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Could lower leg Wartenberg test be used as a predictor of restrictions in temporomandibular joint movements in CP patients?

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Purpose: Patients with spasticity suffer not only from neurological problems but also from various dentistry problems due to spasticity of the jaw muscles. Measurements of motion in temporomandibular joints should reflect the amount of abnormal muscle tone of these muscles. The aim of this study was to find out if the measurements of temporomandibular joint movements performed with the ultrasound Zebris device are different in cerebral palsy patients than in healthy subjects; and to find out if the information on the degree of spasticity in the lower legs provided by the Wartenberg test could be used to predict the degree of spasticty in the jaw muscles. *Method*: Twenty five healthy subjects and 25 cerebral palsy patients participated in the study. Two types of measurements were performed: temporomandibular movements measured with Zebris device, and instrumented Wartenberg test. *Results*: The laterotrusion and opening movements are different in CP patients than in healthy subjects. Laterotrusion movement correlates with velocity measured during the Wartenberg test. *Conclusion*: This finding suggests that high spasticity in the lower legs could indicate jaw movement restrictions in CP patients.

Key words: *spasticity, temporomandibular joints, Zebris, Wartenberg test*

1. Introduction

Patients with spasticity suffer not only from neurological problems (functional disorders, coordination problems, muscular co-contractions, etc.) but also from various dentistry problems, some of which are related to spasticity of the jaw muscles. It was found that cerebral palsy (CP) patients with worse oral-motor performance had a higher rate of caries than CP patients with proper oral-motor performance [8]. CP patients revealed also a high prevalence of enamel defects: 44% [5].

Cerebral palsy patients have various degree of spasticity, present in various parts of the body. Clinically, the presence and degree of spasticity is assessed in the upper and lower limbs, but it is known that it can also be present in the muscles of other parts of the body, for example in the jaw muscles. This is the reason for a high prevalence of speech and other oral-motor dysfunctions (approximately 38% of CP patients have impaired speech) [7]. The clinical tests used for spasticity assessment (Ashworth, Tardieu) are subjective tests, with low accuracy [2]. Therefore, Wartenberg [10] introduced in the 1950s the so-called Wartenberg test (also called pendulum test), from which several indices are calculated. These indices reflect damping of limb movement, and together with the maximum velocity of the limb during this test constitute the measure of the degree of spasticity. The Wartenberg test can be performed either in the upper or (more often) in the lower limbs, but not in other body parts.

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Spasticity of the jaw muscles influences oral-motor ability. Therefore, measurements of motion in temporomandibular joints should reflect the amount of abnormal muscle tone of the jaw muscles. Temporomandibular joints function is usually assessed clinically, using cards [4]. Ultrasound Zebris device enables the objective measurement of temporomandibular joint movements with high reliability and validity [3]. Unfortunately, there is no data if such measurements could differentiate healthy subjects from patients with oral-motor dysfunctions.

Therefore the aims of this study were:

– to find out if the measurements of temporomandibular joint movements performed with the ultrasound Zebris device in cerebral palsy patients differ from the ones taken in healthy subjects;
– to find out if the information on the degree of spasticity in the lower legs provided by the Wartenberg test could be used to predict the degree of spasticty in the jaw muscles.

2. Material and methods

2.1. Material

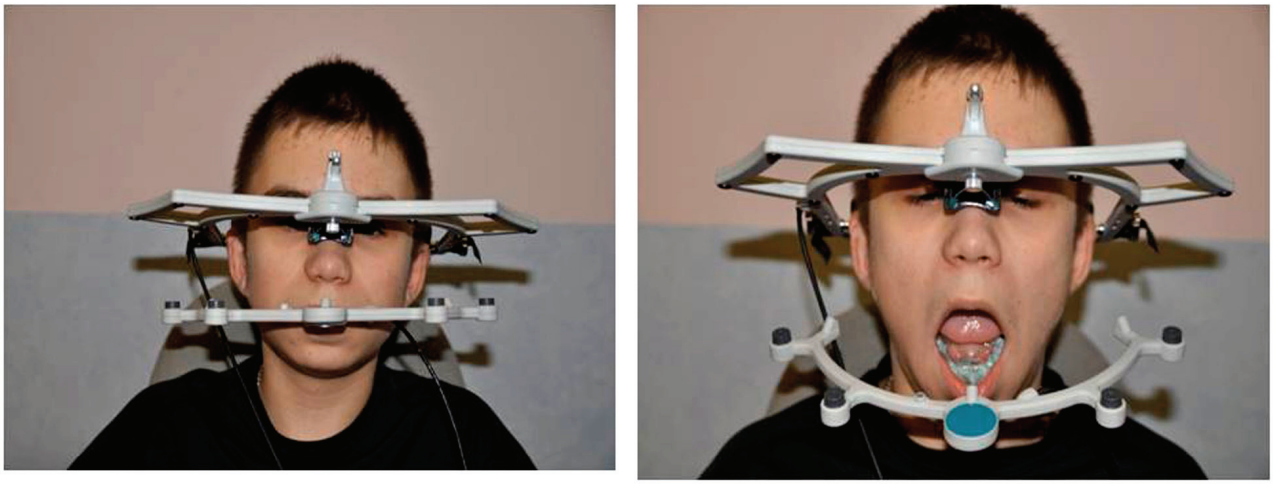
There were two groups of participants taking part in the study. The first group consisted of 25 healthy participants (15 boys, and 10 girls) aged from 7 to 18 years. The second group consisted of 25 cerebral palsy patients with spastic diplegia (14 boys, 11 girls) aged from 7 to 18 years.

All patients were treated at The Children's Memorial Health Institute (CMHI). The study was approved by the Ethical Committee of CMHI.

2.2. Methods

There were two types of tests.

(a) (b)



(c)

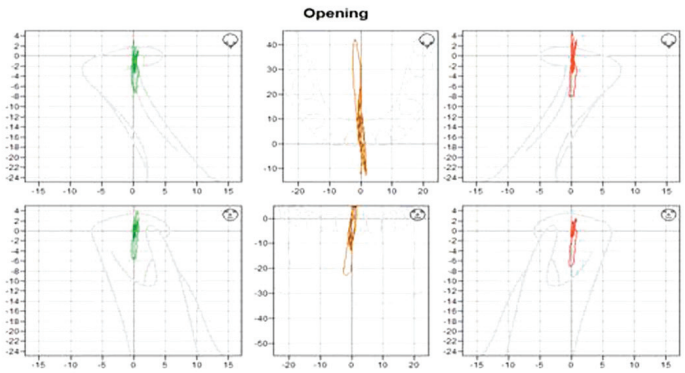


Fig. 1. Zebris device mounted on the head and jaw of a healthy participant:
(a) neutral position; (b) opening movement;
(c) charts drawn by the Zebris WinJaw software during opening movement

The first was carried out using the ultrasound Zebris device dedicated for temporomandibular joint measurements. The participants had to repeat a series of jaw movements: opening of the jaw (as wide as possible), retrusion movement, and laterotrusion, left and right, as defined by the manufacturer of this device.

Zebris device comprises of two elements (as shown in Fig. 1): one is mounted on the subject's head, and serves as reference, the other is mounted on the jaw. Device measures the relative motion of the jaw element in respect to the head element, and shows separately the range of movement for left and right temporomandibular joints.

The second one was an instrumented Wartenberg test [9]. The free oscillatory movement of the lower limbs was measured using the optoelectronic VICON MX system. Prior to the measurements, six markers (three per limb) were attached to the participants' lower limbs: on the knee and ankle joints, and on the greater trochanters. The data were captured by the Nexus software and later exported in the ASCII format. Based on the marker data, the knee angle was calculated, and later all the indices as defined by the Wartenberg test, together with the maximum velocity. Those calculations were performed in Matlab, using custom-made procedures. The test was performed four times per each limb, with a one-minute break between the trials, and the results were averaged later on.

All healthy participants and CP patients underwent Zebris tests, 15 out of 25 CP patients underwent also the Wartenberg test.

The collected data were then analysed using the Statistica 10.0 software. The dependencies were analysed using rank Spearman correlation coefficient, and comparisons between two groups were carried out using the Mann–Whitney test.

3. Results

During the opening movement, the range of the left and the right joint is correlated: in healthy participants the correlation is strong: $R = 0.739$, and in spastic patients moderate: $R = 0.598$.

During two other movements there was no correlation between the range of the left and the right joint in healthy participants, while in spastic patients, statistically significant correlations were found: during retrusion movement $R = 0.752$, during laterotrusion $R = 0.642$.

When comparing the results between healthy and spastic participants, statistically significant differences were found in laterotrusion and opening movements.

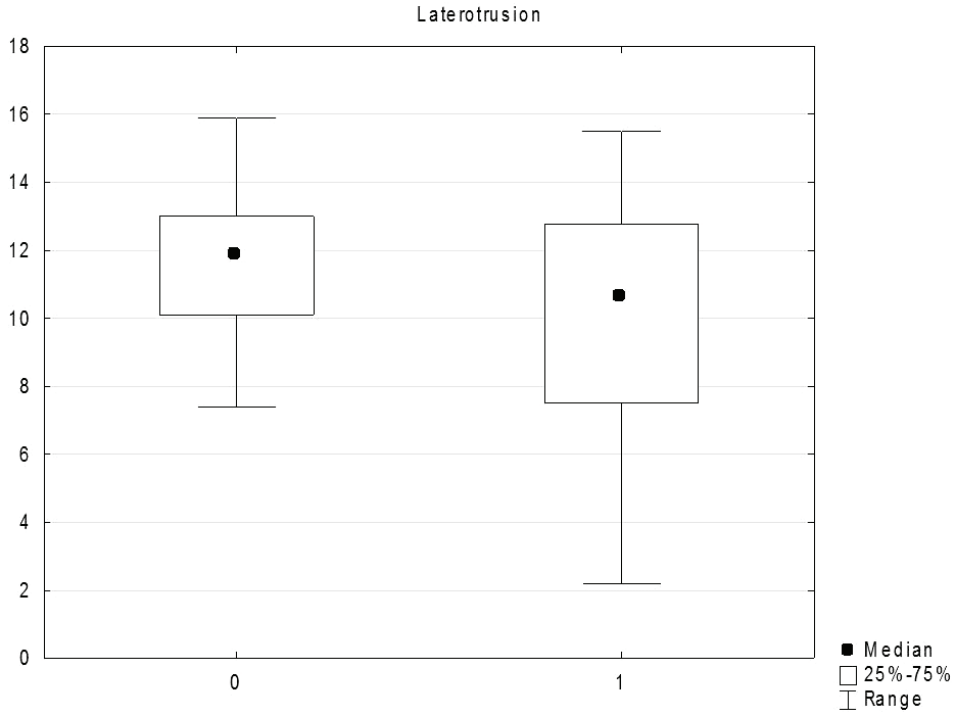


Fig. 2. Comparison of laterotrusion between healthy (0) and spastic (1) participants ($p = 0.041$).
The data from the left and the right joints were pooled together (separately for healthy and spastic participants)

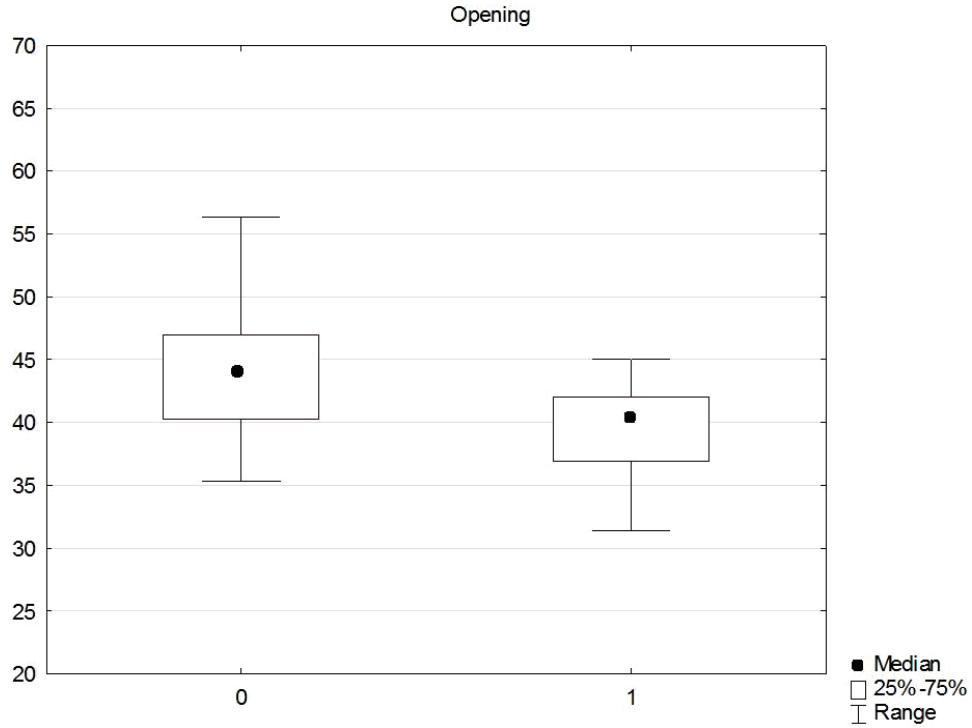


Fig. 3. Comparison of jaw opening between healthy (0) and spastic (1) participants ($p = 0.009$).
The data from the left and the right joints were pooled together (separately for healthy and spastic participants)

The correlations between Wartenberg indices and the maximum velocity and temporomandibular joint motions were calculated (opening, retrusion, and laterotrusion movements measured with Zebris device). Neither of the correlations was statistically significant, except for a correlation between the maximum velocity of the lower limb in the Wartenberg test and laterotrusion movement: $R = 0.439$.

4. Discussion

Cerebral palsy is a neurological condition caused by some kind of injury to a developing brain. This injury occurs during or around the time of the birth. In every patient this damage is different, and therefore functional problems of patients are very variable. If present, the spasticity is not limited to specific body parts, and its degree can vary from segment to segment. Therefore, strong spasticity in one body segment does not automatically indicate spasticity of similar degree in other parts. On the other hand, in the clinical environment the amount of spasticity in a patient (as a whole) is assessed based on the evaluation conducted in the lower (or upper) extremities. In CP children jaw movements could be restricted by malalignement of the body segments, including retraction of the head and neck. They could be restricted also by spasticity of the jaw muscles, but there are no clinical or instrumented methods which would allow for the direct assessment of their spasticity. Therefore, the aim of this study was first to see if the jaw movements measured by the ultrasound Zebris device differ between healthy and spastic subjects, and, second, to find out if there is any dependence between spasticity measured in lower extremities and restrictions in the jaw movements in spastic patients.

The obtained results showed, that the retrusion movements do not differ significantly between healthy and spastic participants, but the laterotrusion and opening movements were smaller and more variable in spastic participants. Joint ranges (between left and right temporomandibular joints) were correlated in healthy participants only during the opening movement, while in spastic subjects during all three movements. These results could suggest that in cerebral palsy participants spasticity is present also in the muscles spanning the jaw, and it could influence negatively the ability of the patients to perform jaw movements. Our study confirms the finding of the study done by dos Santos and de Oliveira [1], which showed that the inter incisal distance during opening was decreased in cerebral palsy patients.

The medium correlation between the maximum velocity of the lower limb during the Wartenberg test

(taken as the best index from this test reflecting the level of spasticity [9]) and the laterotrusion movement of the jaw suggests, that in patients with cerebral palsy the degree of spasticity measured in one body segment reflects (to some extend, as the correlation is medium, although statistically significant) its degree in other segments, although more studies with methods allowing for direct measurement of jaw muscles spasticity, are needeed to confirm this hypothesis. A positive correlation means that higher velocity (i.e., less spasticity) is connected with a higher range of laterotrusion jaw movement.

The shortcoming of the present study is the relatively low number of particapnts but both types of the measurements are time-consuming and require long preparation of the subjects beforehand. They also require good cooperation of the patients. Not all patients with cerebral palsy patients underwent both tests: Zebris and Wartenberg. The measurements could not interfere with rehabilitation treatment of the patients (the primary aim of their stay), and in case of 10 of them there was not enough time to perform both tests.

5. Conclusion

Ultrasound Zebris device can be used for the measurements of the temporomandibular joints not only in healthy participants but also in patients with abnormal muscle tone. The results show that the laterotrusion and opening movements are different in CP patients than in healthy subjects. Moreover, laterotrusion movement correlates with velocity measured during the Wartenberg test, which suggests that high spasticity in the lower legs could indicate the jaw movements restrictions, possibly by spasticity in the jaw muscles. This fact has a practical implication, as such patients should receive more frequent dental care. The abnormal oral-motor function in spastic patients with cerebral palsy could lead to temporomandibular joint contractures [6], decreases the range of opening movement. This makes feeding, dental hygiene or dental treatment more difficult.

Acknowledgement

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