PAPER DETAILS

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Do anthropometric characteristics of head and neck affect the craniocorpographic balance measurement?

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Abstract

Objectives: The present work aimed to study the relationship of some head and neck anthropometric characteristics with the data obtained from balance analysis.

Methods: Thirty healthy male volunteers participated in the study. The measurements obtained at the same time of day (10:00–12:00). Craniocorpography section of the CMS20P-2 (Zebris© Medical GmbH, Isny im Allgäu, Germany) was used for measurements. The head length, head circumference, head width, neck circumference and neck width and length anterior-posterior diameter were measured. As the balance values, the longitudinal deviation, lateral sway width, angular deviation, self-spin, longitudinal sway, lateral sway, angle of torticollis were evaluated. The relationships between data were compared statistically.

Results: The head length showed moderate correlation with lateral sway width (r=-0.29), self-spin (r=-0.35) and lateral sway (r=0.28). A moderate positive relationship was found between the head length and longitudinal deviation. The correlation was also moderate between neck circumference, neck width and longitudinal sway. Neck circumference and neck width values showed a moderate correlation with longitudinal sway (r=0.46 and r=0.36).

Conclusion: The results of this showed that there is a moderate correlation between the balance and the head-neck characteristics.

Keywords: anthropometry; balance; head; neck

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Introduction

Body balance is maintained by a network composed of the brainstem, cerebellum, brain and sensory organs.[1–6] Stimuli received from the proprioceptive receptors and also vestibular and visual stimuli are analysed with this network to maintain balance of our body. Any disturbances in this network may lead to symptoms such as vertigo and tinnitus.[2,3,7–9]

Balance measurement was first performed by Unterberger for the diagnosis of vertigo using the closed-eye stepping test.[2,3,7] Fukuda[5] developed this test and added numerical data to it. In 1968, photographic techniques were added to these tests by Claussen.[1,3,6,10,11] This technique developed by Claussen called craniocorpography (CCG) helped to obtain the data of quantitative and objective balance analysis on patients. The CCG technique relies on recording patients' movements digitally by means of an apparatus with sensors attached to head and shoulder. A computer records the results and prints them into a polar coordinate system.

Previous studies investigated the correlation between balance and body movements in pathological conditions such as vestibular, whiplash, and abnormal psychomotor activity.[1,2,7,10,12] The studies reported that CCG might be useful in the follow-up of pathological conditions.[1,12,13] However, there is no study on the effects of head and neck posture and anthropometric characteristics on CCG data. The aim of the present study, therefore, was to study the relationship of some head-neck anthropometric characteristics with the data obtained from balance analysis by using CCG.

Materials and Methods

Ethical approval was obtained from the Scientific Research Ethics Committee (Decision number: 12/03 Date: 02.05.2012). Thirty healthy volunteer male subjects participated; mean age was 20.27±1.31 years, mean height was 1.77±0.06 m and mean weight 78.67±14.46 kg. Subjects with previous movement system dysfunctions, head and neck injury, vestibular disease and psychomotor activity disorders were not included in the study. The subjects did not have any physical activity on an ongoing basis.

CCG section of the CMS20P-2 device (Zebris© Medical GmbH, Isny im Allgäu Germany) and the WinBalance database were used for balance measurements. The system consists of a main unit, a measuring sensor, a helmet marker, a shoulder marker which transfers the data into the computer software and a computer. The anthropometric data were collected using thr Harpenden anthropometer set (Holtain Ltd., Crymych, Dyfed, Wales, UK)

The measurements of all subjects were carried out at the same time of day (10:00 am–12:00 am). The experimental protocol was explained to each subject before measurement. The head and neck apparatus were then placed. The sensor was placed behind the subject. The subjects were positioned standing upright with their back facing the device, eyes closed and hands parallel to the ground. First, the Romberg test was performed to measure the balance. The balance of the subjects was evaluated by the device for 60 seconds and recorded in the computer environment. After the first measurement, the subjects rested for 5 minutes and then, the Unterberger test was performed. The subjects stepped in situ eyes closed and hands parallel to the ground. The balance of the subjects was evaluated with the device for 60 seconds and recorded in the computer environment. The same examiner measured the head-neck anthropometric data of the subjects three times and the data were recorded by taking the mean of these measurements. For the CCG technique, the following seven parameters were measured in each subject:

- **Longitudinal sway (LONS) (cm):** indicates the shifting distance of head and shoulders frontward and backward during the test period.
- **Lateral sway (LATS) (cm):** indicates the lateral displacement distance of the helmet marker.
- **Torticollis angle (TA) (º):** the degree of the angle between the end positions of head and shoulder at the end of the posture test.
- **Longitudinal deviation (LDEV) (cm):** the measurement of the distance between the starting point and the end point during stepping.
- **Lateral sway width (LATSW) (cm):** the distance of maximal lateral left and right swing movements of head and shoulder during stepping.
- **Angular deviation (ADEV) (º):** the deviation angle of the line combining the starting point and the end point from the midline during stepping.
- **Self-spin (SS) (º):** the angle when the body rotates around its own axis during stepping. It shows the angles between the start and end points of the shoulder marker. Right turn is used as negative direction, and left turn is used as positive direction by the software.

The parameters measured as anthropometric data were:

- **Head length:** the distance between opisthocranion and glabella in an anatomical position.
- **Head circumference:** circumference of the head measured from the line passing over the inion and supraorbital crest.
- **Head width:** it is the distance between the left and right eurion, the most lateral point of the parietal tuberosity.
- **Neck circumference:** circumference of the neck measured just below the laryngeal prominence, perpendicular to the long axis of the neck.
- **Neck width:** the diameter of the neck circumference measured on coronal plane.
- **Neck antero-posterior diameter:** the diameter of the neck circumference measured on sagittal plane.

The SPSS version 20.0 software for Windows (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. The correlation between the data was compared using the Spearman's correlation test. Correlation coefficients (r) of 0–0.24, 0.25–0.49, 0.5–0.74, 0.75–1 were considered as weak, moderate, strong and very strong correlation, respectively.

Results

The demographic and CCG data obtained from our study is shown in **Table 1**. There was a significant moderate negative correlation between head length and SS (r=-0.389; p=0.033) (**Figure 1**). There was a moderate positive correlation with no statistically significant differ-

Table 1
Anthropometric and CCG parameters.

Parameters (n=30)	Mean±SD
Age (year)	20.27±1.31
Height (cm)	1.77±0.06
Weight (kg)	78.67±14.46
BMI	25.04±4.12
ADEV (°)	15.67±15.74
HC (cm)	58.41±1.79
HL (cm)	20.3±0.7
HW (cm)	16.29±1.13
LATS (cm)	3.08±1.6
LATSW (cm)	15.06±9.06
LDEV (cm)	93.05±33.79
LONS (cm)	5.78±1.89
NAP (cm)	11.63±0.64
NC (cm)	38.22±2.44
NW (cm)	11.98±0.6
SS (°)	34.40±30.59
TA (°)	9.90±5.91

ADEV: angular deviation; **BMI:** body mass index; **HC:** head circumference; **HL:** head length; **HW:** head width; **LATS:** lateral sway; **LATSW:** lateral sway width; **LDEV:** longitudinal deviation; **LONS:** longitudinal sway; **NAP:** neck antero-posterior diameter; **NC:** neck circumference; **NW:** neck width; **SS:** self-spin; **TA:** torticollis angle.

ence between head length and LATS (r=0.260; p=0.166). Although there was a moderate negative correlation between head circumference and LATS (r=-0.327; p=0.078) and SS (r=-0.262; p=0.161), it was not significant. There was a moderate positive correlation with no statistically significant difference between head width and LDEV (r=0.308; p=0.098) and LATSW (r=0.313; p=0.092) while there was a moderate negative correlation between it and ADEV (r=-0.318; p=0.086). There was a significant moderate negative correlation between neck circumference and LDEV (r=-0.408; p=0.025) (**Figure 2**). The moderate correlations between LONS, TA and SS and neck circumference were not significant (**Table 2**).

Discussion

It is important to use anthropometric data to design an optimal product in the field of ergonomics. While designing a product, it must be considered that there are number of differences among the individuals.[14] These differences come from the gender, body mass index (BMI), age and ethnic characteristics.[15] The anthropometric methods have been used as a guide in a wide range of areas from the diagnosis of numerous diseases to the suitability of living and working environments. It has been reported that BMI, waist circumference and waist/hip ratio are used to predict the increased risk in

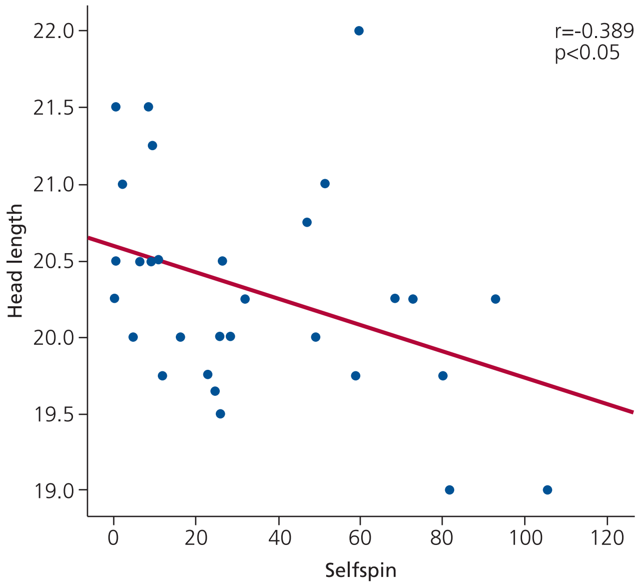

Figure 1. Correlation curve between head length and self-spin.

chronic diseases such as hypertension and diabetes.[16] Although the anthropometric measurements have been used in such conditions, the correlation between CCG and anthropometric measurements is lacking. CCG is a medical investigation and measurement procedure developed in 1968 by Claus-Frenz Claussen for to document and evaluate disorders of the equilibrium.[1,3,6,10,11] The studies on CCG indicated that this device was most use-

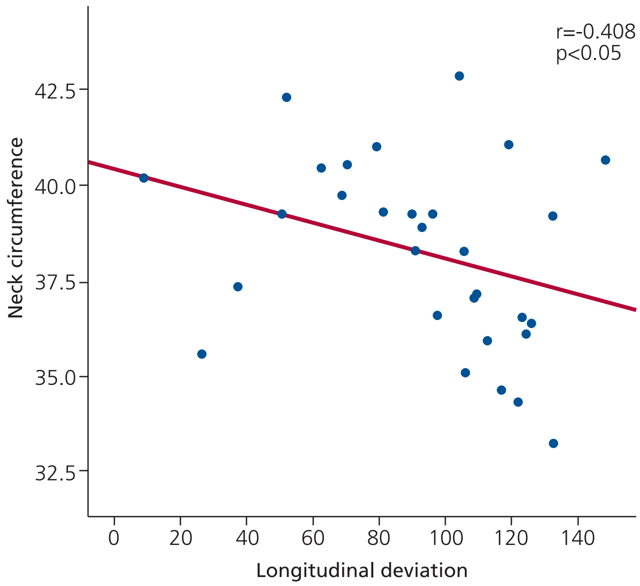

Figure 2. Correlation curve between neck circumference and longitudinal deviation.

Table 2

Spearman correlation analysis for anthropometric and CCG data.

		LONS	LATS	TA	LDEV	LATSW	ADEV	SS
Head length	r	0.170	**0.260**	-0.138	-0.043	-0.118	0.027	**-0.389***
	p	0.368	**0.166**	0.466	0.822	0.536	0.885	**0.033**
Head circumference	r	0.029	-0.020	-0.190	**-0.327**	-0.057	0.045	**-0.262**
	p	0.881	0.918	0.313	**0.078**	0.766	0.814	**0.161**
Head width	r	-0.011	0.130	0.039	**0.308**	**0.313**	**-0.318**	-0.148
	p	0.953	0.493	0.839	**0.098**	**0.092**	**0.086**	0.436
Neck circumference	r	**0.289**	0.185	**-0.256**	**-0.408***	-0.164	0.043	**-0.290**
	p	**0.122**	0.327	**0.173**	**0.025**	0.386	0.822	**0.120**
Neck width	r	**0.314**	-0.007	0.019	-0.076	-0.235	0.003	-0.115
	p	**0.092**	0.969	0.923	0.688	0.212	0.988	0.546
Neck antero-posterior diameter	r	0.237	0.088	**-0.290**	-0.024	0-.188	0.141	-0.086
	p	0.207	0.645	**0.120**	0.900	0.320	0.459	0.653
BMI	r	0.237	0.127	-0.226	-0.272	0.079	-0.013	-0.135
	p	0.208	0.503	0.230	0.146	0.680	0.947	0.478

r: Spearman's correlation coefficient; 0-0.24 poor, 0.25–0.49 moderate, 0.5–0.74 well, 0.75–1 high correlation; **p:** correlation is significant at the 0.05 level; **ADEV:** angular deviation; **LATS:** lateral sway; **LATSW:** lateral sway width; **LDEV:** longitudinal deviation; **LONS:** longitudinal sway; **SS:** self-spin; **TA:** torticollis angle.

ful in the diagnosis and treatment follow-up of peripheral vestibular diseases. Alpini et al.[1] indicated the normal values of the parameters evaluated in the standing test as LONS in the range of 1.75–10.53 cm and LATS in the range of 1.74–7.06 cm. In the stepping test, the normal range of LDEV was defined as 30.03–113.35 cm, LATS as 5.17–16.15 cm, the mean ADEV was defined as 55.13° to the right and 48.37° to the left, and SS as 82.21° to the right, 82.89° to the left. The data obtained from our study was fitting to normal range values. Szirmai et al.[13] found that the longitudinal deviation increased in patients with vestibular system pathology. In our study, we determined a significantly moderate negative correlation between this parameter and neck circumference, and showed that the self-spin value was not affected by vestibular system pathology. However, in another study, it increased in patients with peripheral system disease.[13] Our study revealed that this value was affected by anthropometric data. There was a statistically significant negative correlation between self-spin value and head length.

Serafini et al.[3] showed that angular deviation increased, but lateral sway did not change in patients with peripheral labyrinthine disease. We did not find any correlation between these parameters and anthropometric measurements.

Anthropometry is one of the important factors in the design of ergonomic devices to be used on people. Lacko et al.[17,18] designed easier-to-use EEG headsets by performing anthropometric measurements. With this study, they showed that 3D anthropometry is a suitable tool for ergonomic design. Silva et al.[19] performed 39 different body measurements on Brazilian pilots for the design of aircraft cockpit and hardware. Hsiao[15] made four different anthropometric designs for respiratory device test panel, fire extinguishing mask size, fire truck cabin, fall protection safety belt.

Our results showed that CCG may also be affected by anthropometric data as it is affected by pathological conditions. Therefore, we suggest it is necessary to consider the anthropometric characteristics of the patients while using CCG in clinical diagnosis and follow-up.

Author Contributions

SÇ: design and writing of the study, EU: statistical analysis, AY: interpretation of anthropometric measurements, MP: interpretation of balance measurement, MK: conducting balance measurements, DDA: conducting anthropometric measurements, AZYK: conducting balance measurements.

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