

Assessment of cranial blood flow in cervical spondylosis patients

RC Siwach¹, Sanjeev Kumar², Mukesh Kumar^{3,*}

^{1,3}Professor, ²Assistant Professor, BPS GMC, Khanpur Kalan, Sonapat, Haryana

***Corresponding Author:**

Mukesh Kumar

Professor, BPS GMC, Khanpur Kalan, Sonapat, Haryana

Email: mkumar5031@rediffmail.com

Abstract

Background: The effect of rotation of head movement on cerebral artery blood flow in normal subjects has been widely studied. Many factors effect blood flow through the vertebral artery such as rotation of head, variably sized arteries, atheroma, tortuous vertebral arteries, carotid sinus compression etc.

Objective: To determine the effect of head and neck movement on the cranial blood flow in cervical spodylosis patients with reticulopathy.

Material and methods: Fifty participants (23 male, 27female) with informed consent (20-70 years) participated in this study. Subjects with severe hypertension, cardiovascular, liver, kidney or other life threatening diseases were excluded. The changes in the Anterior, Middle, and Posterior cerebral arteries blood flow between the neutral (face to front) and rotated head positions (flexion and extension) was measured with Trans-cranial Doppler Method in healthy and Cervical Spondylosis with reticulopathy patients.

Results: No significant differences in the afferent cerebral blood flow of the neutral and of the changed head positions in cervical spondylosis patient was found. In Cervical Spodylosis patients with reticulopathy, the mean values of cerebral blood flow were insignificantly different as compared to neutral position, however according to the data collected till now, the lowest blood inflow level was recorded during extension of the head. Flow changes were less than 10% considered to be normal.

Conclusion: The flow changes in the afferent cerebral arteries of healthy subjects were insignificant. When a person has cervical spondylosis with reticulopathy, flexion and extension of head may diminish blood flow through the vertebral artery in its course through the cervical spine. Further studies and data are required to establish association.

Keywords: Cervical spondylosis, Cranial blood flow, TCD

Introduction

Cervical spondylosis briefly described as osteoarthritis of cervical spine. The disease is associated with degenerative changes of the cervical spine. Due to the modern unhealthy lifestyle such as long hours in front of computer screens or absence of exercise, and increased work pressure, the morbidity rate associated with cervical spondylosis is increasing and the age of onset is decreasing¹.

The pathogenesis of cervical spondylosis leading to vertigo presented in the literature is quite complex i.e. may be neurological or vasogenic. The vertebrobasilar circulation supplies the vestibular labyrinth, VIII nerve, brain stem, cerebellum and occipital lobe. Cervical osteophytes can press on the vertebral artery causing its occlusion during head rotation^{2,3}. End range positions of neck are potentially implicated in causing changes in blood flow in craniocervical arteries^{4,5}.

One factor that may contribute to adverse neurovascular events following head rotation, may be the position of neck rotation close to the end of the physiological range, which could temporarily compromise blood flow⁶. These few changes may be an indication of increased biomechanical stress of the arterial wall⁷. Cervical rotation, can alter velocity of blood flow in the cerebral arteries in some individuals^{8,9}. Most studies typically examined blood

flow in one vessel; however examination of blood flow in one vessel cannot provide a complete picture of blood flow to brain.

There have been few studies evaluating the effect on blood flow in the craniocervical vessels during neck rotation.

The purpose of this study therefore was to examine the effect of flexion and extension of cervical spine on blood flow velocity in the craniocervical arteries in cervical spondylosis patients. The objective was to determine whether there were any differences in craniocervical arterial blood flow velocity or total blood flow velocity to the brain between the position involved in exercises, which may help inform risk assessment by patients as well as by health professionals.

Our aims were-

1. Do certain neck positions used in exercises cause a greater difference in blood flow velocity in the craniocervical arteries compared with the neutral position than others?
2. Do certain neck position cause greater difference in total blood flow velocity to the brain compared with the neutral position than others?

Method

Design: The study was an experimental transcranial Doppler ultrasound study examining blood flow

velocity in the Anterior, Middle and Posterior cerebral arteries in the neutral neck position and comparing these measurements with blood flow measurements in 2 other neck positions in cervical spondylosis patients. Informed consent was obtained from all participants.

Participants: Fifty cervical spondylosis patients with age group 20-70 years diagnosed clinically and radiologically with cervical spondylosis having only radiculopathy without any other neurological symptoms attending outpatient department of Orthopedics Government medical college for women, Khanpur Kalan, Sonapat were recruited in to the study. Participants were excluded if they had serious primary disease such as hypertension, cardiovascular, cerebrovascular disease; liver disease, kidney disease, hematopoietic system disease mental disorder and any history of cervical spine trauma, any congenital disorder recognized as being associated with hyper mobility or instability of the upper cervical spine and diagnosed vertebrobasilar insufficiency.

Experimental conditions

The following sequence of neck position was used

1. Neutral
2. Extension of neck as far as possible
3. Flexion of neck as far as possible

Measurement of blood flow velocity: Peak blood flow in each cerebral artery (Anterior, Middle and Posterior) was measured with transcranial Doppler ultrasound through temporal window. In order to assess the effect of neck position on blood flow, average peak blood flow velocity measured in cm/second was used as the primary test variable and was analyzed in neutral and each of the neck position for each artery. Average blood flow velocity in each artery was then compared between the neutral position and each of the experimental neck position to determine whether blood flow velocity changed from neutral.

Measurement of total blood flow velocity to the brain: Total blood flow velocity to the brain was determined from the sum of the average flow velocity (cm/sec.) in all the three anterior, middle and posterior arteries. The total blood flow velocity for each of the neck position then was compared with neutral. A difference in average total blood flow velocity (increase or decrease) is then calculated.

Results

Fifty participants (23 male, 27female) with a mean age of 45.4years (SD \pm 11.9) were recruited into the study.

Table 1: Average Blood Flow velocity (cm/s) in the Craniocervical Arteries for Each Neck Position

S. No.	Cerebral blood vessel	Cerebral blood flow velocity in neck positions (cm/sec.)		
		Neutral (mean \pm s.d.)	Extension (mean \pm s.d.)	Flexion (mean \pm s.d.)
1.	LMCA	69.40 \pm 20.19	64.47 \pm 14.24	59.87 \pm 16.42
2.	RMCA	59.97 \pm 16.34	62.90 \pm 19.07	63.82 \pm 17.14
3.	LACA	64.80 \pm 19.51	63.32 \pm 13.90	63.22 \pm 19.11
4.	RACA	49.37 \pm 15.45	49.52 \pm 17.69	51.87 \pm 15.40
5.	LPCA	64.07 \pm 14.35	67.75 \pm 14.50	62.62 \pm 13.73
6.	RPCA	60.75 \pm 16.56	67.37 \pm 26.45	59.75 \pm 14.81

LMCA, left middle cerebral artery, RMCA, right middle cerebral artery, LACA, left anterior cerebral artery, RACA, right anterior cerebral artery, LPCA, left posterior cerebral artery, RPCA, right posterior cerebral artery

Table 2: The Mean Difference (cm/s) Between Each Neck Position and the Neutral Position with P Value

S. No.	Cerebral blood vessels	P value			Difference between neck position and neutral	
		Neutral Vs extension	Neutral Vs Flexion	Extension Vs flexion	Extension – Neutral	Flexion – neutral
1.	LMCA	.196	.004	.102	-4.93	-9.53
2.	RMCA	.353	.222	.676	2.93	3.85
3.	LACA	.602	.618	.967	-1.48	-1.58
4.	RACA	.956	.246	.448	0.15	2.50
5.	LPCA	.120	.749	.068	3.68	-1.45
6.	RPCA	.271	.458	.059	6.62	-1.00

Table 3: Total Blood flow velocity to the Brain (Sum of Average Flow velocity (cm/s) in all arteries, difference between neck position and neutral, P Value and percentage difference

Neck position	Total blood flow velocity (cm/sec.)	Difference between neck position and neutral		
		Neck position-neutral	P	% difference
Neutral	61.39±18.11	NA	NA	NA
Extension	62.56±19.00	1.17	NS	1.90
Flexion	60.19±16.53	-1.20	NS	-1.95

Effect of Neck Position on Blood Flow velocity:

Measurements of average blood flow velocity (cm/sec.) for anterior, middle, and posterior cerebral arteries in the neutral condition and each of the experimental conditions are presented in Table 1. In order to compare differences in average velocity flow between all 3 positions to see if any of the neck positions had greater effect on any artery than another, we analyzed velocity using a linear mixed effects model with one categorical variable with 3 levels (neutral, extension, flexion position). The significance level was set at $<.05$ and following a significant effect, post hoc testing was carried out. The results showed no significant differences in flow velocity for either of the cerebral arteries (anterior, middle, posterior) artery but a statistically significant difference between positions for the left middle cerebral artery ($P<.004$) are found. (Table 2). During extension of neck blood flow velocity decreases insignificantly in LMCA, LACA. During flexion blood flow also decreases insignificantly in LMCA, LACA, LPCA, and RPCA.

Total blood flow velocity (Table 3) to the brain did not vary substantially from neutral in any test position. Flow generally decreased slightly for flexion position but increased in extension position. The total flow volume for all positions was analyzed. No significant difference was found among positions. The change in blood flow was less than 10%, which is considered to be the normal variation for cerebral inflow¹⁰.

Discussion

This comparative Doppler ultrasonographic study examined blood flow velocity in the craniocervical arteries in different neck positions and compared the measurements of blood flow velocity with that in the neutral position to identify if any neck positions were potentially more hazardous than others. Our study showed no change in blood flow by any of the neck positions and no position had significantly greater effect on blood flow than any other. Total cerebral inflow velocity also remained fairly constant in all positions, suggesting that cerebral perfusion similarly was not negatively affected by any of the neck positions. To date, there have been no previous studies of cervical spondylosis patients, investigating blood flow in the craniocervical vessels in different neck positions using transcranial Doppler method. The results of this study suggest that common neck

positions used in exercise practice do not, appear to pose a risk to blood flow to the brain, at least on the grounds of their effects on blood flow. Blood flow velocity in the craniocervical arteries. Blood flow varied between neck positions but was not significantly changed by any neck positions used in common neck exercise procedures compared with the neutral position.

Previous studies examining blood flow changes during neck rotation have generally examined flow in specific arteries only, notably the vertebral arteries^{11,12,13} which does not allow consideration of the cerebral circulation as a whole. Decrease in flow during rotation may represent a risk factor for neurovascular complication¹⁵. It has been suggested that clinicians should measure flow in the vertebral arteries as part of premanipulative screening of the cervical spine.¹²

Our study contrasts with some previous studies which show reduction in flow velocity in the vertebral arteries with contralateral rotation^{11,12,13}.

Using MRA, Weintraub and Khoury showed that blood flow may be reduced in the vertebral artery on contra lateral rotation, but their study was of older patients with advanced cerebro-vascular disease who do not represent the population of interest for the current study aim, and even in this group only about 50% showed changes in flow. Interestingly, although not statistically significant, the current study also suggests that when total flow velocity is decreased in one neck position (flexion), it appears to be compensated by increased flow in another neck position (extension).

It is important to consider, however, that although a healthy artery should have the capacity to easily withstand such mechanical stress, the effects on arteries that are in a weakened state either from underlying arteriopathy or a temporary friable state due to infection or the potential presence of pro-inflammatory factors in the circulation areas yet unknown in the human model.

However, other factors such as the state of the arterial wall and the effect of the thrust maybe more important determinants of risk from exercises applied to the neck, and future studies could investigate these factors. The present study showed that total blood inflow to the brain was not significantly changed from the neutral position by any of the test positions, and none of the positions showed a compromise to total cerebral blood flow velocity. This finding was further supported by the fact that no signs or symptoms of cerebral ischemia were evident.

A previous ultrasound study demonstrated marked reduction or even cessation of vertebral artery flow on neck rotation in some individuals, yet no signs of vertebrobasilar insufficiency being elicited¹⁴ suggesting cerebral blood supply was not compromised. This conclusion is not surprising given the homeostatic function of the Circle of Willis in maintaining a constant blood supply to the brain. Small fluctuations (<10%) in flow volume to the brain normally occur according to an individual's arousal state and increase if the individual is anxious or doing a mental task, which is not considered to be detrimental to brain function¹⁰.

Clinically, the results of this study suggest that if blood flow in one vessel is low or absent by a neck position, it may still be adequately compensated by increase blood flow in other arteries. So concern about the safety of particular neck position in terms of brain ischemia may generally be unwarranted.

Conclusion

Although concerns have been raised about the safety of exercises applied to the neck, in particular the upper cervical spine segments, none of the positions tested in this study demonstrated any significant change in blood flow volume from the neutral position. Moreover, no position including had any greater effect on blood flow than any other. Total blood supply to the brain remains constant in all positions. Decrease in flow in one vessel is compensated for by an increase in another. This finding suggests that the neck positions themselves are not inherently hazardous in terms of compromise to blood flow in the cranio-cervical arteries, and it is more likely, therefore, that other factors such as the state of the arteries and the effect of the manipulative thrust may be more important. Future imaging studies focusing on blood flow in normal or individual cranio-cervical arteries may be particularly useful.

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