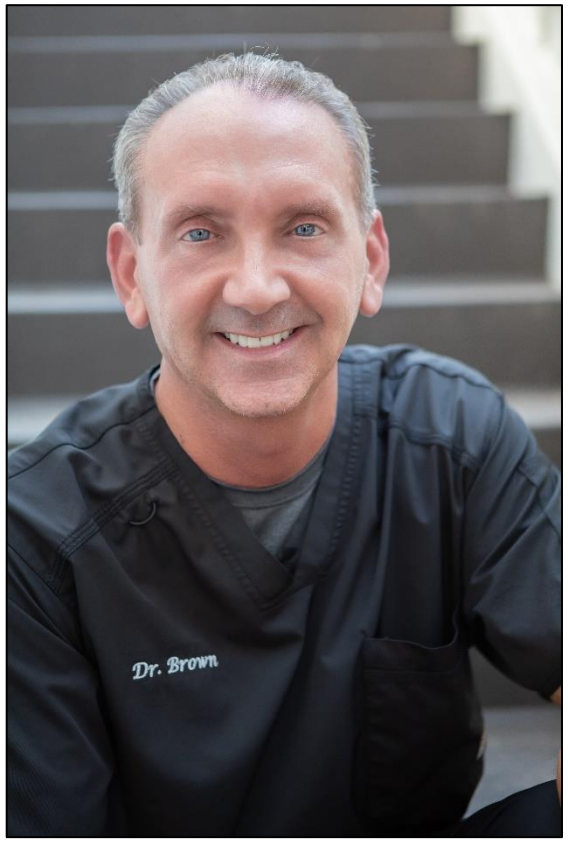
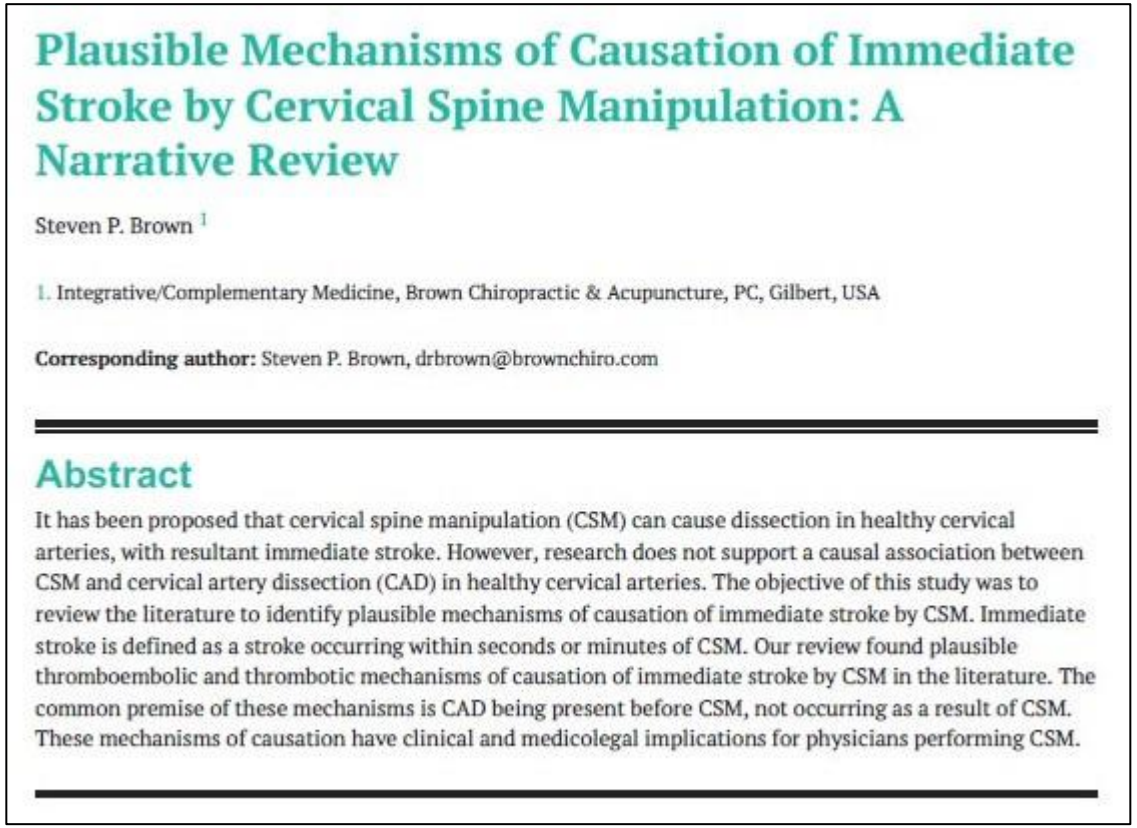
Plausible Mechanisms by which Cervical Spine Manipulation Can Cause Immediate Stroke



- **Steven Brown, DC, Dipl Med Ac**
- **Doctor of Chiropractic**
- *www.brownchiro.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. Brown [1]

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

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

Abstract

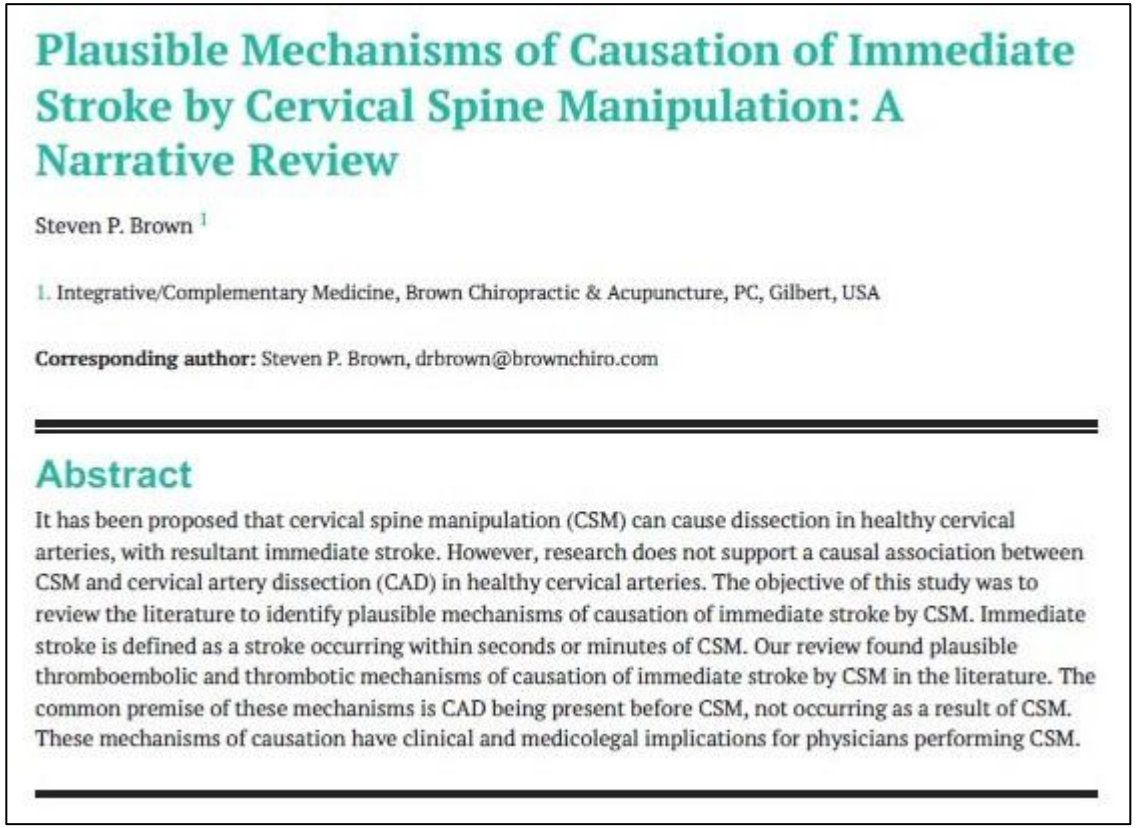
It has been proposed that cervical spine manipulation (CSM) can cause dissection in healthy cervical arteries, with resultant immediate stroke. However, research does not support a causal association between CSM and cervical artery dissection (CAD) in healthy cervical arteries. The objective of this 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

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

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- **Clinical Implications**
- 1. Informed Consent
- 2. History & Examination
- 3. Diagnosis
- **Implications for Physician Liability**
- **Implications for Medicolegal Causation**

Plausible Mechanisms of Causation of Stroke

Literature Search: 12 Results

Year	Lead Author	Field	Design	Publication	Mechanism(s)
1989	Mas	Neurology	Case Report	Neurology	Thromboembolic Thrombotic
1999	Haldeman	Neurology (Chiropractic)	Case Series	Spine	Thromboembolic Thrombotic
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2002	Haldeman	Neurology (Chiropractic)	Case Series	Journal of Neurology	Thromboembolic Thrombotic
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2013	Tuchin	Chiropractic	Review	International Journal of Clinical Practice	Thromboembolic
2015	Whedon	Chiropractic	Case Cohort	Journal of Manipulative & Physiological Therapeutics	Thromboembolic
2016	Thomas	Physical Therapy	Review	Manual Therapy	Thromboembolic Thrombotic
2016	Neeb & Reuter	Neurology	Review	Treatment-Related Stroke	Thromboembolic Thrombotic

Plausible Mechanisms of Causation of Stroke

Mechanisms of Causation

Mechanism of Causation	Description
1. Thrombotic	An already large cervical artery thrombus could be suddenly repositioned in such a way that it blocks the cervical artery, resulting in ischemic stroke from vascular occlusion.
2. Thromboembolic	Sudden neck movement from CSM could dislodge a loosely adherent cervical artery thrombus. The dislodged embolus may travel and occlude a smaller artery that supplies the brain, resulting in ischemic stroke.

Steven Brown, DC, Dipl Med Ac

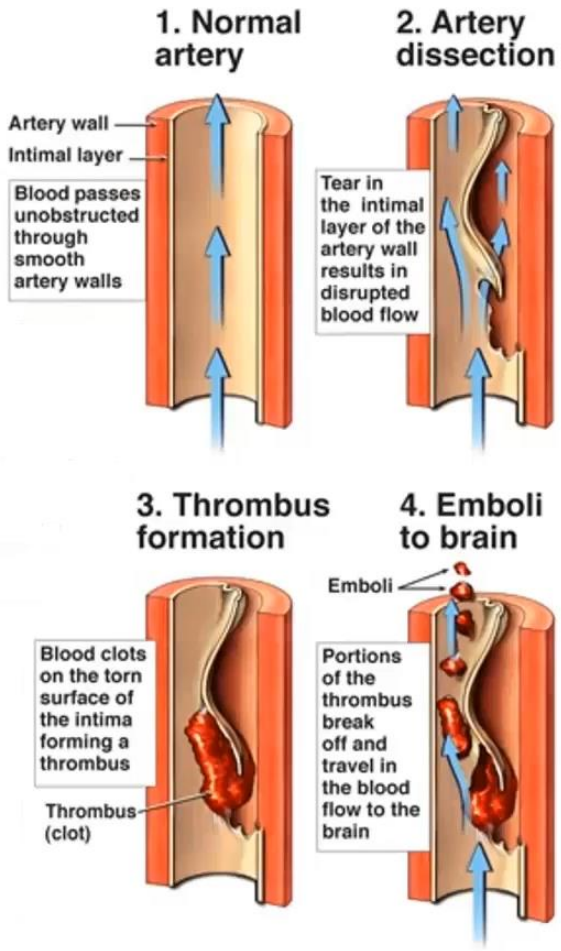
Postgraduate Course: CSM, CAD & Stroke

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

- **William Lauretti, DC, FICC, FACC**
- American Chiropractic Association
- NCMIC Speaker’s Bureau
- Northeast College of Health Sciences

Plausible Mechanisms of Causation of Stroke

2023 Lauretti ACA Seminar



- "We may be seeing those patients in that Stage 3 where they have the thrombus there, and the cervical adjustment may be enough force to not create a dissection, but *it may be enough force to break the clot free*. And that may be why the patient is having symptoms right in the chiropractor's office right after that."
- **William Lauretti, DC, FICC, FACC**

Steven Brown, DC, Dipl Med Ac

Postgraduate Course: CSM, CAD & Stroke

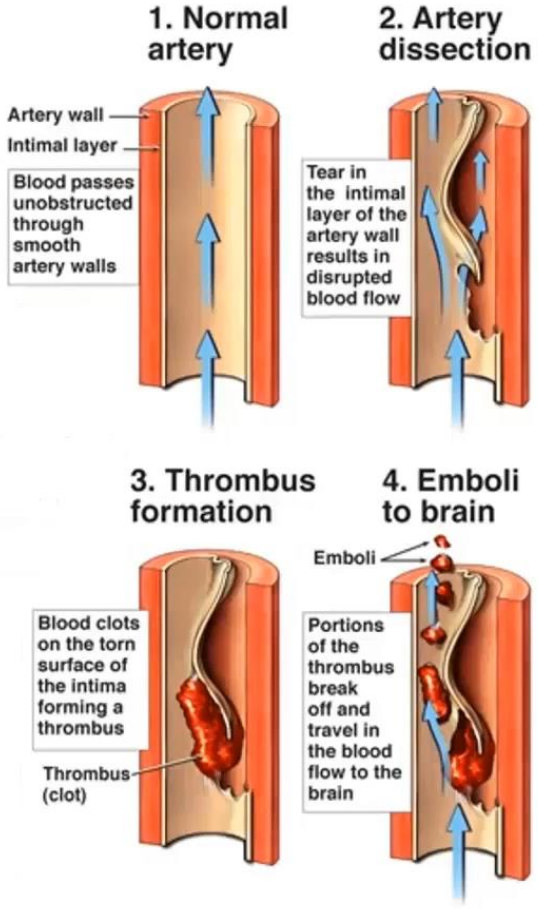
- **Stroke & Manipulation 104**
- 8 hours

- **Stroke & Manipulation 106**
- 4 hours

- **Joseph Ferezy, DC, DACAN, FIACN**
- *Chirocredit.com*
- *Chiroclasses.com*

Plausible Mechanisms of Causation of Stroke

2018 Ferezy ChiroClasses Seminar



- "Let's say that the artery was dissecting, but not a stroke, and then the adjustment was given, the dissection continued along, or *a thrombus broke an emboli off* of it and that traveled, and the person had a stroke, then you could say that the adjustment precipitated the stroke."

- **Joseph Ferezy, DC, DACAN, FIACN**

Plausible Mechanisms of Causation of Stroke
Reactions to this Study

- **1.** There is no convincing evidence that CSM can cause CAD in a healthy cervical artery. (2016 Church)
- **2.** It is plausible that CSM can cause thromboembolic or thrombotic stroke when performed in the presence of CAD. (12 studies)
- **Chiropractors & Defense Attorneys:** “No way! CSM can’t cause stroke!”
- **Neurologists & Plaintiff Attorneys:** “No way! CSM can cause CAD!”
- **Physical Therapists:** “Makes sense.”

Clinical Implications
The Standard of Care

- The standard of care for the chiropractic profession is what a *reasonable & prudent* chiropractic physician would do under same or similar circumstances.
- **The standard of care is determined from:**

1. Peer reviewed research, practice guidelines & best practices.
2. What is taught in accredited chiropractic graduate programs.
3. What is taught in accredited chiropractic postgraduate programs.
4. Legal & regulatory requirements for the practice of chiropractic.
5. Community standards in the local geographical region.

Clinical Implications

Breaches of The Standard of Care

- **Common breaches of the SOC for the chiropractic profession in cases of CSM, CAD, and immediate post-manipulative stroke.**

- 1. Failure to obtain Informed Consent to risk of CAD or stroke from CSM.
- 2. Misdiagnosis of cervical artery dissection.
- 3. Failure to diagnose and refer CAD to medical emergency.
- 4. Causation of stroke by performing CSM in the presence of CAD.
- 5. Misdiagnosis of stroke.
- 6. Failure to diagnose and refer stroke to medical emergency.

Clinical Implications

Informed Consent to Risk of *CAD* from CSM

- As there ***is*** a risk of CAD from CSM (in the presence of arterial weakness), and the potential consequences are severe, verbal & written informed consent to the risk of thromboembolic or thrombotic stroke from CSM should be obtained.

Clinical Implications

Informed Consent to Risk of *CAD* from CSM

- Even with a thorough history & examination, it is still possible to fail to diagnose arterial weakness (Ehlers-Danlos syndrome IV, fibromuscular dysplasia…).
- Therefore, physicians performing CSM should obtain informed consent to the risk of CAD as the result of CSM.

Clinical Implications

Informed Consent to Risk of ***Stroke*** from CSM

- As there ***is*** a risk of stroke from CSM, and the potential consequences are severe, verbal & written informed consent to the risk of thromboembolic or thrombotic stroke from CSM should be obtained.

Clinical Implications

Informed Consent to Risk of ***Stroke*** from CSM

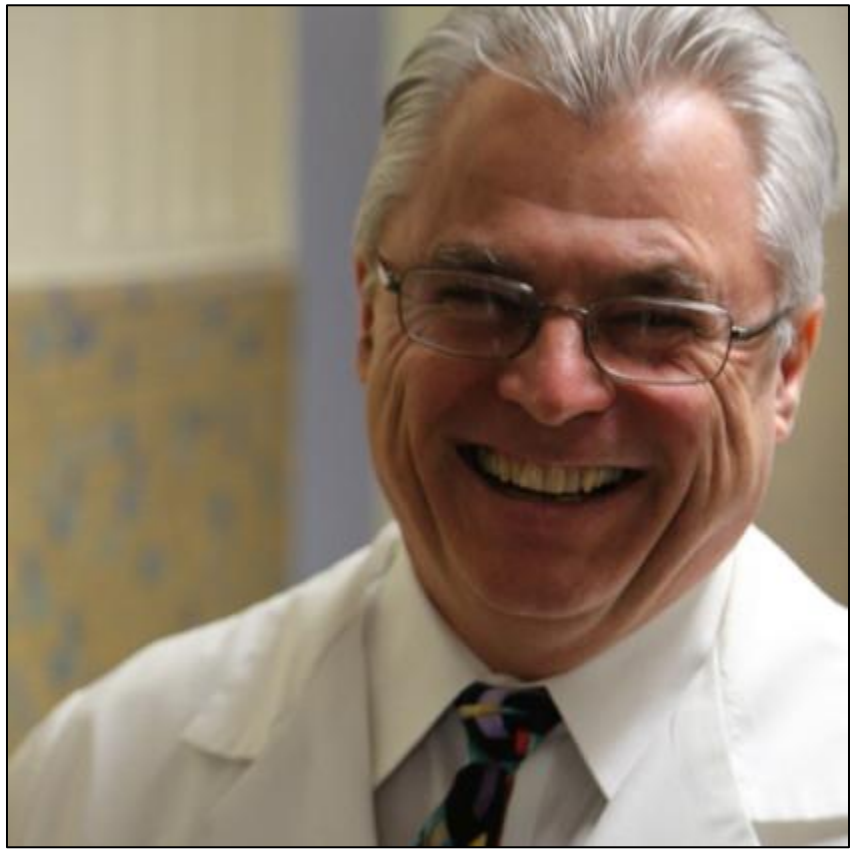
- Even with a thorough history & examination, it is still possible to fail to diagnose CAD.
- Therefore, physicians performing CSM should obtain informed consent to the risk of stroke as the result of CSM.

Clinical Implications

Informed Consent: 2008 Lehman

- **1.** The Informed Consent form should be signed by the patient.
- **2.** The Informed Consent form should be signed by the physician.
- **3.** There should be a physician/patient ***discussion*** documented in the chart.

- Lehman JJ, et al.
- **Should the chiropractic profession embrace the doctrine of informed consent?**
- J of Chiropractic Medicine. September 2008.



Clinical Implications

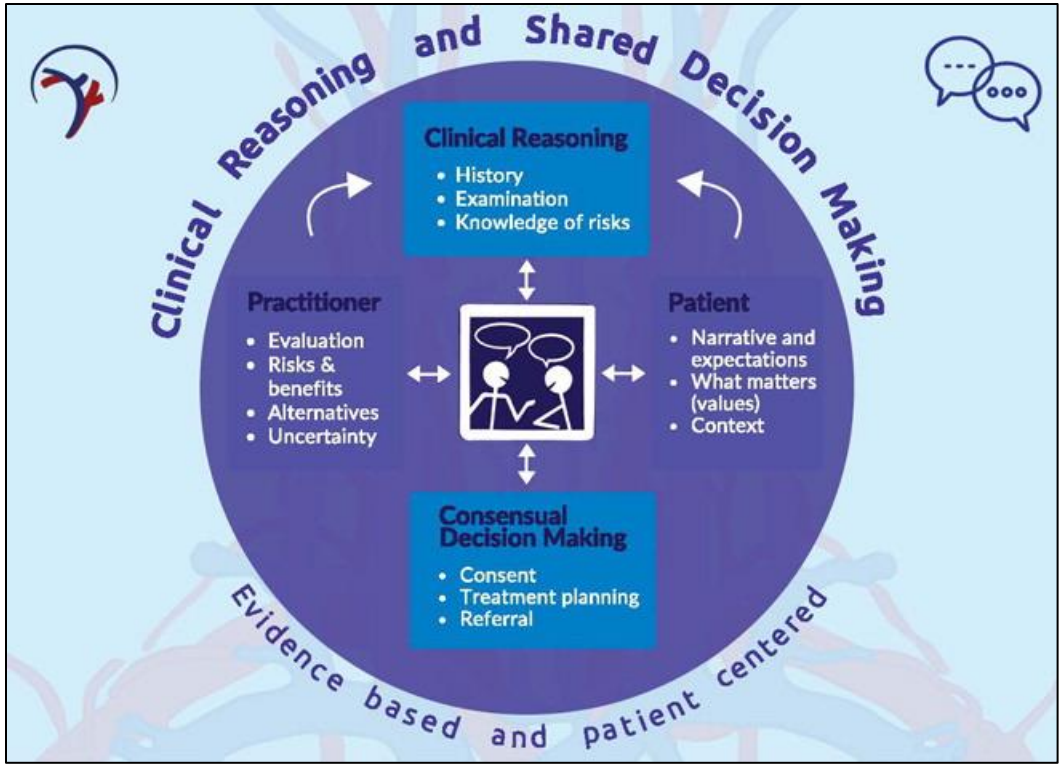
Informed Consent: Association of Chiropractic Colleges

- The physician should take into consideration both:
- 1. The potential *severity* of the injury or adverse consequences which may result.
- 2. The *likelihood* that the injury or consequence will occur.

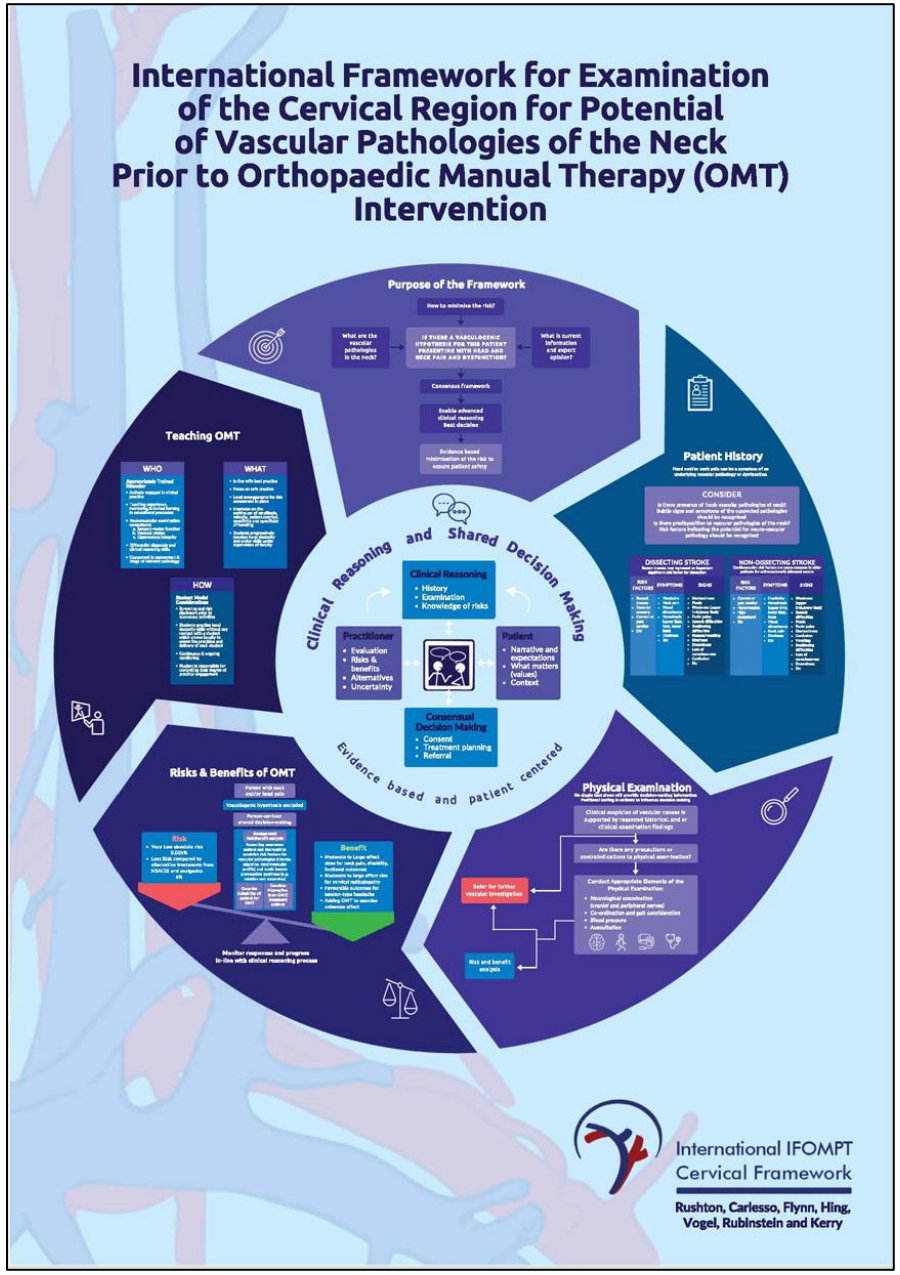
- If a certain risk is a mere possibility which ordinarily need not be disclosed, yet if its occurrence carries *serious consequences*, such as paralysis or death, it should be regarded as a material risk requiring disclosure.
- The physician should obtain *verbal & written* informed consent.

Clinical Implications

Informed Consent: IFOMPT Statement



- "It is recommended that informed consent be obtained after a process of shared decision-making."
- "Informed consent is obtained when a patient explicitly indicates either verbally *or* in writing, following adequate disclosure of information about the proposed procedure, and their consent to proceed with the treatment."



Clinical Implications

IFOMPT Cervical Framework

- Rushton A, Carlesso LC, Flynn T, Hing WA, Kerry R, *Rubinstein SM*, et al.
- **International Framework for Examination of the Cervical Region for potential of vascular pathologies of the neck prior to Orthopaedic Manual Therapy (OMT) Intervention: International IFOMPT Cervical Framework.**
- International Federation of Orthopaedic Manipulative Physical Therapists. 2020.

Clinical Implications

International IFOMPT Cervical Framework

- **Sidney Rubinstein, DC, PhD**
- 1992, Los Angeles College of Chiropractic
- 2008, Vrige University Amsterdam

- Rubinstein SM, et al.
- **A systematic review of the risk factors for cervical artery dissection.**
- Stroke. July 2005.

Clinical Implications

Discussion of Informed Consent

Clinical Implications

2010 Connecticut Board of Chiropractic

- The evidence is ***insufficient*** to conclude that a stroke or CAD is a risk or side effect of CSM. (The likelihood of suffering a stroke following an appointment with a DC is no greater than that following an appointment with a PCP).
- DCs are ***not*** required to address stroke or CAD as part of securing informed consent by patients to such treatment.
- DCs ***are*** required by the SOC to perform a history and physical examination and if determined that a patient is having a stroke or CAD, refrain from providing care and refer the patient for medical diagnosis and treatment.

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ANNALS OF MEDICINE
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REVIEW ARTICLE

OPEN ACCESS Check for updates

A risk–benefit assessment strategy to exclude cervical artery dissection in spinal manual-therapy: a comprehensive review

Aleksander Chaibi[a,b] and Michael Bjørn Russell[a,b]

[a]Head and Neck Research Group, Research Centre, Akershus University Hospital, Oslo, Norway; [b]Institute of Clinical Medicine, Akershus University Hospital, University of Oslo, Nordbyhagen, Norway

ABSTRACT

Cervical artery dissection refers to a tear in the internal carotid or the vertebral artery that results in an intramural haematoma and/or an aneurysmal dilatation. Although cervical artery dissection is thought to occur spontaneously, physical trauma to the neck, especially hyperextension and rotation, has been reported as a trigger. Headache and/or neck pain is the most common initial symptom of cervical artery dissection. Other symptoms include Horner's syndrome and lower cranial nerve palsy. Both headache and/or neck pain are common symptoms and leading causes of disability, while cervical artery dissection is rare. Patients often consult their general practitioner for headache and/or neck pain, and because manual-therapy interventions can alleviate headache and/or neck pain, many patients seek manual therapists, such as chiropractors and physiotherapists. Cervical mobilization and manipulation are two interventions that manual therapists use. Both interventions have been suspected of being able to trigger cervical artery dissection as an adverse event. The aim of this review is to provide an updated step-by-step risk–benefit assessment strategy regarding manual therapy and to provide tools for dinicians to exclude cervical artery dissection.

KEY MESSAGES

- Cervical mobilization and/or manipulation have been suspected to be able to trigger cervical artery dissection (CAD). However, these assumptions are based on case studies which are unable to established direct causality.
- The concern relates to the chicken and the egg discussion, i.e. whether the CAD symptoms lead the patient to seek cervical manual-therapy or whether the cervical manual-therapy provoked CAD along with the non-CAD presenting complaint.
- Thus, instead of proving a nearly impossible causality hypothesis, this study provide clinicians with an updated step-by-step risk–benefit assessment strategy tool to (a) facilitate clinicians understanding of CAD, (b) appraise the risk and applicability of cervical manual-therapy, and (c) provide clinicians with adequate tools to better detect and exclude CAD in clinical settings.

ARTICLE HISTORY
Received 29 December 2018
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KEYWORDS
Cervical artery dissection; vertebral artery dissection; carotid artery dissection; stroke; manual-therapy; manipulation

Clinical Implications

Diagnostic Assessment to Exclude CAD

- Chaibi A, Russell MB
- **A risk-benefit assessment strategy to exclude cervical artery dissection in spinal manual-therapy: a comprehensive review**
- Annals of Medicine
- March 2019

Clinical Implications

Diagnostic Assessment to Exclude CAD

- **Aleksander Chaibi, DC, PT, PhD**

- DC, Macquaire University
- PT, Fontys University
- PhD, Headaches, University of Oslo School of Medicine
- Senior Researcher, University of Oslo School of Medicine
- Clinician at Atlasklinikken in Oslo

Clinical Implications

History Taking & Examination

- "History taking, especially regarding the *time of symptom onset*, is the single most important factor for detecting subtle symptoms of CAD; thus, PCPs and, especially, manual therapists should dedicate enough time during the first consultation to allow for *thorough history taking* and physical examination."
- There is no single *objective* screening test for CAD. In *March 2004*, US chiropractic colleges agreed to abandon the teaching and use of provocative testing.
- Therefore, the physician must have knowledge of the *subjective* symptoms of CAD, and a *high index of clinical suspicion*.

Clinical Implications

History Taking & Examination

- Gottesman RF, et al.
- **Clinical characteristics of symptomatic vertebral artery dissection: a systematic review.**
- Neurologist. September 2012.

- Gottesman RF, et al.
- **Imaging characteristics of symptomatic vertebral artery dissection: a systematic review.**
- Neurologist. September 2012.

Table 2

Symptoms and signs associated with VAD.

	# Studies	Total sample size (N)	Number of subjects with symptom	Pooled proportion (pooled SE)	Range of proportions
Dizziness/ Vertigo	18 [8, 16, 19, 28, 30, 32, 44, 47, 52, 55-57, 60-62, 65, 73, 74]	467	273	0.58 (0.53)	5-100%
Headache	32 [2, 9, 11, 12, 15, 19, 21, 22, 24, 25, 27, 28, 30, 32, 33, 35, 38, 41-46, 52, 53, 57, 60, 64-66, 69, 73]	689	348	0.51 (0.7)	6-93%
Neck Pain	27 [11, 12, 14, 15, 21, 22, 24, 25, 30, 35, 37, 38, 41, 43-45, 52, 53, 56, 57, 60, 61, 64-66, 69, 73]	526	244	0.46 (0.69)	10-80%
Gait problems/ Ataxia	10 [1, 6, 8, 16, 52, 53, 56, 57, 61, 65]	150	57	0.38 (0.43)	7-71%
Visual symptoms	17 [1, 6, 8, 12, 16, 30, 32, 37, 47, 52, 53, 56, 57, 61, 65, 72, 73]	314	114	0.36 (0.53)	4-88%
Nausea/ Vomiting	13 [1, 8, 12, 30, 32, 44, 52, 56, 57, 60, 65, 73, 74]	306	108	0.35 (0.42)	5-79%
Nystagmus	7 [6, 8, 30, 37, 56, 61, 65]	150	44	0.29 (0.30)	4-55%
Horner's syndrome	11 [30, 41, 44, 47, 52, 55, 60, 61, 65, 72, 73]	265	58	0.22 (0.03)	6-36%
Sensory deficits	17 [1, 8, 16, 30, 32, 37, 47, 52, 53, 55-57, 60, 61, 65, 72, 73]	335	70	0.21 (0.43)	4-58%
Cranial nerve palsies	11 [8, 30, 37, 47, 52, 53, 55, 56, 65, 72, 73]	241	51	0.21 (0.32)	4-43%
Dysphagia	6 [16, 53, 57, 60, 65, 74]	102	13	0.13 (0.20)	5-29%
Tinnitus	4 [5, 32, 44, 65]	238	17	0.07 (0.09)	5-13%

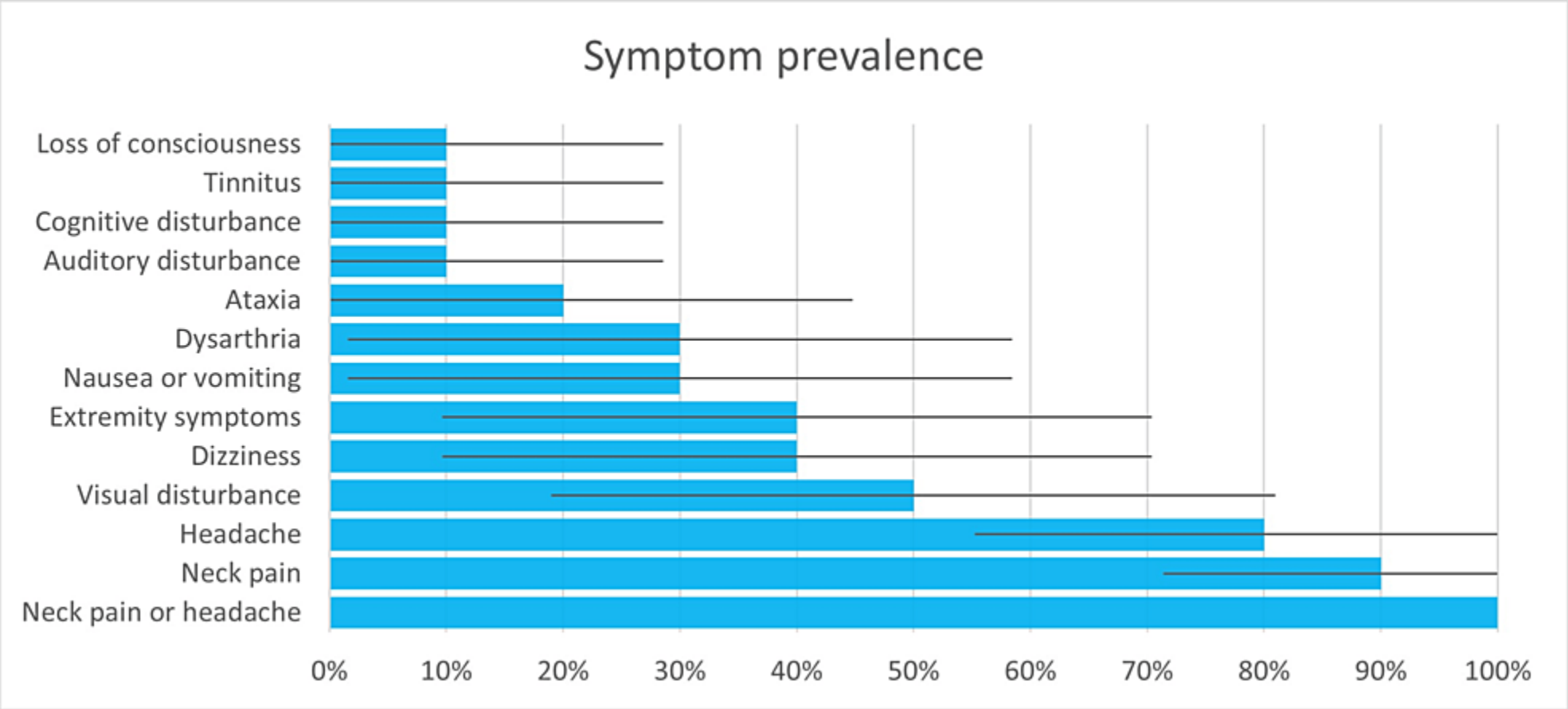
Clinical Implications

History Taking & Examination

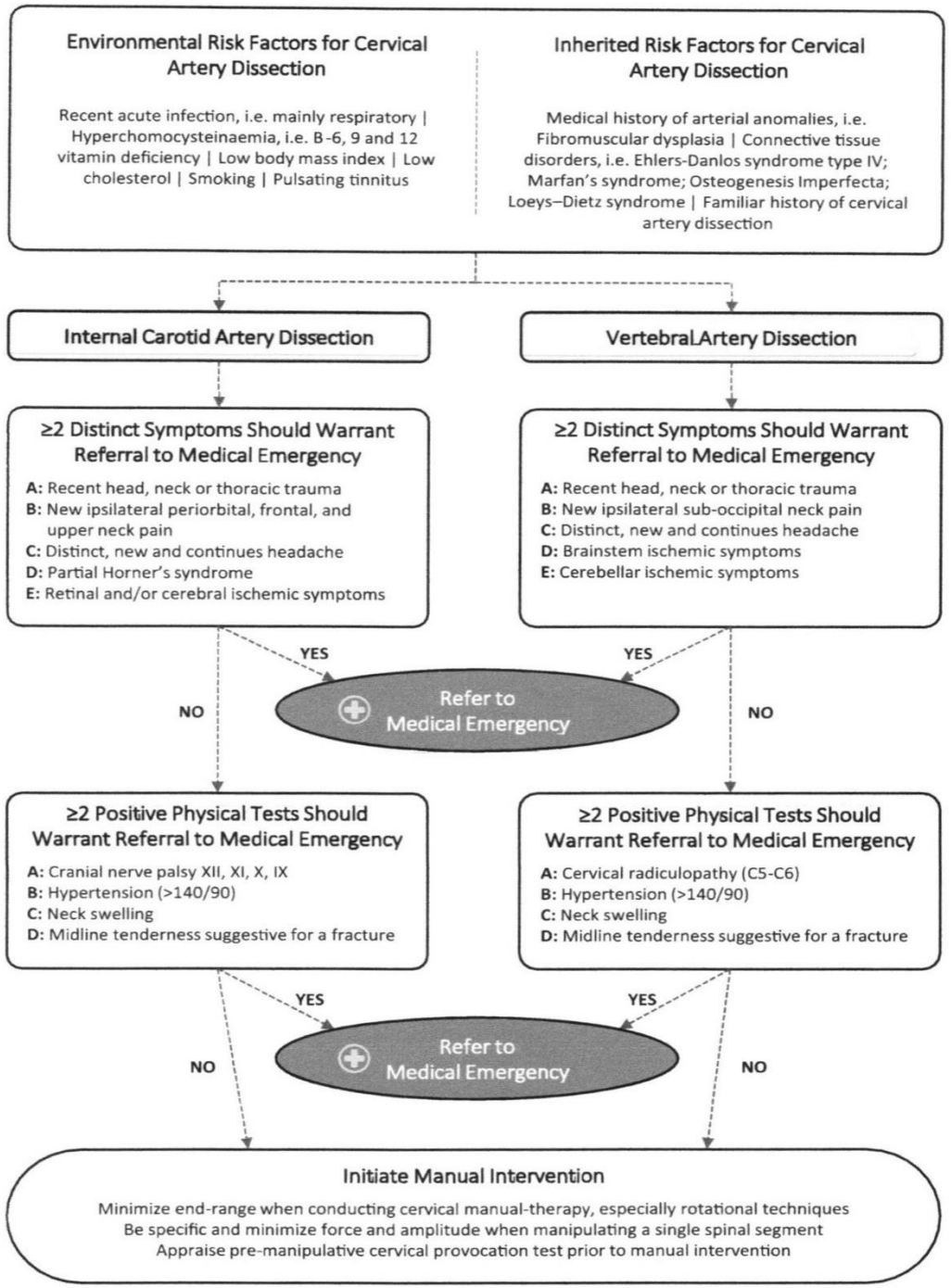
- In this study, *dizziness or vertigo* was the most common symptom among individuals with vertebral artery dissection. *Not neck pain and headache*.
- "Nearly one in four patients had *no craniocervical pain* either as an index symptom or evolving by the time of diagnosis."
- "VAD should be considered in the diagnostic assessment of patients presenting with dizziness *or* craniocervical pain, even in the absence of other risk factors."

Clinical Implications

History Taking & Examination



- Trager R J, et al. **Symptoms of Patients With Vertebral Artery Dissection Presenting to Chiropractors: A Systematic Review and Meta-Analysis.** Cureus. December 2023.



Clinical Implications

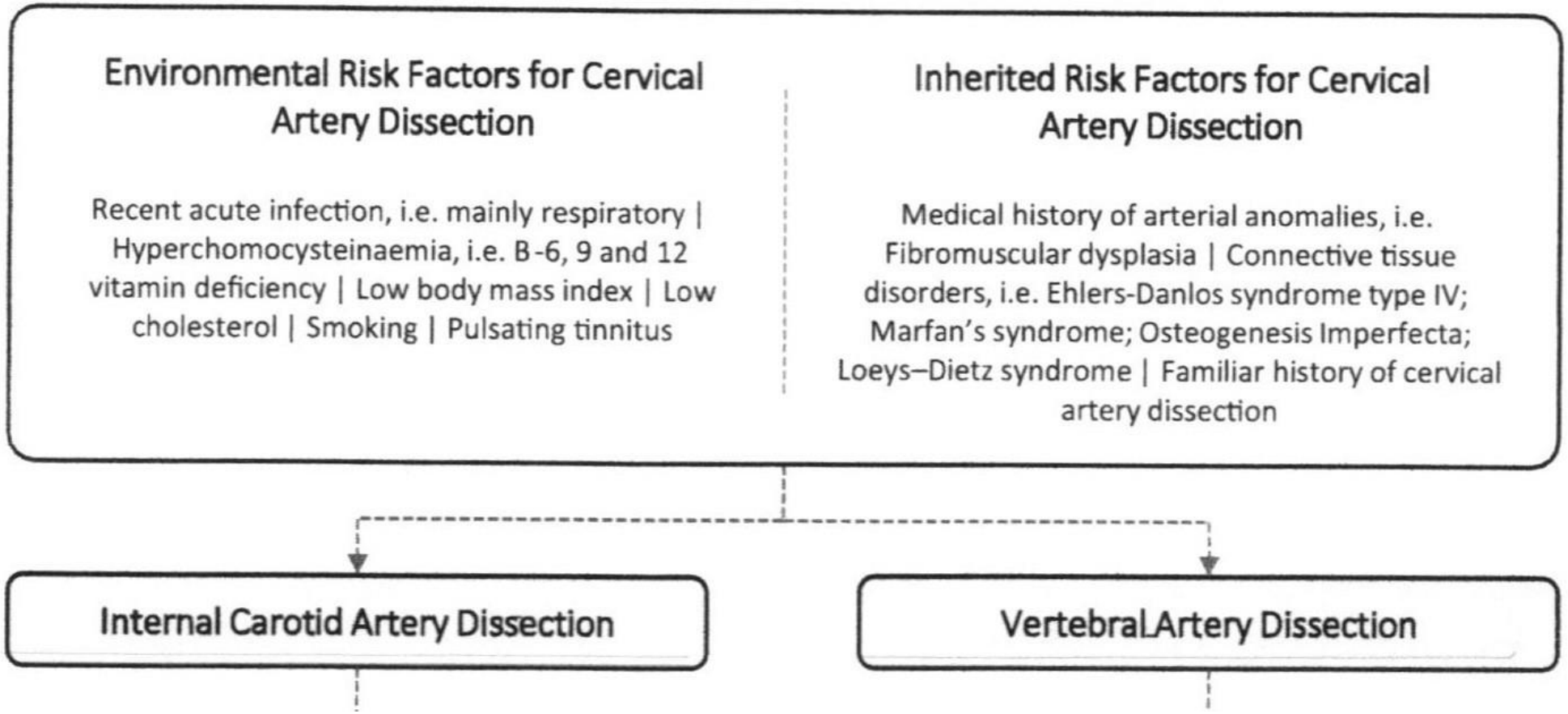
Diagnostic Assessment to Exclude CAD

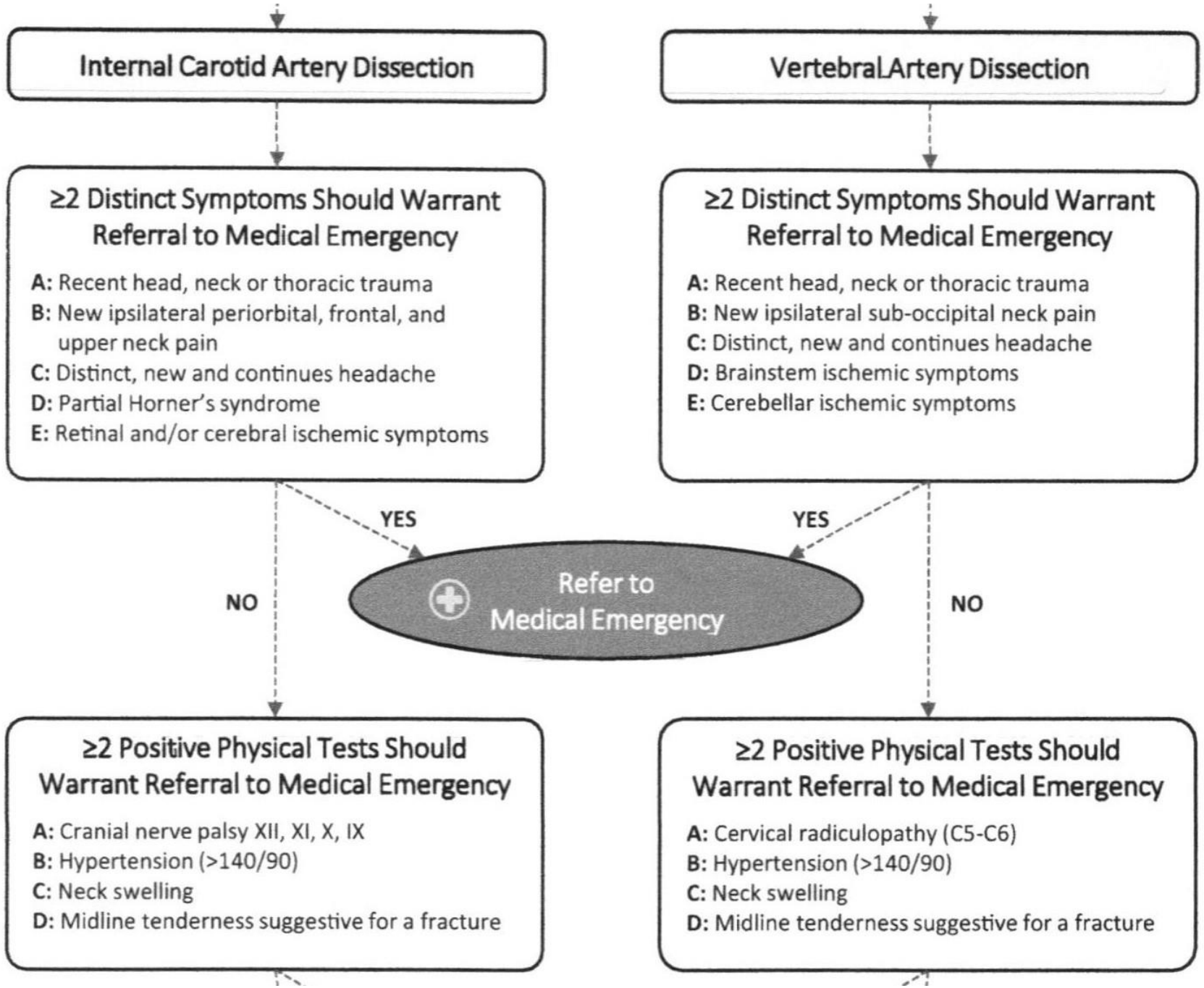
- "…focus should be directed to the early detection and exclusion of CAD, and questions should be raised on how to minimize the risk."

- Chaibi A, Russell MB
- **A risk-benefit assessment strategy to exclude cervical artery dissection in spinal manual-therapy: a comprehensive review**
- Annals of Medicine
- March 2019

Clinical Implications

Diagnostic Assessment to Exclude CAD




Internal Carotid Artery Dissection
VertebralArtery Dissection
≥2 Distinct Symptoms Should Warrant Referral to Medical Emergency
A: Recent head, neck or thoracic trauma
B: New ipsilateral periorbital, frontal, and upper neck pain
C: Distinct, new and continues headache
D: Partial Horner's syndrome
E: Retinal and/or cerebral ischemic symptoms
≥2 Distinct Symptoms Should Warrant Referral to Medical Emergency
A: Recent head, neck or thoracic trauma
B: New ipsilateral sub-occipital neck pain
C: Distinct, new and continues headache
D: Brainstem ischemic symptoms
E: Cerebellar ischemic symptoms
YES
YES
NO
NO
Refer to Medical Emergency
≥2 Positive Physical Tests Should Warrant Referral to Medical Emergency
A: Cranial nerve palsy XII, XI, X, IX
B: Hypertension (>140/90)
C: Neck swelling
D: Midline tenderness suggestive for a fracture
≥2 Positive Physical Tests Should Warrant Referral to Medical Emergency
A: Cervical radiculopathy (C5-C6)
B: Hypertension (>140/90)
C: Neck swelling
D: Midline tenderness suggestive for a fracture

Clinical Implications

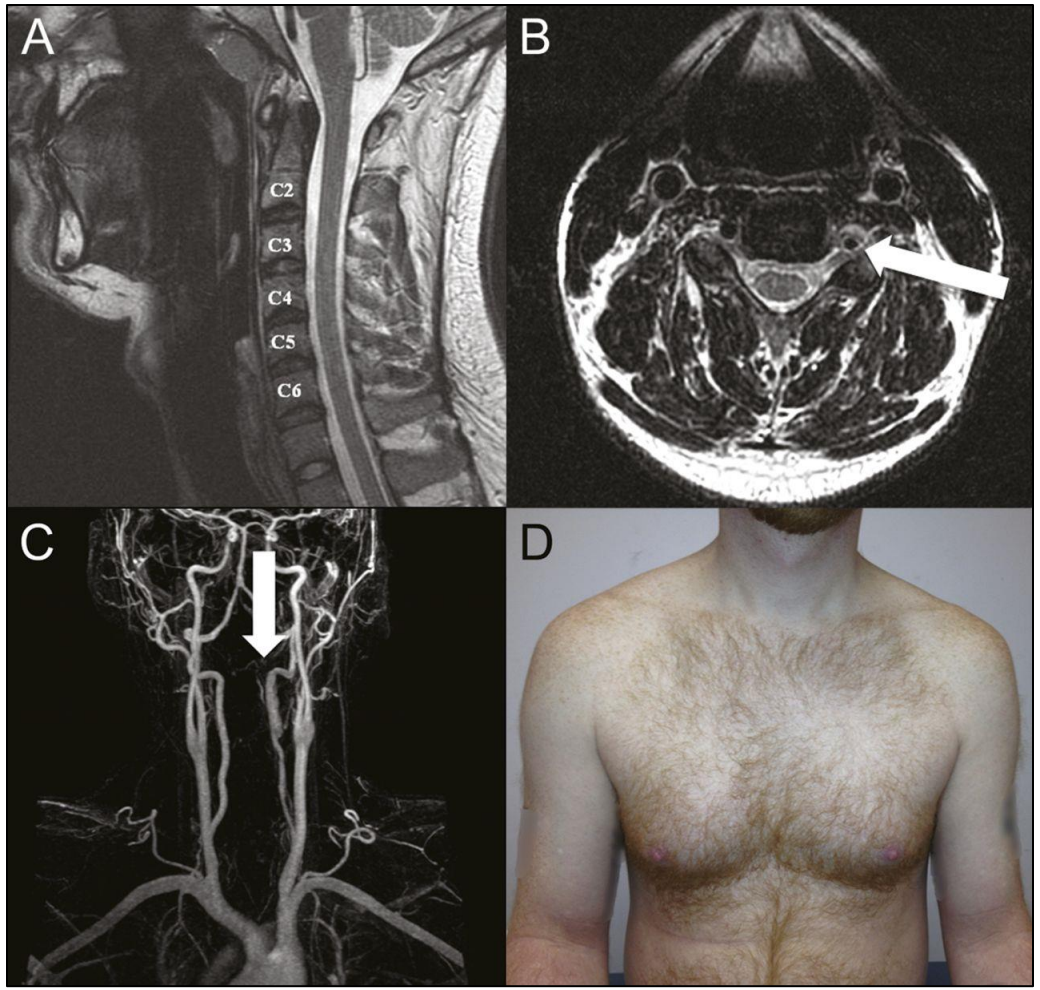
2013 Quinn: VAD & C5-C6 Radiculopathy

- A 32-year-old mechanic developed severe left neck pain. Two days later, left arm weakness, two days later, left jaw numbness.
- Exam revealed weakness in the C5 myotome & absent biceps reflex, but no facial or jaw numbness.

- Quinn C, Salameh J.
- **Vertebral artery dissection causing an acute C5 radiculopathy.**
- Neurology. September 2013.

Clinical Implications

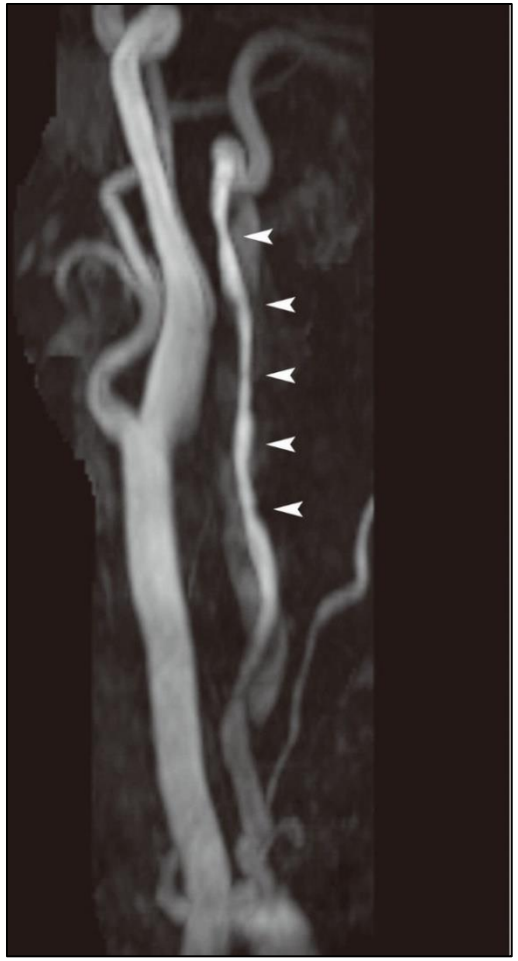
2013 Quinn: VAD & C5-C6 Radiculopathy



- (A) No disc herniations.
- (B) Large left V2 VAD compressing the C5 nerve root.
- (C) MRA and CTA confirmed intramural hematoma with dissection flap from C2-C4.
- (D) EMG & neuroexam 1 month later, subacute C5 radiculopathy & atrophy in the C5 myotome.

Clinical Implications

2013 Silbert: VAD & C5-C6 Radiculopathy

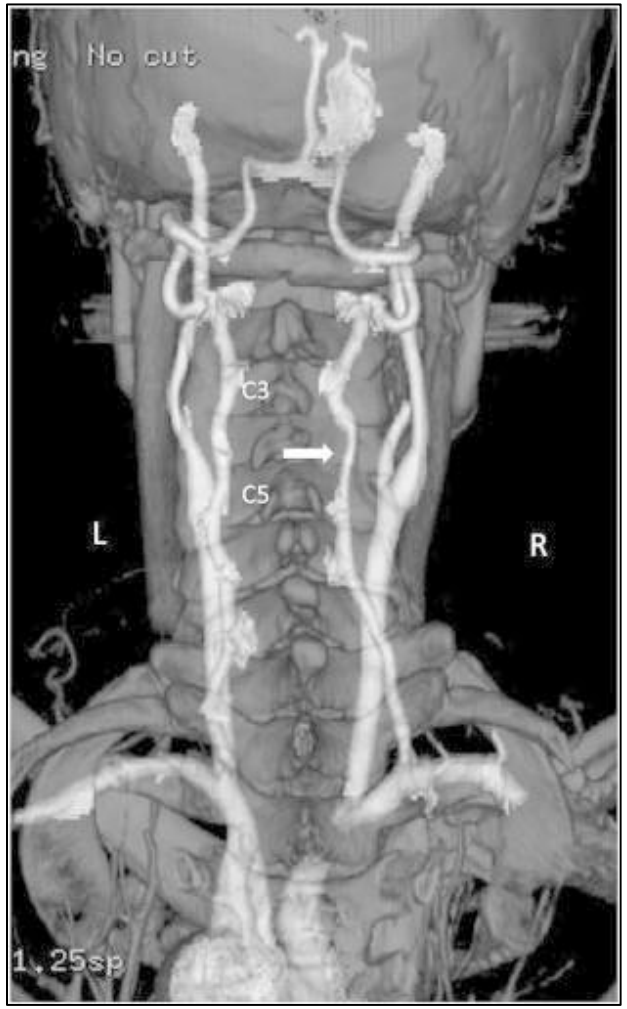


- 43-year-old woman with proximal left arm weakness and neck pain aggravated by movement.
- Left VAD with intramural hematoma from C2-C7 compressing left C5 and C6 nerve roots.

- Silbert BI, et al.
- **Vertebral artery dissection as a cause of cervical radiculopathy.**
- Asian Spine J. December 2013.

Clinical Implications

2014 Mattox: VAD & C5-C6 Radiculopathy

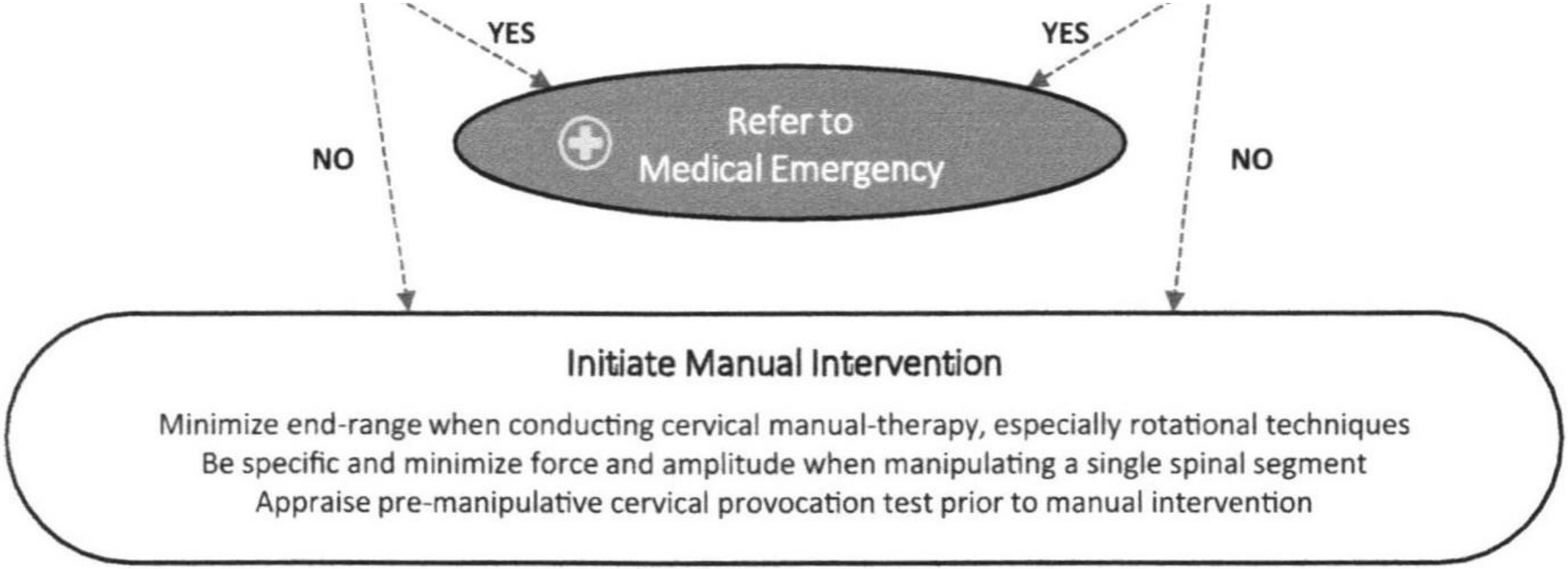


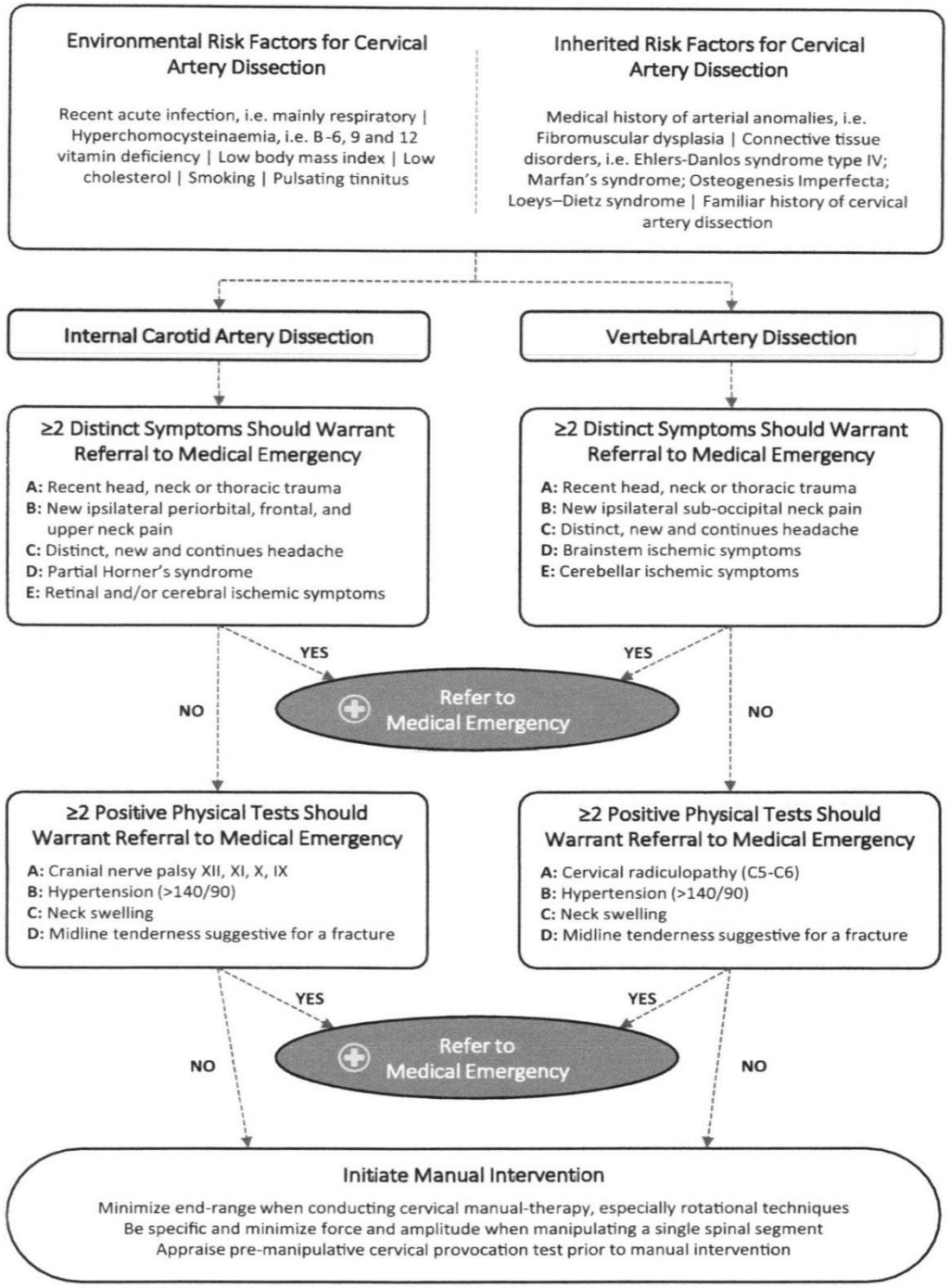
- 45-year-old woman with neck pain, headache & pain in the posterior portion of right arm down to the elbow three days.
- Dissection right V2 from C3-C5 compressing nerve roots.

- Mattox R, et al.
- **Recognition of spontaneous vertebral artery dissection preempting spinal manipulative therapy: a patient presenting with neck pain and headache for chiropractic care.**
- Journal of Chiropractic Medicine. June 2014.

Clinical Implications

Diagnostic Assessment to Exclude CAD





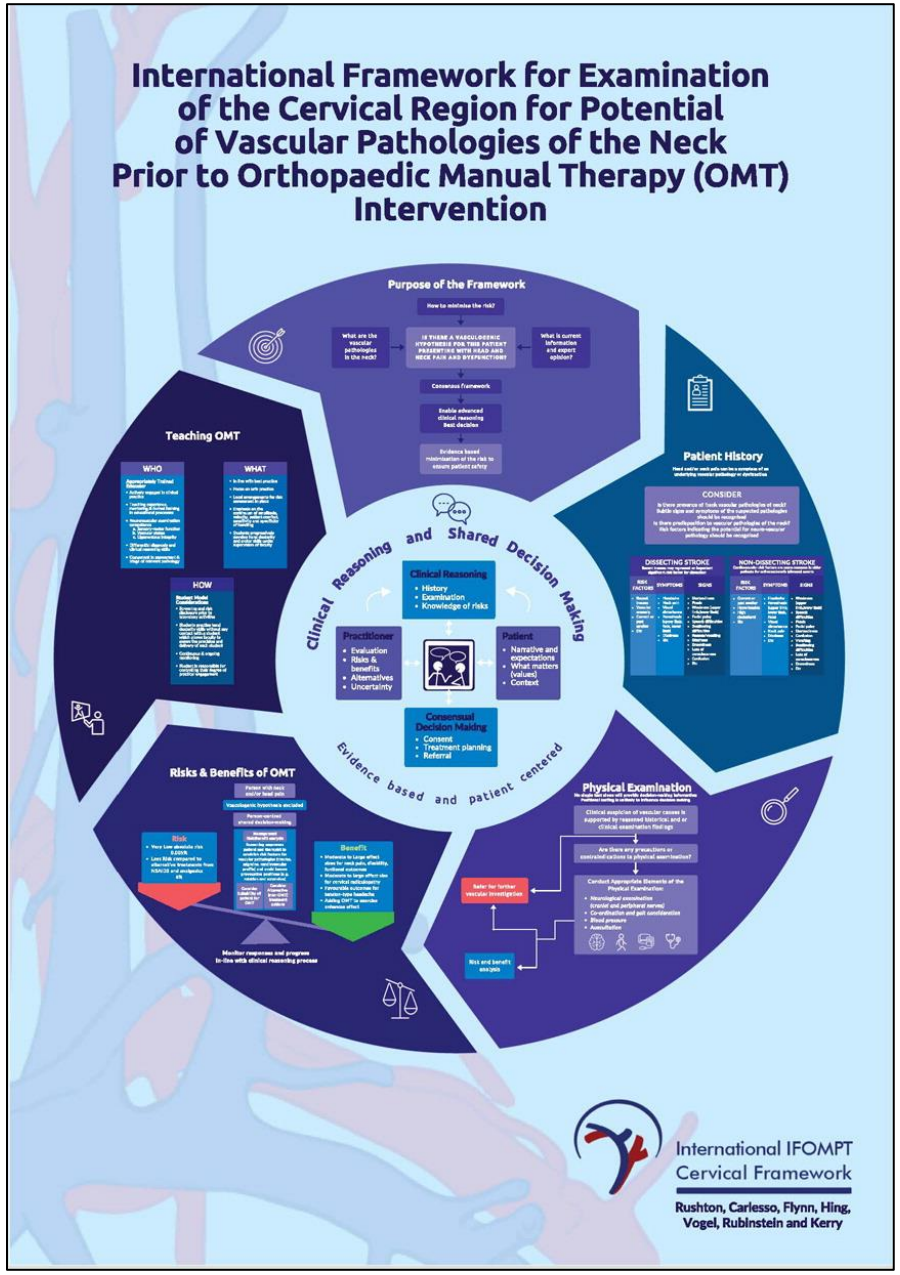
Clinical Implications

Diagnostic Assessment to Exclude CAD

- Aleksander Chaibi, DC, PT, PhD
- Michael Bjørn Russell, MD

- **A risk-benefit assessment strategy to exclude cervical artery dissection in spinal manual-therapy: a comprehensive review**

- Annals of Medicine
- March 2019



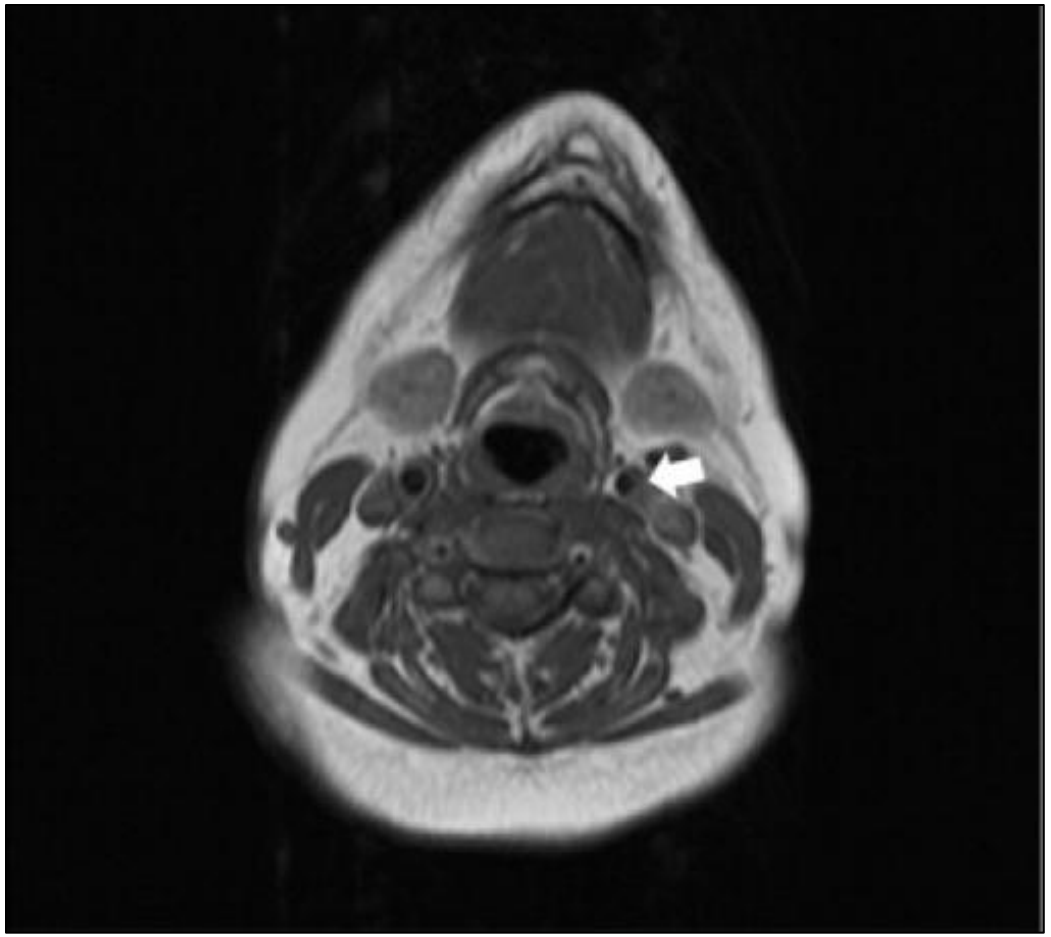
Clinical Implications

IFOMPT Cervical Framework

- Rushton A, Carlesso LC, Flynn T, Hing WA, Kerry R, *Rubinstein SM*, et al.
- **International Framework for Examination of the Cervical Region for potential of vascular pathologies of the neck prior to Orthopaedic Manual Therapy (OMT) Intervention: International IFOMPT Cervical Framework.**
- International Federation of Orthopaedic Manipulative Physical Therapists. 2020.

Clinical Implications

2011 Mosby Case Report: DC Diagnosis of VAD



- "This case suggests that careful *history taking* and *awareness* of the symptoms of VAD are necessary in cases of sudden head and neck pain."

- Mosby JS, et al.
- **Vertebral artery dissection in a patient practicing self-manipulation of the neck**
- J of Chiropractic Medicine
- December 2011

Clinical Implications

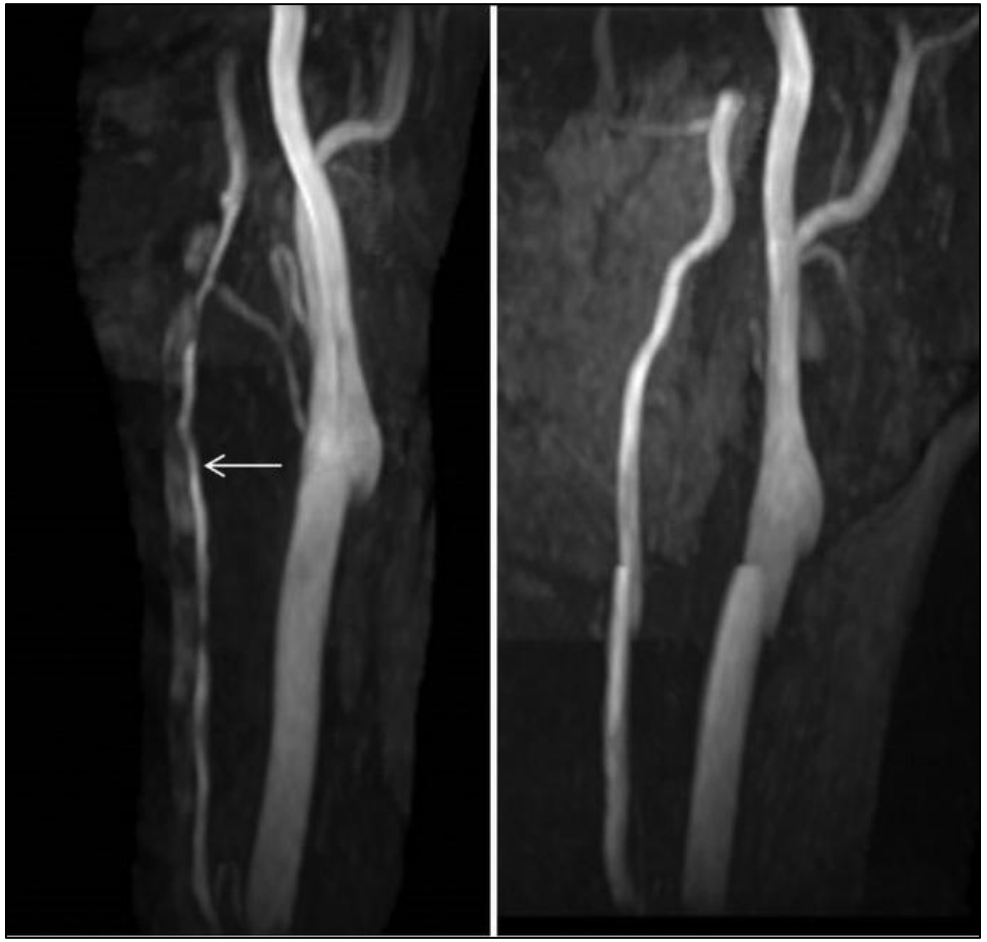
2011 Mosby Case Report: DC Diagnosis of VAD

- 42-year-old female sought care for left shoulder pain and left lower neck pain. Twelve days prior, she had “the worst headache of her life,” which began in her left lower cervical spine and extended to her left temporal region. The pain was sudden and severe, was described as sharp and burning, and lasted 3 hours. She reported nausea, vomiting & blurred vision. History & examination suggested that the patient's head and neck pain was not *musculoskeletal* in origin, but *vascular*.

- She repeatedly requested that CSM be performed, but instead was referred to the local ED for further evaluation. MRA revealed left VAD from C6 to the C2-C3 interspace and a 3-mm dissecting pseudoaneurysm at the C3 level. She underwent stent-assisted percutaneous transluminal angioplasty combined with antiplatelet therapy and experienced a good outcome.

Clinical Implications

2015 Futch Case Report: DC Diagnosis of VAD



- 30-year-old woman presented with severe neck pain. ER two days earlier for sudden onset transient loss of left peripheral vision.
- No CSM. DC ordered MRA. Showed acute left VAD with early thrombus formation.
- Treated with aspirin therapy. Thrombus resolved. No stroke.

- Futch D, et al.
- **Vertebral artery dissection in evolution found during chiropractic examination.**
- BMJ Case Reports. November 2015.

Clinical Implications

2015 Tarola Case Report: DC Diagnosis of VAD

- 34-year-old woman with a constant burning pain at the right side of her suboccipital neck and upper shoulder with a limited ability to turn her head from side to side, periods of blurred vision & muffled hearing.
- Dizziness, visual & auditory disturbances, and balance difficulty abated within 1 hour of onset (lifting) and were not present at the evaluation.
- Pins and needles sensation on the dorsal surface of both forearms. Turning head from side-to-side aggravated the pain.

- Tarola G, et al.
- **Chiropractic Response to a Spontaneous Vertebral Artery Dissection.**
- Journal of Chiropractic Medicine. September 2015.

Clinical Implications

2015 Tarola Case Report: DC Diagnosis of VAD

- Patient advised of the possibility of CAD, recommended to the ED. Patient declined. Convinced by her DC (three days later) to present to the ED.
- MRA showed left VA was hypoplastic and appeared to terminate at the left PICA.
- Abrupt moderately long segment of narrowing involving right VA beginning near the junction of V1 & V2 segments.
- Radiologist noted right VAD. Treated with aspirin, condition resolved.

Plausible Mechanisms of Causation of Stroke

2002 Haldeman Case Series

- “This study was unable to identify factors from the clinical history & physical examination of the patient that would assist a physician attempting to isolate the patient at risk of cerebral ischemia after CSM.”

- Haldeman S, et al.
- **Unpredictability of cerebrovascular ischemia associated with CSM therapy: a review of 64 cases after CSM.**
- Spine. January 2002.

Plausible Mechanisms of Causation of Stroke

2002 Haldeman Case Series

- “Cerebrovascular accidents after manipulation appear to be unpredictable and should be considered an inherent, idiosyncratic, and rare complication of this treatment approach.”

- Haldeman S, et al.
- **Unpredictability of cerebrovascular ischemia associated with CSM therapy: a review of 64 cases after CSM.**
- Spine. January 2002.

SPINE Volume 27, Number 1, pp 49–55

Unpredictability of Cerebrovascular Ischemia Associated With Cervical Spine Manipulation Therapy

A Review of Sixty-Four Cases After Cervical Spine Manipulation

Scott Haldeman, MD, PhD, FRCP(C),*† Frank J. Kohlbeck, DC,†‡ and Marion McGregor, DC, FCCS(C), MSc§

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**

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 indepen-

J Neurol (2002) 249 : 1098–1104
DOI 10.1007/s00415-002-0783-4

ORIGINAL COMMUNICATION

Scott Haldeman
Frank J. Kohlbeck
Marion McGregor

Stroke, cerebral artery dissection, and cervical spine manipulation therapy

Abstract Stroke represents an infrequent adverse reaction associated with cervical spine manipulation therapy. Attempts to identify the patient at risk and the type of manipulation most likely to result in these complications of manipulation have not been successful. A retrospective review of 64 medical legal cases of stroke temporally associated with cervical spine manipulation was performed to evaluate characteristics of the treatment rendered and the presenting complaints in patients reporting these complications. These files included records from the practitioner who administered the manipulation therapy, post stroke testing and treatment records usually by a neurologist, and depositions of the pa- any point during the course of treatment. Certain patients reporting onset of symptoms immediately after first treatment while in others the dissection occurred after multiple manipulations. There was no apparent dose-response relationship to these complications. These strokes were noted following any form of standard cervical manipulation technique including rotation, extension, lateral flexion and non-force and neutral position manipulations. The results of this

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Received in revised form:
26 November 2001
Accepted: 15 January 2002

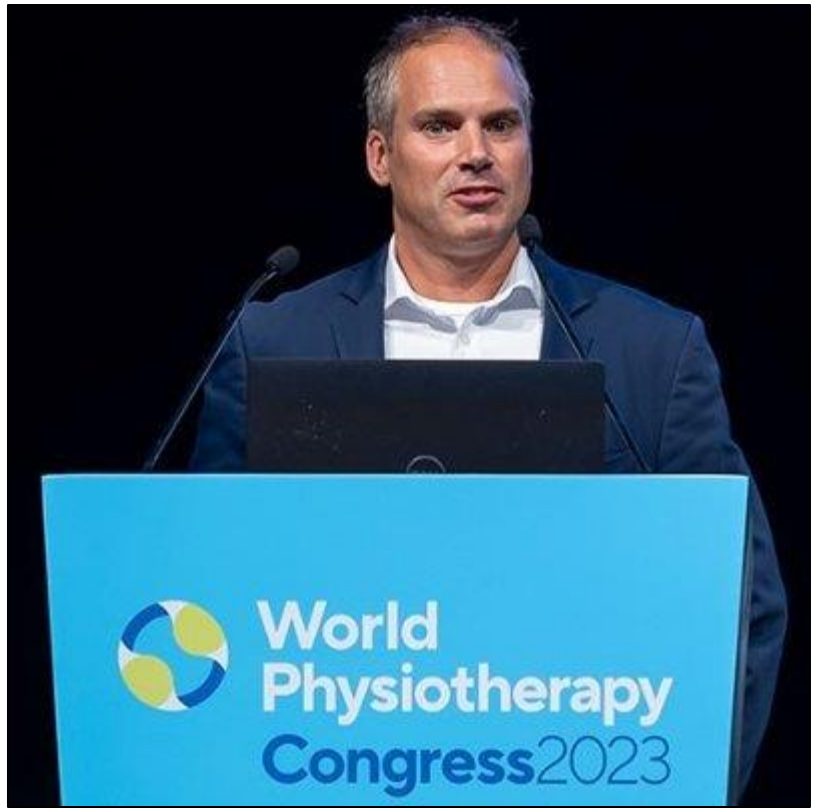
Table 1 Summary of patient complaints of the 16 patients experiencing new type, severe, and/or sudden onset of head and/or neck pain prior to the cervical spine manipulation with which the cerebrovascular accident was associated.

Age (years)	Gender	Area of Pain	Onset of Pain*	Comments
32	Female	Head and Neck	4 days	Patient bent down to pick a small object off the floor and felt something pop in her upper back associated with a sudden onset of a severe headache.
33	Male	Head and Neck	8 days	Sudden onset of most severe headache in life causing visit to emergency room 8 days prior to incident.
32	Female	Neck	12 days	Extremely severe neck pain with onset while performing dance maneuver.
32	Female	Head and Neck	3 weeks	Awakened with severe head and neck pain 3 weeks prior incident, which had been constant since and with occasional associated visual disturbance in right eye. Patient states that she never experienced headaches before.
48	Female	Head and Neck	10 days	Sudden onset of severe, unrelenting headache not relieved by injections or oral analgesics causing emergency room visit before consultation with practitioner of manipulation therapy.
42	Male	Head and Neck	10 days	Onset of neck pain while bending over to work on model car. Developed into worst pain the patient ever felt in life.
35	Female	Head and Neck	22 days	Patient was involved in racquetball tournament 3 weeks earlier. Woke up with headache and neck pain the morning after the tournament that progressively worsened, becoming worst-headache that patient had ever experienced in life.
28	Female	Head and Neck	20 days	Onset of severe pain at base of skull and shooting through right side of head. Skin, scalp and forehead sensitive to touch. First time patient experienced this type of pain.
36	Female	Head	1 week	Onset of neck pain about one week prior. Patient had history of migraines, but described current headache as different than previous headaches.
34	Female	Head and Neck	1 week	Patient had been painting ceiling and developed severe headache unlike any she had previously experienced.
38	Female	Head and Neck	2 weeks	Onset of headaches associated with dizziness/vertigo becoming progressively worse and interfering with work, sleep, and daily routine.
26	Female	Head and Neck	2 days	Onset of severe headache. No prior history of headaches.
40	Female	Head and Neck	5 days	Patient had bent down to pick up a toy and experienced immediate pain and burning sensation in the back of her neck with subsequent neck stiffness. Pain initially moderate, but became progessively worse. The day prior to the incident she visited an urgent care facility and was prescribed vicoden. Patient had also received pain injection 3–4 days prior to incident.
40	Female	Head and Neck	3–4 days	Patient experienced stiff neck after full evening of hanging pictures on wall. Patient described significant amount of pain with numbness and tingling in hands and face. The morning of the incident, the patient bent over to tie her shoes and upon standing up became very faint and had to sit down for a while. Pain described as unlike her usual migraines.
35	Female	Head and Neck	1 month	Onset of progressively worsening neck pain and headache associated with dizziness, tinnitus, and nausea following lumpectomy. No relief with medications.
38	Female	Head and Neck	3 weeks	Patient describes constant, severe headache with nausea for 3 weeks.

*Onset of pain prior to the cervical manipulation and associated with an event other than spinal manipulation.

Clinical Implications

2021 Hutting Case Report: Failure to Diagnose VAD

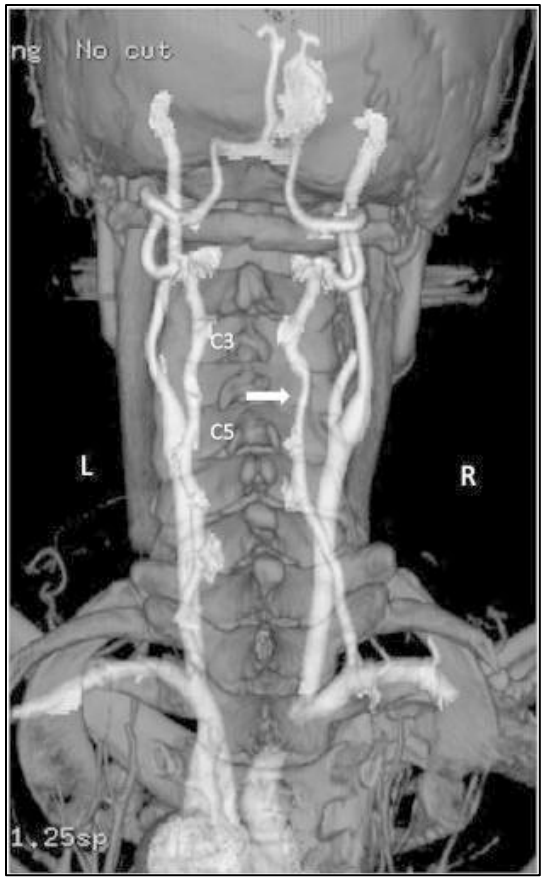


- 49-year-old man with left neck pain & mild occiput pain. No injury. No medications. Referred for PT.
- Immediate stroke during cervical spine mobilization. Vertebral artery dissection.
- Patient was a non-native Dutch speaker. Personal & family history of high blood pressure & high cholesterol. Personal history of angioplasty.

- Hutting N, et al.
- **Identifying vascular pathologies or flow limitations: Important aspects in the clinical reasoning process.**
- Musculoskelet Sci Pract. June 2021.

Clinical Implications

2014 Mattox Case Report: Failure to Diagnose VAD

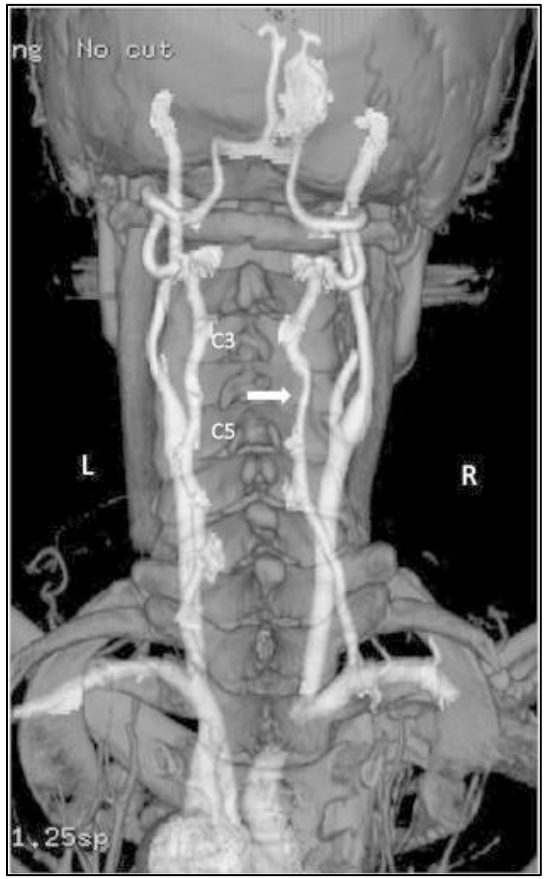


- **Subjective**
- A 45-year-old female presented with upper back/neck pain and stiffness, headache, and pain in the posterior portion of the right arm down to the elbow of 3 days duration. Discomfort progressed in severity in the 24 hours prior to presentation, which is what prompted her appointment. No history of trauma.

- Mattox R, et al.
- **Recognition of spontaneous VAD preempting SMT: a patient presenting with neck pain and headache for chiropractic care.**
- Journal of Chiropractic Medicine. June 2014.

Clinical Implications

2014 Mattox Case Report: Failure to Diagnose VAD



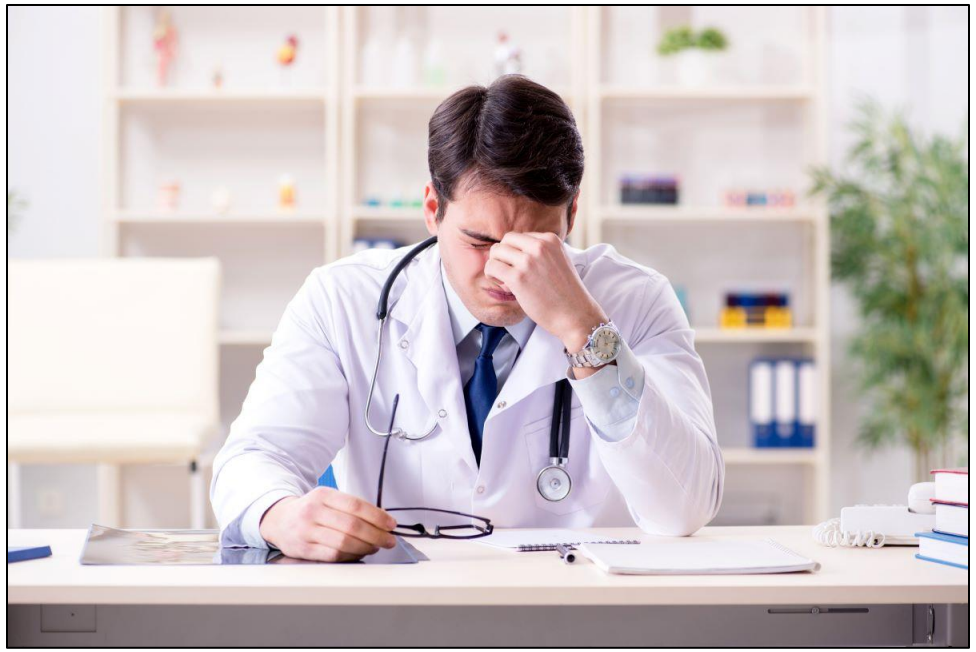
- **Objective**
- "Physical examination revealed painful & limited active ROM in the cervical region. Palpation was provocative for tenderness."

- No vital signs. No blood pressure.
- No orthopedic or neurological testing.
- No imaging considered or ordered.

- **Diagnosis**
- Myofascial pain syndrome.
- No differential diagnosis was formulated.
- Spontaneous VAD was *not* recognized.

Clinical Implications

Failure to Diagnose CAD



- **Common Misdiagnoses:**
- Cervical segmental dysfunction
- Vertebral subluxation complex
- Cervical sprain/strain
- Myofascial pain syndrome
- Migraine
- Stress/Tension headache
- Neck pain
- Torticollis
- Sinus infection
- Cervicogenic dizziness

Clinical Implications

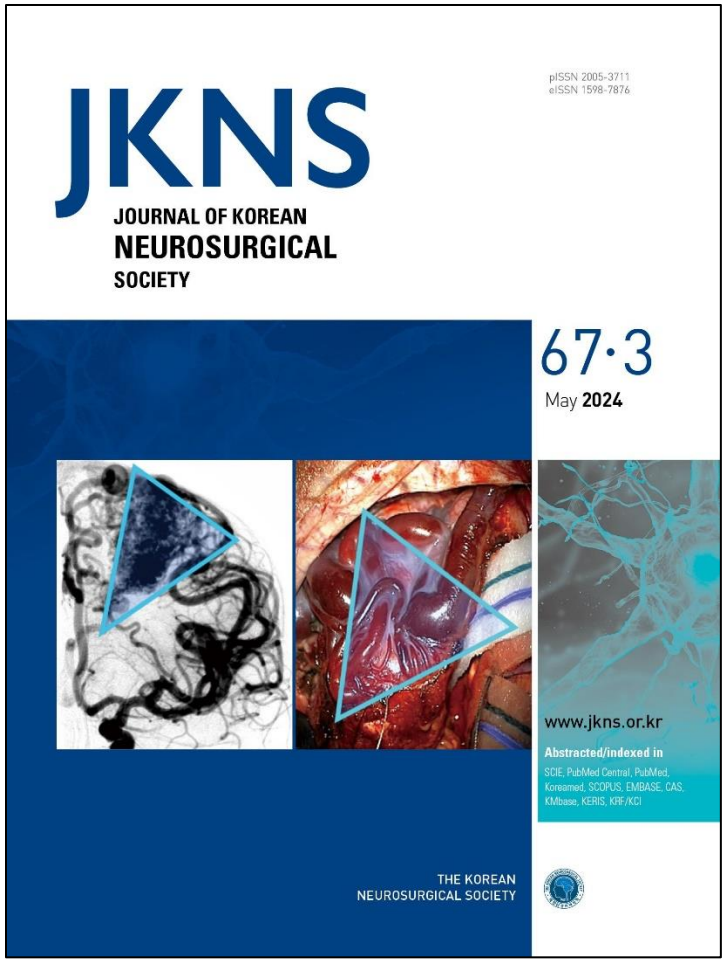
Cervical Artery Dissection: Good Prognosis

- “Neck pain is a reliable symptom of the onset of dissection…”
- “These otherwise asymptomatic lesions will heal when left alone…”

- Norris JW, et al.
- **Sudden neck movement and cervical artery dissection.**
- Canadian Medical Association Journal.
- July 2000.

Clinical Implications

Cervical Artery Dissection: Good Prognosis



- "Most dissections of the vertebral arteries heal spontaneously and especially, extracranial VADs generally carry a good prognosis."

- Park, et al.
- **Vertebral artery dissection: natural history, clinical feature and therapeutic considerations.**
- J. Korean Neurosurg Soc.
- September 2008.

Clinical Implications

Cervical Artery Dissection: Good Prognosis

- "…in general, individuals with VAD appear to have relatively good outcomes when treated in routine clinical fashion."

- Gottesman RF, et al.
- **Clinical characteristics of symptomatic vertebral artery dissection: a systematic review.**
- The Neurologist. September 2012.

Clinical Implications

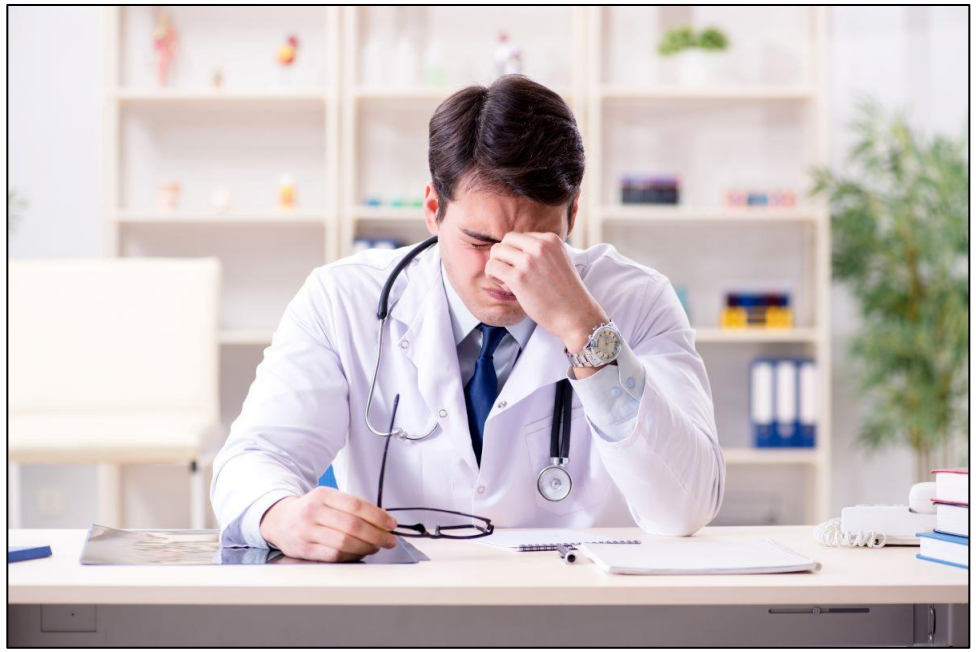
Cervical Artery Dissection: Good Prognosis

- In a population with CAD without ischemia, **98.3%** did not develop stroke in the first 12 weeks following diagnosis and treatment of CAD.
- The number who developed stroke after 12 weeks was not statistically significant.
- The risk of stroke following CAD without ischemia at time of diagnosis appears to be limited to the first 2 weeks.

- Morris NA, et al.
- **Timing of Incident Stroke Risk After CAD Presenting Without Ischemia.**
- Stroke. March 2017.

Clinical Implications

Failure to Diagnose Stroke



- **Common Misdiagnoses:**
- “Reaction to the adjustment”
- Sympathetic reaction/storm
- Vaso-vagal response
- Loose otolith (“crystals”)
- Hypoglycemia (low blood sugar)
- Flu
- Anxiety attack
- Vertigo attack

Clinical Implications

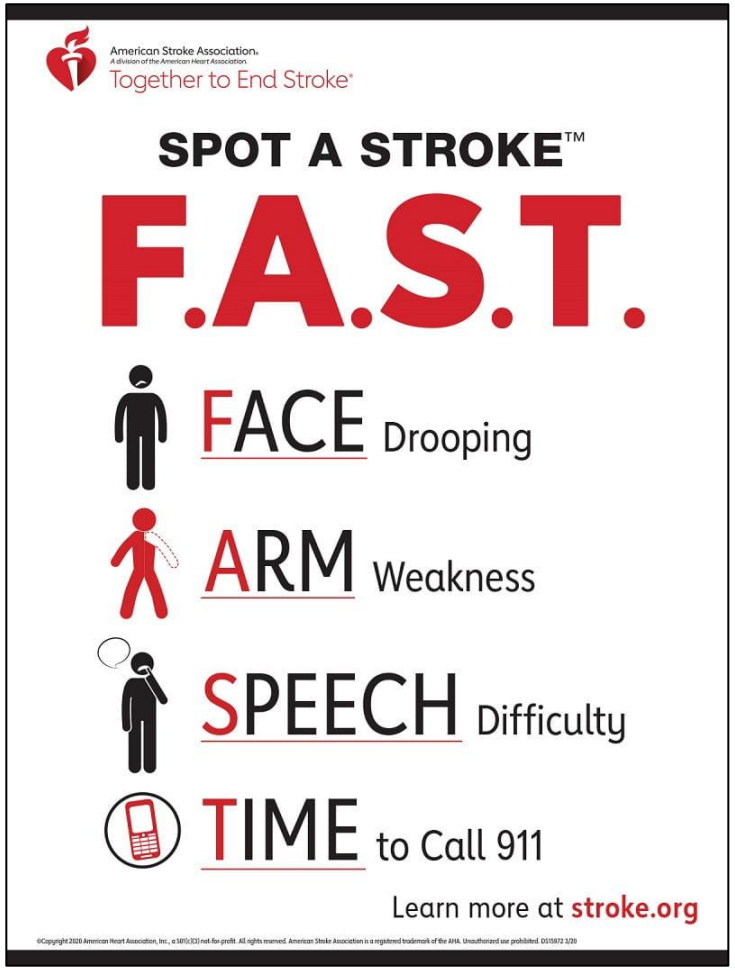
Toxin Release

- Spinal manipulation may cause **toxin release** with symptoms that last for hours or days.
- Experienced by approximately **20%** of chiropractic patients.
- **35 million** people in the US visit a chiropractic physician annually.
- **7 million** people per year in the US experience toxin release after spinal manipulation.

- **Symptoms of Toxin Release After Spinal Manipulation**
- 1. Dizziness
- 2. Nausea
- 3. Headaches
- 4. Sweating
- 5. Fatigue
- 6. Diarrhea
- 7. Fever

Clinical Implications

Signs & Symptoms of Stroke



- DCs should be aware of the signs & symptoms of *immediate post-manipulative stroke* to make a referral to medical emergency:

- **NAUSEA/VOMITING**
- **DIZZINESS/VERTIGO**
- **DIAPHORESIS**
- **TIME to Call 911**

Clinical Implications

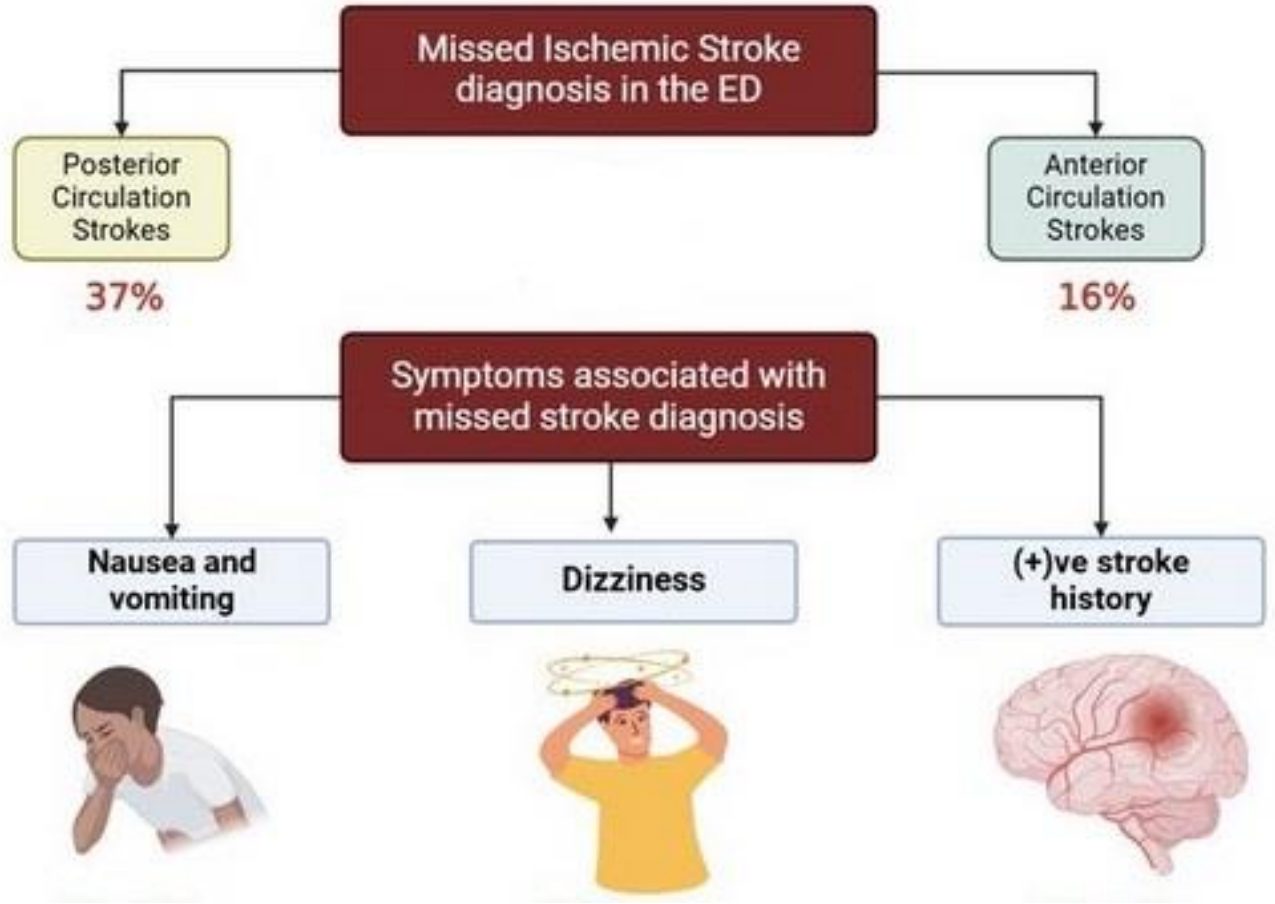
Signs & Symptoms of Stroke

- **5 “Ds”, 3 “Ns”, and an “A”**

- **D**izziness (vertigo)
- **D**rop attacks (loss of consciousness)
- **D**iplopia (double vision)
- **D**ysarthria (difficulty talking)
- **D**ysphagia (difficulty swallowing)
- **N**ausea (vomiting)
- **N**umbness (of face)
- **N**ystagmus (repetitive, uncontrolled eye movements)
- **A**taxia (loss of coordination & balance)

Clinical Implications

Missed Ischemic Stroke Diagnosis in the ED by Emergency Medicine & Neurology Services (2016 *Stroke*)



Implications for Physician Liability

Three Clinical Settings

- **1.** Patient presenting with symptoms of *neck pain* and/or *headache* accompanied by *neurological* symptoms has an immediate stroke after CSM.
- **2.** Patient presenting with symptoms of *neck pain* and/or *headache* has an immediate stroke after CSM.
- **3.** Patient presenting with *no symptoms* has an immediate stroke after CSM.
- **IN ALL THREE CLINICAL SETTINGS, CAD MUST BE EXCLUDED BEFORE PERFORMING CSM.**

Implications for Physician Liability

Three Clinical Settings

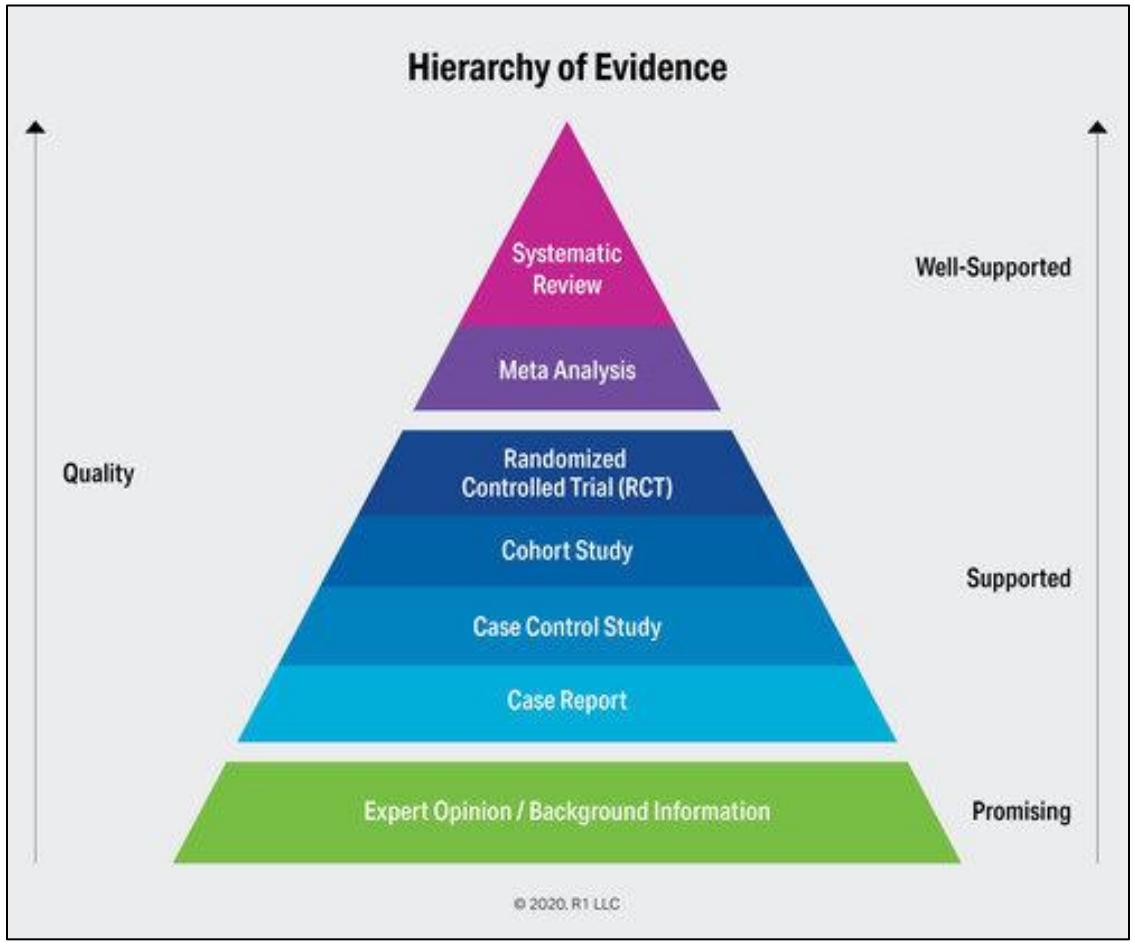
- **3.** Patient presenting with *no symptoms* has an immediate stroke after CSM.

- The healing arterial wall may become asymptomatic with the thrombus still present. The physician may fail to diagnose the asymptomatic CAD if they do not obtain a thorough history to discover a recent history of neck pain and/or headache characteristic of CAD.

- Lee et al. (2006) reported three cases of asymptomatic CAD *at the time of imaging*. However, medical records were not reviewed for a recent history of neck pain and/or headache characteristic of CAD.

Implications for Medicolegal Causation

2019 Ahuja



- Randomized controlled trials (RCTs) have not been done.
- RCTs are infeasible in these clinical settings due to the:
- **1.** Rarity of CAD
- **2.** Life-threatening nature of stroke
- As RCTs are infeasible, the next best external evidence that is available must be used.

Implications for Medicolegal Causation

2019 Ahuja

- **RCTs have never been done on:**
- Appendectomy
- Aortic aneurysm repair
- Any major surgical intervention
- The Heimlich Maneuver
- External defibrillation

- Ahuja AS.
- **Should RCT's be used as the gold standard for evidence-based medicine?**
- Integr Med Res. 2019.

Criteria for Medicolegal Causation

2018 Freeman

- In the absence of RCTs, medicolegal causation can be established as more likely than not on the basis of:
- **1.** Plausibility
- **2.** Temporality
- **3.** Lack of a more probable alternative explanation
- Freeman MD. **A Practicable and Systematic Approach to Medicolegal Causation.** Orthopedics. March 2018.

Criteria for Medicolegal Causation

Criteria	Description
1. Plausibility	There should be pre-existing CAD. Thromboembolic and thrombotic mechanisms of causation of immediate stroke by CSM are plausible in the presence of CAD.
2. Temporality	There should be a close temporal association (seconds or minutes) between CSM and the onset of ischemic stroke symptoms.
3. Lack of a more probable explanation	There should not be a more probable alternative explanation for the cause of the post-manipulative stroke. If it is hours, days, or weeks after CSM before the onset of ischemic stroke symptoms, there could be a more probable alternative explanation for the cause of the stroke.

Criteria for Medicolegal Causation

Confounders

- A confounder is any unmeasured variable that may make a purported causative relationship correlative or associative.
- If a confounder is present, there may be a more probable alternative explanation for the alleged causal relationship.
- However, in the case of an *immediate* thromboembolic or thrombotic stroke after CSM performed in the presence of CAD, the presence of a confounder is unlikely.
- In cases of *non-immediate* stroke after CSM, the presence of a confounder is more likely.

Criteria for Medicolegal Causation

Alternative Explanation 1: Coincidence

- **It is a "*coincidence*" the stroke occurred immediately after CSM. It was a "*spontaneous event*" unrelated to the CSM.**
- In many cases the CAD is present and stable for days or weeks before stroke occurs. It is only immediately after CSM that ischemic symptoms of stroke begin or worsen. It is unlikely that a pre-existing CAD, which had been present and stable for days or weeks, coincidentally evolves into stroke immediately after CSM.
- The *most probable* explanation is that CSM caused the stroke by a thromboembolic or thrombotic mechanism.
- If a case proceeds to trial, the jury will decide if it was a "coincidence".

Criteria for Medicolegal Causation

Protopathic Bias

- Occurs when an exposure (CSM) is delivered in the presence of one disease (CAD) before a second disease occurs (stroke). This can lead to the conclusion that the exposure (CSM) caused the outcome (stroke), even though CSM was not on the causal pathway.
- In cases of *non-immediate stroke*, protopathic bias can explain the association between CSM and stroke. There is no plausible causal pathway, there is no temporality, and there could be a more probable alternative explanation.
- However, in cases of *immediate* stroke, there are plausible causal pathways, there is temporality, and there is not likely to be a more probable alternative explanation.
- **There is a basis for medicolegal causation in the case of an immediate stroke.**

Establishing Medicolegal Causation

Alternative Explanation 1: Coincidence

- “It is highly improbable that a young patient will have a stroke and have had SMT within seconds purely by chance given the relatively low frequency of both events.”

- Smith WS, Johnston SC, et al.
- **Spinal manipulative therapy is an independent risk factor for vertebral artery dissection.**
- Neurology. May 2003.

Criteria for Medicolegal Causation

Alternative Explanation 2: Further Neck Movements

- **When ischemic symptoms after CSM begin after further neck movements, an alternative explanation is that further neck movements dislodged or repositioned a thrombus. This may or may not be a more probable alternative explanation.**
- If the patient performed neck movements involving *full possible ROM* then those neck movements may be a more probable alternative explanation. Movements involving full possible ROM:
- **1.** Exert more stretch on the cervical artery than CSM
- **2.** Elongate the cervical artery more than CSM.

Criteria for Medicolegal Causation

Alternative Explanation 2: Further Neck Movements

- Summary of the results of four biomechanical cadaver studies demonstrating that strains to the cervical arteries during CSM are typically less than **50%** of strains obtained during normal ROM testing, and **far less** than failure strains.

- Symons B, Herzog W.
- **Cervical artery dissection: a biomechanical perspective.**
- J Can Chiropr Assoc. December 2013.

Criteria for Medicolegal Causation

Alternative Explanation 2: Further Neck Movements

- "Measured in arbitrary in-situ head/neck positions, VA were slack. It appears that this slack must be taken up prior to VA experiencing tensile force. During CSMs (using cervical spine extension and rotation), arterial length changes remained below that slack length, suggesting that VA *elongated but were not stretched* during the manipulation."

- Gorrell LM, et al.
- **Vertebral arteries do not experience tensile force during manual cervical spine manipulation applied to human cadavers.**
- J Man Manip Ther. August 2023.

Criteria for Medicolegal Causation

Alternative Explanation 3: Stroke is Inevitable

Murphy *Chiropractic & Osteopathy* 2010, **18**:22
http://www.chiroandosteo.com/content/18/1/22

CHIROPRACTIC & OSTEOPATHY

COMMENTARY Open Access

Current understanding of the relationship between cervical manipulation and stroke: what does it mean for the chiropractic profession?

Donald R Murphy[1,2,3]

Abstract

The understanding of the relationship between cervical manipulative therapy (CMT) and vertebral artery dissection and stroke (VADS) has evolved considerably over the years. In the beginning the relationship was seen as simple cause-effect, in which CMT was seen to cause VADS in certain susceptible individuals. This was perceived as extremely rare by chiropractic physicians, but as far more common by neurologists and others. Recent evidence has clarified the relationship considerably, and suggests that the relationship is not causal, but that patients with VADS often have initial symptoms which cause them to seek care from a chiropractic physician and have a stroke some time after, independent of the chiropractic visit.

This new understanding has shifted the focus for the chiropractic physician from one of attempting to "screen" for "risk of complication to manipulation" to one of recognizing the patient who may be having VADS so that early diagnosis and intervention can be pursued. In addition, this new understanding presents the chiropractic profession with an opportunity to change the conversation about CMT and VADS by taking a proactive, public health approach to this uncommon but potentially devastating disorder.

Criteria for Medicolegal Causation

Alternative Explanation 3: Stroke is Inevitable

- **VADS: “Vertebral Artery Dissection & Stroke”**
- VAD and Stroke are two separate conditions.

- **There is an “inevitable progression” of VAD to stroke which “occurs as a result of the natural history of VADS.”**
- FALSE. It is not “inevitable” that VAD will progress into stroke.

- **Most VADs do not cause strokes.**
- Most VADs heal spontaneously and carry a good prognosis.

- **Most strokes are not caused by VADs.**
- VADs and ICADs together account for only **2%** of ischemic strokes.

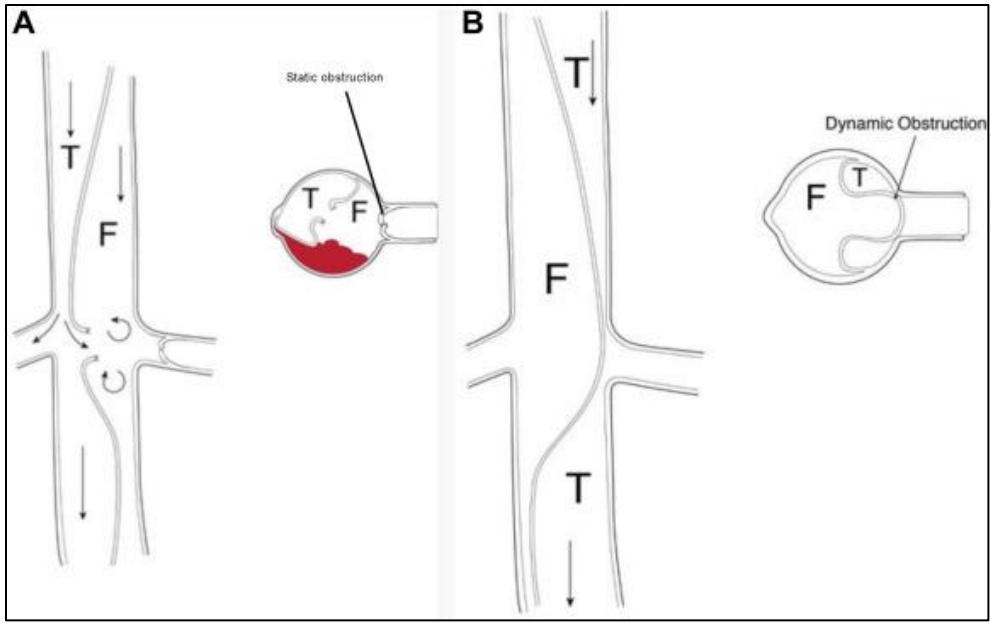
Criteria for Medicolegal Causation

Alternative Explanation 3: Stroke is Inevitable

- With proper diagnosis and treatment, dissection rarely progresses into stroke.
- In general, individuals with VAD appear to have relatively good outcomes when treated in a routine clinical fashion [2012 Gottesman].
- When CAD is diagnosed and referred for emergency medical care, the chance of avoiding stroke is almost 100% [2017 Morris].

Suggestions for Further Research

Intimal Flap Mechanism

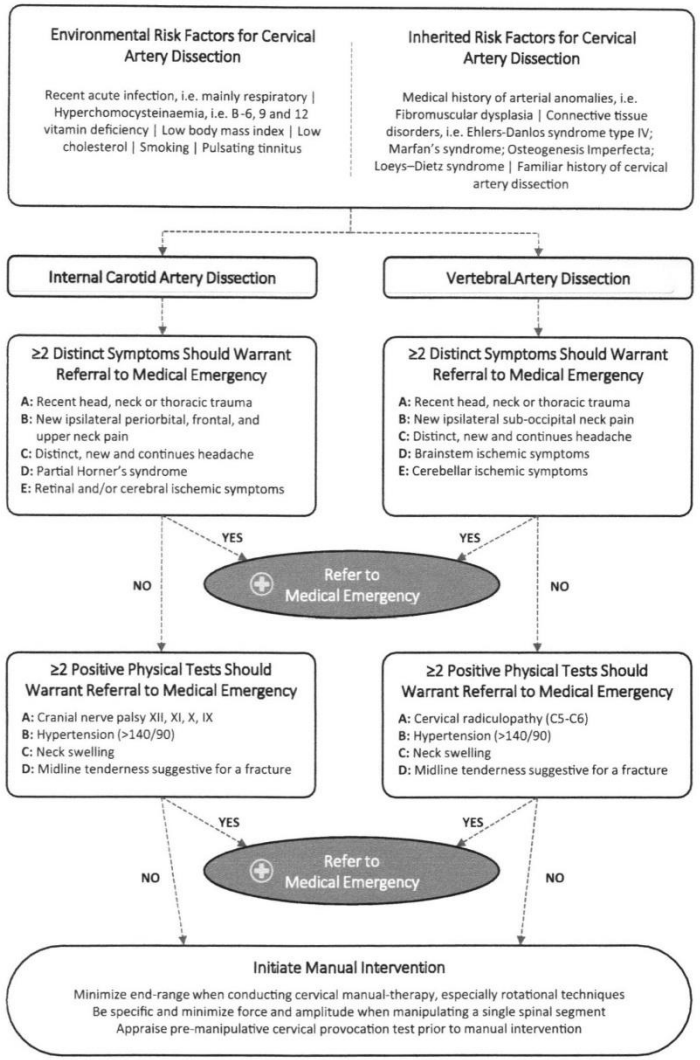


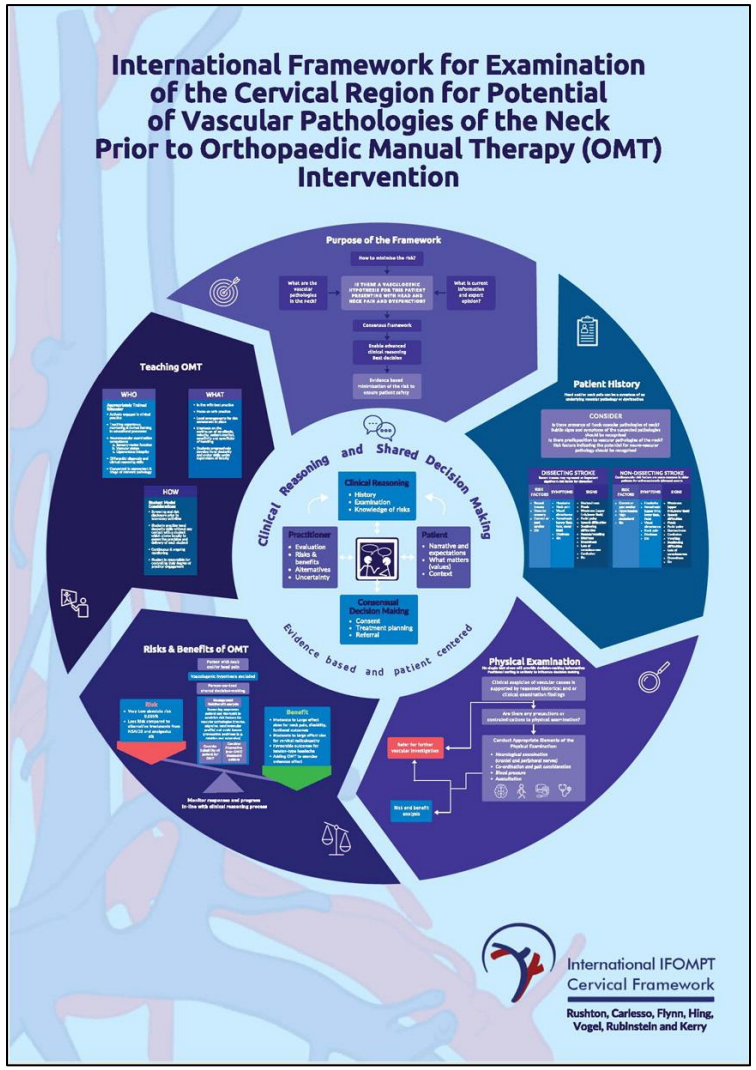
- In a patient susceptible to CAD, it is plausible that CSM could cause CAD and the intimal flap could obstruct the cervical artery or a branch vessel, impede blood flow to the brain, and cause immediate post-manipulative ischemic stroke. No study was found that proposed this mechanism in a *cervical artery*.

- Lombardi JV, et al. **Society for Vascular Surgery (SVS) and Society of Thoracic Surgeons (STS) reporting standards for type B aortic dissections.** J Vasc Surg. March 2020.

Suggestions for Further Research

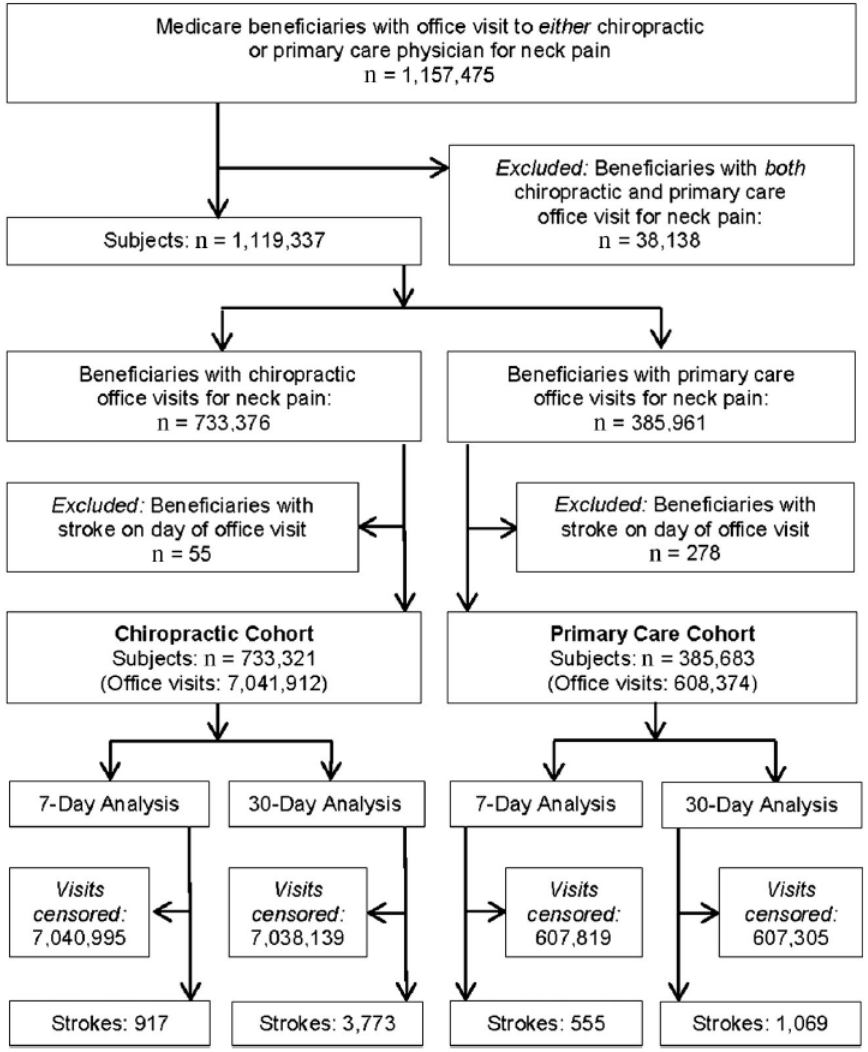
Clinical Practice Guidelines





Suggestions for Further Research

Immediate Cohort



- Epidemiological studies with an immediate cohort established *by the medical records*.
- In Whedon's 2015 study, *55* cases of stroke which occurred on the same day as a DC office visit were excluded.
- Whedon *speculated* that the stroke occurred before the DC visit.

Plausible Mechanisms of Causation of Stroke

Limitations

- 1. This is a narrative review, rather than a systematic review. As article screening and data extraction were done by a single author, it is possible that relevant articles may have been missed, or that there may have been errors in extraction.

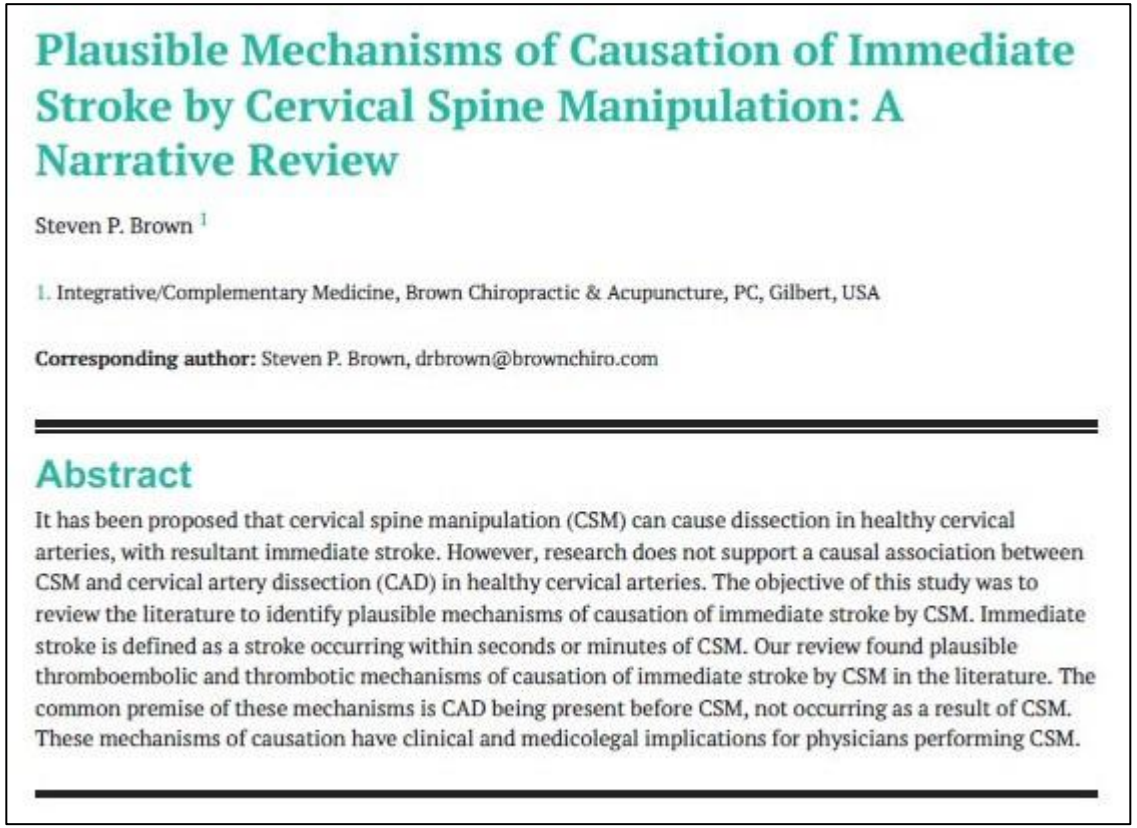
- 2. Only two literature databases were searched. Future research could be improved by searching databases from physiotherapy, osteopathic, naturopathic, neurology, and emergency medicine professions. Other databases that could also be searched include EBSCOhost, Scopus, Web of Science, and Google Scholar.

Plausible Mechanisms of Causation of Stroke

Conclusions

- **1.** There are plausible thromboembolic and thrombotic mechanisms of causation of immediate stroke by CSM in the literature. (12 studies)
- **2.** The common premise of these mechanisms is CAD being present *before* CSM, and not occurring because of CSM.
- **3.** These mechanisms of causation have clinical *and* medicolegal implications for physicians performing CSM.

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

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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