SPORTSINJURYLAB

Are there differences in the symmetry of EMG activity in the muscles of mastication between (a) junior elite soccer players with and without fixed orthodontic appliances, (b) junior elite soccer players with relatively good and relatively bad postural control and (c) between junior elite soccer players with 3 or more and with less than 3 physical problems.

Methods and results of BTS research by SportsInjuryLab

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Methods

Procedure and Participants

Three Belgian clubs in the highest professional soccer division were contacted and both agreed to participate with their elite junior squads. The clubs were visited by the first author to further explain the aims and procedures of the project, to gather information on the number of players and to make arrangements with regard to the research procedures. Players and their legal guardians received a written description of the research procedure and informed consent and assent forms from their fully informed team leader(s).

Parental informed consent and adolescent informed assent was obtained for 167 participants aged 12-18 years. Participants arrived forty-five minutes before training at the club, where they completed a questionnaire detailing age, player position, oral health and previous sport injuries, performed single-limb-standing balance tests, with and without cotton rolls between their premolars and first molar and underwent a surface electromyography (sEMG) recording. The Dutch questionnaire was professionally translated into French and then translated back into Dutch to ensure accuracy. Ethical approval for this study was provided by the Ethical Committee of Ghent University Hospital.

Questionnaire variable

Experience with fixed orthodontic appliance (FOA) was measured with questions about orthodontic treatment. The first question asked whether the participant has, or has had one of the several types of FOA's (photographs were shown). In case of a positive response, they were asked how long they have or have had a FOA attached to the maxillary and/or to the mandibular dental arch. Based on their responses, the participants were divided into two FOA-groups: FOA-N (participants who never have had a FOA) and FOA-CP (participants with current or past FOA).

Physical Problems in the Past Year (PPPY) was assessed with a checklist indicating whether the participant have recurrent physical complaints during past year in 12 body parts: hip, groin, hamstring, quadriceps, knee, Achilles tendon, ankle, foot, neck, shoulder and low back. PPPY was scored 0 (low) if less than 3 items and scored 1 (high) if 3 or more items were checked present.

Postural stability

As the technical movements of soccer players are performed in an unipedal posture, we measured the postural stability of the participants while they stood in a unipedal stance. In addition, the participants closed their eyes to eliminate visual input. 20-sec. balance trials were performed on both the kicking and non-dominant leg unipedal stance with eyes closed, first without then with cotton-rolls between the posterior teeth. Participants were instructed to raise one leg and to stand upright as still as possible, with their arms loosely hanging by their sides.

Postural stability was assessed by measuring the Centre Of foot Pressure sway area (COP sway area), an indicator of control on the sway pattern, i.e. the deviations from vertical when standing upright. The COP sway area was measured using the Footscan USB2-system version 7.7 (RS Scan International, Olen, Belgium) composed of a 50 x 40 cm foot pressure platform with 4096 sensors, sampling at 100 Hz, an USB interface box to connect to a personal computer and software to calculate the COP sway area, i.e. the area of an ellipse that covered the whole COP trajectory during the trial.

Outliers on the four balance trials were identified as those values outside two inter-quartile ranges from the median. Outliers were corrected with the data from the balance trials standing on the same foot. Postural Control was calculated as the mean of the COP sway areas in the four unipedal stance trials (i.e. standing on kicking and on non-dominant leg, with and without cotton rolls between the posterior teeth).

Surface Electromyography

In all subjects, surface EMG of the right and left masseter (MM) and anterior temporal (AT) muscles was performed during maximum voluntary teeth clenching (MVC) (Ferrario et al., 2006; Sforza et al., 2010). To standardize the EMG potentials of the MM and AT muscles, two 10 mm thick cotton rolls were positioned on the mandibular second premolars and first molars of each participant, and a five-second maximum voluntary clench was recorded. For each muscle, the mean EMG potential during the standardization test was set at 100%, and all further EMG potentials were expressed as a percentage of this value (unit: mV/mV 100). In each subject, the test recording of EMG activity was made during a five-second maximum voluntary clench. The test was performed without changing the electrodes or moving the cables. During the whole procedure, the participants sat with their heads unsupported and were asked to maintain a natural erect position. For each patient and muscle, the standardized EMG potentials were used to plot the relevant EMG waves. The following calculations were then performed.

EMG activity was recorded using an electromyography analyzer with wireless probes (BTS FREEEMG 300, BTS S.p.a., Garbagnate Milanese, Italy) and bipolar electrodes. The analogue signals were amplified and digitized (gain 500, resolution 16 bit, sensitivity < 0.7 μV, temporal resolution 1 ms) using differential amplifiers with a high common mode rejection ratio (CMRR > 110 dB in the range 0–50 Hz, input impedance > 10 GΩ). EMG signals recorded were digitally band-pass filtered between 80 and 400 Hz with a second-order Butterworth filter, and rectified by calculating the root mean square (RMS) in temporal windows of 25 ms. The system was interfaced with a computer, and BTS Dental Contact Analyzer software v2.3.20 (BTS S.p.a., Garbagnate Milanese, Italy) was used for signal recording and analysis.

The following *sEMG indices* were then computed.

1. To assess muscle symmetry, the EMG record of paired (left and right) MM and AT muscles were compared by computing a percentage overlapping coefficient (POC, unit: %). POC is an index of the symmetric distribution of the muscular activity determined by the occlusion: if two muscles contract with perfect symmetry, a POC up to 100% is to be expected. POC-TA and POC-MM values below 83% were regarded as deviant (Ferrario et al., 1991).

1.The variables LR-TA and LR-MM indicate the direction of the prevalence, and are scored as: -1=left prevalence +1= right prevalence.

2. To assess the presence of a possible lateral-deviation effect on the mandible during the test given by unbalanced contractile activity of contralateral MM and TA muscles, for instance right MA and left TA, the Torque Coefficient (TC, unit%) was calculated. This index ranges between 0% (complete presence of lateral displacing force) and 100% (no lateral displacing force) (Ferrario et al., 2006). TC values below 90% were regarded as deviant (Ferrario et al., 1991). The variable LT-TC indicate the direction of the prevalence, and is scored as: -1=left prevalence +1= right prevalence.

3. To individuate the most prevalent pair of masticatory muscles, the activity index (ACT, unit%) was computed as: 100 – (the percentage ratio of the absolute difference between the mean MM and TA standardized potentials, and the sum of the same standardized potentials) (Sforza et al., 2010; Tartaglia et al., 2008). ACT is 100 when the MM muscle and TA muscle standardized potentials are equal and close to 0 when the MM muscle standardized potentials are larger than the TA muscles ones and when the TA muscles potentials are larger, and null when they are equal. ACT scores below 90 are regarded as deviant.

The variable AP-ACT indicates which standardized potential are higher and it scores -1 if the TA muscle standardized potentials are larger than the MM muscles and +1 if the MM muscle standardized potentials are larger.

4. The mean (masseter and temporalis) total standardized muscle activities (unit: lV/lV s%) were named IMP (Impact) , and were computed as the integrated areas of the EMG potentials over time (Ferrario, et al., 2006). IMP scores outside the region 85≤ IMP ≤ 115 are regarded as deviant.

Results

Differences in sEMG indices between players with and without fixed orthodontic appliances.

Out of the 167 participants 43 (30%) had a fixed orthodontic appliance (FOA), 21 () have had a FOA and 103 never had a FOA. The sEMG indices of the participants with actual FOA (FOA group) and without any use of a FOA (non-FOA group) are presented in Table 1. Lower levels of symmetry were found on all sEMG indices for the FOA-group, but a significant worse symmetry of the FOA-group was only found for ACT. With regard to the frequency of deviant scores, we found more deviant TC-scores in the FOA-group (53%) than in the non-FOA group (35%): χ^2= 4.33, p<0.05. In addition we found more prevalence of the right MM muscle in the FOA-group (67%) while less difference in prevalence was found in the non-FOA group (45% prevalence of the right MM muscle): χ^2= 6.30, p<0.05.

Table 1

Means (standard deviation) of the sEMG indices of the FOA and the non-FOA groups

sEMG indices	Non-FOA group (n=103)	FOA-group (n=43)	t_{144} (two-tailed p-value)
POC-TA	83.9 (7.5)	82.5 (10.8)	0,90 (p<0.37)
POC-MM	82.6 (9.2)	80.4 (10.9)	1.25 (p<0.21)
TC	88.5 (6.4)	86.7 (7.3)	1.53 (p<0.13)
ACT	85.3 (8.2)	81.2 (11.7)	2.41 (p<0.02)
IMP	109.5 (40.7)	119.9 (66.9)	-1.15 (p<0.25)

Distribution of the sEMG indices in the non-FOA group.

The statistics of the sEMG indices in the non-FOA group are presented in Table 2.

Table 2.

Means, standard deviations, percentages deviant scores and percentages of the different prevalence's

sEMG indices	Means	Sd's	% Deviant	% of the preferences/deviancies
POC-TA	83.9	7.5	22%	53% left TA muscle preference
POC-MM	82.6	9.2	30%	55% left MM muscle preference

TC	88.5	6.4	35%	17% deviant left, 18% deviant right
ACT	85.3	8.2	25%	MM potentials larger in 75%
IMP	109.5	40.7	61%	27% below 85, 34% above 115

Differences in the symmetry of EMG activity in the muscles of mastication between) junior elite soccer players (non FOA) with relatively good and relatively bad postural control.

As posture may be influenced by the quality of occlusion, better sEMG indices will be expected in the 25 (25%) players with the highest levels of postural control compared with the 25 (25%) players with the lowest levels. However, we only found a significant difference in the expected direction for POC-TA and a trend ($p<0.10$) for IMP (see Table 3).

Table 3

Means (standard deviation) of the sEMG indices of players with highest and lowest levels of postural control.

sEMG indices	High level of postural control (n=25)	Low level of postural control (n=25)	t_{48} (one-tailed p-value)
POC-TA	86.8 (2.7)	84.1 (7.4)	1.71 ($p<0.05$)
POC-MM	83.9 (4.9)	84.2 (7.6)	-0.13 ($p<0.45$)
TC	89.5 (3.5)	90.1 (3.2)	-0.64 ($p<0.26$)
ACT	86.3 (7.1)	86.5 (5.9)	-0.11 ($p<0.46$)
IMP	104.0 (30.5)	122.4 (54.8)	-1.46 ($p<0.07$)

Differences in the symmetry of EMG activity in the muscles of mastication between) junior elite soccer players (non FOA) with less than 3 and with 3 or more physical problems in the past year.

As problems with occlusion may be associated with physical problems in other parts of the body, we expected better sEMG indices in the players with two or less complaints in the past year, compared with players with 3 or more problems. With the exception of POC-TA all differences were in the expected direction, while a significant difference in the expected direction was found for ACT (see Table 4).

Table 4

Means (standard deviation) of the sEMG indices of players with 2 or less and players with 3 or more physical problems.

sEMG indices	0 - 2 physical problems (n=85)	3-7 physical problems (n=17)	t_{100} (one-tailed p-value)
POC-TA	83.6 (7.8)	85.9 (5.2)	-1.17 (n.s.)
POC-MM	83.0 (7.5)	80.5 (15.2)	1.01 (0.16)
TC	88.8 (5.1)	87.0 (11.0)	1.06 (0.15)
ACT	86.2 (7.3)	80.7 (10.9)	2.61 (0.005)
IMP	108.9 (42.3)	112.7 (33.8)	-0.35 (0.36)

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