

The Safety of Cervical Manipulation: Putting Stroke Risk in Perspective, Part 1

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Relative Activity Risks

Several studies have attempted to link chiropractic manipulation to adverse events, the most serious and widely studied being strokes following dissections of the vertebral artery.¹⁻⁶ To begin to shed light on this problem, several retrospective studies against large population bases have been conducted. As shown in **Table 1**,⁷⁻¹⁵ a large sampling of such studies indicates that the number of serious complications or cerebrovascular accidents (CVAs), as established by researchers from both the chiropractic and medical professions, ranges from one case per 400,000 manipulations to zero in 5 million.

Data from the Rand Corporation suggests the rate of vertebrobasilar accident or other complications (cord compression, fracture or hematoma) is just 1.46 per million manipulations, with the rates of serious complications and death from cervical spine manipulation estimated to be 0.64 and 0.27 per million manipulations, respectively.¹⁶

TABLE 1: PROBABILITY OF STROKE OR SERIOUS ADVERSE EVENTS FOLLOWING CERVICAL MANIPULATION

Source	Method	Risk Per Manipulation
Dvorak ⁷	Survey of 203 members of Swiss Society of Manual Medicine [all non-chiropractors]	1 serious complication / 400,000
Patijn ⁸	Review of computerized registration system in Holland	1 complication / 518,000
Haldeman ⁹	Extensive literature review to formulate practice guidelines	1-2 strokes / 1 million
Jaskoviak ¹⁰	Clinical files of National College	0 complication / 5 million 15-year period
Henderson / Cassidy ¹¹	Canadian Memorial Chiropractic College Clinic	0 complications / 5 million 9-year period
Hurwitz ¹⁶	RAND cervical study literature review	0.64 serious complications / 1 million; 0.27 deaths / 1 million
Carey ¹²	Claim review: Canada's largest malpractice insurance company	1 CVA / 3 million; 0 deaths 5-year period
NCMIC ¹³	Claim review: principal chiropractic malpractice insurance company within U.S.	1 CVA / 2 million 3-year period
Haldeman ¹⁴	Claim review: Canada's largest malpractice insurance company	0.17 CVA / 1 million 10-year period
Thiel ¹⁵	U.K. survey of 28,807 treatment consultations	No adverse events

A more recent review, involving a large number of presumed cervical manipulations performed (134.5 million) over an extended period (10 years), used malpractice claims from the Canadian Chiropractic Protective Association. It revealed a total of 43 cases of neurological symptoms retrieved from patient records, 23 of which involved stroke. The total yield of strokes, therefore,

was just 23/134.5 million, a frequency rate of one per 5.85 million (0.17 per million) cervical manipulations.¹⁷

The risk estimates attributed to cervical manipulation are significantly less (by orders of magnitude) than those associated with various medical procedures and lifestyle activities, as shown in **Table 2**.^{16,17-23} In an exhaustive review of risk estimates from multiple phases of life, it can be seen that substantially greater risks attributed to the medical procedures have been deemed "acceptable" by the routine adoption of such terminologies as *risk-adjusted mortality rates* and *net clinical benefits*.²⁴ The risks inherent in other lifestyle activities, also appearing to be readily accepted by the public at large, are apparent in **Table 2** and again outweigh those associated with cervical manipulation by several orders of magnitude, in striking contrast to the dire warnings about the risks of cervical manipulation in the media.²⁵⁻³⁰

Artery Dissection

Structural considerations: The vertebral and basilar arteries, comprising the vertebrobasilar system, supply blood to the posterior brain. The vertebral artery (VA) itself, emerges from the subclavian artery, passes through the transverse foramina of C6 - C1 to become the atlantal segment as it exits through the transverse foramen of C1. It is here that the atlantal segment abruptly bends from a vertical to horizontal orientation. It is at this juncture at which the artery is believed to be most susceptible to injury related to sudden and/or extreme head movement.³¹ Three layers from inside to out (tunica intima, tunica media, tunica adventia) comprise the cervical arteries.³²

Mechanisms of dissection: As the layer which makes up the vessel lining, the tunica intima is more susceptible to tearing³² and as such is the typical site of the initial defect which initiates a vertebral artery dissection (VAD). A typical developing dissection involves the formation of an intimal flap following an initial tear, with the potential for the separation of layers caused by blood flowing into the breach.

Further damage may be wrought by pulsatile pressure to the muscular layer, causing further splitting of the intima and media during a dissection. Subintimal hemorrhaging may rupture back into the arterial lumen distally, creating a double (false) lumen. As blood accumulates within the separated vessel layers, a thrombus is created with further deformation of the intima and obstruction of blood flow. If emboli detach from the primary thrombus, they may travel distally to block progressively smaller vessels in the brain.³²

TABLE 2: RISKS IN PERSPECTIVE: COMPARISON OF DEATH RATES ATTRIBUTED TO VARIOUS CAUSES

Risk	Frequency (Per Million)
Neurological complications from cervical manipulation	0.3 ¹⁶
Spinal surgery	700 ¹⁷
Total hip replacement	4,900-15,300 ¹⁸
Appendectomies	13,500 ¹⁹
Nuclear bone scan	333 ²⁰
Medication errors, outpatient	7,633 ²¹
GI bleeding due to NSAID use	400 ²²
Smoking: 20 cigarettes per day	5,000 ²³
Drinking: 1 bottle of wine per day	75 ²³
Canoeing	10 ²³
Motorcycling	20,000 ²³
Automobile driving (United Kingdom)	169 ²³
Soccer, football	39 ²³

TABLE 3: RATES OF STROKE COMPARED TO INCIDENCE OF ARTERIAL DISSECTIONS

Attributed Cause	Rate [Per Million]
Spontaneous, hospital-based ³³	10-15
Spontaneous, community-based ³⁴⁻³⁵	25-30
Cervical manipulation ⁷	25
Cervical manipulation ⁸	10-20*
Cervical manipulation ¹⁰	0
Cervical manipulation ¹⁶	6.4*
Cervical manipulation ¹²	1.7*

Corrected to represent the average incidence per patient, assuming the average number of manipulations per patient to equal 10, as reported in the literature.

Putting It in Perspective

Perhaps the most compelling information that needs to be brought forward to bring the debate about cervical manipulations into objective terms has to do with the fact that a significant number (and most likely the majority) of VADs happen to be spontaneous cervical artery dissections (sCADs). Numerous reports (to be discussed below), addressing both the frequency of occurrence of VADs and their association with virtually any activity associated with turning the head, should reduce the utility of attributing strokes to cervical manipulations to virtually an academic exercise.

As shown in **Table 3**, the annual incidence of spontaneous VADs in hospital settings has been estimated to occur at the rate of 1-1.5 per 100,000 patients³³ The corresponding VAD incidence rate in community settings has been reported to be twice as high.³⁴⁻³⁵ Using an estimated value of 10 from the literature to represent an average number of manipulations per patient per

episode,³⁶ it becomes apparent that the proposed exposure rate for CVAs attributed to spinal manipulation is no more than equivalent to the spontaneous rates for cervical arterial dissections as reported.³³⁻³⁵

If the threat of stroke or stroke-like symptoms is to be properly assessed, therefore, at least half our attention needs to be directed toward the spontaneous events instead of primarily or solely upon spinal manipulation. Furthermore, a large number of common lifestyle activities have been shown to be associated with cerebral ischemia (**Table 4A**) 24 or VADs themselves (**Table 4B**).³⁷ All are decidedly nonmanipulative. By way of illustration, one recent investigation has described beauty parlor stroke syndrome and salon sink radiculopathy, confirmed by both patient symptoms and blood flow velocities in the bilateral vertebral and carotid arteries as measured by a diagnostic ultrasound instrument.³⁸

TABLE 4A: SELECTED ACTIVITIES SUSPECTED OF DISRUPTING CEREBRAL CIRCULATION²⁴

- Angiography
- Bleeding nose
- Axial traction
- Calisthenics
- Cervical extension for X-rays or CTS
- Cervical rotation while backing up a car
- Coughing
- Dental procedure
- Football
- Gymnastics
- Hanging out washing (laundry)
- Overhead work
- Roller-coaster ride
- Telephone call
- Traction and short-wave diathermy
- Trampoline
- Watching aircraft
- Yawning

TABLE 4B: NONMANIPULATIVE MANEUVERS ASSOCIATED WITH CEREBROVERTEBRAL ACCIDENTS²⁷

- Childbirth
- By surgeon or anesthetist during surgery
- Calisthenics
- Yoga
- Overhead work
- Neck extension during radiography
- Neck extension for a bleeding nose
- Turning the head while driving a vehicle
- Archery
- Wrestling
- Emergency resuscitation
- Star gazing
- Sleeping position
- Swimming
- Rap dancing
- Fitness exercise
- Beauty parlor stroke
- Tai chi

For over 30 years, the amino acid homocysteine has been implicated as key component of atherosclerotic disease.³⁹⁻⁴⁷ More direct observations point toward the disruption of the structures of collagen and elastin in the arterial wall:

- In the majority of skin biopsies taken from patients with cervical arterial dissections, irregular collagen fibrils and elastic fiber fragmentations have been found.⁴⁸
- Homocysteine activates metalloproteinases⁴⁸ and serine elastases,⁴⁹ directly or indirectly leading to the decrease *in vitro* of the elastin content of the arterial wall. The opening and/or enlargement of fenestrae in the medial elastic laminae would be expected to lead to the premature fragmentation of the arterial elastic fibers and degradation of the extracellular matrix.⁴⁸⁻⁴⁹
- Homocysteine has been shown to block aldehydic groups in elastin, inhibiting the cross-linking needed to stabilize elastin.⁵⁰
- The cross-linking of collagen may also be impaired by homocysteine.⁵¹
- Experimentally elevated levels of homocysteine produce patchy desquamation of 10 percent of the aortic surface in baboons.⁴⁵
- Endothelium-dependent and flow-mediated vascular dilation is impaired in individuals with elevated levels of homocysteine.⁴⁷
- In cell culture experiments, addition of homocysteine into the medium induces cell detachment from the endothelial cell monolayer.⁵²

Yet even a tighter coupling between sCADs and increased amounts of homocysteine is suggested by the following observations. Patients undergoing sCADs are more than three times as likely as asymptomatic patients to yield plasma homocysteine levels exceeding 12 micromoles/L. They are also more than twice as likely to have elevated homocysteine as patients experiencing ischemic strokes without arterial dissection.⁵³

CAD patients yield average homocysteine levels of 17.9 micromoles/L while asymptomatic patients report an average of 6.0 micromoles/L.⁵⁴ And homocysteine levels exceeding 10.2 micromoles/L are associated with a doubling of vascular risk.³⁹

Finally, genetic defect in humans involving tetrahydrofolate reductase, the enzyme which produces the methyl-donating co-factor required to convert homocysteine to methionine, is associated with elevations of the rates of sCADs.⁵³ This metabolic block would be expected to cause homocysteine to accumulate intracellularly.⁵⁵

The striking association of homocysteine with sCAD raises the possibility that a relatively simple diagnostic test is at hand for determining patients at risk for sCAD and who would accordingly be advised to avoid cervical manipulation. Until recently, the gold-standard methodology for determining plasma homocysteine was high-pressure liquid chromatography, gas chromatography and mass spectrometry.⁵⁶⁻⁵⁸ Fortunately, this cumbersome technology has recently been correlated with a much simpler enzyme conversion immunoassay (EIA).⁵⁹

An even more rapid assay method by means of an automated analyzer is also available, requiring only microliter amounts of reagent and sample.⁶⁰ This essentially means that homocysteine levels can be determined in any number of clinical reference laboratories already established to measure blood analytes.

Editor's Note: Part 2 of this article, scheduled for the June 3 issue, discusses symptoms of arterial distress and flaws in the medical literature regarding stroke risk and spinal manipulation.

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