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Unpredictability of Cerebrovascular Ischemia Associated With Cervical Spine Manipulation Therapy

A Review of Sixty-Four Cases After Cervical Spine Manipulation

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Study Design. A retrospective review of 64 medicolegal records describing cerebrovascular ischemia after cervical spine manipulation was conducted.

Objectives. To describe 64 cases of cerebrovascular accidents temporally associated with cervical spine manipulation therapy in terms of patient characteristics, potential risk factors, nature of complication, and neurologic sequelae.

Summary of Background Data. Approximately 117 cases of postmanipulation cerebrovascular ischemia have been reported in the English language literature. Proposed risk factors include age, gender, migraine headaches, hypertension, diabetes, birth control pills, cervical spondylosis, and smoking. It is often assumed that these complications may be avoided by clinically screening patients and by premanipulation positioning of the head and neck to evaluate the patency of the vertebral arteries.

Methods. Three researchers using a uniform data abstraction instrument performed an independent review of 64 previously unpublished medicolegal records describing cerebrovascular ischemia after cervical spine manipulation. These cases were referred to a single physician for review over a 16-year period from across the United States and Canada. Descriptive statistics were calculated for characteristics of the patients and the complications. Means and standard deviations were computed for continuous variables. Frequencies and proportions were calculated for categorical variables.

Results. This study was unable to identify factors from the clinical history and physical examination of the patient that would assist a physician attempting to isolate the patient at risk of cerebral ischemia after cervical manipulation.

Conclusion. Cerebrovascular accidents after manipulation appear to be unpredictable and should be considered an inherent, idiosyncratic, and rare complication of this treatment approach. [Key words: complications, manipulation therapy, vertebral artery dissection] **Spine 2002;27:49–55**

Manual manipulation of the cervical spine has been reviewed recently by a number of independent agencies and commissions that have cautiously endorsed its use. The Quebec Task Force on Whiplash-Associated Disorders, after a review of clinical trials, described mobilization and manipulation as effective for patients with this disorder while stating that there is no evidence for the effectiveness of such common procedures as soft collars, corticosteroid injections, acupuncture, heat, ice, or muscle relaxants.[61] The Rand Corporation, in its review of published clinical trials, reported that there is evidence to support the conclusion that cervical spine manipulation or mobilization may provide at least short-term pain relief and range of motion enhancement for persons with subacute or chronic neck pain as well as muscle tension headaches.[15]

These conclusions, together with a growing number of prospective controlled clinical trials of varying quality on the use of manipulation for the management of neck pain[12,37–39,69] and headache,[2,7,11,34] have led to the increasing acceptance and use of this treatment method. This growing acceptance has, in turn, accented the necessity to evaluate not only the effectiveness of manipulation, but also its potential side effects and complications, the most serious of which is considered to be the risk of cerebrovascular accidents.

In 1934, a medicolegal abstract first noted cerebrovascular accidents after cervical spine manipulation.[22] Since then, approximately 117 cases have been reported in the English literature in 69 separate articles.[28] Most of these articles present single case reports or small studies of two to five cases. Krueger and Okasaki[40] from the Mayo Clinic conducted the largest case study, which included 10 cases collected over a period of 15 years. These cases were inevitably evaluated retrospectively after a patient's admission to a hospital for brain stem, cerebellar, or cerebral ischemia. With the exception of two cases,[41,56] the authors did not report any attempt to contact the practitioner of manipulation or describe any independent evaluation of data accuracy, nor have they attempted to assess exposure to putative risk factors associated with these complications of manipulation.

Proposed risk factors for vertebrobasilar artery dissections have included age,[16,24,32,44,53,60] gender,[16,24,32,49,58,71] migraine headaches,[1,17] hypertension,[13,16,18,23,25,49,58,65] diabetes,[18,25,65] birth control pills,[4,5,17,46] cervical spondylosis,[25,48,65] and smoking.[16] It has often been assumed that dissections may be avoided by screening patients clinically through appropriate history, and by positioning of the head and neck before manipulation to evaluate the patency of the vertebral arteries.[25,65] An evaluation of the literature on the

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Table 1. Documentation Available in 64 Medicolegal Files of Cerebrovascular Accidents Associated With Cervical Spine Manipulation

	n (%)
Manipulation Practitioner Records	
History	53 (83)
Examination	46 (72)
Chart notes	46 (72)
Billing	33 (52)
Medical records	
Preincident	26 (41)
Hospital	58 (91)
Neurologic consultation	55 (86)
Rehabilitation records	26 (41)
Diagnostic tests	
CT	53 (83)
MRI	40 (63)
Angiography	46 (72)
EEG	19 (30)
Doppler	11 (17)
Evoked potentials	9 (14)
Visual fields	2 (3)
Depositions	
Patient	38 (59)
Practitioner	38 (59)
Consultant	23 (36)
Expert	25 (39)
Other	12 (19)

CT = computed tomography; MRI = magnetic resonance imaging; EEG = electroencephalogram.

proposed risk factors, precipitating manipulation, and screening methods did not show a basis for these conclusions.[28]

Conclusions based on review of previously published case reports of various quality, however, have serious shortcomings. Access by the authors to 64 well-documented previously unpublished cases created the opportunity to evaluate the accuracy of the prior literature reviews.

■ Methods

Over the period 1978–1994, one of the authors (S.H.) was consulted and asked to review 64 cases in which a cerebrovascular ischemic event occurred after cervical spine manipulation therapy. These cases involved claims of malpractice on the part of the manipulation practitioner. Because of the litigious nature and seriousness of these cases, extensive documentation and discovery were available for review. These cases were referred from both plaintiff and defense attorneys across the United States and Canada. Several different malpractice insurance companies insured the clinicians who were the subjects of this litigation. All the cases referred for review over the 16-year time span were included in this study without selection as to the origin of the referral, the validity of the malpractice claim, or the insurance carrier involved. The referring attorneys supplied charts, reports, and depositions, and the reviewing author was paid an hourly consultation fee. Table 1 shows the frequency of each type of data element found among the 64 files. Details regarding patient characteristics and case specifics were compared with previously published case reports in an attempt to eliminate any redundant reporting. The 64 cases presented in this article represent unique incidents that, to the best of the authors' knowledge, have not been published previously.

After the initial review of the files, a data abstraction instrument with specific definitions and terms was developed that addressed patient medical history, onset and chronologic progression of neurologic dysfunction after cervical manipulation, cerebrovascular diagnostic and treatment procedures, and sequelae. The abstraction instrument was constructed to collect data on the following putative risk factors: migraine, hypertension, diabetes, cardiovascular disease, oral contraceptive use, smoking, cocaine and amphetamine use, recent head and neck trauma, and cervical spine bony pathology. This instrument was used by three research assistants, who performed independent reviews of the files.

Subsequently, the three reviewers, not including the author who was consulted originally on the cases, met to compare the data from their independent reviews. Where there was disagreement, they revisited the files to reach consensus regarding file content and information gathered. One reviewer left the study after the consensus process was completed on the initial 53 files. The same procedure was used in the analysis of 11 additional files, but involved only the two remaining reviewers. Descriptive statistics were calculated. Means and standard deviations were computed for continuous variables. Frequencies and proportions were calculated for categorical variables.

■ Results

Age and Gender

The case series involved 23 (36%) men and 41 (64%) women (Table 2) with an average age of 36.3 ± 6.1 years (range, 24–53 years).

Disorders Leading to Manipulation Therapy

Table 3 summarizes health concerns of the patients leading to consultation with a practitioner of spinal manipulation. The patients typically presented with more than one disorder. Most of the patients (n = 59; 92%) presented with a history of head and/or cervical disorders.

Putative Risk Factors

Table 4 shows the prevalence of the putative risk factors reported in the 64 cases. Frequency data are presented both as percentages of all 64 files and as a percentage of the files with explicitly available data. Among the records with available data, approximately one third of the patients had histories of migraine headaches. Almost 25% were smokers, and 13% had hypertension. For comparison, the prevalence figures for these factors in

Table 2. Age Distribution of the 64 Medicolegal Cases of Cerebrovascular Accidents Associated With Cervical Spine Manipulation Therapy, by Gender

	Male n (%)	Female n (%)	Total n (%)
Age (y)			
<30	2	6	8 (12)
30–39	10	24	34 (53)
40–49	10	11	21 (33)
>50	1	0	1 (2)
Total	23 (36)	41 (64)	64
Mean age	37.5	35.8	36.4
Standard deviation	7.01	5.34	6.05

Table 3. Summary of Patient Reports Leading to Consultation With Practitioner of Manipulation Therapy

Presenting Problem	Patients* (n)	%
Head pain	49	77
Neck pain	58	91
Upper extremity pain	16	25
Thoracic pain	15	23
Lumbar pain	16	25
Lower extremity pain	5	8

* Numbers add to more than 64 and percentages add to more than 100 because patients typically presented with problems involving multiple areas.

the general U.S. population also are presented in Table 4.[9, 21,26,42,51,55,68]

In 27 cases, the practitioner described screening before manipulation, with the patient's neck positioned in rotation and extension to test the patency of the vertebral arteries.[25,65] None of these patients showed adverse responses to this screening test before the manipulation.

Neurologic Symptoms After Manipulation

For 62 to 64 of the cases (depending on the particular symptom), information was available on the type of neurologic disorders experienced by the patient after manipulation of the cervical spine (Table 5). The most common reported neurologic symptom was loss of coordination, which was present in 52 (81%) of the cases.

For 63 cases, information was available on the time of onset of neurologic symptoms subsequent to the manipulation therapy (Table 6). In 40 of the cases (63%), the reported onset of neurologic symptoms was immediately after manipulation of the cervical spine. In 60 of the cases (94%), the onset of neurologic dysfunction was within 48 hours. The longest reported time between spinal manipulation and onset of symptoms was 11 days. This patient was a 28-year-old woman with a 3-week history of sudden onset neck pain, for which carisoprodol was prescribed. Eleven days before presenting to the emergency room with signs of ischemia, which culminated in the loss of consciousness, she received cervical spine manipulation for the first and only time without obvious change in neck pain symptoms.

Table 5. Number and Percentage of 64 Cerebrovascular Accidents Associated With Cervical Spine Manipulation Therapy (CSMT), by Presenting Neurologic Symptoms or Clinical Findings Experienced After Cervical Spine Manipulation Therapy

Neurologic Dysfunction	Patients (n)	%
Nystagmus	30	47
Visual disturbances	43	67
Loss of coordination	52	81
Hearing deficits/tinnitus	8	13
Numbness	37	58
Dizzy/vertigo/nausea/vomiting	50	78
Speech/swallowing dysfunction	44	69
Loss of consciousness	14	22
Death	2	3

In addition to the preceding case, three other patients experienced the onset of cerebrovascular accidents more than 48 hours after cervical manipulation. The first case involved a 24-year-old man involved in a motor vehicle accident 3 months earlier. He reported progressively worsening left shoulder and upper back pain, for which he underwent manipulative treatment. His symptoms improved, and he returned to work 4 days after his last visit to the chiropractor. At work that day, he experienced a sudden onset of vertigo, sweating, tinnitus, nausea, and loss of coordination.

In the second case, a 42-year-old man presented with a 1-week history of bilateral occipital neck pain. Neck

Table 4. Number and Percentage of Postmanipulation Cerebrovascular Accident Cases, by Potential Risk Factor

Potential U.S. Risk Factor	Frequency in Reviewed Cases: Cases (n)	All Cases (%)	Cases With Available Data* (%)	General Population† (%)
Migraines (total)	17	27	34	—
Female	16	39	47	—
Male	1	2	6	—
Confirmed migraine diagnosis (total)	4	6	8	—
Female	4	10	12	21–28[42]
Male	0	0	0	4–8[42]
Hypertension	8	13	13	7–37[9]
Diabetes	2	3	3	3–6[1]
Cardiovascular disease	3	5	5	9[51]
Oral contraceptive (of the 41 female cases)	2	5	5	3–60[68]
Smoking	13	20	23	28[21]
Cocaine/amphetamine	2	3	5	—
Head/neck trauma	9	14	15	—
Cervical spine bony pathology	7	11	12	20–35[26]

* Information regarding presence or absence of potential risk factors was not always available in the 64 cases.
† U.S. general population prevalence figures cannot be used to make inferential statements regarding risk factors and are presented in this table to stimulate potential areas for future research. General population migraine prevalence data refer to the population within the age range represented in the authors' case files (i.e., patients 25 to 50 years of age).

Table 6. Number and Percentage of 64 Cerebrovascular Accidents Associated With Cervical Spine Manipulation Therapy, by Time of Neurologic Dysfunction Onset After Cervical Spine Manipulation Therapy

Time to Onset	Cases n (%)	Cumulative n (%)
Immediately	40 (63)	—
5–30 Minutes	8 (13)	48 (75)
1–12 Hours	6 (9)	54 (84)
13–23 Hours	2 (3)	56 (88)
1–2 Days	4 (6)	60 (94)
3–7 Days	2 (3)	62 (97)
> 1 Week	1 (2)	63 (98)
Unknown	1 (2)	64 (100)
Total	64	—

manipulation did not alter the symptoms. Five days after cervical manipulation, the patient noted swallowing and visual disturbances, numbness in the left side of his face, and a strange sensation in his right hand that progressed to involve most of his right side.

The third case was that of a 45-year-old man who had been receiving regular manipulation therapy for low back pain. After cervical spine manipulation therapy, he experienced 15 minutes of a spinning sensation, which completely subsided. Three days later, after 2 days of participating in a fishing tournament, the man returned to work, and while bending over to coil up a hose, experienced a severe spinning sensation, nausea, and lack of coordination.

Treatment and Long-Term Sequelae After Dissection

Information in 35 case files (55%) showed the use of heparin, Coumadin, or both. Aspirin was given to 10 patients (16%) without anticoagulant treatment. Another 19 patients (30%) received no treatment with aspirin or anticoagulants.

The neurologic status 1 year after the stroke was available for 46 patients, 2 of whom had died (Table 7). Eight patients (18%) reported complete recovery. The most prevalent residual symptoms were incoordination, numbness, speech or swallowing dysfunction, and visual disturbances.

■ Discussion

This is the largest case series of cerebrovascular accidents temporally associated with cervical spine manipulation therapy, the next largest being the 10 cases reported by Krueger and Okasaki.[40] The 64 cases presented in this article represent a 55% increase over the approximately 117 reports of cerebrovascular accidents after cervical spine manipulation appearing in the English literature over the past six decades.[28] A problem in the attempt to study these events is their apparent rarity and the difficulty accumulating a large series from a single institution or location. Major neurologic centers reportedly see only one to three cases of vertebrobasilar artery dissection per year,[6,31,45,49] with 14% to 30% of the patients presenting with a history of cervical spine manipulation.[28,45,63]

The cases described in this article were accumulated over a 16-year period from all geographic areas in the United States and Canada. There is no intent to suggest that they represent more than a percentage of all cases that occur in North America, or to suggest that any inference can be drawn from the current data regarding the frequency of such occurrences. Current frequency estimates for cerebrovascular accidents vary from 1 in 400,000–500,000[20] to 1 in 3.85 million cervical spine manipulations.[10] The Rand Corporation monograph assessing the literature estimated the risk of vertebrobasilar or other complications at 1.46 per 1 million manipulations, and major impairment at 6.39 per 10 million manipulations.[15] A survey in Denmark showed a similar frequency, estimating 1 cerebrovascular accident for every 1.3 million cervical treatment sessions.[36]

The current study had a number of limitations. The case study was limited to patients whose providers were subjects of litigation, and thus likely included a distinct subset of all postmanipulation cerebrovascular accident cases. The findings therefore may not be generalizable to other populations of cases. Nevertheless, this study included cases with full recovery, others with minor residuals, some with major residuals, and two deaths, spanning the spectrum of potential outcomes.

The adversarial nature of litigation could have led bias from inaccurate reporting by patients and providers, especially given the historical negative opinion of manipulation by many medical practitioners and specialists. Similarly, the practitioner being sued may have provided inaccurate information. The resulting biases, however, are unlikely to have been any greater in this study than in other reports because most of the data were gleaned from the medical records established before the litigation was instituted. Although statements by the patient and physician in the litigation process may be considered suspect, and perhaps subject to recall bias, it is difficult to imagine any other source superior to sworn testimony under penalty of perjury, especially when it is consistent with the medical records, as was most of the data in this case study.

Theoretically, it would be possible to reduce the frequency of complications after manipulation if the patient at

Table 7. Number and Percentage of 64 Cerebrovascular Accidents Associated With Cervical Spine Manipulation Therapy (CSMT), by Residual Neurologic Dysfunction Measured 1 Year After the Incident

Residual Neurologic Dysfunction	Patients	%*
Complete recovery	8	18
Nystagmus	5	11
Visual disturbances	13	30
Loss of coordination	22	50
Hearing deficits/tinnitus	1	2
Numbness	15	34
Dizzy/vertigo/nausea/vomiting	10	23
Speech/swallowing dysfunction	14	32
Loss of consciousness	0	—

* Data regarding residual dysfunction 1 year after the incident were available in 44 cases. Two deaths resulted from the ischemic event, and another 18 files did not contain records of neurologic evaluation 1 year after the cerebrovascular accident.

risk could be identified and excluded from receiving manipulation. Various authors have suggested that age, gender, migraine, hypertension, diabetes, birth control pills, smoking, and cervical spondylosis may represent risk factors.[16,18,25,44,53,65] This article presents descriptive data for these suggested risk factors. Because the current authors had access to medical and chiropractic files and depositions, these data were collected in much greater detail than those noted in previously published case reports that depended solely on medical records. The more complete data from the current study, therefore, serve to confirm previous reviews of the case reports.

Ideally, prevalence data calculated from the 64 study cases would be compared with corresponding prevalence data from a population of patients receiving cervical spine manipulation therapy who did not experience a cerebrovascular accident. Such data, however, are not available. In the absence of an appropriate comparison group, prevalence figures have been listed from the general U.S. population for the suggested risk factors solely as a point of reference without any attempt to make inferences regarding risk. Prospective data collection describing specific patient characteristics of populations receiving cervical manipulation therapy with and without experiencing adverse reactions would overcome the barriers to statements of inference encountered in both this study and previously published studies. Although this topic should be the subject of prospective studies, the rare nature of this complication makes such studies very difficult.

The current data are consistent with the literature in showing that most cerebrovascular accidents after spine manipulation occur in patients between the ages of 30 and 50 years. Terrett and Kleynhans,[66] however, pointed out that this is the age group most likely to seek spine manipulation, and that overlapping graphs can be drawn to depict the incidence of cerebrovascular complications and the population receiving manipulation. The current case study involved a greater number of women than men. This contrasts with a prior review of the English literature that suggests an almost equal number of men and women experiencing these complications,[28] and with a similar review by Hurwitz et al,[33] which reports a slightly higher percentage of men with the disorder. However, it is consistent with reviews not limited to articles published in English.[2,66]

There is no evidence that the older population at risk for arteriosclerotic vascular ischemia is more likely to incur these complications after cervical manipulation. None of the arteriographs in the current study of 64 cases showed the presence of arteriosclerotic plaquing. Therefore, the widely accepted risk factors for arteriosclerotic and thrombotic strokes probably do not apply. Thus, screening for bruits, hypertension, diabetes, smoking, and the like, commonly carried out by primary care physicians to identify patients at risk for arteriosclerotic strokes does not appear to be of any benefit in determining the likelihood that a given patient may be at risk for a stroke after manipulation.

Migraine headache has been implicated by Mas et al[45] and D'Anglejan-Chatillon et al[17] as a risk factor for vertebrobasilar artery dissection. The prevalence of self-reported migraine in the current study was 34%, but only 8% of the cases were medically confirmed migraines. This percentage is within the range of the prevalence reported by Lipton and Stewart[42] in the general population for this age group. Even if the severe headaches reported as migraine in 47% of all female patients are accepted as such, the issue still is not clear because 77% of the patients actually were seeking manipulation therapy for the treatment of their headaches.

Most cerebrovascular accidents that occur after cervical spine manipulation result from vertebrobasilar artery dissection. The cases in the current study overwhelmingly involved the C1–C2 segment of the vertebral arteries. The cerebrovascular accidents were on the left side in 58% of the cases and the right side in 23% of the cases, affecting both arteries in 19% of the cases for which information was available. The reason for the preponderance on one side was not evident. Furthermore, no specific vascular pathology was isolated in these cases. A hypoplastic or aberrant vertebrobasilar artery was reported for only two cases in which angiography was performed, and in only one case was there a suggestion of fibromuscular hyperplasia. The angiogram was reported as normal or unremarkable in seven cases, raising the possibility that a reversible spasm or embolism that had dislodged was the cause of the ischemia.

Two of the 64 cases resulted in death, and these did not show a specific pathology in the vertebral arteries on autopsy. The first patient was noted to have a hemangioma of the venous plexus in the region of the pons, which hemorrhaged, and the second patient had a ruptured berry aneurysm. None of the dissections resulted in death, although 5 were bilateral and 14 resulted in loss of consciousness. Only 2 of the 64 cases resulted from dissection of the internal carotid artery. Only five cases of carotid artery dissection associated with manipulation are found in the English literature, with three showing only internal carotid artery involvement and the other two showing the involvement of multiple vessels.[3,19,29,43,54]

Most of the patients in this study had substantial residuals, including loss of coordination and other symptoms of brain stem injury including dizziness, nausea, speech and swallowing difficulties, and numbness. Almost 30% of the patients described visual disturbances suggesting either higher brain stem or occipital cortex dysfunction. The literature suggests a much better recovery rate after vertebrobasilar artery dissection. The relatively greater prevalence of residuals in the current study population probably reflects a greater likelihood of initiating legal action if there are residual symptoms.

Practitioners of manipulation have attempted to reduce the frequency of cerebrovascular accidents by testing the patency of the vertebral arteries before manipulation and changing the methods of manipulation. The current data on screening before manipulation by plac-

ing the head and neck in extension and rotation suggest that this test is not capable of screening out the patients at risk. This is consistent with recent studies showing that rotation and extension of the neck *in vivo* may not significantly reduce vertebral artery flow as previously postulated.[14,57,62,67,70] Furthermore, only two of the current patients showed a unilaterally small or absent vertebral artery on arteriography, which would theoretically result in a positive test.

Most vertebrobasilar artery dissections occur in the absence of cervical manipulation, either spontaneously or after trivial trauma or common daily movements of the neck, such as backing out of a driveway,[59,60,72] painting the ceiling,[52,64] playing tennis,[35] sneezing,[27] or engaging in yoga exercises.[30,50] suggestions that there may be an inherited arterial defect in the cerebral arteries that makes certain individuals prone to cerebral artery dissection[8,47] may hold the answer for these seemingly random cerebrovascular injuries after manipulation of the cervical spine.

At this writing, a physician wishing to advise a patient considering cervical manipulation is limited in the information that can be offered. Screening the patient for arteriosclerotic vascular disease or risk factors would not exclude a patient from receiving cervical manipulation or guarantee that the patient will not have a stroke after manipulation. It is, however, possible to inform the patient of this risk, to discuss the relative risk of other common treatments for neck pain such as nonsteroidal antiinflammatory drugs, surgery, and other common medical procedures, and to explain that according to the current understanding of this problem, cerebrovascular symptoms are unpredictable, inherent, and rare complications of cervical manipulation.

■ Key Points

- Cerebrovascular ischemia is a rare complication of cervical spine manipulation therapy.
- The patients in this study, predominantly women with a mean age of 35.8 years, presented with symptoms of head and neck pain.
- The onset of symptoms was within 2 days of the manipulation in 94% of the cases, and within 30 minutes in 75% of the cases.
- Risk factors for arteriosclerotic strokes do not appear to be prominent in these cases.
- These complications appear to be unpredictable, and should be considered as inherent and idiosyncratic.

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