Article
Arq Neuropsiquiatr 2011;69(3):509-512

The use of a neck brace does not influence visual vertical perception

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ABSTRACT
Subjective visual vertical (SVV) evaluates the individual's capacity to determine the vertical orientation. Using a neck brace (NB) allow volunteers' heads fixation to reduce cephalic tilt during the exam, preventing compensatory ocular torsion and erroneous influence on SVV result. **Objective:** To analyze the influence of somatosensory inputs caused by a NB on the SVV. **Method:** Thirty healthy volunteers performed static and dynamic SVV: six measures with and six without the NB. **Results:** The mean values for static SVV were –0.075°±1.15° without NB and –0.372°±1.21° with NB. For dynamic SVV in clockwise direction were 1.73°±2.31° without NB and 1.53°±1.80° with NB. For dynamic SVV in counterclockwise direction was –1.50°±2.44° without NB and –1.11°±2.46° with NB. Differences between measurements with and without the NB were not statistically significant. **Conclusion:** Although the neck has many sensory receptors, the use of a NB does not provide sufficient afferent input to change healthy subjects' perception of visual verticality.
Key words: visual perception, proprioception, saccule, utricle.

O uso do colar cervical não influência na percepção de verticalidade visual

RESUMO
A subjetiva vertical visual (SVV) avalia a capacidade do indivíduo determinar a posição vertical. O uso do colar cervical (CC) fixa a cabeça do voluntário, reduzindo a inclicação cefálica durante o exame e prevenindo a torção ocular compensatória que influencia na SVV. **Objetivo:** Analisar a influência de informações sometossensoriais causadas pelo uso de um CC na SVV. **Método:** Trinta voluntários saudáveis realizaram a SVV estática e dinâmica: seis medidas com e seis medidas sem o CC. **Resultados:** O valor médio da SVV estática foi –0,075°±1,15° sem CC e –0,372°±1,21° com. Na SVV dinâmica no sentido horário foi 1,73°±2,31° sem CC e 1,53°±1,80° com. Na SVV dinâmica no sentido anti-horário foi –1,50°±2,44° sem CC e –1,11°±2,46° com. As diferenças entre as medidas com e sem CC não foram estatisticamente significativas. **Conclusão:** Apesar de o pescoço possuir inumeros receptores sensoriais, o uso do CC não fornece aferências suficientes para alterar a percepção de visual de verticalidade de voluntários saudáveis.
Palavras-chave: percepção visual, propriocepção, sáculo, utrículo.

The ability of humans to spatially orient in relation to the Earth's gravitational axis is important for the maintenance of posture, gait and for most motor activities. This spatial orientation is achieved through four different sensory inputs: the interoceptive, visual, somatosensory and vestibular systems[1-7].

The perception of verticality is represented by the subjective haptic vertical (SHV), the subjective postural vertical (SPV) and the subjective visual

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Support
CAPES (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior) and CNPq (Conselho Nacional de Desenvolvimento Científico e Tecnológico)

Received 7 October 2010
Accepted 9 February 2011

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vertical (SVV). The SHV is determined by manipulating a wooden or metal rod into the Earth-vertical position with the patients' eyes closed and is essentially driven by proprioceptive afferent signals[8]. The SPV is assessed by seating the subjects in a tiltable chair. Vision is blocked and the subjects must state when they perceive that their body is vertically oriented[8-10]; this perception is determined only by interoceptive inputs[9,11]. The SVV is assessed by instructing subjects to adjust a visible line in complete darkness without any references about the real vertical position. This perception depends only on vestibular information with the assistance of the visual clues, independent not only of the somatosensory receptors but also of truncal graviceptors when subjects are in an Earth-vertical position[11-13]. According to Curthoys et al.[14], the change in torsional eye position (following a neurectomy) is accompanied by a change in the perceived visual orientation of a small illuminated line at a straight ahead eye level position in an otherwise completely darkened room.

It has been consistently observed in the literature that the somatosensory inputs influence both the E- and A-effect of SVV. The E-effect is a deviation of the SVV opposite to the head tilt side, when the roll-tilt of the head is less than 45 degrees[15,16]; the A-effect is a deviation of the SVV in the same side to the head tilt, when the roll-tilt of the head is 80-90 degrees. In the A-effect, even normal subjects invariably set the line tilted in the direction of body tilt by some 10-30 degrees[16,17].

Despite the existence of several studies analyzing the SVV in both healthy subjects and vestibular dysfunction patients[2,3,18-21], most of them did not ensure fixation of the volunteers' heads. This procedure (which can be achieved with the use of a neck brace) is essential to reduce cephalic tilt during the exam and to minimize possible A- and E-effects that can generate compensatory ocular torsion and influence the SVV result[14-17]. Based on these observations, the aim of this study was to determine whether the somatosensory inputs that are provided by the use of the neck brace during SVV tests influence the exam's result.

METHOD

Subjects

Thirty healthy volunteers, 23 female (76.7%), aged between 20 and 35 years (mean age 24.17±3.9) were selected. The exclusion criteria included history of any of the following: vestibulopathy (or any previous sensation of dizziness or vertigo), migraine, neurologic and metabolic disease. Subjects who wore visual corrective lenses performed the exam while wearing them.

This study was approved by the University of São Paulo's ethics committee (Comitê de Ética em Pesquisa - CEP, protocol number 364/2008). Written informed consent was obtained from all of the subjects.

Equipment

To assess the SVV, subjects were seated in a 45-cm tall seat and a 30-cm long dark tube was used to isolate the volunteer from visual references. On the white background of a HP Pavilion 15.4" computer, a 11-cm red line was projected for the static SVV[7].

The dynamic SVV was assessed using 1- to 5-cm diameter black circles, randomly distributed on a white background, which could move in either a clockwise or a counterclockwise direction at a velocity of 30°/second[7].

Procedure

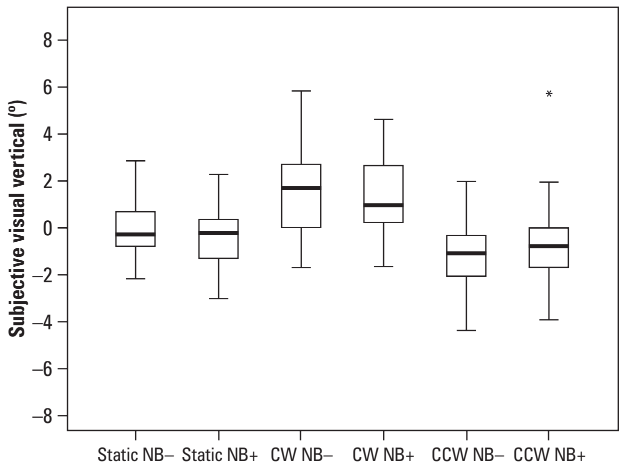
The volunteer remained in a seated upright position, with the right hand on the table to control the computer mouse. The right mouse button could move the line in a clockwise direction and the left mouse button could move it in a counterclockwise direction. The angular deviations of the virtual line were compared to the real vertical and defined as positive if tilted clockwise and negative if tilted in a counterclockwise direction. To minimize the learning effect, each volunteer performed five static SVV measures that were not included in the results of this study. In each session, six measures were performed with the neck brace and six without it. The final result was determined by the mean value of the six measurements in each condition (with and without a neck brace). The exams were performed in the following order: static SVV, clockwise dynamic SVV and counterclockwise dynamic SVV. Between exams, the volunteers rested for five minutes. Furthermore, fifteen volunteers first performed the exam with the neck brace and the other fifteen first performed the exam without the neck brace.

Data analysis

Comparisons of the mean values of the six measures, with and without the neck brace, were performed with SPSS (Statistical Package for Social Sciences) Software 17.0 for Windows. After performing a Shapiro-Wilk test, the variables of static SVV with and without the neck brace and clockwise dynamic SVV with and without the neck brace presented a normal distribution and were analyzed with the Student's t-test, whereas the variables of the counterclockwise dynamic SVV did not present a normal distribution and were analyzed with the Mann-Whitney U test. In all tests, the criterion for statistical significance was two-tailed and set at $\alpha<0.05$.

RESULTS

Figure presents the median values and the interquartile ranges of each SVV condition with and without neck



NB: without neck brace; NB+: with neck brace; CW: clockwise: CCW: counterclockwise.

Figure. Median values and interquartile ranges of each subjective visual vertical condition with and without neck brace.

brace: static SVV, clockwise dynamic SVV and counterclockwise dynamic SVV.

During static SVV, the mean value was very close to the real vertical position (0°) in both conditions, with the neck brace (–0.372°±1.21°) and without it (–0.075°±1.15°). The mean values for dynamic SVV in the clockwise direction were 1.73°±2.31° without a NB and 1.53°±1.80° with a NB. The dynamic SVV in the counterclockwise direction was –1.50°±2.44° without a NB and –1.11°±2.46° with a NB. The differences between the measurements with and without a NB were not statistically significant.

DISCUSSION

Recently, new methods of vestibular system evaluation have been introduced in clinical routines, transforming the investigation of vestibule-ocular reflexes that have originated on otolithic macula[15]. Thus, more thoroughly understanding the functionality of the otolith end organs leads to a more precise diagnosis and consequently to a better therapeutic response. Among these assessments, the determination of the SVV is a simple and low-cost assay of otolithic function[15].

Normal values of static SVV in the Brazilian population vary from –2.0° to +2.4°, independent of age and gender[5]. In the present study, the volunteers exhibited a performance level that can be considered normal, both with and without the neck brace. Although the dynamic SVV results were slightly higher than the static SVV results, the dynamic SVV deviations in clockwise and counterclockwise directions did not exceed the normal limits for static SVV that were found previously[5].

The present study shows that the perception of verticality in healthy volunteers is not affected by somatosensory inputs originating from the use of a neck brace. This result corroborates the findings of Faralli et al.[18], who studied the influence of somatosensory inputs that are provided by the plantar surface (like the neck, the plantar surface is also full of mechanoreceptors and tactile receptors). Faralli et al.[18] found no significant difference in the SVV results in healthy subjects, when comparing the performance with and without proprioceptive inputs from the plantar surface. These data suggest that the otolithic organs are themselves capable of providing the information that is necessary to adjust the SVV, regardless of significant visual or somatosensory external information.

In addition, Mazibrada et al.[2] found no significant bias of static SVV in three patients with bilateral somatosensory deafferentation. Furthermore, Trousselard et al.[16] found that somatosensory inputs were required during body tilt to estimate the SVV and the body orientation. This finding suggests that proprioceptive afferents are more important when the head and body are tilted in order to influence the A- and E-effect. Moreover, it provides evidence for the use of a simple procedure that ensure the fixation of the head for the correct assessment of the visual vertical perception, with no haptic influence. Further studies are necessary to prove not only the influence of proprioceptive stimuli in the perception of visual verticality, but also to check the consequences of that influence in patients with vestibular or neurological dysfunction.

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