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Research article

Assessment of jaw muscles and cervical spine muscles isometric force using a hand-held dynamometer in young adults

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Abstract: Our study aims to investigate the jaw and cervical spine muscle isometric forces in healthy young adults. Fifty-four subjects (21.2 ± 4.82 years) met the inclusion criteria and agreed to participate in the study. Muscle forces were assessed with a hand-held dynamometer. A significant positive correlation was found between jaw opening forces and cervical flexors forces (r=0.62, p0.0001) and between lateral mandible deviation forces and cervical spine lateral flexion forces, both for right and left side (r=0.65, p<0.0001; r=0.69, p<0.0001, respectively. In healthy young adults, using a hand-held dynamometer for muscle strength testing, significant positive correlation was found between jaw opening forces and cervical flexors forces and between lateral mouth deviation force and cervical spine lateral flexion forces, both for right and left side. The relationship between jaw muscles forces and cervical spine muscles forces is a topic that needs to be further studied, also together with posture and balance.

Keywords: Jaw muscles, cervical spine muscles, force, assessment, young adults

1. Introduction

Previous studies have focused on the relationship between the somatognathic system and the cervical spine [1]. There was a great attention directed towards the research of the possible correlation between the temporomandibular disorders and cervical spine dysfunctions [2,3]. The functional relationship between masticatory and neck muscles has also been studied, a co-activation of neck muscles being reported during different submaximum and maximum bite forces and jaw clenching [4–6].

Muscle strength assessment is an important part in the rehabilitation, both for diagnosis and for treatment, a decreased muscle strength leading to functional impairments, imbalances, posture and balance impairments, dysfunction and disabilities [7–11].

Our study aims to investigate the jaw and cervical spine muscle isometric forces in healthy young adults. We hypothesized that there will be correlations between jaw opening forces and cervical flexors, and between lateral mandibular deviation forces and cervical spine lateral flexion forces.

2. Results

Fifty-four subjects (21.2 ± 4.82 years) met the inclusion criteria and agreed to participate in the study. Anthropometric data are presented in Table 1.

Table 1. Subjects` characteristics.

Parameter	
Sex: Male, n(%) / Female, n(%)	11 (20.37) / 43 (79.63)
Weight, kg (mean±SD)	64.21 ± 13.05
Height, cm (mean±SD)	167.55 ± 6.24
BMI, kg/m^2 (mean±SD)	22.84 ± 4.31

Force muscle values are presented in Table 2. A significant positive correlation was found between jaw opening forces and cervical flexors forces (r=0.62, p0.0001) and between lateral mandible deviation forces and cervical spine lateral flexion forces, both for right and left side (r=0.65, p<0.0001; r=0.69, p<0.0001, respectively.

Table 2. Jaw and cervical muscle forces.

Tested muscles	
Cervical flexors, N (mean±SD)	80.58 ± 20.75
Cervical extensors, N (mean±SD)	80.58 ± 26.16
Right cervical flexors, N (mean±SD)	67.36 ± 23.15
Left cervical flexors, N (mean±SD)	66.78 ± 24.4
Right mandibular deviation, N (mean±SD)	46.92 ± 20.42
Left mandibular deviation, N (mean±SD)	48.62 ± 20.89
Jaw opening forces, N (mean±SD)	54.21 ± 20.75

All tested subjects had normal values for cervical spine range of motion (Table 3).

Table 3. Cervical spine range of motion

Tested movements	
Flexion (mean±SD)	41.4° ± 9.5°
Extension (mean±SD)	44.5° ± 11.2°
Right lateral flexion (mean±SD)	42.3° ± 8.8°
Left lateral flexion (mean±SD)	39.1° ± 6.8°

3. Discussion

Our study included healthy young adults, with no temporomandibular disorders or cervical spine complaints. We aimed to analyse the relationship between jaw muscle forces and cervical spine forces. The cervical spine range of motion was also tested. We found a significant positive correlation was found between jaw opening forces and cervical flexors forces and between lateral mandible deviation forces and cervical spine lateral flexion forces. Studies have demonstrated the relationship between opening and closing movements of the jaw and cervical rotations around a transversal axis (flexion-extension) [12]. Eriksson et al. [13] reported that jaw opening-closing movements are paralleled by active concomitant head-neck movements, explained by the existence of an integrated neural control mechanism for the jaw and neck muscles [14].

The maxim jaw opening forces had a mean value of 54.21 ± 20.75 N in our study. Xu et al. [15] reported maximum jaw-opening forces ranging from 4.6 to 141.6 N. The pilot study of Brunton et al. (2016) showed that there was a marked difference between male and female jaw opening forces [16]. We could not make the same comparison as the two groups had a different distribution (43 women versus 11 men) and this is a limitation of our study.

Versteegh et al. provided a standardized method for assessing cervical spine movements, namely flexion, extension, right and left lateral flexion using a hand-held dynamometer (MicroFet2), with a good to high reliability [17]. In our study we also used this dynamometer for testing mouth opening force and right and left mandibular deviation forces, as well as cervical muscles forces.

The assessment of healthy young adults offers relevant data regarding muscle strength (jaw and cervical spine), range of motion and plantar pressure in relation to dental occlusion[13]. The results can contribute to long-term monitoring of somatognathic system and cervical spine, as these studies should have a significant importance for the prevention field.

4. Materials and Methods

Sixty volunteer young adults agreed to participate in this observational study. Inclusion criteria were 1) age between 18 and 25 years; 2) no musculoskeletal disorders in the cervical or jaw regions; 3) no dental or orthodontic treatment in progress, 4) no tooth extractions. Participation in the study was voluntary. Written informed consent was obtained from all participants. The study has been carried out in accordance with the Declaration of Helsinki.

Muscle forces were assessed with a hand-held dynamometer (MicroFet2, Hoggan Health Industries, Draper, USA). All testing were performed with subjects in a seated position. The hand-held dynamometer was placed in contact with the subjects` head while the examiner applied a fixed counter-pressure [18]. The pad of the dynamometer was placed on the center of the forehead for cervical flexion; on the superior part of the occipital protuberance for cervical extension; on the lateral part of the head, just above the ear for right and left side flexion [18,19]. For mandible lateral deviations, the dynamometer`s pad was placed on the mandible`s body (right and left, respectively) (Figure 1) and for jaw opening forces, the pad was placed under the menton. Subjects had to generate a maximum voluntary contraction against the examiner`s force, applied for 3-4 minutes [18]. The muscle forces were measured in Newton (N).

The cervical range of motion was assessed using a goniometer. The subjects were tested in a seated position. For flexion and extension range of motion, the goniometer was placed on the lateral aspect of the head, with the axis over the external auditory meatus, the stationary arm perpendicular to the floor and the moving arm aligned parallel to the base of the nose [20]. For lateral flexion, the goniometer was placed with the axis over the spinous process of the C7 vertebra, the stationary arm aligned perpendicular to the floor and the moving arm aligned over the external occipital protuberance of the occiput [20].

The statistical analysis was performed using the MedCalc software version 20.014 (MedCalc Software Ltd, Ostend, Belgium). Data were tested for normality using Shapiro-Wilk test and descriptive statistics was performed (mean and standard deviation for normal distributed data). Paired t-tests were used to examine differences between muscle forces, and Pearson correlation coefficients were used to investigate the relationship between different data. Statistical significance was set $p<0.05$ for all te Sixty volunteer young adults agreed to participate in this observational study. Inclusion criteria were 1) age between 18 and 25 years; 2) no musculoskeletal disorders in the cervical or jaw regions; 3) no dental or orthodontic treatment in progress, 4) no tooth extractions. Participation in the study was voluntary. Written informed consent was obtained from all participants. The study has been carried out in accordance with the Declaration of Helsinki.

Figure 1. Test position for lateral mandibular deviation muscle forces

5. Conclusions

In healthy young adults, using a hand-held dynamometer for muscle strength testing, significant positive correlation was found between jaw opening forces and cervical flexors forces and between lateral mouth deviation force and cervical spine lateral flexion forces, both for right and left side.

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