European Journal of Osteopathy
& Related Clinical Research

ORIGINAL ARTICLE

Immediate Effects of Occipito-atlo-axoid manipulation on Foot Support: Baropodometric Study

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Received: June 12th, 2012; accepted: July 18th, 2012

ABSTRACT

Keywords:
Spinal manipulation;
atlantooccipital joint;
atlantoaxial joint;
propioception;
weight support.

Introduction: Postural balance is maintained thanks to a continually changing system of inputs and outputs. The goal of these changes is to maintain the sight and labyrinthine centres horizontal. To do this, the upper cervical spine has an important role, ensuring the head's direction within the area. This study is about assessing the effect on the support of proprioceptive normalisation of the suboccipital spine.

Objectives: To assess immediate changes in pressure distribution on the arch support after occipito-atlo-axoid thrust (OAAT).

Material and methods: A single blind randomised controlled trial (RCT) of an experimental explanatory nature was carried out using the strategy of a blind (no connection between the assessor and inspector) assessor. Each subject was assessed before and after the procedure or placebo using a pressure platform. The subjects were assessed without footwear receiving standardised orders. The sample had 46 subjects (25 men and 22 women) with an average age of 24.98±3.04. For comparison between groups of the variance for parametric variables, the ANOVA statistic was used and for the non-parametric variables the Mann Whitney U test was used.

Results: An increase was seen in the "maximum pressure" (p=0.044) and in the "load percentage on the left foot" (p=0.048) coming close to equitable bilateral distribution.

Conclusions: Occipito-atlo-axoid manipulation increases the maximum support pressure and approaches the percentage for equitable bilateral load distribution in healthy subjects. The results could lead to considering changes in support after the technique, which must be verified in later studies with larger samples.

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INTRODUCTION

Foot support changes with modifications to postural balance[1]. Postural balance is governed by a complex system of inputs and outputs, the first coming from the somatosensory, vestibular and visual systems[1-4] and the second aimed at the muscles, both coordinated by the cerebral cortex, cerebellum and basal ganglia[5]. Therefore, this refers to a continuous dynamic process that seeks balance against gravity and has an effect on support.

The support area, along with control of active body alignment, anti-gravitational tone, the visual range and internal references determine postural direction and balance[2].

Somatosensory information obtained through proprioceptors and exteroceptors plays an important role in maintaining balance[6-8]. These receptors are incorporated into the fascia framework that extends throughout the body[9-11], in such a way that change in fascia tissue can be a cause for alternation in balance[12].

Cervical spine and balance

The articular and periarticular structures of the cervical spine, above all the upper cervical complex, are provided with a large number of mechanoreceptors and nociceptors per unit of mass[10, 11]. Dysfunction of the high cervical spine, therefore, can cause alteration of the somatosensory inputs and affect the workings of the musculoskeletal system, as well as contributing to the appearance of local and regional symptoms[10, 13].

The centre of gravity for balance in the head is immediately before the occipital condyles and, therefore, it tends to move forwards due to gravity.

The posterior cervical muscles take on special importance in this imbalance[10, 14].

Baropodometry

Baropodometry enables registering the characteristics of foot pressure. Knowledge of distribution of foot loads is useful in the diagnosis of the musculoskeletal system and enables the assessment of its biomechanics[15]. It is a non-invasive method, valid for conducting or completing diagnoses and for monitoring treatments[16].

Thrust techniques

High-speed and low-range techniques, also known as thrust, are performed using therapeutic application of an intense movement with specific direction against the motion barrier on joints and other tissues. They frequently cause cavitation, due to the separation of the articular faces. A neurological silence is achieved that inhibits hypertonia of the monoarticular muscles, due to the inverse myotatic reflex mechanism, breaking the irritative articular vicious circle and improving the articular congruence[13].

GOALS

To verify whether the occipito-atlo-axoid thrust technique affects the proprioception of the suboccipital spine, sufficiently as to modify the postural balance and distribution of loads on the arch support.

MATERIAL AND METHODS

Study design

A single-blind randomised controlled clinical trial of an experimental explanatory nature was conducted using the strategy of a blind assessor (no connection between the assessor and inspector).

The subject did not know the group they belonged to and to ensure their blindness, they did not know how many measurements were going to be conducted on them. The assessment was performed before and after the procedure.

Study population

The sample was made up of individuals with no pathology, physiotherapy students at the Cardenal Herrera University CEU in Elche, who fulfilled the criteria for selection into the study.

Selection criteria

Criteria for inclusion: individuals without previous cervical pathology who are Physiotherapy students at the Cardenal Herrera University (CEU) in Elche. The criteria for exclusion was: a) suffering from or having suffered from pathologies of the postural control system (postural captors, central nervous system or locomotor apparatus), b) showing orthopaedic defects or injuries in lower limbs or the spine, c) having suffered traumatic injuries in lower limbs or the spine in the previous 12 months or suffering from the effects of previous injuries, d) having pain at the time of the study, e) showing contraindications to the procedure being studied, f) having received manipulation treatment in the previous six months and g) having had surgery of any type.

Randomisation

The subjects were assigned to groups using simple randomisation.

Study subjects

They formed two groups: OAAT was applied bilaterally to the procedure group (n=26): the same position for pressure was applied to the control group (n=20) as that of the procedure group, but no thrust was performed.

Two adjacent rooms were used to perform the study with identical atmospheric conditions and without any altitude difference between them, always using the same sequence, following the recommendation of the French Association of Posturology[17]. The time between the procedure and post-procedure measurement was always less than one minute.

Study protocol

We informed the subjects of the study's general aspects using an informed consent form, in accordance with the current Spanish legislation (Act 15/1999). After signing the informed consent form, the pre-procedure measurements were taken; then, the related procedures were applied to each group and finally, the measurements were repeated post-procedure.

Assessments performed

A baropodometric[18] platform was used for the assessment (Diagnostic Support S.R.L., "Multisensor Clinical" model; 4 sensors/cm2; 40 captures/second) and the data was recorded by the Milletrix software (Diagnostic Support. V.1.0.0.26). The baropodometric record was performed with the subject's heels aligned in a comfortable position, looking forwards at the eye height, towards a wall 5m away from the subject. A clear panel was positioned at each side closing off a 3 m wide passageway. Silence, a constant temperature (20º-23º) and good light (2000 Lux) were maintained. The baropodometric record lasted five seconds. The measurement was taken without footwear[19, 20] and the orders given to the subject were standardised, so that they did not disproportionately affect the postural attitude[21].

Baropodometric data was recorded for each subject referring to the surface (total support, right hind foot, left hind foot, right forefoot, left forefoot, percentage of the right foot with regards to the total) loads (maximum, average, percentage on the left foot, load over the left forefoot with regard to the load on the left foot, load on the right forefoot with regard to the load on the right foot).

Procedures performed

Procedure group: OAAT was applied bilaterally to the procedure group (n=26). OAAT was applied on rotation on the vertical axis what goes through the odontoid processes of the axis. Neither flexion nor extension was used and very little lateral flexion, always carrying it out bilaterally. It managed to restore mobility in a non-specific way in the joints between the occipital, atlas and axis 22. It was performed with the subject in a supine position, the physiotherapist at the side in order to manipulate in a forward feint, looking at the head of the subject at the arm height; the upper hand takes the cranium so that, on turning the subject's head, it stayed between the bed and the head serving to stabilise it, whilst the forearm was located within the extension of the odontoid processes of the axis; the lower hand made contact with the opposite side of the cranium with the thumb behind the mastoid processes, the index finger on the temple, keeping within the axis of the radius, middle finger in the direction of an angle with the eye, ring finger towards the nose, little finger in flexion of the metacarpal phalangeal joint and extension of the interphalangeal joints, is placed under the chin, whilst the forearm rests on the sternum in the direction of the left cranium parallel to the spine.

The technique was performed in two stages: a) light cephalic traction and search for the motion barrier using light circumduction movements, b) the left hand makes a movement in pure rotation, at the same time that the cranium makes an axial traction in the axis of the odontoids of the axis. Both actions must make up a helicoidal movement towards the end of the bed[13].

Control group: the same position for pressure was applied to the control group (n=20) as the procedure group, but no thrust whatsoever was performed to rule out the exteroceptive effect related to contact by the physiotherapist and articular movement without thrust.

Statistical analysis

Statistical analysis was conducted using the SPSS programme version 15.0. For the descriptive analysis the average and the standard deviation were calculated. To verify normality the Kolmogorov-Smirnov test was carried out and for homoscedasticity the Levene test.

To assess the pre/post intergroup differences the T test was used for related samples (if normality and homoscedasticity were fulfilled) or the Mann-Whitney U test (if they were not fulfilled).

To conduct the analysis of pre/post intergroup differences between groups, we used the ANOVA statistic. The value of significance was established at $p<0.05$.

RESULTS

Characteristics of the subjects

The sample included 46 subjects (24 men and 22 women) divided into 2 groups; procedure (26 subjects) and control (20 subjects).

The age ranged between 19 and 31 with an average of 25.0± 3.1, the average weight was 68.1±8.4 kg, whilst the average height was 171.2±8.4 cm. This means that the Body Mass Index (BMI) was at an average value of 23.3±1.7.

The average physical activity was 2.63±2.83 hours weekly, with 0 as the most frequent value (43.5% of the subjects).

With the T test on students (Mann-Whitney for the non-parametric variables), we verified the differences according to the pre-procedure characteristics of the sample. No differences were identified according to the level of physical activity (measured in three intervals: 0, 1-5, +6 hours).

The area of total support was better in men than women. There were no significant differences in the baropodometric records in connection to age (in 2 intervals: 19-25 and 26-32 years).

The overweight subjects (BMI>24.9) showed a maximum support pressure, greater than those who showed normal BMI ($p=0.044$).

Effects of the procedure technique

To check the effect of the procedure, the percentage of change between the pre-procedure and post-procedure records was calculated.

An increase of 4.72±11.75% was identified in the maximum pressure ($p=0.044$), in addition to a reduction of -3.33±5.02% in the area of support of the left hind foot ($p=0.042$) over the control group.

For the right foot, the area of support of the hind foot after the procedure was reduced by -2.21±6.79, although the latter did not reach the significant level ($p=0.077$).

Approach towards symmetry of the load between both feet after the procedure also occurred ($p=0.048$).

Variables	Pre (n= 26)	Post (n= 26)	Confidence interval for the average at 95%	K-S test (pre/post)	p
SupTotal	188.52±26.59	184.79±26.68	[(-4.24) - 0.44]	0.200/0.200	0.061
PrMax	737.53±115.54	772.53±155.31	[(-0.02) - 9.47]	0.200/0.042	0.036
PrMed	379.02±43.65	396.15±69.93	[(-0.61) - 9.51]	0.200/0.035	0.036
SupApizq	55.96±10.10	54.82±9.62	[(-5.84) - 2.67]	0.200/0.001	0.336
SupApDch	58.11±11.06	56.39±11.16	[(-6.64) - 1.15]	0.200/0.200	0.042
SupRpIzq	37.09±5.05	37.02±5.06	[(-2.24) - 2.04]	0.198/0.200	0.666
SupRpDch	37.31±4.81	36.42±4.87	[(-4.95) - 0.53]	0.200/0.200	0.027
%cargaRpIzq	52.42±6.48	52.54±6.01	[(-1.66) - 1.90]	0.200/0.200	0.459
%cargaRpDch	54.76±7.71	54.66±7.96	[(-1.46) - 1.26]	0.056/0.200	0.081
%SupDch	50.60±1.65	50.28±2.55	[(-1.56) - 0.93]	0.200/0.200	0.604
%CargaIzq	49.05±2.83	49.81±1.13	[(-0.10) - 1.63]	0.182/0.200	0.125

Table 1.- Baropodometric data for the procedure group

SupTotal=Total support area (cm2); PrMax=maximum pressure (g/cm2); PrMed=Average pressure (g/cm2); SupApIzq/SupApDch/SupRpIzq/SupRpDch=Area of support of the left forefoot, right forefoot, left hind foot and right hind foot respectively (cm2); %cargaRpIzq=Percentage of load on the left hind foot with respect to the total load on the left foot; %cargaRpDch=percentage of load on the right hind foot with respect to the total load on the right foot; %SupDch=percentage of support area of the right foot with respect to the total area; %Carga Izq=percentage of load on the left foot with respect to the total load. The confidence interval shown indicates the pre-post percentage increase.

Variables	Pre (n= 20)	Post (n= 26)	Confidence interval for the average at 95%	K-S test (pre/post)	p
SupTotal	176.19±12.06	175.22±10.87	[(-1.42) - 0.44]	0.001/0.011	0.694
PrMax	776.99±46.17	780.30±49.60	[(-0.68) - 1.52]	0.200/0.200	0.491
PrMed	370.44±23.32	383.91±18.94	(1.83 - 5.76)	0.064/0.001	0.033
SupApizq	55.00±10.57	55.60±10.19	[(-0.86) - 3.85]	0.200/0.200	0.311
SupApDch	56.92±10.44	56.79±9.72	[(-1.61) - 1.86]	0.200/0.200	0.844
SupRpIzq	36.81±6.61	35.52±6.38	[(-5.68) – (-0.98)]	0.200/0.200	0.126
SupRpDch	35.86±5.98	36.25±5.91	[(-1.66) - 4.43]	0.200/0.200	0.112
%cargaRpIzq	53.42±6.43	53.07±5.56	[(-1.66) - 0.95]	0.200/0.200	0.161
%cargaRpDch	54.36±4.28	54.12±4.07	[(-1.53) - 1.05]	0.120/0.200	0.511
%SupDch	51.53±1.77	49.93±1.71	[(-2.61) – (-0.60)]	0.200/0.132	0.103
%CargaIzq	49.29±2.94	48.86±2.89	[(-1.23) - 0.37]	0.200/0.199	0.164

Table 2.- Baropodometric data for the control group

Variables are the same as table 1. Values expressed as an average ± the standard deviation.

	Control	Procedure	p-value (*ANOVA/ Mann Whitney U**)
SupTotal	-0.49±1.98	-1.90±5.80	0.176 (‡)
PrMax	0.42±2.35	4.72±11.75	0.044 (‡)
PrMed	3.79±4.19	4.45±12.54	0.626 (‡)
SupApizq	1.50±5.04	-1.5810.53	0.240 (‡)
SupAntDch	-0.24±2.76	-2.75±9.64	0.187 (‡)
SupRpIzq	-3.33±5.02	-0.10±5.31	0.042
SupRpDch	0.12±3.71	-2.21±6.79	0.077
%cargaRpIzq	-0.36±2.79	0.12±4.41	0.674
%cargaRpDch	1.39±6.50	-0.10±3.37	0.881
%SupDch	-1.61±2.15	-0.32±3.09	0.118
%CargaIzq	-0.43±1.71	0.76±2.14	0.048

Table 3.- Results of the comparison between groups of the pre-post percentage increase

Variables are the same as table 1. Values expressed as an average ± the standard deviation.

p-value from ANOVA/ Mann Whitney U(‡)

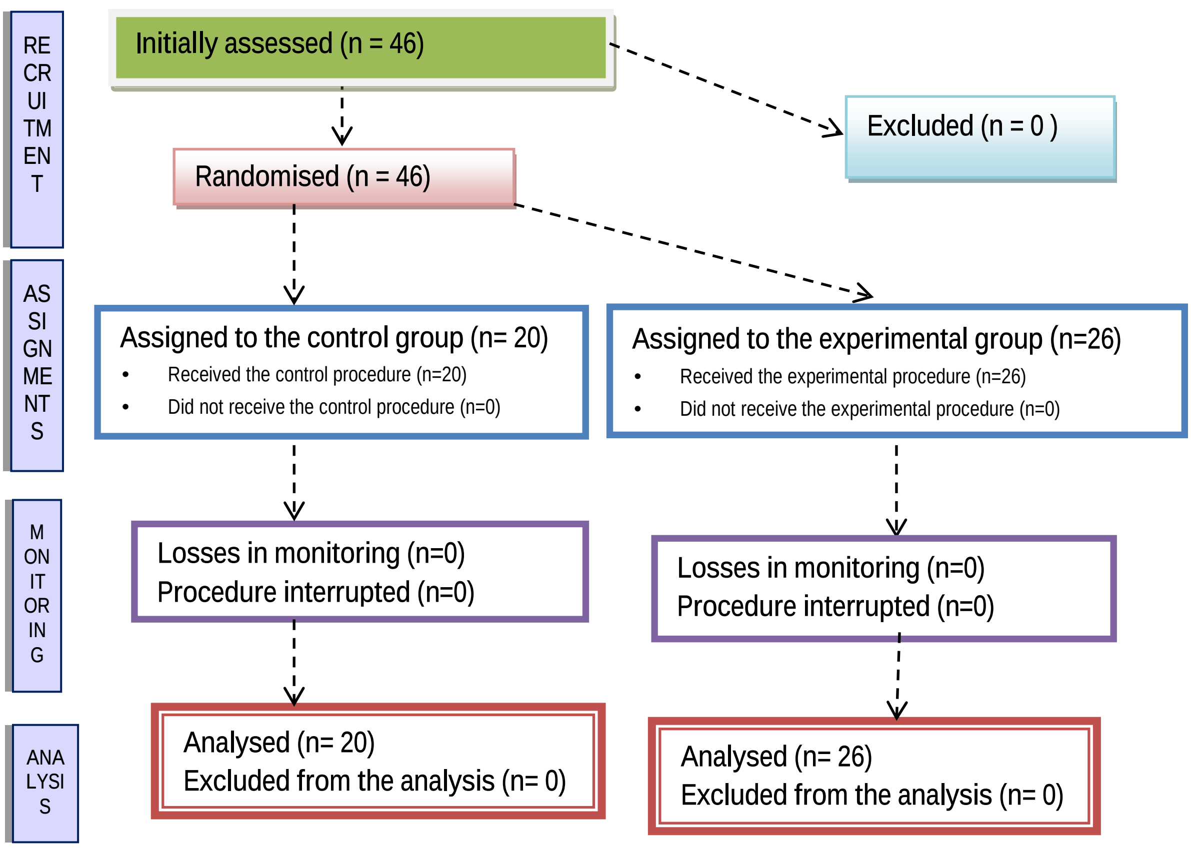

Figure 1.- Flow chart on the distribution of the sample (Consort)

DISCUSSION

The occipito-atlo-axoid manipulation technique changes the baropodometric records. Change in the recorded support shows an increase in the maximum pressure and approach towards symmetry of loads between both feet. Significant changes are also seen in the area of support, although not attributable to the procedure.

Baropodometry has been effectively used in the assessment of common balance disorders, as well as in assessing the effectiveness of a treatment in changes to the central nervous system (cerebellar ataxia[23], incomplete spinal cord injury [24], cervical polyneuropathy [25]…), alterations to the postural captors (vestibulars[26], Menieres disease[27], visual[28], proprioceptive [7, 29-31], cranio-mandibular [32, 33]) or alterations of musculoskeletal elements (gonarthritis[34], articular prostheses[35], lumbago[36], articular reconstruction surgeries[37], spinal defects[38, 39], ankle sprains[40], foot surgery[41, 42], treatment of foot defects with orthotics[43, 44]).

Thrust techniques

Different thrust techniques for the cervical spine were studied to show reduction in pain and increase in the range of mobility [45-48]. Others looked for effects through the action on the autonomous nervous system (changes in pupil reaction[49], in intra-ocular pressure [50] or blood pressure [50, 51]).

The change in baropodometric parameters were studied after the application of certain manual techniques such as overall manipulation of the pelvis [52], decompression of the tibioperoneal astragalus[53], correction of anterior dysfunction in the astragalus [40] or dysfunction of the forefoot varus [54]. The usefulness of the baropodometry is recognised for the study of the somasensatory effect of the thrust techniques[55].

OAAT was studied to establish what its effects are on the mouth's opening range and on pain in the clamping points of the masticatory muscle[56], ocular pressure and blood pressure[50]. In our bibliographic review, we have not found evidence that any study has been conducted on the effect of OAAT on the balance and distribution of foot loads through pressure platforms.

Thrust techniques on the cervical spine have an effect on the cortical areas of the somasensatory integration[57]. The somasensatory effect of OAAT can help improve the head's balance on the spine and, therefore, stability is balanced with the subject approaching symmetry of load between both feet.

The sympathetic effect related to the stimulation of the upper cervical ganglion and release of possible fascia pressure causing small reductions in the vertebral arteries' lumen can help improve vascularisation of the cephalic postural captors and the integration centres of the central nervous system and, thereby, improve function in the postural balance system. In order to confirm this aspect, it would be important, in future research, to assess the OAAT´s effect on the vertebral or carotid arterial lumen.

We did see some evidence that variables of sex, age, physical activity or BMI in the described intervals influence the OAAT effects.

Limits and future research

a) Measurement standardisation. Support continuously changes and our protocol assessed the support for 5 seconds, which makes up a baropodometric recording limit. On indicating specific orders and aware of what is observed maintenance of balance is done consciously and this situation could change the distribution of loads on feet. Use of different assessment protocols could be the subject of future research.

b) By referring to healthy subjects, the information that we obtain is on the technique's physiology and not on its clinical effects. The application of this technique on subjects with instability where the proprioceptive captor is changed (such as for example cerviogenic proprioceptive vertigo[17, 58]), could be the subject of future research. In these cases, we might also find secondary cervical vertigo at temporary alteration of blood flow of one of the vertebral arteries, due to the articular injury or cervical somatic dysfunction[59].

c) Due to the much higher standard deviations seen and much lower effects, the low sample size may have discounted small differences. Future research could be carried out with a large sample.

d) A non-specific overall technique that generally restores mobility in the region, so that it would not be necessary to assess whether each individual showed or not specific dysfunctions in the suboccipital spine. Validation is needed of diagnostic test for cervical mobility[60, 61],in order to determine the stabilometric nature of each osteopathic dysfunction and to apply specific techniques for each of them.

CONCLUSIONS

Occipito-atlo-axoid manipulation applied on subjects without cervical pathology achieves a symmetric approach on the distribution of the loads supported between both feet. The results encourage us to consider changes in support after the technique, which must be verified in later studies with larger samples.

ETHICAL STANDARDS

The Helsinki Declaration recommendations on clinical research (2004) have been followed. Confidentiality of data was guaranteed at all times, in accordance with the 15/1999 Data Protection Act.

CONFLICT OF INTEREST

The authors declare they do not have any conflict of interest.

ACKNOWLEDGEMENTS

We would like to thank all those people who took part in the study and who have made this research possible.

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