Br J Pain. São Paulo, 2018 apr-jun;1(2):103-10

ORIGINAL ARTICLE

Influence of osteopathic cervical manipulation on blood flow velocity of the cerebral circulation in chronic neck pain: analysis of three groups

Influência da manipulação osteopática cervical na velocidade de fluxo sanguíneo da circulação cerebral em indivíduos com cervicalgia crônica: análise de três grupos

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DOI 10.5935/2595-0118.20180021

ABSTRACT

BACKGROUND AND OBJECTIVES: Spinal manipulation (SM) can reduce or improve the pain and dizziness originated in the neck. However, there is some criticism against SM. The objective of this study was to check if the osteopathic manipulation (OM) with a cervical rhythmic articulatory technique (CRAT) provides oscillations of the blood flow velocity (BFV) in the internal carotid arteries (ICA), vertebral arteries (VA) and basilar artery (BA), and if this technique is a risk factor for this circulatory system.
METHODS: The study was conducted with 73 individuals (men and women) with mechanical cervicalgia, with an average age of 37.7±6.4 years. Fifty-eight had mild to moderate pain, randomly divided into control group (CG) and experimental-1 (EG-1), and 15 with severe pain in the experimental-2 group (EG-2). All subjects were submitted to the artery ultrasound (ICA, VA, and BA) in a blind methodology for the tests 1 (E1) and 2 (E2). Between E1 and E2, one single OM-CRAT was performed in the EGs 1 and 2 and resting for the CG.
RESULTS: In the EG-1 there was a slight reduction of the BFV in the right ICA. In the EG-2 there was a significant increase of the BFV in the right VA. All samples presented normality. In the CG there was a reduction of the BFV in the left VA. When comparing the three groups, there was significance for the CG as EG-2 of the BFV in the right ICA (in E1) and of the BFV in the left ICA (in E2).
CONCLUSION: Despite the BFV oscillations, one can conclude that the OM-CRAT generates oscillation in the BFV within the normality parameters and it is not a risk factor for cerebral circulation.

Keywords: Carotid arteries, Cervicalgia, Doppler ultrasound, Neck pain, Spinal manipulation, Vertebral artery.

RESUMO

JUSTIFICATIVA E OBJETIVOS: A manipulação vertebral cervical (MVC) pode reduzir ou melhorar a dor e a tontura de origem cervical. No entanto, há críticas contra a MVC. O objetivo deste estudo foi verificar se a manipulação osteopática (MO) com técnica articulatória rítmica cervical (TARC) proporciona oscilações de velocidade de fluxo sanguíneo (VFS) nas artérias carótidas internas (ACI), vertebrais (AV) e basilar (AB), e se essa técnica é um fator de risco para esse sistema circulatório.
MÉTODOS: A casuística foi constituída de 73 indivíduos (homens e mulheres) com cervicalgia mecânica, com idade média de 37,7±6,4 anos, sendo 58 com dor leve a moderada, divididos por aleatorização em grupos controle (GC) e experimental-1 (GE-1), e 15 com dor intensa no grupo experimental-2 (GE-2). Todos foram submetidos à ultrassonografia arterial (em ACI, AV e AB) em metodologia encoberta para os exames 1 (E1) e 2 (E2). Entre E1 e E2 foi realizado única MO-TARC para os GE 1 e 2, e repouso para o GC.
RESULTADOS: Em GE-1 houve pequena redução de VFS da ACI direita. Em GE-2 houve aumento significativo de VFS na AV direita. Todas as amostras apresentaram normalidade. Em GC houve redução de VFS da AV esquerda. No comparativo entre os três grupos houve significância para o GC como GE-2 na VFS da ACI direita (em E1) e na VFS da ACI esquerda (em E2).
CONCLUSÃO: Apesar das oscilações de VFS, concluiu-se que a MO-TARC gera oscilação de VFS dentro dos parâmetros de normalidade e não é um fator de risco para a circulação cerebral.

Descritores: Artérias carótidas, Artéria vertebral, Cervicalgia, Dor de pescoço, Manipulação da coluna, Ultrassonografia Doppler.

INTRODUCTION

Cervical spine pain of mechanical origin is a common condition, represented by pain and range of motion (ROM) limitation, sensitivity or neck muscles tenderness, and can become chronic or recurrent[1,2]. This condition can be related to repetitive movements, inadequate posture during work activity[3] or be induced

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Submitted in May 19, 2017.
Accepted for publication in April 23, 2018.
Conflict of interests: none – Sponsoring sources: none.

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by trauma or whiplash injury[4]. This can cause microtraumas on the cervical vertebrae and myofascial periarticular tissues[1,2]. If these injuries are followed by an articular vertebral restriction, it can be called vertebral somatic dysfunction, which induces the sensitization of the neural circuit, associated to the sympathetic hyperactivity, increase in vascular tone, and myofascial tensions[5,6]. Neck pain by mechanical dysfunction can alter the posture control system and create a body imbalance (sensation of instability or dizziness), due to the relationship with the central nervous system, proprioceptive afferents of the somatosensorial system, vestibular system, control of eye movement and the vision[7,9]. However, the body imbalance is usually attributed to the visual system and labyrinth disease[8,9], or even to the vertebrobasilar insufficiency, which can be confirmed by cervical flexion-rotation clinical tests[10.11] and by vascular ultrasound that checks the blood flow velocity (BFS) of the internal carotid arteries (ICA), vertebral arteries (VA) and basilar (BA)[5,12].

On the other hand, in individuals with common neck pain, the VA, BA and ICA blood flow is not impaired by the rhythmic osteopathic manipulation of the cervical spine[5].

The objective of the osteopathic manipulative treatment (OMT) is to treat the vertebral somatic dysfunctions or vertebral hypomobilities that can be among the causes of neck pain, posture alteration, cervical-related dizziness, some headaches, etc.[5,6,13-17].

It is possible to have oscillations after a cervical vertebral manipulation, sometimes with an increase in the BFS[5,15,16], an improvement in muscle strength and enduranve[17], increase in cervical ROM, and reduction of cervical pain[6,13] and headache[18]. Among the several osteopathic manipulation (OM) techniques is the cervical rhythmic articulatory technique (CRAT) with rotation and sliding[5,6,15].

The dissection of the VA associated with the cervical vertebral manipulation is rare; however, according to some references, it can be serious or fatal in some cases[19-21]. However, there are reports that the cervical vertebral manipulation and the cervical mobilization do not present a vascular risk to vertebral and carotid arteries[5,22-24], and that this technique can provide normal oscillations or a slight increase in BFS[5]. The VA dissection should be attributed to the mechanical impact, as whiplash trauma, and not to the cervical vertebral manipulation[23]. In general, the dissection of the carotid arteries is usually attributed to the car accidents, being a rare consequence of the cervical vertebral manipulation[21].

However, OM-CRAT stimulates BFS oscillations of the cerebral arteries (ICA, VA, and BA) within the parameters normality, and it can activate or increase the cerebral circulation[5,15].

The objective of this study was to investigate if the CRAT with *rotation and sliding* influences the oscillations (increase or reduction) of the BFS of the ICA, VA, and BA comparing three groups with neck pain.

METHODS

The study was randomized, blind, and controlled, with a comparative analysis of three groups. The study population was of 73 individuals (men and women), as follows: 58 individuals (18 men and 40 women), with average age of 36.0±6.5 years (men: 36.5±6.1 years; women: 34.8±7.3 years) with chronic, mild and moderate mechanical neck pain; and 15 individuals (2 men and 13 women), with average age of 37.7±6.4 years (men, 38.3±6.7 years, women, 34±1.4 years) with severe chronic mechanical neck pain (but, not unbearable or disabling), complaining about occasional and mild dizziness. The level of pain was classified according to the Neck Disability Index - section 1. The volunteers were employees of the General Hospital of the Federal University of Paraná.

The sample of 73 patients corresponds to a confidence level of 90%, and sample error of 6.5%, that can vary for more or less.

The division of the groups was carried in the following way: the group with 58 individuals with mild to moderate neck pain was randomized into a control group (CG n=29), and experimental group-1 (EG-1 n=29). The experimental group-2 with severe neck pain (GE-2 n=15) was in a sequential form.

The period of the study was from August 2010 to March 2012, and from March to August 2013.

The methods were always carried by the same professionals, one operator-1 blind for the ultrasound, and operator-2 for rest control and execution of the OM-CRAT. The individuals were analyzed by vascular ultrasound at two moments, blind and sequential, for the ICA, extra and intracranial VA and BA, including test 1 (E1) and test 2 (E2). The E2 occurred after resting in the CG, and after OM-CRAT in the EG. The procedures were performed in a single session of approximately 20-25 minutes for each subject. After the interview, the data collection and the signature of the Free and Informed Consent Form (FICT), the subject was positioned in the supine position on a stretcher, with the head on a small and low pillow (children-like), remaining in a quiet environment until the end of the procedures, that followed this sequence:

1. Ultrasound (E1) (n=73);
2. Rest in CG (n=29)/and OM-CRAT in EG-1 (n=29) and in EG-2 (n=15);
3. Ultrasound (E2) (n=73).

The inclusion criteria were individuals with age between 25 and 45 years, of both genders, not taking medication. The CG and the EG-1 had healthy individuals and could include chronic common neck pain, of mild and moderate intensity, and with some cervical ROM limitation. The EG-2 had individuals with chronic common neck pain, intense pain, and some cervical ROM limitation. The intensity of pain was considered according to the Neck Disability Index.

The exclusion criteria were any alteration that could preclude the protocol fulfillment, as unbearable or disabling pain, moderate or important dizziness or vertigo; or other signs of vertebrobasilar failure during the procedures, change of blood flow in the first ultrasound of the protocol, cervical hypomobility (e.g.: spondylosis, bone malformation, spine deformity as Scheuermann's disease), individuals in post-operative stage, sequel by cranial or spine trauma, using crutches, a walker or wheelchair.

Vascular ultrasound

The ultrasound was performed in the three groups by the same researcher with the blind method (operator-1). The ultrasound device model was VIVID, from GE, with a linear transducer of 7.5 to 10 MHz for extracranial circulation, and a transversal transducer of 1.5 to 5 MHz for intracranial circulation[5]. Tests 1 and 2 were performed (E1 and E2), for 3 minutes each. Soon after each test, operator-1 left the room and returned 5 minutes later for the next step. After the routine examination to evaluate abnormal findings in the carotid and vertebral, and absence of pathological changes, the samples of the arterial Doppler for the right ICA (RICA), left ICA (LICA), VA (RVA) and left VA (LVA), RCA in its intracranial segment (RCA Intra), LVA in its intracranial segment (LVA Intra) and BA were saved. The direct analysis of the same vessels was repeated in the second step (E2). In all analyzed vessels, the following variables were collected: peak systolic velocity (PSV); end diastolic velocity (EDV); average velocity (AV); pulsatility index (PI); resistance index (RI). The three last ones were collected by means of a formula (Excel 2010 software). Studies report that the reference values for normal adults are as the following arteries and variables: VA: 20-68 in PSV, 9-33 in EDV, 16-48 in AV; BA: 35-87 in PSV, 16-44 in EDV, 25-62 in AV, ICA: 54-90 in PSV, 21-31 in EDV, 32-46 in AV[12,25].

Rest for the control group

Controlled by operator-2, the subject was instructed to relax and rest for 5 minutes.

OM-CRAT

In EG-1 and EG-2, the OM-CRAT was performed by operator-2, involving the subject's neck with the index finger next to each vertebra and its interface joint (posterior region of the transverse processes). Performing passive rhythmic and smooth movements with three repetitions for each interface joint (zygapophyseal joint), i.e., with mobilizations from one side to the other, associating lateral sliding with rotation, in a "∞" movement at the axial view. The process started with the first thoracic vertebra (T1) rising through all cervical vertebrae until the atlanto-occipital joint. On the upper cervical, three mobilizations in flexion, and three in bilateral extension of the occipital condyle were added (atlanto-occipital), plus three lateral sliding to the atlas, and three rotations to C3 and three rotations to C2-C1. For the atlanto-occipital, one of the hands was on the head of the subject (the frontal bone region)[5].

This study was approved by the Research Ethics Committee (CEP-HC-UFPR: 2233.127/2010-06) and is in compliance with the Declaration of Helsinki.

Statistical analysis

The statistical analysis used the Student's *t*-test (average and standard deviation), ANOVA One Way and TUKEY (post-hoc) (to compare the three groups) and Kolmogorov-Smirnov (for the normality test of the three groups). The program used for calculation was Excel 2010.

RESULTS

Table 1 shows, in the CG, the result of the Student's t-test with a significance level of 0.05 (5%), where there was a significant dif-

Table 1. Comparison between the averages of the flow speed of the tests 1 and 2 in the control group (n=29 with mild to moderate neck pain)

Vessel and side	Flow speed	Average (cm/s)		Standard deviation		Statistics *t*	p value
		E1: Pre-rest	E2: Post-rest	E1: Pre-rest	E2: Post-rest		
R Extra VA	PSV	48.79	47.28	16.35	19.48	0.62	0.5419
	EDV	15.90	15.55	6.90	7.39	0.41	0.6824
	AV	26.86	26.13	9.68	10.89	0.57	0.5748
L Extra VA	PSV	53.93	50.38	12.90	13.01	2.13	*0.0422
	EDV	17.72	16.83	6.93	5.82	1.14	0.2623
	AV	29.79	28.01	8.51	7.76	1.82	0.0799
R Intra VA	PSV	47.11	47.54	10.90	11.88	-0.30	0.7653
	EDV	22.96	23.18	5.79	5.84	-0.29	0.7740
	AV	31.01	31.30	7.31	7.73	-0.30	0.76
L Intra VA	PSV	55.52	55.48	14.81	14.77	0.02	0.9844
	EDV	26.59	27.59	7.50	8.13	-1.22	0.2328
	AV	36.23	36.89	9.72	10.18	-0.61	0.5489
BA	PSV	62.76	63.31	14.92	15.83	-0.35	0.7316
	EDV	29.07	29.48	7.10	7.11	-0.58	0.5655
	AV	37.83	37.79	10.23	10.59	0.04	0.9693
R ICA	PSV	82.70	73.95	25.42	19.56	1.96	0.0654
	EDV	28.25	28.25	7.02	8.84	0.00	1.0000
	AV	46.40	43.48	11.12	10.42	1.30	0.2082
L ICA	PSV	81.35	79.25	19.53	17.76	0.52	0.6083
	EDV	29.80	28.65	8.82	6.78	0.81	0.4287
	AV	46.98	45.52	11.49	9.38	0.75	0.4595

R = right side; L = left side; Extra VA = extracranial vertebral artery; Intra VA = intracranial vertebral artery; BA = basilar artery; ICA = internal carotid artery; E1 = test 1; E2 = test 2 or post-rest; PSV = peak systolic velocity; EDV = end diastolic velocity, AV = average velocity.

ference in the reduction of BFV (in PSV) only in the left extracranial VA, comparing the average of BFV variables before (E1) and after rest (E2 or ECR). If the other variables are considered, the reduction is remarkable, with no statistical significance of the BFV in the extracranial VA and ICA on both sides. RI and IP oscillations were below zero, with no statistical significance, and were excluded from the table to reduce its size.

Table 2 shows, in the EG-1, the result of the Student's t-test with a significance level of 0.05 (5%), where there was a significant difference in the reduction of BFV (in EDV and AV) only in the right extracranial ICA, comparing the average of BFV variables before (E1) and after the OM-CRAT. One can notice a slight increase in the BFV in the right intracranial VA and BA, however with no statistical significance.

Table 3 shows, in the EG-2, the result of the Student's t-test with a significance level of 0.05 (5%), where there was a significant difference in the increase of the BFV (in the EDV variable) in the right extra and intracranial VA, comparing the average of tests 1 and 2 of the EG-2. One notices that the other BFV variables follow the increase in the left VA and ICA, however with no statistical significance.

Table 4 shows that at the level of significance of 0.05 (5%), in test 1, all samples are acceptable as from the normal population or with normal flow speed.

Table 2. Comparison between the averages of the flow speed of the tests 1 and 2 in the experimental group-1 (n=29 with mild to moderate neck pain)

Vessel and side	Flow speed	Average (cm/s)		Standard deviation		Statistics *t*	p-value
		E1: Pre-OM-CRAT	E2: Post-OM-CRAT	E1: Pre-OM-CRAT	E2: Post-OM-CRAT		
R Extra VA	PSV	54.59	48.10	17.72	13.62	1.97	0.0583
	EDV	15.83	14.76	5.37	5.37	0.95	0.3488
	AV	29.23	25.78	9.17	7.26	1.88	0.0712
L Extra VA	PSV	53.03	52.52	11.45	15.86	0.23	0.8203
	EDV	16.34	16.93	3.74	5.90	-0.77	0.4498
	AV	28.57	28.79	5.05	8.47	-0.18	0.8558
R Intra VA	PSV	50.55	52.10	13.14	11.39	-1.00	0.3268
	EDV	24.48	25.52	5.42	6.17	-1.19	0.2445
	AV	33.17	34.38	7.60	7.55	-1.16	0.2577
L Intra VA	PSV	57.00	55.14	12.63	12.32	1.19	0.2456
	EDV	27.07	26.03	5.96	5.76	1.24	0.2268
	AV	37.05	35.74	7.70	7.59	1.29	0.2059
BA	PSV	65.59	67.03	11.63	16.40	-0.61	0.5443
	EDV	30.31	31.55	5.67	7.11	-0.95	0.3521
	AV	41.18	42.57	8.44	10.96	-0.86	0.3962
R ICA	PSV	80.08	78.88	20.87	24.55	0.38	0.7077
	EDV	29.96	26.08	8.15	9.22	2.57	*0.0167
	AV	46.67	43.68	11.16	11.95	2.17	*0.0396
L ICA	PSV	84.35	83.77	21.93	24.19	0.17	0.8636
	EDV	32.12	31.50	9.14	6.35	0.41	0.6832
	AV	49.53	48.92	12.05	11.15	0.34	0.7401

R = right side; L = left side; Extra VA = extracranial vertebral artery; Intra VA = intracranial vertebral artery; BA = basilar artery; ICA = internal carotid artery; E1 = test 1; E2 = test 2 or post-rest; PSV = peak systolic velocity; EDV = end diastolic velocity, AV = average velocity.

Table 3. Comparison between the averages of tests 1 and 2 in the experimental group-2 (n=15 with severe neck pain and occasional mild dizziness)

Vessel and side	Flow speed	Average (cm/s)		Standard deviation		Statistics *t*	p-value
		E1: Pre-OM-CRAT	E2: Post-OM-CRAT	E1: Pre-OM-CRAT	E2: Post-OM-CRAT		
R Extra VA	PSV	51,93	52,20	14.43	12.85	-0.101	0.9212
	EDV	15.53	17.93	6.61	6.04	-2.462	*0.0274
	AV	27.67	29.36	8.62	7.97	-1.212	0.2455
L Extra VA	PSV	53.33	53.20	10.47	10.02	0.053	0.9583
	EDV	18.13	18.73	3.93	4.32	-0.609	0.5520
	AV	29.87	30.22	5.79	5.74	-0.251	0.8054
R Intra VA	PSV	44.67	47.20	10.95	13.13	-1.036	0.3178
	EDV	21.13	23.73	5.38	6.86	-2.295	*0.0377
	AV	28.98	31.56	7.13	8.89	-1.661	0.1189

Continue...

Table 3. Comparison between the averages of tests 1 and 2 in the experimental group-2 (n=15 with severe neck pain and occasional mild dizziness) – continuation

Vessel and side	Flow speed	Average (cm/s)		Standard deviation		Statistics *t*	p-value
		E1: Pre-OM-CRAT	E2: Post-OM-CRAT	E1: Pre-OM-CRAT	E2: Post-OM-CRAT		
L Intra VA	PSV	55.87	53.00	15.24	14.25	1.747	0.1026
	EDV	25.73	24.33	6.09	7.94	1.015	0.3274
	AV	35.78	33.89	9.01	9.76	1.387	0.1870
BA	PSV	64.47	63.97	9.97	16.06	0.185	0.8559
	EDV	28.93	29.47	5.09	6.72	-0.327	0.7483
	AV	40.78	40.96	6.51	9.59	-0.089	0.9301
R ICA	PSV	84.47	82.47	20.04	27.41	0.421	0.6801
	EDV	34.80	32.60	8.70	9.55	0.880	0.3937
	AV	51.36	49.22	11.75	15.15	0.707	0.4912
L ICA	PSV	80.80	86.73	16.61	14.47	-1.552	0.1431
	EDV	36.13	35.60	7.73	11.10	0.221	0.8225
	AV	51.02	52.64	9.78	11.79	-0.631	0.5383

R = right side; L = left side; Extra VA = extracranial vertebral artery; Intra VA = intracranial vertebral artery; BA = basilar artery; ICA = internal carotid artery; E1 = test 1; E2 = test 2 or post-rest; PSV = peak systolic velocity; EDV = end diastolic velocity, AV = average velocity.

Table 4. Kolmogorov-Smirnov Normality Test - Test 1

Vessel and side	Flow speed	CG (n=29)		EG-1 (n=29)		EG-2 (n=15)	
		d	p	d	p	d	p
R Extra VA	PSV	0.1396	p>0.20	0.1352	p>0.20	0.1685	p>0.20
L Extra VA		0.1561	p>0.20	0.1650	p>0.20	0.1633	p>0.20
R Intra VA		0.1393	p>0.20	0.1938	p>0.20	0.1489	p>0.20
L Intra VA		0.1413	p>0.20	0.1089	p>0.20	0.1197	p>0.20
BA		0.1576	p>0.20	0.0942	p>0.20	0.1768	p>0.20
R ICA		0.1544	p>0.20	0.1520	p>0.20	0.0992	p>0.20
L ICA		0.1328	p>0.20	0.1361	p>0.20	0.1562	p>0.20
R Extra VA	EDV	0.1557	p>0.20	0.1101	p>0.20	0.1211	p>0.20
L Extra VA		0.1212	p>0.20	0.1454	p>0.20	0.1176	p>0.20
R Intra VA		0.1516	p>0.20	0.1886	p>0.20	0.1197	p>0.20
L Intra VA		0.1104	p>0.20	0.1183	p>0.20	0.1709	p>0.20
BA		0.1068	p>0.20	0.1381	p>0.20	0.1614	p>0.20
R ICA		0.1238	p>0.20	0.1249	p>0.20	0.1774	p>0.20
L ICA		0.1351	p>0.20	0.1225	p>0.20	0.1421	p>0.20
R Extra VA	AV	0.1401	p>0.20	0.1249	p>0.20	0.2215	p>0.20
L Extra VA		0.1576	p>0.20	0.1146	p>0.20	0.1768	p>0.20
R Intra VA		0.1464	p>0.20	0.1569	p>0.20	0.1273	p>0.20
L Intra VA		0.1595	p>0.20	0.1147	p>0.20	0.1469	p>0.20
BA		0.0971	p>0.20	0.0975	p>0.20	0.1191	p>0.20
R ICA		0.1071	p>0.20	0.1594	p>0.20	0.1514	p>0.20
L ICA		0.1746	p>0.20	0.1069	p>0.20	0.1486	p>0.20

CG = control group (n=29); EG-1 = experimental group 1 (n=29); EG-2 = experimental group 2 (n=15); R = right side; L = left side; Extra VA = extracranial vertebral artery; Intra VA = intracranial vertebral artery; BA = basilar artery; ICA = internal carotid artery; E1 = test 1; E2 = test 2 or post-rest; PSV = peak systolic velocity; EDV = end diastolic velocity, AV = average velocity.

Table 5 shows that at the level of significance of 0.05 (5%), in test 2, all samples are acceptable as from the normal population or with normal flow speed.

Table 6 shows the comparison of the three groups (CG, EG-1, EG-2) in test 1, where there is a small significance only in the EDV of the right ICA in the CG with the EG-2 (Tukey test). The other arteries and variables did not show significant differences

Table 7 shows the comparison of the three groups (CG, EG-1, EG-2) in test 2, with significance only in the EDV of the left ICA in the CG with the EG-2. The other arteries and variables did not show significant differences.

Table 5. Kolmogorov-Smirnov Normality Test - Test 2

Vessel and side	Flow speed	CG (n=29)		EG-1 (n=29)		EG-2 (n=15)	
		d	p	d	p	d	p
R Extra VA	PSV	0.1734	p>0.20	0.1356	p>0.20	0.0987	p>0.20
L Extra VA		0.1706	p>0.20	0.1650	p>0.20	0.1292	p>0.20
R Intra VA		0.1221	p>0.20	0.1938	p>0.20	0.2630	p>0.20
L Intra VA		0.0628	p>0.20	0.1089	p>0.20	0.0962	p>0.20
BA		0.1514	p>0.20	0.0942	p>0.20	0.1593	p>0.20
R ICA		0.1881	p>0.20	0.1520	p>0.20	0.1503	p>0.20
L ICA		0.1289	p>0.20	0.1361	p>0.20	0.1711	p>0.20
R Extra VA	EDV	0.2213	p>0.10	0.1101	p>0.20	0.1136	p>0.20
L Extra VA		0.1003	p>0.20	0.1454	p>0.20	0.1367	p>0.20
R Intra VA		0.1227	p>0.20	0.1886	p>0.20	0.2178	p>0.20
L Intra VA		0.1076	p>0.20	0.1183	p>0.20	0.1489	p>0.20
BA		0.1893	p>0.20	0.1381	p>0.20	0.1350	p>0.20
R ICA		0.1236	p>0.20	0.1249	p>0.20	0.1891	p>0.20
L ICA		0.9351	p>0.20	0.1225	p>0.20	0.1831	p>0.20
R Extra VA	AV	0.2187	p>0.15	0.1249	p>0.20	0.1468	p>0.20
L Extra VA		0.1386	p>0.20	0.1146	p>0.20	0.1362	p>0.20
R Intra VA		0.1238	p>0.20	0.1569	p>0.20	0.2654	p>0.20
L Intra VA		0.0687	p>0.20	0.1147	p>0.20	0.1745	p>0.20
BA		0.1343	p>0.20	0.0975	p>0.20	0.1514	p>0.20
R ICA		0.2296	p>0.20	0.1594	p>0.20	0.1409	p>0.20
L ICA		0.1643	p>0.20	0.1069	p>0.20	0.1431	p>0.20

CG = control group (n=29); EG-1 = experimental group 1 (n=29); EG-2 = experimental group 2 (n=15); R = right side; L = left side; Extra VA = extracranial vertebral artery; Intra VA = intracranial vertebral artery; BA = basilar artery; ICA = internal carotid artery; E1 = test 1; E2 = test 2 or post-rest; PSV = peak systolic velocity; EDV = end diastolic velocity, AV = average velocity.

Table 6. ANOVA and post-hoc test (Tukey test) - Test 1

Vessel and side	Flow speed	ANOVA		TUKEY - p		
		F	p	CG and EG1	CG and EG-2	EG-1 and EG-2
R Extra VA	PSV	0.89	0.4158	0.3824	0.8226	0.8698
L Extra VA		0.04	0.9586	0.9555	0.9864	0.9966
R Intra VA		1.34	0.2683	0.5202	0.7972	0.2703
L Intra VA		0.09	0.9185	0.9152	0.9967	0.9653
BA		0.36	0.6998	0.6776	0.9073	0.9591
R ICA		0.20	0.8204	0.9175	0.9708	0.8166
L ICA		0.16	0.8561	0.9482	0.9681	0.8477
R Extra VA	EDV	0.02	0.9829	0.9991	0.9820	0.9882
L Extra VA		0.75	0.4749	0.5828	0.9679	0.5390
R Intra VA		1.83	0.1675	0.5600	0.5610	0.1480
L Intra VA		0.20	0.8192	0.9588	0.9142	0.8030
BA		0.38	0.6840	0.7257	0.9974	0.7640
R ICA		3.06	0.0545	0.7499	0.0489	0.1538
L ICA		1.90	0.1592	0.7934	0.1442	0.3306
R Extra VA	AV	0.48	0.6189	0.5965	0.9599	0.8568
L Extra VA		0.30	0.7452	0.7730	0.9995	0.8207
R Intra VA		1.67	0.1950	0.5157	0.6674	0.1827
L Intra VA		0.12	0.8881	0.9340	0.9859	0.8936
BA		1.16	0.3198	0.3264	0.5513	0.9887
R ICA		1.03	0.3543	0.9966	0.4093	0.4117
L ICA		0.35	0.7030	0.8641	0.6830	0.9119

CG = control group (n=29); EG-1 = experimental group 1 (n=29); EG-2 = experimental group 2 (n=15); R = right side; L = left side; Extra VA = extracranial vertebral artery; Intra VA = intracranial vertebral artery; BA = basilar artery; ICA = internal carotid artery; E1 = test 1; E2 = test 2 or post-rest; PSV = peak systolic velocity; EDV = end diastolic velocity, AV = average velocity.

Table 7. ANOVA and post-hoc test (Tukey test) - Test 2

Vessel and side	Flow speed	ANOVA		TUKEY - p		
		F	p	CG and EG-1	CG and EG-2	EG-1 and EG-2
R Extra VA	PSV	0.49	0.6164	0.9792	0.6033	0.7042
L Extra VA		0.27	0.7619	0.8243	0.7952	0.9867
R Intra VA		1.33	0.2701	0.3252	0.9958	0.4057
L Intra VA		0.17	0.8412	0.9950	0.8373	0.8765
BA		0.42	0.6569	0.6545	0.9920	0.8178
R ICA		0.57	0.5685	0.7663	0.5503	0.8884
L ICA		0.62	0.5401	0.7325	0.5259	0.8931
R Extra VA	EDV	1.24	0.2949	0.8840	0.4726	0.2676
L Extra VA		0.66	0.5207	0.9973	0.5343	0.5705
R Intra VA		1.08	0.3459	0.3337	0.9578	0.6386
L Intra VA		1.03	0.3614	0.6939	0.3393	0.7409
BA		0.76	0.4715	0.5052	0.9999	0.6221
R ICA		2.41	0.0991	0.7070	0.3540	0.0811
L ICA		3.33	0.0426	0.4490	0.0328	0.2522
R Extra VA	AV	0.86	0.4277	0.9885	0.5011	0.4299
L Extra VA		0.41	0.6672	0.9212	0.6408	0.8296
R Intra VA		1.24	0.2945	0.3114	0.9944	0.5036
L Intra VA		0.53	0.5894	0.8816	0.5604	0.8014
BA		1.52	0.2256	0.2029	0.6155	0.8799
R ICA		1.18	0.3159	0.9985	0.3684	0.3560
L ICA		1.89	0.1608	0.5402	0.1372	0.5388

CG = control group (n=29); EG-1 = experimental group 1 (n=29); EG-2 = experimental group 2 (n=15); R = right side; L = left side; Extra VA = extracranial vertebral artery; Intra VA = intracranial vertebral artery; BA = basilar artery; ICA = internal carotid artery; E1 = test 1; E2 = test 2 or post-rest; PSV = peak systolic velocity; EDV = end diastolic velocity, AV = average velocity.

DISCUSSION

In this study, the OM-CRAT was performed in several directions of joint mobilization, within the physiological limits of the cervical spine, but without using the extension positioning associated with rotation[5,6].

The OM-CRAT increased the BFV in the cerebral circulation through the right VA and left CA (in EG-2, Table 3) and the right VA and BA (in the EG-1, Table 2), where other studies presented similar results[5,15].

In the three groups, for tests 1 and 2, all the samples were acceptable as from the normal population or with normal BFV (Tables 4 and 5), and the same result was confirmed in other studies in comparison with the normal population, but with no other therapy[12,25]. Thus, in this study, even with a small reduction in some BFV variables (Tables 1 and 2), one can see that there were no hypoflow or vascular insufficiency of the arteries examined by ultrasonography.

Despite having significant BFV oscillations or not, the result of all the tables can be considered as normal variables of the BFV. Therefore, it is possible to state that OM-CRAT (with *sliding and rotation*) influences the BFV oscillations within the normality parameters in the three cervical-cerebral arteries (ICA, VA, BA), with no risks to the circulatory system to the population with mechanic neck pain of mild to severe intensity, with and without mild and occasional dizziness.

The results are also correlated with the references that the cervical vertebral manipulation does not cause undue injuries on the VA or CA, not being a risk factor or injury to the vertebrobasilar or carotid arteries[5,15,16,21-24].

In a detailed analysis of the arteries and/or between one side and the other of the arteries (Tables 1, 2 and 3), it is noted that the BFV increases or decreases, generating flow compensations in the same moment.

Regarding EG-2, with a history of occasional dizziness related to the neck pain, it is in agreement with the descriptions of the references that mechanical neck pain can be associated to dizziness due to the mechanical vertebral dysfunction and to the pain that disturbs the innervation and the posture control system[4,7-9].

After the OM-CRAT, all individuals reported a sensation of well-being, relaxation and/or reduction in the neck pain.

As in other studies, the whiplash trauma due to a car accident is considered the main cause of VA and ICA injuries[21,23]. These cases require caution and investigation to know if cervical OM is contraindicated or not.

STUDY LIMITATIONS

The sample size was considered small for the duration of the study, and it should be taken into account the audience restriction due to the inclusion and exclusion criteria. The variables of the study that could interfere in the evaluation of the circulation and OM-CRAT were age, gender, physical fitness, anatomical differences of the arteries diameter, muscle-articular dysfunctions, cervical ROM and state of emotional stress.

CONCLUSION

The results of the vascular ultrasound showed that the BFV oscillations were within the normality parameters in patients submitted to OM-CRAT (EG-1 and EG-2) and at rest (CG).

ACKNOWLEDGMENTS

To the professionals of the scientific council of the Escuela de Osteopatía de Madrid, of the Post-graduation in Communication Disorders of the University of Tuiuti of Paraná, and the Research Ethics Committee of the General Hospital of the Federal University of Paraná. Also, to my friend Genoveva Freire D' Aquino, my aunt Viviana R. Zurro and my beloved wife, Karin Teuber Stelle.

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