



EFFECT OF A PERFORMING MOUTHGUARD ON MUSCLE RECRUITMENT IN WHEIGHTLIFTING



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INTRODUCTION

In 1977, Stenger introduced a theory on the ideal distance between the mandible and the temporomandibular joint (TMJ), induced by orthodontic removable retainer, that could affect the position of the cervical vertebrae in a way to enhance the transmission of nerve signals through the central nervous system. The theory explains that such improvement of nerve signals transmission affects the performance of peripheral muscle areas.¹

This study is focused on the connection between the ideal position of the mandible and the muscle strength of professional athletes; during the years, a lot of orthopaedic appliance designs for mandible repositioning appeared, proving the constantly more convincing hypothesis that the optimal position of the orthopaedic appliance for mandible repositioning can affect the body posture and therefore the activation of the peripheral muscle areas crucial for better sports performance.^{2,3}

Nowadays, the correlation between the dental occlusion and the body posture is proven. At this point it is important to define the concept of “a muscle chain” which is represented as a group of muscles interconnected like the chain rings where at any contraction and/or muscle movement there is the chain reaction of contractions and movements of other muscles related to the same chain.⁴

The “kinetic chain” is composed of three interrelated systems: rigid elements system (bones), the joints (articular elements and ligaments) and the third one is the muscle system that is the engine of the movement system controlled by CNS (central nervous system).

The kinetic chain is open when the interconnected segments have one or more degrees of freedom; closed kinetic chain is when every segment is connected with the previous and the following one without any degree of freedom.

The mandibular motion is realised through a kinetic chain of the stomatognathic system which consists of neck flexor muscles, neck extensor muscles, cranial muscles, chewing muscles, facial muscles, tongue and deglutition muscles and the scapula-humeral muscles of the clavicular joint.⁵

The mandible, the skull, the hyoid, the scapula-humeral muscles of the clavicular joint together with the TMJ and cervical spine represent the rigid and articular elements; This chain is closed when the interposition of teeth is at

maximum intercuspation, so when the upper dental arch teeth slightly overlap the mandibular arch teeth.

The improper cranial alignment, caused by the problem that derives from cranio-mandibular and/or atlanto-occipital area, will pass along the hyoid bone and supra-hyoid muscles to underlying structures that in order to adapt to a different tension will trigger a compensation series which eventually could even have an impact on feet. If, on one hand for some vertebral blocks a root cause of the problem lays in the improper occlusion, then on the other hand the improper occlusion might be the consequence of the altered vertebral column micro movements that in order to compensate can gradually affect even the mouth area.^{6,7,8}

The mechanisms, independent from our will and at different levels wrapped in the sensorimotor systems, that control the posture activities can result in the permanent antigravity contraction of numerous muscle chains which control the joints too.⁹

Our attention is focused on weightlifting, a sport where, in order to reduce the trauma caused by teeth clenching or teeth grinding during the athlete's technical performance and energy recall optimization, the use of mouth guards is highly recommended.



The level of a specific professional attention for athletes that do this sport both at professional and dilettante level is on a daily basis becoming more important.

Our aim is to help them to reach the best results in sport activity by working on different parameters starting from the advanced techniques introduction, new materials or accessories research, adequate psychological approach to a proper and continuously more specific nourishment.

In this context the athlete is closely followed at postural

and muscular level especially the one with evident defects possible to enhance or the one with a trauma to recover from.

The last but not least is to increase their satisfaction resulting from their discipline by reducing the risks of injuries and enhancing their performances considering timing, strength and muscle fatigue reduction. Weightlifting is an integral part of a training method known as CrossFit. For some years now, in the Olympic weightlifting discipline in the USA, the use of mouth guards is required.¹⁰

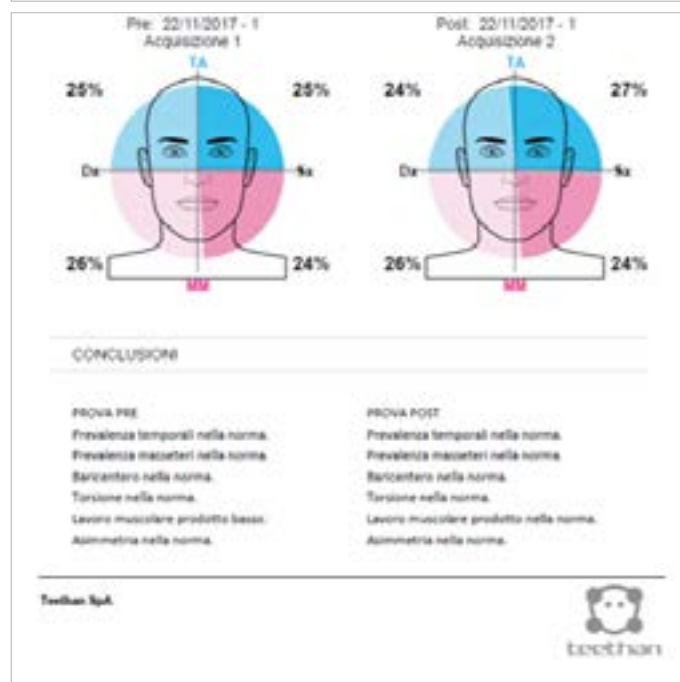
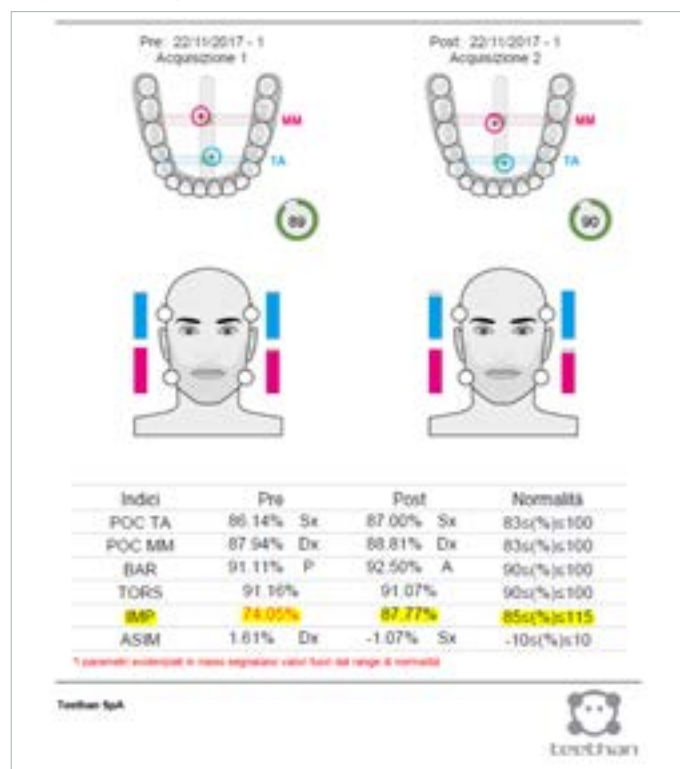
MATERIALS AND METHODS

While studying fifteen athletes devoid of temporomandibular disorders in order to analyse the function of the chewing, masseter and temporal muscles we have used the “Teethan” unit with 10 mm diameter bipolar electrodes for superficial electromyography (EMG). Our scope was to examine and analyse the variations of these muscles activities by observing what was happening when they were clenching their teeth so closing the kinetic chain and we were also observing the muscle activities when inserting the mouth guard ‘Fluobite’ between the two dental arches in order to maintain the open kinetic chain.¹¹



We were trying to answer the question if an individual protection mouth guard could have an influence on muscle mechanism activation.¹²

The Fluobite is a specific mouth guard made of medical silicone designed for diverse weightlifting disciplines. It is moulded in two sizes. The thickness of the medical silicone in occlusal plane is 3mm with the hardness of 70 shore. It is a mobile oral appliance which allows the user to position it according to his/her preferences. The test has been performed in order to obtain the fundamental indicators for patient’s occlusal state evaluation. This test consists of two separate teeth clenching 5 sec tests and it gives us an important insight in evaluation of the IMPACT index.¹³



This value is correlated to the intensity of muscle activity and reflects the maximum force of the patient's teeth clenching; once the measurement unit is calibrated the first test is performed at maximum intercuspation and during the second one the Fluobite is used in order to prevent teeth contact.

If there are the nociceptive reflexes which induce the CNS to reprocess the data sent by the pain receptors or proprioceptive oral receptors before they give clearance to masticatory muscles to contract, the IMPACT index significantly reduces.

A non fully balanced occlusion might represent an alert signal and as a reflex to it the protection mechanism might reduce the intensity of muscle activity.

Concerning the above mentioned Dr Manfredi says: "the lack in the occlusal stability could create an undesired energy leaking point, inexplicable in the athletes' well-trained bodies, which in layman's terms is like a supporting foot slip or in technical terms is the antagonistic pairs balance loss of the agonist and antagonist muscles. It could cause the injuries and repetitive muscle tears or strains."¹⁴

RESULTS

The data readings reveal how the index increases in fourteen out of fifteen tested athletes. The two sets of data (pre and post) were subjected to a test (t-test) to determine the importance of the differences in the respective average value statistics. The scope of the test is to evaluate the probability that possible differences might be related to random fluctuations and not to diverse real performances. This analysis is conducted under a conservative hypothesis by overestimating the standard deviation in the denominator of the Student's t variable supposing that it is equal to the average value of the two samples' standard deviation. The analysis result brings to a conclusion that if the two samples of the test subjects, without the bite, were tested, only in 10 % of cases would be measured differences equal to those emerged in this experimental research.

Thanks to the use of a Fluobite the closed kinetic chain becomes an open kinetic chain isolating the nociceptive interfering reflexes therefore the maximum jaw closure force increases in fourteen testing subjects; it seems that the testing subjects were constantly searching for a "guided and efficient" open kinetic chain.

This fact is closely linked to an American study which

asserts how the stomatognathic kinetic chain variation of the masticatory muscle force during the maximum jaw closure effort measured by EMG is related to the mandible spatial positions; it is also possible to link the positioning of the mandible itself with the increase in the muscle strength of the rest of the body; another study though, states that the increase of the occlusal vertical dimension in patients with TMJ disorders leads to an increase in the electromyographic activity during the mouth closure in favour of temporal and masticatory muscles.^{15,16}

A mouth guard inserted between the two dental arches causes the increase of the occlusal vertical dimension and our obtained data are supporting this evaluation.

DISCUSSION

Even nowadays, the evaluation of the masticatory muscles force increase in healthy subjects and the athletic performance is still to be closely examined; unfortunately, just recently this topic has been reconsidered by the scientific literature.^{17,18}

During the weightlifting activities, the constant search for occlusal support creates a closed kinetic chain.



If the occlusion is imbalanced or instable the function may become pathogen, so inside the various postural system components starting from the tooth and periodontal ligament throughout the kinetic chain itself the force vector development will not follow the proper biomechanical scheme.

The occlusal imbalance is closely related to an improper body alignment and in the subject with the occlusal alterations the constant postural compensation patterns will be manifested. The body tries to limit this imbalance in any possible way by taking the

atypical positions which result in “downward” syndromes that move downward the postural chain and could be transmitted to the feet themselves; later on they become “upward” syndromes because they take the upward path from the base of support to the cranial area. In order to reduce a muscle fatigue the organism tries to reach the muscle compensation with minor athletic efficiency and higher possibility of injury.

Therefore, in this compensatory mechanism a part of the athlete's strength that is in circulation is lost in vain.

A temporary posture correction with a help of the oral appliance in order to reinforce the body posture supporting planes and to enhance the athlete's dynamic equilibrium, often permits the improvements of the dysfunctions that result from occlusal defects which can lead to a possible performance improvement.

Therefore, we can notice an energy out-come increase, highlighted by the movement acceleration increase. Further on we will see the formula where A (acceleration) stands for the ratio between V/T (velocity/time) and is measured in m/s^2 (meter/square second).

This evaluation could be represented with the formula $F=M \times A$ where the F stands for force, M stands for mass (a barbell and weight plates mass) and A stands for the acceleration. According to this hypothesis the Force value can increase considering the Mass value as a constant.

We should keep in mind the parameter of Velocity too. It is an integral part of Power and is clearly represented in the following formula: $P=F \times V$

All these data lead to a conclusion that an exemplary neuro-mechanical mechanism might be developed which further on might have an impact on the system efficiency augmentation.

CONCLUSION

In any sport activity a different type of force is necessary and every athlete should aim at and reach the optimum

force level in his/her discipline at any moment of the athletic programme during the year. This programme incorporates different training phases, contests and muscle and strength maintenance.

In the weightlifting discipline, where the body is highly stressed by the weight used, the execution technique, and proper acquisition of the sensorimotor scheme allow the athlete to control the intensity and velocity so that he/she will enhance the quality outcome of the workout itself; up to now using the adequate technologies the acceleration parameter is considered one of the most significant parameters to control in order to follow and register the improvements in weightlifting athletes.

The things that make them strong are: their capacity to give the maximum force in minimum possible time and their hard training to develop the explosive force; it would be significant to study this parameter with an accelerometer attached to the weight plates after positioning a mouth guard in order to have a direct overview of the occlusal splint impact on the occlusion and posture relationship. It could also clarify if the use of a mouth guard might effectively increase the acceleration during the execution of a given weightlifting movement influencing not only the facial muscles activation but also the activation of the peripheral muscles.

The practitioners of non contact sports like the weightlifting, by using a mouth guard could gain a benefit in the increase of the muscle activation.

The desire to transform a simple mouth guard in a specific oral appliance that enhances the athlete's performance and force is making inroads among the coaches/instructors and athletes that are looking for a competitive advantage; these occlusal appliances might become specifically designed in a more rigid silicone targeted for the trainings or designed in a less rigid silicone with the inferior shore for the competitions.

19,20,21

We have a high-performance mouth guard era on the horizon.



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