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Original Article

The influence of the stomatognathic system on explosive strength: a pilot study

Antonino Patti, MSc[1, 2]*, Antonino Bianco[1], Giuseppe Messina[1, 2], Antonio Paoli[3], Marianna Bellafiore[1], Giuseppe Battaglia[1], Angelo Iovane[1], Marcello Traina[1], Antonio Palma[1]

[1] *Sport and Exercise Sciences Research Unit, University of Palermo: Via Giovanni Pascoli 6, 90144 Palermo, Italy*
[2] *Posturalab Italia, Italy*
[3] *Department of Biomedical Science, University of Padua, Italy*

Abstract. [Purpose] Recent findings suggest there is an interesting interaction between the stomatognathic system and the musculoskeletal system. The aim of this study was therefore to examine the influence of the temporomandibular joint on the explosive strength of the lower limbs. [Subjects and Methods] An observational study was carried out. The subjects were 60 male football players who voluntarily participated in the investigation. After a warm-up phase of 10 minutes, each participant performed three Squat Jumps (SJ) with different mandible positions: mouth closed and mouth open. SJ heights were recorded using a Sensor Medica force platform and the FreeMed system. [Results] Sixty participants were enrolled in this study (age: 24 ± 7 yrs; height: 174 ± 4.6 cm; weight 63.7 ± 7.6 kg). The SJ heights with the mouth closed, 38.50 ± 4.001 cm, were shorter than those with the mouth open, 40.4 ± 4.1 cm. Statistical analysis showed there was a statistically significant difference between the performances. [Conclusion] This pilot study highlighted that occlusal factors can influence physical performance and this could have practical applications in sports and exercise science. However, our results have to be confirmed in studies with larger numbers of participants and supported by other investigations.

Key words: Stomatognathic system, Explosive strength, Dental occlusion

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INTRODUCTION

The literature suggests that there is a correlation between the stomatognathic system and the musculoskeletal system. Indeed, it seems certain that an alteration of the tooth-mandible-tongue complex affects postural attitude[1]. It has been reported that proprioception and postural control are of great importance for optimal sports injury prevention[2–5]. In this context, Lee et al. confirmed that an exercise program aiming to improve proprioception can positively influence the balance ability of stroke patients[6]. Tecco et al. reported a change in the postural stability of subjects with knee pathologies. These pathologies can generate changes in the function of the masticatory muscles, neck and trunk[7]. Moreover, the mandible position is determined by dental occlusion, the relative position of teeth to each other[8, 9]. In addition, some studies have found that the stomatognathic system and mandible disorders can influence the spine[10, 11]. Tecco et al. also observed that the loading percentage and the loading surface on the right and the left feet were influenced by an experimentally induced imbalance of occlusion created by a cotton roll positioned in dental arches[12]. Furthermore, the literature suggests that the temporomandibular joint (TMJ) affects other systems[13, 14]. Björne showed that tinnitus and vertigo were common in patients with TMJ dysfunction. Many of their patients also had symptoms of cervical spine disorders and head, neck and shoulder pain[14]. It is also interesting to note that craniocervical flexion exercise increased postural stability[15]. Yong et al. investigated the postural

*Corresponding author. Antonino Patti (E-mail: patti.nino@libero.it)

stability of twenty-four subjects, randomly assigned to an exercise or control group, who performed a craniocervical flexion exercise four days per week for five weeks and reported their postural stability increased[15]. Moreover, Björne showed that muscular problems and tinnitus were reduced by injection of lidocaine into the jaw muscle[14]. Recently, Martines et al. confirmed that tinnitus influences the postural control[13]. Furthermore, some studies have reported that the stomatognathic system affects physical performance, and that muscle activity is dependent on the position of the TMJ[1, 12]. Some studies have shown that the stomatognathic system could elicit improvements in sport performances[16, 17], but the hypothesis has not yet been confirmed[18]. In 2012, Baldini et al. reported there was an increase in the relative strength of the quadriceps muscles when a patient wore an occlusal splintsplint[19]. Our interest has focused on the role of the mandible position in physical performance, and the aim of this study was to examine the influence of the temporomandibular joint and dental occlusion on the explosive strength of football players.

SUBJECTS AND METHODS

We performed an observational study. This study was performed in compliance with the Declaration of Helsinki, and the principles of the Italian data protection act (196/2003) were observed. The athletes selected for this study were number of 60 male football player volunteers. The squat jump (SJ) was the evaluation instrument adopted. SJ is well known and has been studied widely[20–23]. The SJ execution was standardized with a joint angle at departure of 90° degrees. Participants were instructed to jump for maximal height. The importance of avoiding any kind of preparatory countermovement was stressed. The protocol established for the execution of the jumps was as follows. In a warm-up phase of 10 minutes, the athletes performed light running (<65% VO_2max) and stretching exercises (four times 6 static postures for 20 seconds each), then each individual performed three practice SJs with the mouth closed (MC), and mouth open (MO). Then the athletes climbed on the platform for measurement and proceeded to perform SJs under the two different occlusal conditions. The participants were given a 2 minutes rest period between trials, and SJ was performed without shoes. The values were recorded using the FreeMed system and a force platform (Sensor Medica; Guidonia Montecelio, Roma). Statistical analysis was performed by a statistician. All data were input to an Excel file and the best performance of both occlusal conditions was selected for comparison. Statistical analysis was performed using StatSoft's STATISTICA software for Windows, Vers. 8.0 (Tulsa, OK). The paired t-test, one tail ($p<0.05$), was used to detect significant differences.

RESULTS

Sixty subjects were enrolled in this study (age: 24 ± 7 yrs; height: 174 ± 4.6 cm; weight 63.7 ± 7.6 kg). The best performances recorded were 38.50 ± 4.001 cm with MC and 40.41 ± 4.093 cm with MO. The Statistical analysis showed there was a statistically significant difference between the performances ($p< 0.0001$). The mouth open condition resulted in improvement in the vertical jump height compared to the mouth closed condition.

DISCUSSION

Some studies have found that there is a correlation between the stomatognathic system and the musculoskeletal system, and that an alteration of the tooth-mandible-tongue complex seems to affect postural attitude[1, 11]. However, the conclusions of the different studies are not unanimous. Many studies are found in the literature, but despite the high number of articles published, the mechanism through which orthodontic treatment influences the etiology of TMJ dysfunction is still unknown[24]. In the present study, we sought to investigate whether the position of the mandible affects the explosive force. Our results are certainly encouraging but, according to the scientific literature, it is conceivable that the protagonist of the change is the trigeminal nerve[25–27]. Numerous anatomical associations have been described between the trigeminal system and the nervous structures implicated in posture control. The mesencephalic nucleus of the trigeminal nerve is a sensorial nucleus with unique characteristics[28]. Gangloff and Perrin showed that the trigeminal nerve affected postural stabilization. Their results demonstrated the effects of trigeminal afferences on postural stabilization[29]: postural deviation under the eyes closed condition was observed after unilateral truncular anaesthesia of the mandibular nerve in static posturography[29]. Similarly, our results show that the mandible position influences physical performance. Another item of interest is the relationship between the trigeminal nerve and the muscle-fascial chain. The fascial system is important not only because it can passively distribute tension in the body muscles when mechanically stimulated, but also because it contains mechanoreceptors and possesses an autonomous contractile ability that influences the tension of the fasciae. These tensions seem to influence the body posture[28]. Oh et al. showed that the stomatognathic alignment exercise improved TMJ function[30]. The stomatognathic alignment exercise program was performed by an experimental group and consisted of mobility exercises for the TMJ and neck, and postural correction. At the end of the study, all the parameters of neck mobility and mouth opening had significantly improved. In conclusion, the result of this pilot investigation suggests that the mandible position influences physical performance, and that this could have practical applications in sports and exercise sciences. These conclusions need to be supported by further studies with different cohorts and larger populations.

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