and risk of MCS, the use of nonthrust mobilization techniques should be considered as an alternative to MCS for all practitioners of manual therapy.

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