

Plausible Mechanisms by which Cervical Spine Manipulation Can Cause Immediate Stroke



- **Steven Brown, DC, Dipl Med Ac**
- **Doctor of Chiropractic**
- *www.brownochiro.com*
- **Chiropractic Expert Witness**
- *www.thechiropracticexperts.com*
- **Study at *Cureus.com***

Plausible Mechanisms of Causation of Immediate Stroke by Cervical Spine Manipulation: A Narrative Review

Plausible Mechanisms of Causation of Immediate Stroke by Cervical Spine Manipulation: A Narrative Review

Steven P. Brown¹

1. Integrative/Complementary Medicine, Brown Chiropractic & Acupuncture, PC, Gilbert, USA

Corresponding author: Steven P. Brown, drbrown@brownchiro.com

Abstract

It has been proposed that cervical spine manipulation (CSM) can cause dissection in healthy cervical arteries, with resultant immediate stroke. However, research does not support a causal association between CSM and cervical artery dissection (CAD) in healthy cervical arteries. The objective of this study was to review the literature to identify plausible mechanisms of causation of immediate stroke by CSM. Immediate stroke is defined as a stroke occurring within seconds or minutes of CSM. Our review found plausible thromboembolic and thrombotic mechanisms of causation of immediate stroke by CSM in the literature. The common premise of these mechanisms is CAD being present before CSM, not occurring as a result of CSM. These mechanisms of causation have clinical and medicolegal implications for physicians performing CSM.

- **Part 1**
- Biography & Case Review
- **Part 2**
- Plausible Mechanisms of Causation
- **Hour 3**
- Clinical & Medicolegal Implications

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Medicolegal Experience



- **Chiropractic Expert Witness**
- Plaintiff or Defense
- Vertebral artery dissection
- Internal carotid artery dissection
- Stroke
- Disc & spinal cord injury
- Cauda equina syndrome
- Thoracic outlet syndrome
- Pneumothorax
- Fracture

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Medicolegal Experience



- **Chiropractic Expert Witness**
- **40** cases of manipulation & stroke
- **25** cases of immediate stroke
- Vertebral artery stroke
- Internal carotid artery stroke
- Hemorrhagic stroke
- **34** postgraduate courses in manipulation, dissection & stroke

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#1 Postgraduate Course: CSM, CAD & Stroke



- **Answering Questions about Chiropractic & Stroke: Part 1 & 2**
- 2 hours

- **William Lauretti, DC, FICC, FACC**
- American Chiropractic Association
- NCMIC Speaker's Bureau

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#2 Postgraduate Course: CSM, CAD & Stroke



- **Stroke & Manipulation 104**
- 8 hours
- **Stroke & Manipulation 106**
- 4 hours
- **Joseph Ferezy, DC, DACAN, FIACN**
- *Chirocredit.com*
- *Chiroclasses.com*

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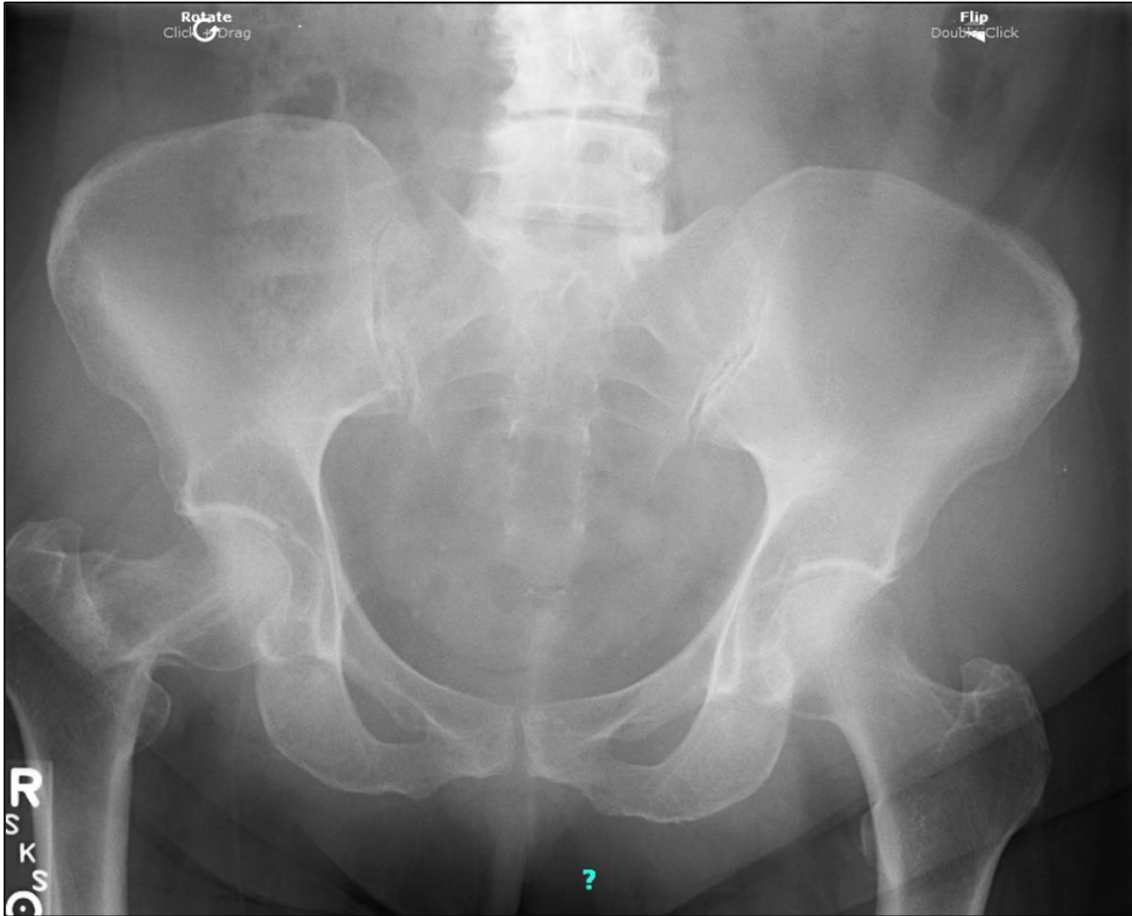
#3 Postgraduate Course: CSM, CAD & Stroke



- Preventing Complications of Cervical Spinal Manipulation: Applying Chiropractic Adjustments to Difficult Conditions
- 2 hours
- **David Graber, DC, CCSP, DACBSP**
- Northeast College of Health Sciences
- *Chiroexcellence.com*

Steven Brown, DC, Dipl Med Ac

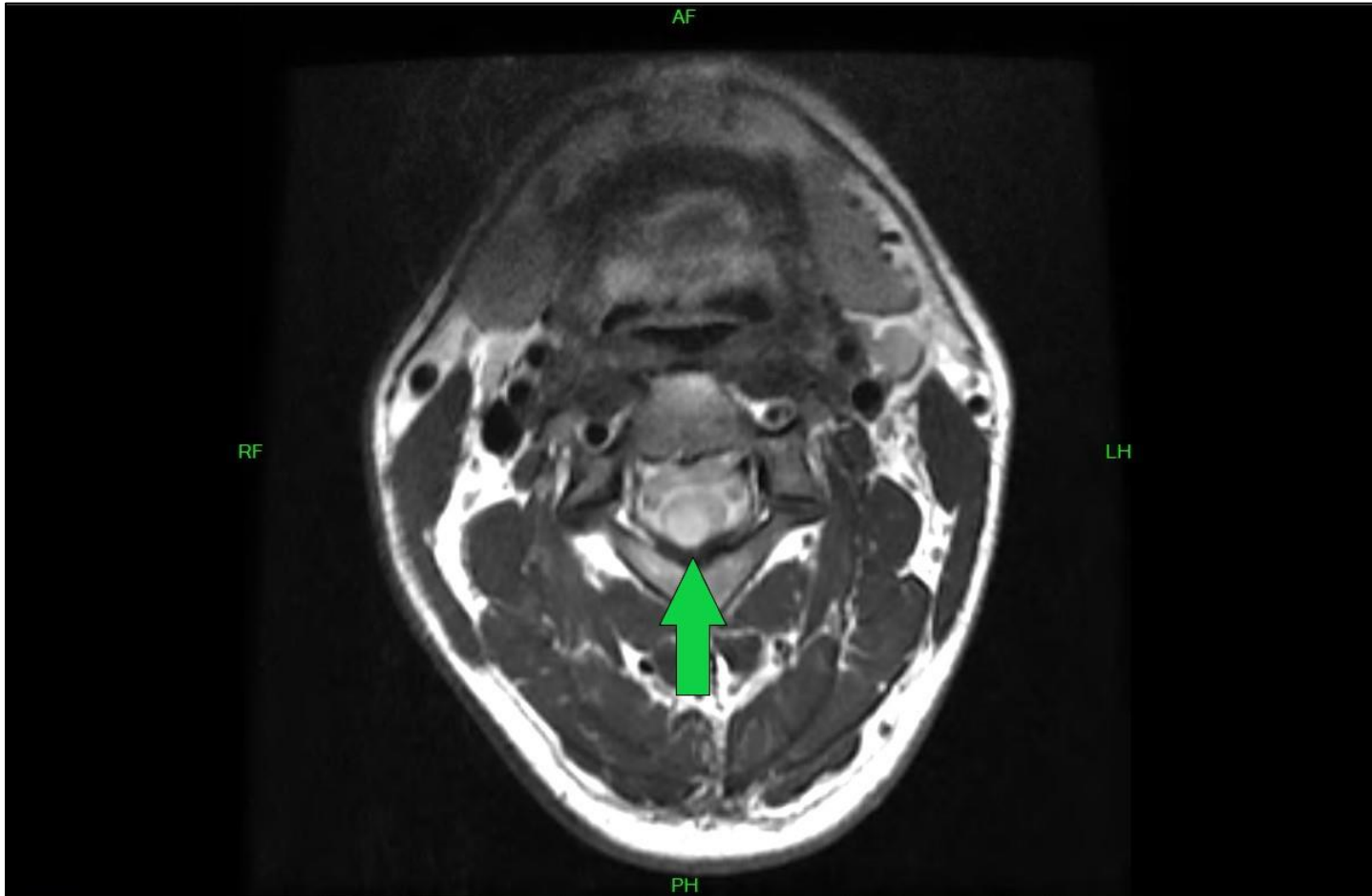
Research Publications



- **2024 Case Report**
- **Cureus Journal of Medical Science**
- Impacted & Angulated Right Hip Fracture in a Patient Reporting No History of Trauma Presenting to a Chiropractic Physician: A Case Report

Steven Brown, DC, Dipl Med Ac

Research Publications



- **2024 Case Report**
- **Cureus Journal of Medical Science**
- **Diagnosis of Cervical Spinal Cord Multiple Sclerosis by a Chiropractic Physician: A Case Report**

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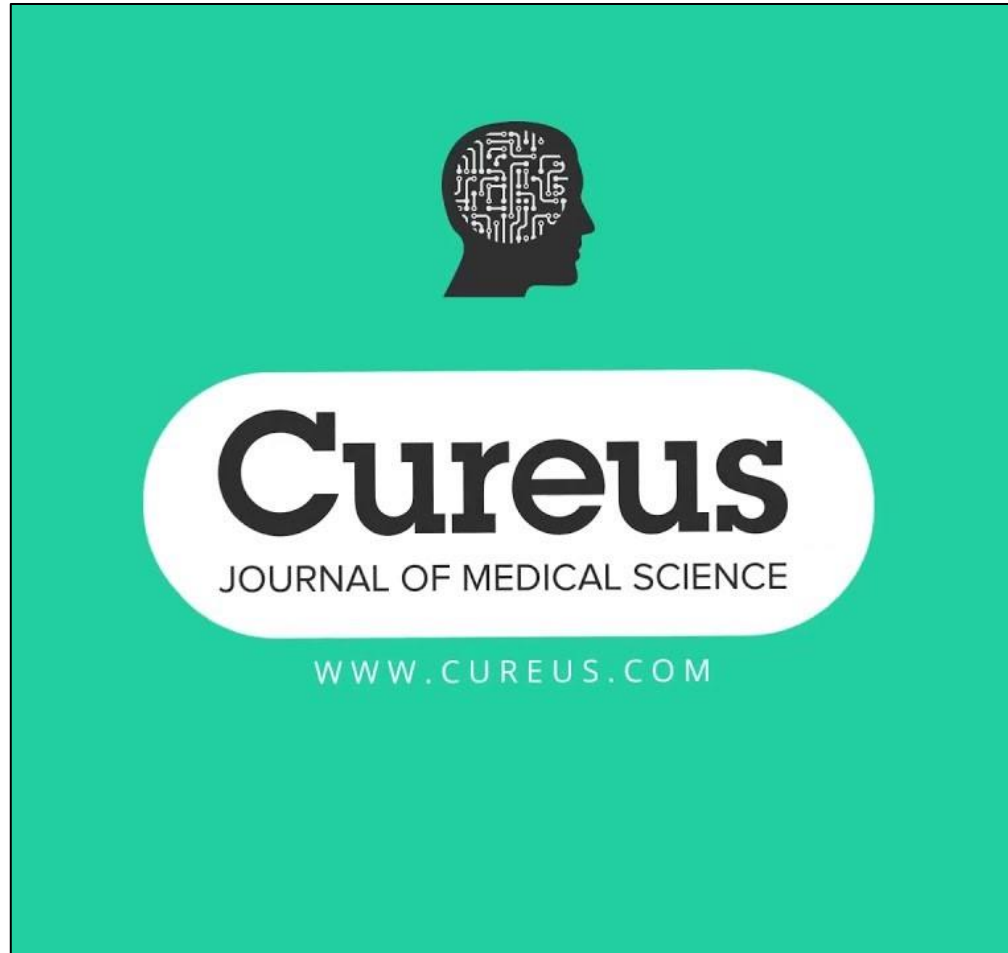
Research Publications



- **2024 Commentaries**
- **Journal of the International Academy of Musculoskeletal Medicine**
- Cervical Spine Manipulation, Immediate Stroke, and the Diagnosis of Dissection: A Commentary on Cassidy 2008
- Diagnosing Vertebral Artery Dissection: Commentary on the 2014 Mattox Case Report

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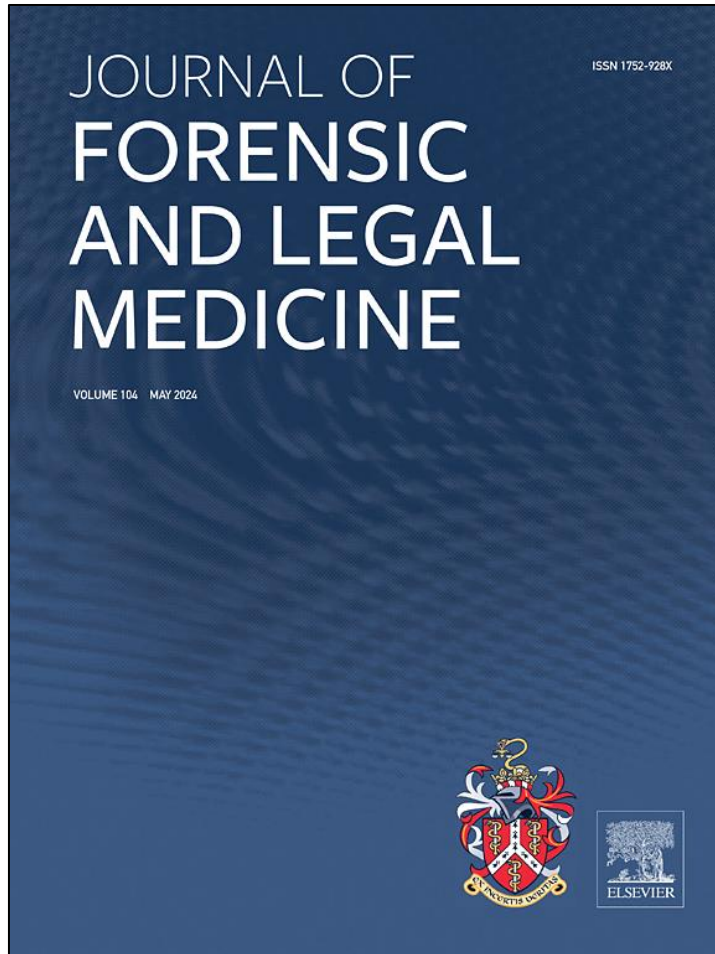
Research Publications



- **2024 Reviews**
- **Cureus Journal of Medical Science**
- Plausible Mechanisms of Causation of Immediate Stroke by CSM: A Narrative Review
- CSM & CAD: A Review of 10 Case Reports
- Concept & Design by Dr. Peter Tuchin

Steven Brown, DC, Dipl Med Ac

Research Publications



- **2024 (Peer review)**
- **Journal of Forensic & Legal Medicine**
- Review of Nine Malpractice Cases with Allegations of Causation of Cervical Artery Dissection by Cervical Spine Manipulation: No Evidence for Causation

Steven Brown, DC, Dipl Med Ac

Research Publications



- 2024 (Submitted)
- **Forensic Science International: Reports**
- Forensic analysis of the cause of bilateral vertebral artery dissection diagnosed following chiropractic cervical spine manipulation

Steven Brown, DC, Dipl Med Ac Media

St. Louis County woman says she suffered a stroke after visiting the chiropractor

A Ballwin woman is one of multiple people around the country who are suing chiropractors over strokes after rapid force was applied to their necks.



- 2024, KSDK TV
- St. Louis, Missouri
- Paula Vasan

Steven Brown, DC, Dipl Med Ac

Conference Presentations

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Mathew Christopher- E/M Rules and More	Diane Kraemer- Clinical and Dx Findings and Classification of Spine Disorders From a Neurosurgical Perspective
Steven Brown- Manipulation and Stroke	
Jeffrey Cates- Tools to Evaluate Literature	Dan Bowerman- Clinical and Forensic Considerations of the Physical Examination for the Practitioner and Consultant
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- 2023 American College of Chiropractic Consultants Annual Conference
- Chicago, Illinois
- Plausible Mechanisms of Causation of Immediate Stroke by Cervical Spine Manipulation

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Conference Presentations



- **2024 International Webinar on Neurology & Brain Disorders**
- **Bangkok, Thailand**
- **Plausible Mechanisms of Causation of Immediate Stroke by Cervical Spine Manipulation**

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Conference Presentations



UNIVERSITY OF
BRIDGEPORT

NEUROMUSCULOSKELETAL MEDICINE SYMPOSIUM

August 2-4, 2024

The University of Bridgeport through the Health Sciences Postgraduate Education Department is offering a postdoctoral program in Neuromusculoskeletal Medicine.

Featured speakers include Drs. Steven Brown, Anthony Nicholson, and Nelson Marquina.

Location: on campus in the Chiropractic Building at the corner of Linden and Hazel on August 2-4, 2024 (Friday, Saturday, and Sunday).



SPEAKER
Steven Brown,
DC, Dipl Med Ac
Chiropractic Expert Witness
& IME



SPEAKER
Anthony Nicholson,
DC, DACNB, DIANM
CEO, Chiropractic Development
International

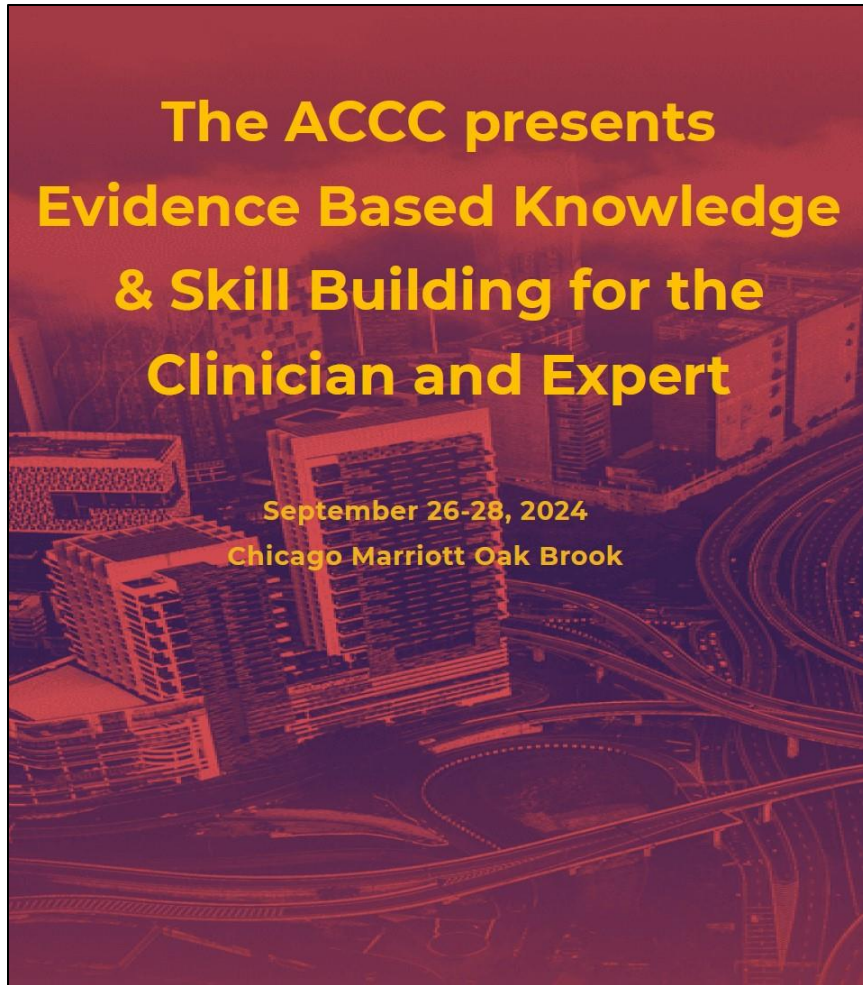


SPEAKER
Nelson Marquina,
MSc, DC, PhD
CSO, Laser Biotech
International

- **2024 University of Bridgeport Neuromusculoskeletal Symposium**
- **Bridgeport, Connecticut**
- **Plausible Mechanisms of Causation of Immediate Stroke by Cervical Spine Manipulation**

Steven Brown, DC, Dipl Med Ac

Conference Presentations



- **2024 American College of Chiropractic Consultants Annual Conference**
- **Chicago, Illinois**
- **Plausible Mechanisms of Causation of Immediate Stroke by Cervical Spine Manipulation: Clinical & Medicolegal Implications**

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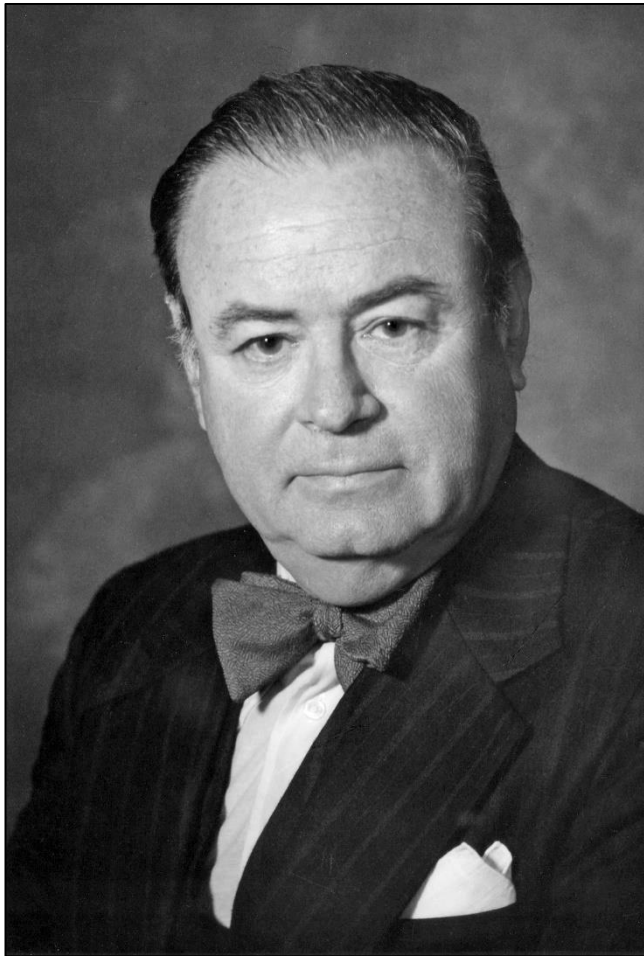
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- Biography & Case Review

- **Part 2**
- Plausible Mechanisms of Causation

- **Hour 3**
- Clinical & Medicolegal Implications

Immediate Stroke after CSM

1947 Pratt-Thomas Case Series



- Pratt-Thomas HR, et al.
- **Cerebellar and spinal injuries after chiropractic manipulation.**
- *Journal of the American Medical Association.*
- March 1947.

Immediate Stroke after CSM

1947 Pratt-Thomas Case Series: Case 1

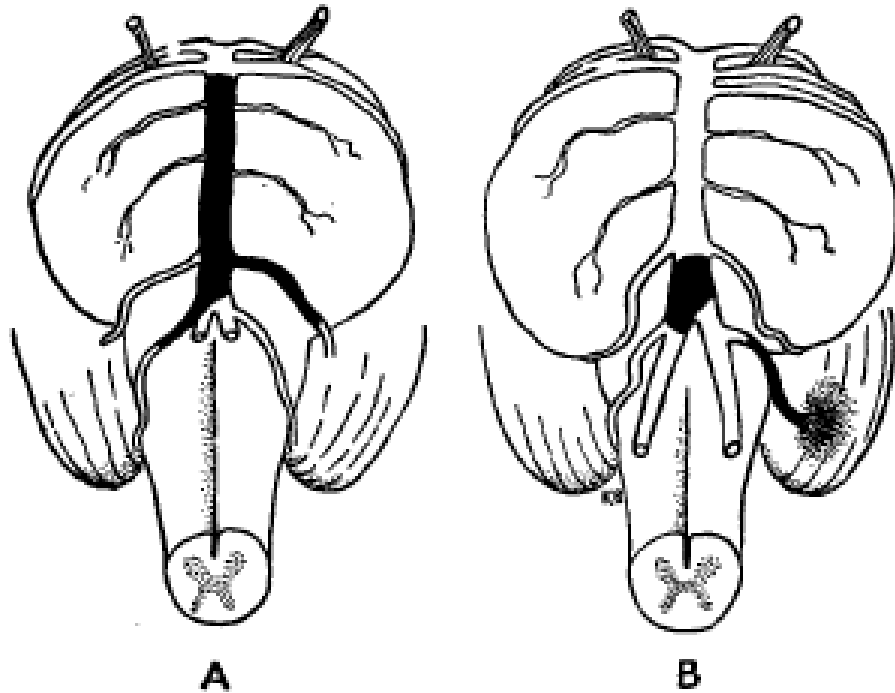


Fig. 1A—Diagram of basilar artery in case 1 showing thrombus (black) in basilar, left anterior inferior and right posterior inferior cerebellar arteries. B, case 2, showing thrombus in basilar, right vertebral and left posterior inferior cerebellar arteries with softening of the left tonsil.

- 32-year-old male. Neck pain, headache, dizziness & nausea for four weeks prior to CSM. Frequent adjustments for two weeks. Unconscious during CSM, death 24 hours later.
- Autopsy showed thrombosis of basilar, left anterior-inferior cerebellar & right posterior-inferior cerebellar arteries.

Immediate Stroke after CSM

1947 Pratt-Thomas Case Series: Case 2

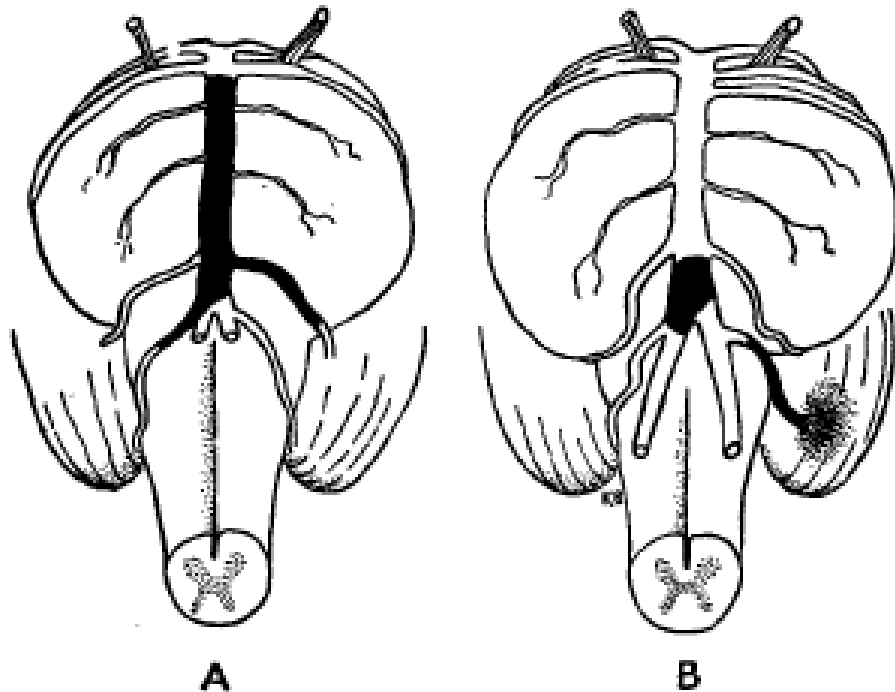
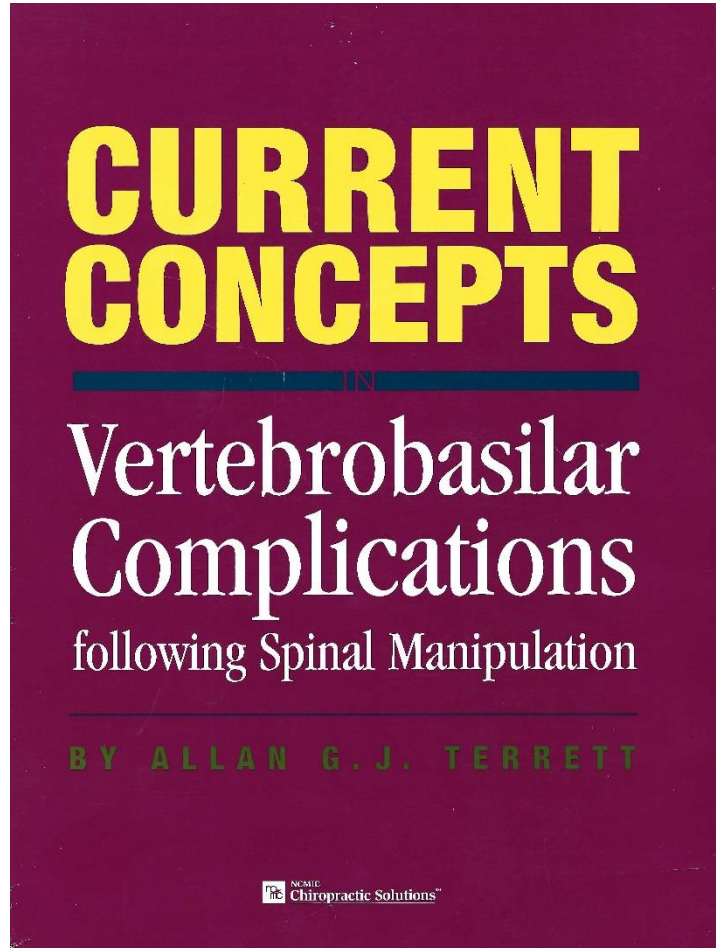


Fig. 1A—Diagram of basilar artery in case 1 showing thrombus (black) in basilar, left anterior inferior and right posterior inferior cerebellar arteries. B, case 2, showing thrombus in basilar, right vertebral and left posterior inferior cerebellar arteries with softening of the left tonsil.

- A white woman aged 35 had been periodically visiting a DC because of “hay fever”. After a “treatment” she complained of feeling “dizzy”, and at the suggestion of the DC she remained for further treatment.
- The next day she was taken to her home in an unconscious condition by the DC at 1 pm. He instructed the family to take her to a physician. She was brought to the hospital in an unconscious state and expired that night at 10:30 pm.

Immediate Stroke after CSM

1934-1999 Terrett Cases



- **255** cases of cervico-cerebral artery syndromes after CSM.
- **198** cases reported temporality.
- **137** cases were immediate.
- Terrett, Allan G.J.
- **Current concepts in vertebrobasilar complications following spinal manipulation.**
- **NCMIC. 2nd ed. 2001.**

Immediate Stroke after CSM

1993, Britt Harwe, Connecticut



- 26 years old
- Neck pain before CSM
- Immediate stroke with CSM
- Vertebral artery dissection
- DC called 911 saying patient had a “reaction to the treatment”
- \$900,000 settlement
- *chiropracticstroke.com*

Immediate Stroke after CSM

2008, CNN Chiropractic Stroke Report



Immediate Stroke after CSM

1996 Klougart Case Series, Denmark

- **5 cases of immediate stroke**
- Klougart N, et al.
- **Safety in chiropractic practice, Part I; The occurrence of cerebrovascular accidents after manipulation to the neck in Denmark from 1978-1988.**
- JMPT. 1996.
- **18/22 cases of immediate stroke**
- Klougart N, et al.
- **Safety in chiropractic practice. Part II: Treatment to the upper neck and the rate of cerebrovascular incidents.**
- JMPT. 1996.

Immediate Stroke after CSM

1998, Laurie Mathiason, Canada



Chiropractic Neck Manipulation: Dangers & Death

- 20 years old
- Neck pain before CSM
- Immediate stroke, convulsions, twitching, foaming at the mouth
- DC allegedly slapped the patient in an attempt to revive her
- Taken to the ER
- Vertebral artery dissection
- Brain-dead the next day

Immediate Stroke after CSM

1999 Hufnagel Case Series, Germany

Table 1 Patients and manipulation characteristics (VA vertebral artery, IC internal carotid artery, r right, l left, bi bilateral, 1+1: complications after first and second manipulations)

Patient no.	Sex	Age (years)	Dissected artery	Indication for manipulation	Vascular risk factors	Manoeuvre type	Manipulation (n)	Latency to onset
1	F	34	VA/r	Migraine, neck pain	None	Rotation, extension, tilting	6	Immediate
2	M	40	VA/r	Neck pain	Mild hypertension	Forceful rotation and extension at the same time	1 + 1	1.5 h; second: 2–3 h
3	F	27	VA/bi	Neck and shoulder pain	None	Right and left rotation, extension	1	1 day
4	F	29	VA/l	Neck pain	Smoking 1 or 2 cigarettes/day	Rapid, repeated right-left turning	Approx. 10	2 days
5	F	29	VA/bi	Neck pain, headache	Mild hypertension	Right-left rotation, abrupt extension, two or three thrusts to the mastoid	2	Immediate
6	F	35	VA/l	Neck pain	None	Forceful rotation to left side three or four times	5	Immediate
7	F	31	VA/l	Neck pain	None	Abrupt forceful rotation to the right	1	Immediate
8	F	34	VA/bi	Neck pain	Mild hypertension	Forceful rotation to right and left once	1	16 h
9	M	35	IC/r	Headache	Smoker, hypercholesterolaemia	Anteversion of head and shoulder, head rotation to both sides	1	Immediate
10	M	46	IC/l	Neck pain	None	Unclear	1	16 h

- Hufnagel A, et al.
- **Stroke following chiropractic manipulation of the cervical spine.**
- *Journal of Neurology.*
- August 1999.

Immediate Stroke after CSM

2001 Haldeman Case Series (CCPA Data)



Table 1: Characteristics of patients who developed vertebral artery dissections following cervical manipulation (*n* = 23)

Characteristic	No. (and %) of patients*
Median age (and range), yr	42.5 (24–75)
Male:female	6 (26):17 (74)
Hypertension	4 (17.4)
Diabetes	0
Oral contraceptive use	1 (4.3)
Migraine	4 (17.4)
Smoking	5 (22)
Elevated cholesterol	0
Time of onset of symptoms following manipulation	
Within 20 min	15 (65)
1–24 h	5 (22)
1–9 d	3 (13)

*Unless stated otherwise.

Immediate Stroke after CSM

2002 Haldeman Case Series (NCMIC Data)



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	—

Immediate Stroke after CSM

2003 Smith Case Control Study



Table 3 Head and neck pain and spinal manipulative therapy (SMT)

Pain and SMT	Dissection, n = 51	Controls, n = 100	<i>p</i> Value
Pain			
Before, during, or after	42 (82)	50 (50)	<0.001
Pain before stroke/TIA	39 (76)	40 (40)	<0.001
Onset before stroke/TIA, d, mean (SD)	7.3 (10.9)	6.3 (9.0)	0.31
SMT			
Ever	27 (53)	42 (42)	0.23
Within 30 d	7 (14)	3 (3)	0.032
New pain or worse pain after SMT	4 (8)	0 (0)	0.012
Immediate stroke/TIA with SMT	2 (4)	0 (0)	0.11
Time from manipulation to stroke/TIA, d, mean (SD)	1.4 (1.2)	8.4 (9.0)	0.011

Immediate Stroke after CSM

2006 Reuter Case Series Germany

- Reuter U, et al.
- **Vertebral artery dissections after chiropractic neck manipulation in Germany over three years.**
- *Journal of Neurology.*
- June 2006.

Age (years)	40.3 ± 11	
Sex	24 female: 12 male	
Hospital days	20 ± 13	
Cardiovascular risk factors		n = 22 (61%)
Disorders associated with VAD (e. g. migraine, FMD)	Yes	n = 9 (25%)
	No	n = 27 (75%)
Latency (manipulation/ onset of complaint)	Within session	n = 5 (14%)
	< 60 mins	n = 4 (12%)
	1–6 hrs	n = 5 (14%)
	6–12 hrs	n = 7 (20%)
	12–48 hrs	n = 5 (14%)
	> 48 hrs	n = 9 (24%)
Chief complaint prior to chiropractic manipulation	Neck muscle tension	n = 27 (75%)
	Tension type headache	n = 7 (20%)
	Migraine	n = 1 (3%)
	Vertigo	n = 1 (3%)
	Lower back pain	n = 2 (6%)
	Debilitating maneuver was conducted by	Orthopedic surgeon
Physiotherapist		n = 5 (14%)
Chiropractor		n = 4 (11%)
GP		n = 2 (6%)
Neurologist		n = 1 (3%)
Homeopath		n = 1 (3%)
Unknown		n = 3 (9%)
Chief complaint after chiropractic neck manipulation		Clinical symptoms attributed to the vertebrobasilar territory
	Any focal neurological deficit	n = 32 (89%)
	Newly developed neck/head pain	n = 8 (22%)
	Progression of symptom	n = 5 (14%)
	Impaired level of consciousness	n = 4 (11%)

Immediate Stroke after CSM

2010, Elizabeth Caplan, Oklahoma

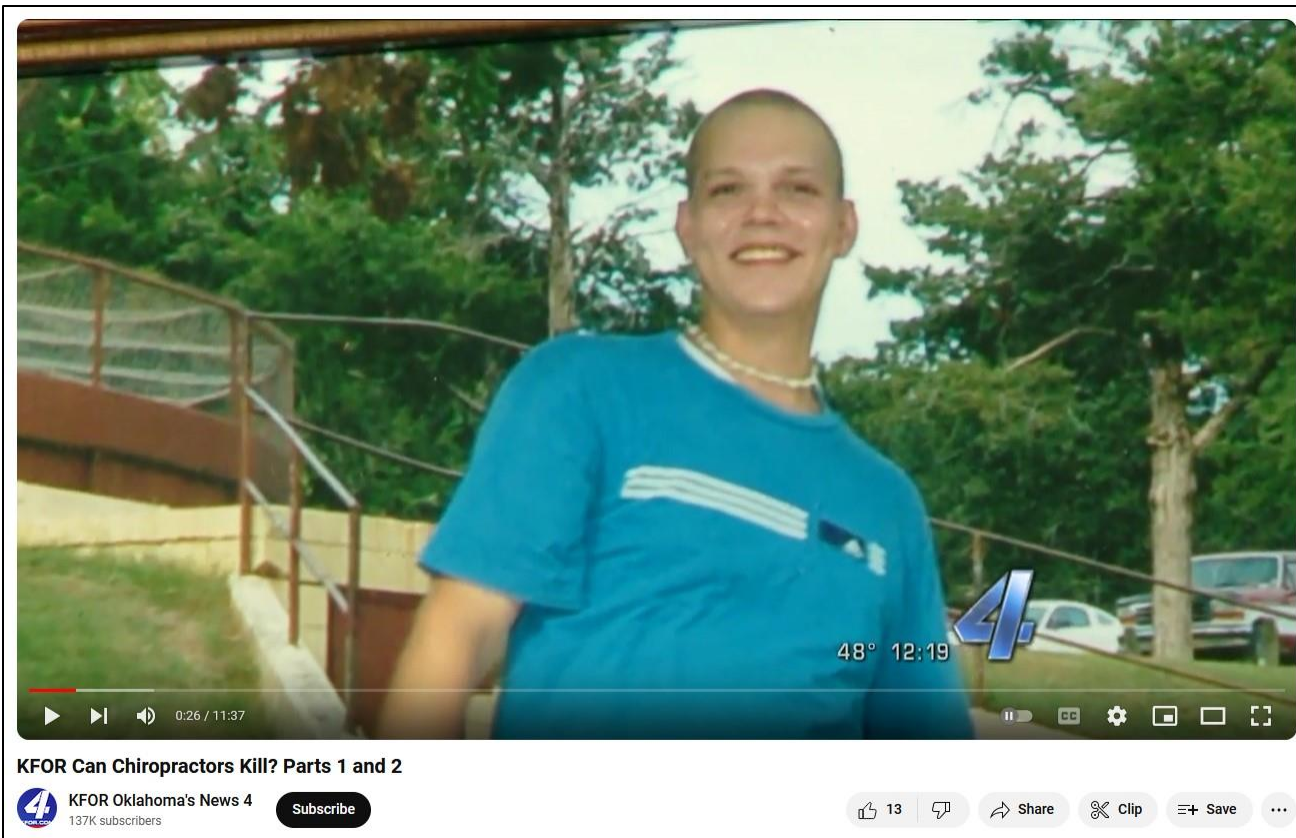


- 44 years old
- Immediate stroke after CSM
- Vision loss in right eye
- Dizziness/nausea/vomiting
- Loss of bowel/bladder control
- Ataxia/dysphagia
- Memory loss
- DC did not call 911
- “Involuntary nerve response”
- Vertebral artery dissection

Immediate Stroke after CSM

2011, Jeremy Youngblood, Oklahoma

- 30 years old
- Neck pain before CSM
- Immediate stroke with CSM
- DC did not call 911
- DC called Jeremy's father
- Father arrived 6 hours later
- Right VAD
- Died two days later
- *chiropracticstroke.com*



Immediate Stroke after CSM

2015, Can Chiropractors Kill?



The image shows a YouTube video player interface. The video title is "KFOR Can Chiropractors Kill? Parts 1 and 2". The video content is a news investigation from NewsChannel 4 (KFOR.com). The video player shows a progress bar at 0:18 / 11:37, a temperature of 48°, and a time of 12:19. The video player includes standard controls like play, volume, and full screen. Below the video player, there is a channel name "KFOR Oklahoma's News 4" with 135K subscribers and a "Subscribe" button. There are also social sharing options: 13 likes, a comment icon, "Share", "Clip", "Save", and a menu icon.

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KFOR.com
Investigation

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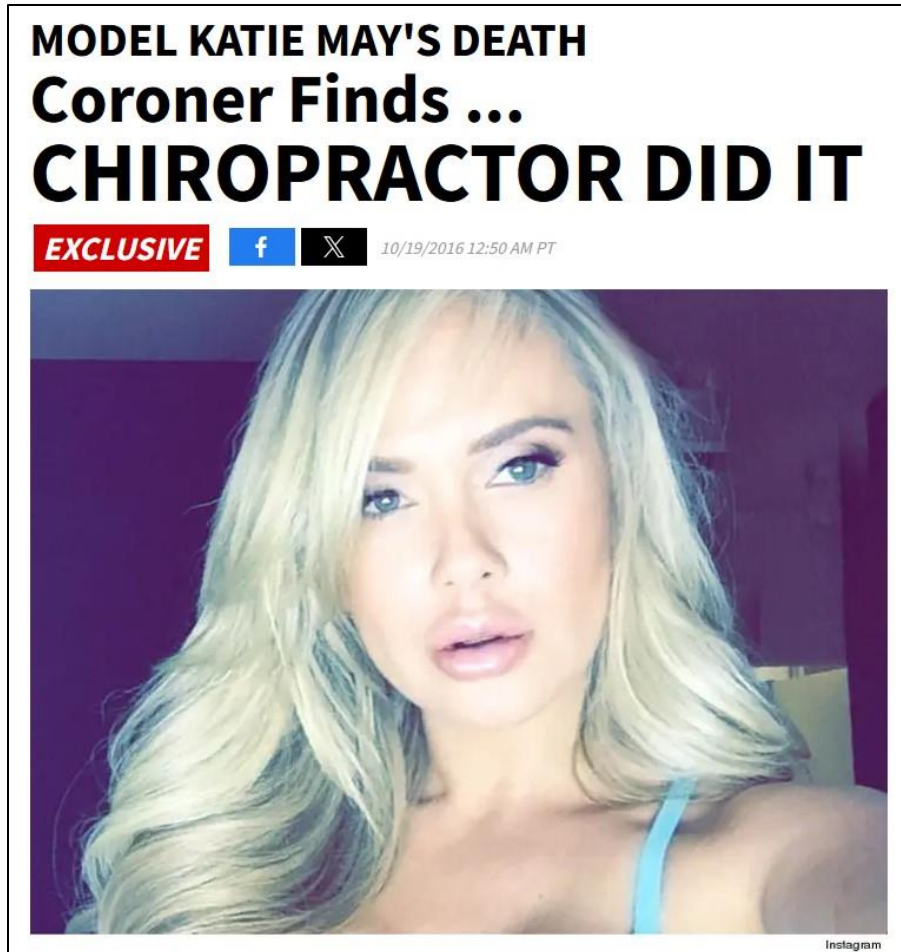
Immediate Stroke after CSM

2015, Jonathan Buckelew, Georgia

- 32 years old, neck pain, headaches, blurred vision, ringing in ears for 4 days following a gym workout
- Immediate stroke with CSM. Locked-In Syndrome.
- **\$75 million jury award**
- DC settled with Plaintiff separately
- **Dr. William Lauretti:** The DC, “...violated acceptable chiropractic practices by manipulating [patient’s] neck when he had demonstrated focal neurological deficits in conjunction with new onset neck pain and headache.”

Immediate Stroke after CSM

2/1/2016, Katie May, California



- 34-year-old professional model
- Neck injury. New, sudden onset, severe, left suboccipital neck pain, left occipital headache, and nausea prior to CSM.
- Bilateral V3 vertebral artery dissection
- Basilar artery occlusion
- Death four days after stroke
- \$250,000 settlement

Immediate Stroke after CSM

2/1/2016, Katie May, California

PLAYBOY MODEL KATIE MAY
Estate Sues Chiropractor ...
**YOUR TREATMENT
KILLED HER**

EXCLUSIVE



6/14/2017 9:17 AM PT



- CSM did **not** cause the left vertebral artery dissection.
- CSM did **not** cause the right vertebral artery dissection.
- CSM did **not** cause the stroke.
- Ischemic stroke symptoms began **7.5** hours after CSM.

Immediate Stroke after CSM

2017 Kennell Case Series



- Kennell KA, et al.
- **Cervical artery dissection related to chiropractic manipulation: One institution's experience.**
- *Journal of Family Practice.*
- September 2017.

TABLE 1

Demographics, original symptoms, and frequency of chiropractor use

Case #	Sex/age	Original symptoms*	Frequency of chiropractor use	Time from manipulation to development of new symptoms
1	M/32	Chronic neck pain	Occasional	Immediate
2	F/37	Chronic neck pain	Once a month for 15 years	Immediate
3	F/40	Neck pain for a few weeks	Several visits subsequent to onset of pain	Immediate
4	F/22	Motor-vehicle accident (MVA) one month earlier; neck pain and stiffness	Unknown	Immediate
5	F/30	Postpartum neck pain and stiffness	First time	Immediate
6	F/45	Chronic headaches	Regular	Immediate
7	M/45	Chronic neck and back pain post MVA 19 years ago	Occasional	Immediate
8	M/44	Neck stiffness for 2 days; no history of trauma	Unknown	Immediate
9	F/46	Sore neck for a few days	Once or twice a year for past 5 years	Immediate
10	F/27	Chronic neck pain and headaches several years post MVA	First time	Immediate
11	F/29	Neck stiffness and migraines	Once a week for 10 years	2 days
12	F/36	Neck pain and migraines	Regular	2-3 days

*Symptoms that led to chiropractic manipulation.

Immediate Stroke after CSM

2018 Turner Case Report



- 32-year-old woman presented to a DC for CSM for “tension-like neck soreness”. Immediately had neck pain & diaphoresis, proceeded to have cardiac & respiratory arrest. EMS called.
- Bilateral V3 VAD and acute bilateral stroke.
- The patient quickly deteriorated and passed away shortly after arrival to the hospital.
- Turner RC, et al. **The potential dangers of neck manipulation & risk for dissection and devastating stroke: An illustrative case & review of the literature.** *Biomed Res Rev.* 2018.

Immediate Stroke after CSM

2019, Becca Barlow, Kentucky



- 31 years old
- Neck pain prior to CSM
- Nursing Mother's Neck
- Immediate nausea, vomiting, dizziness, vertigo, numbness, loss of consciousness
- Three arterial dissections
- Full physical recovery
- \$1,130,900 jury award in 2023

Immediate Stroke after CSM

2022, Mayank Dubey, Arizona



- Everyday aches & pains prior to CSM.
- Immediate facial paralysis, loss of strength, double-vision, eyes looking out to opposite directions, could not stand or sit without falling over.
- Taken to Chandler Regional ER.
- **Vertebral artery dissection.**
- **Brainstem stroke.**
- *gofundme.com*

Immediate Stroke after CSM

2022, Caitlin Jensen, Georgia



- 28 years old
- Neck pain prior to CSM
- Immediate stroke with CSM
- Nausea, vomiting, dizziness
- Speech difficulties
- DC told mother it was a reaction to the treatment
- 4 vertebral artery dissections
- Multiple strokes, “heart attacks”
- Paralysis
- Undisclosed settlement in 2023

Immediate Stroke after CSM

2024, Ashley Nelson, Missouri

St. Louis County woman says she suffered a stroke after visiting the chiropractor

A Ballwin woman is one of multiple people around the country who are suing chiropractors over strokes after rapid force was applied to their necks.



- 40 years old
- Neck pain prior to CSM
- Immediate stroke with CSM
- Vision changes
- Facial paresthesia
- Right VAD
- Brainstem stroke
- KSKD News Investigation

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