Academy of PHYSICAL MEDICINE

Research Paper Review

*This review is published with the permission of Research Review Service (*www.researchreviewservice.com*)*

Changes in vertebral artery blood-flow following various head positions and cervical spine manipulation

Journal of Manipulative & Physiological Therapeutics 2014; 37(1): 22-31

Quesnele J, Triano J, Noseworthy M, Wells G

ABSTRACT

Objective

The objective of the study was to investigate the cerebrovascular hemodynamic response of cervical spine positions including rotation and cervical spine manipulation in vivo using magnetic resonance imaging technology on the vertebral artery (VA).

Methods

This pilot study was conducted as a blinded examiner cohort with 4 randomized clinical tasks. Ten healthy male participants aged 24 to 30 years (mean, 26.8 years) volunteered to participate in the study. None of the participants had a history of disabling neck, arm, or headache pain within the last 6 months. They did not have any current or history of neurologic symptoms. In a neutral head position, physiologic measures of VA blood flow and velocity at the C1-2 spinal level were obtained using phase-contrast magnetic resonance imaging after 3 different head positions and a chiropractic upper cervical spinal manipulation. A total of 30 flow-encoded phase-contrast images were collected over the cardiac cycle, in each of the 4 conditions, and were used to provide a blood flow profile for one complete cardiac cycle. Differences between flow (in milliliters per second) and velocity (in centimeters per second) variables were evaluated using repeated-measures analysis of variance.

Results

The side-to-side difference between ipsilateral and contralateral VA velocities was not significant for either velocities (P = .14) or flows (P = .19) throughout the conditions. There were no other interactions or trends toward a difference for any of the other blood flow or velocity variables.

Conclusions

There were no significant changes in blood flow or velocity in the vertebral arteries of healthy young male adults after various head positions and cervical spine manipulations.

ANALYSIS

Reviewed by Dr. Michael Haneline DC (Research Review Service)

Author's Affiliations
Division of Graduate Studies, Clinical Sciences, Canadian Memorial Chiropractic College, Canada.

Background Information
Vertebral artery (VA) dissection leading to vertebrobasilar artery (VBA) stroke is rare in the general population; however, it is an important cause of nonatherosclerotic stroke in young adults.

Exactly what precipitates VBA stroke is unknown, although it has been suggested that there may be an underlying genetic predisposition in some people that can be triggered by various risk factors. One such risk factor is trivial trauma (e.g., unusual head positions, including cervical manipulation); nevertheless, many VBA strokes occur in the absence of any of the supposed risk factors.

Signs and symptoms of vertebrobasilar insufficiency have been observed when the head is placed in certain positions, especially rotation. It has been speculated that extreme head positions may result in mechanical compression or stretching of the VA and consequent changes in its blood-flow. Furthermore, several studies have reported changes in VA blood-flow after head rotation via Doppler sonography, though the results have been inconsistent (1).

Few studies have investigated the effects of cervical spinal manipulation (CSM) on VA blood-flow and those that have reported inconsistent results, likely due to poor methodology. This milieu casts doubt on whether apparently healthy individuals can actually experience altered cervical blood-flow as a result of these maneuvers.

While detecting subtle blood-flow changes via ultrasound has been shown to be unreliable, magnetic resonance imaging (MRI) techniques, in particular magnetic resonance angiography, are more sensitive. In fact, MRI is considered to be the criterion standard for diagnosing VBA strokes and for quantifying blood-flow volume.

The purpose of this study was to observe VA blood-flow after manipulation and various head positions in order to determine the extent head/neck motion interacts with VA blood-flow.

Pertinent Results

Ten males aged 24 to 30 years participated in the study, all were right-handed. Data collection sessions lasted approximately 2 hours for each participant and they all completed the full testing protocol.

There appeared to be a small side-to-side difference between ipsilateral and contralateral VA flow and VA velocities, with the contralateral side being lower than the ipsilateral. However, this difference was not statistically significant for either flows ($P = .19$) or velocities ($P = .14$). There were no other interactions, nor trends toward differences for any of the other blood flow or velocity variables.

Clinical Application & Conclusions

Based on this small but pertinent study and others that have measured blood-flow after head movements, practitioners who use manual methods can be reasonably confident that there is little or no evidence that various head motions, including CSM, produce significant cerebrovascular hemodynamic effects in the VAs.

Some researchers have suggested that the VA theoretically may be stretched and/or compressed during head rotation, but this mechanism was not tested in this study. However, it has been shown in cadaveric studies (2, 3) that strain forces sustained by the VAs during CSM are lower than those associated with physiologic neck rotation.

A recent study by Thomas et al. (4) used very similar methodology to the current one (i.e. they used MRI to evaluate blood-flow during CSM and head positions) and came to nearly the same conclusion. The Thomas et al. study investigated the effects of manual therapy interventions for mechanical neck pain on vertebral and internal carotid arterial blood-flow, as well as cerebral inflow. They found that the average inflow of blood to the brain was not significantly changed by any of the test positions as compared to neutral; also, there were no flow differences between any of the 4 arteries in any tested head position. However, they did report that there were large blood-flow variations in some individuals.

Two other previous studies have investigated the effects of CSM on VA blood-flow in humans, both conducted by Licht et al. (5, 6). One of the studies examined peak velocity in the VA after CSM in a randomized controlled trial that used Doppler ultrasound, whereas the other study used color-coded duplex. Similar to the current study, they found no change in VA blood-flow or peak velocity with different head positions or after CSM. The consistent findings of these studies lend support to the conclusion that blood velocity and flow through the VA was not significantly changed by head rotations or CSM.

It is important to consider that all participants in these studies have been healthy, so the conclusions that a healthy artery should have the capacity to withstand the mechanical stresses of CSM may not apply to persons with weakened arteries. Some evidence has accumulated which indicates that arteries can become weakened due to underlying arteriopathy that renders the artery friable, which can be caused by conditions such as infection, pro-inflammatory factors, and connective tissue disorders.

Study Methods

Participants were healthy volunteers recruited from a local chiropractic college. They all had received CSM within the 3 months before data collection.

Participants were excluded if they had:

- a history of disabling neck, arm, or headache pain within the last 6 months;
- any current or history of neurologic symptoms including facial or extremity weakness, abnormal sensation to the face, body, or extremities, uncontrolled movements, abnormal gait, dizziness, unexplained nausea/vomiting, difficulty with speaking or swallowing; or
- a history of claustrophobia.

The examiners were blinded and participants were given randomized clinical tasks comprising 4 head positions (neutral, 45° rotation, maximum rotation, and CSM) which were applied once they were positioned supine on the MRI table. Each position was held for 1 minute and then returned to neutral prior to MRI sequencing.

CSM was a high-velocity, low-amplitude impulse, in which the head was positioned in simultaneous axial rotation, lateral bending and flexion. All participants completed the test protocols successfully with no adverse events.

Four MRI series were performed on each participant; one following each head position/CSM. Measurement of blood-flow was done by an experienced MRI analyst who was blinded to the test maneuvers.

Study Strengths / Weaknesses

This was a well-executed study; however, this type of research methodology is inherently unconvincing, mainly because there was no placebo control group comparison.

Study limitations include the following:

- The sample size was small which limits generalizability as well as the number of parameters that can be statistically tested.
- The time interval between head positioning and blood-flow measurement may have been so long that transient effects may have been missed.
- Post-maneuver analysis makes comparison with other real-time studies difficult because only post-procedural effects were described rather than effects that occur during a specific maneuver.
- MRI is considered the most accurate way to measure blood-flow, though it still has drawbacks (e.g., physiologic variation, anatomical variation, vessel movement, poor definition of the vessel boundary, and the general condition of participant).
- The carotid arteries also contribute to cerebral circulation, but their flow was not measured.
- Arterial flow may have been underestimated due to peripheral gating for image acquisition combined with the potentially imprecise orthogonal cross sections.

Only young healthy males participated in this study, which further limits generalizability. Accordingly, the authors suggested that studies in the future should draw from populations considered to be at higher risk, even though risk criteria for VA dissection are currently unclear in the literature.

Additional References

1. Mitchell J. Vertebral artery blood-flow velocity changes associated with cervical spine rotation: a meta-analysis of the evidence with implications for professional practice. J Man Manip Ther 2009; 17: 46-57.
2. Symons BP, Leonard T, Herzog W. Internal forces sustained by the vertebral artery during spinal manipulative therapy. J Manipulative Physiol Ther 2002; 25: 504-10.
3. Wuest S, Symons B, Leonard T, Herzog W. Preliminary report: biomechanics of vertebral artery segments C1-C6 during cervical spinal manipulation. J Manipulative Physiol Ther 2010; 33: 273-8.
4. Thomas L, Rivett D, Bateman G, Stanwell P, Levi C. Effect of selected manual therapy interventions for mechanical neck pain on vertebral and internal carotid arterial blood-flow and cerebral inflow. Phys Ther 2013; 93:1563-1574.
5. Licht P, Christensen H, Højgaard P, Marving J. Vertebral artery flow and spinal manipulation: a randomized, controlled and observer-blinded study. J Manipulative Physiol Ther 1998; 21: 141–4.
6. Licht PB, Christensen HW, Høilund-Carlsen PF. Vertebral artery volume flow in human beings. J Manipulative Physiol Ther 1999; 22: 363-7.

ACADEMY COMMENTS

We concur that the transient effects of manipulation may have been missed by this study. It is possible that the very rare instances of CVA following manipulation were the result of disturbance to pre-existing thrombi by a fleeting disturbance in blood flow.