Gnathological postural treatment in a professional basketball player: a case report and an overview of the role of dental occlusion on performance

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Summary

Aims. **During competitions and training many professional athletes use to wear occlusal splints to improve their sports performance. However, notwithstanding some studies concluded that achieving a balanced cranial-occlusal system could bring to an improvement of sports performances, the results are still contrasting.**
Probably the gnathological postural treatment of athletes has greater influence on performance when the individual suffers of Temporomandibular Joint Disfunction (TMJ) or physio-postural pathologies owing to the consequent alteration of the "tonic-postural system". This clinical case details a gnathological postural approach to a professional basketball player suffering from muscular problems related to the stomatognathic apparatus and a low back pain unresolved with the only physiotherapy, which limited her performance.
Methods. **Force platform and T-Scan III appliances were used in order to check the postural and occlusal condition of the athlete and as an aid to clinical parameters in achieving a correct splint balance.**
Results. **After the treatment involving inserting an occlusal splint and physiotherapy sessions, the patient no longer complained of low back pain problems and the symptoms associated with the stomatognathic apparatus improved considerably. In particular, after the tests carried out on an isokinetic machine, a force increase related to the quadriceps muscles was detected when the patient was wearing the occlusal splint.**
Conclusions. **All athletes must however be analysed individually and carefully with clinical and instrumental analyses in order to consider the possible real effectiveness of an occlusal splint for improving postural structure and sports performance**.

Key words: posture, dental occlusion, bite force, occlusal splint, sports performance, sports medicine.

Introduction

During competitions and training many professional athletes wear occlusal splints to improve their sports performance. In order to achieve the best possible performances, higher-level athletes must be able to adapt totally to movements even when subject to particularly harsh stress. They must have constant control of balance changes and the use of muscular force as well as excellent coordination capacity.
An athlete's motor control is very important as regards improving performance and depends on the visual, vestibular, proprioceptive responses as well as reflexive and voluntary muscle responses (1, 2). It was observed that professional dancers and gymnasts have better postural control than normal subjects (3, 4).
Over the past years, scientific research and clinical evidence highlighted an anato-functional and physio-pathological connection between craniomandibular (CMD) and craniocervical dysfunctions, aggregating various areas of the organism in a single "tonic-postural system" (5- 7).
Notwithstanding some studies concluded that achieving a balanced cranial-occlusal system could bring to an improvement of sports performances (8, 9, 10), the results are still contrasting (11).
Probably the gnathological postural treatment of athletes has greater influence on performance when the individual suffers of TMJ or physio-postural pathologies owing to the consequent alteration of the "tonic-postural system". This report is intended to be a presentation of a clinical approach regarding a professional basketball player.

Clinical case

The patient G.M., a 28-year-old professional female basketball player who played for the Italian national basketball team and currently plays in a second division team, had frequent low back pain complaints which occurred 1 or 2 times a month for 4 or 5 days, making training and playing in matches impossible.
In the past the patient had suffered a minor trauma that distorted her hip, however this did not require surgery.
The radiographic, physiological and orthopaedic analyses showed no vertebral column structural disorder.
The medical staff of the basketball team, who failed in healing the pain with physiotherapy, requested a gnathological postural analysis in order to consider the occlusal system's possible interference with the postural system.
The player underwent the gnathological postural examinations normally carried out on athletes referred to our section: clinical stomatognathic apparatus analysis, postural static scoliometer and podoscope analysis, stabilometric postural analysis via force platform, and computerised occlusion analysis.
Following a particular episode, the patient reported pain caused by both spontaneous and provoked (palpations) muscular problems, at the right masseter muscle with moderate frontal bilateral localized tension cephalea occurring once or twice a week.
The athlete had a normally physiologically and symmetrically mouth opening with no functional limitation or articular noise.
The occlusal analysis showed bilateral crosses at 16/46 and 26/36 and crowns on 11, 21 and 22 (Figs. 1, 2, 3).
A static posture analysis was carried out on a scoliometer showing slight asymmetry (Fig. 4).
A posturometric analysis was carried out on a "Correkta DI Medica" force platform: each recording lasted 51.2 sec, under the following conditions: mandibular rest position, with eyes opened and closed; mandibular position of centric occlusion, with eyes opened and closed; mandibular position with cotton rolls and eyes opened and closed; the athlete underwent an additional test in mandibular rest position with eyes closed and with retroflexed head for evaluating cervical interference (12).
Cotton rolls 8 mm. thick and 37 mm. long were positioned

Figure 1 - Occlusal intra oral photograph.

Figure 2 - Lateral intra oral photograph (right).

Figure 3 - Lateral intra oral photograph (left).

Figure 4 - Static postural evaluations of posture on scoliometer.

on the mandibular teeth distal to the canines. Quiet conditions were maintained during the exam, and disturbing elements were eliminated. A force plate was placed in order to position subjects perpendicularly faced to the wall at 150 cm. The subjects were required to remain as stable as possible, relaxed, with their arms hanging free beside their trunk, and facing the wall without concentrating on a precise point on it. Moreover, all the subjects were asked to avoid alcohol, sport and conservative therapies during the 24 h before the clinical recordings.
The standardized placement of the subjects on the force plate is fundamental to reduce the intersession variability of the exam: a hand was placed under the foot of the subject, lifting the foot until it reached the following criteria using the markers painted on the surface of the platform:
- Feet angle of 30° following the principal red line.
- Calcaneal tendon positioned in correspondence of the length of the foot, expressed in French points and centered on the principal red line.
- Malleolus positioned in correspondence of the angled red line.
- Second foot finger root projection correspondent to the principal red line.
- Foot outline correspondent to the areas drawn on the surface of the platform.

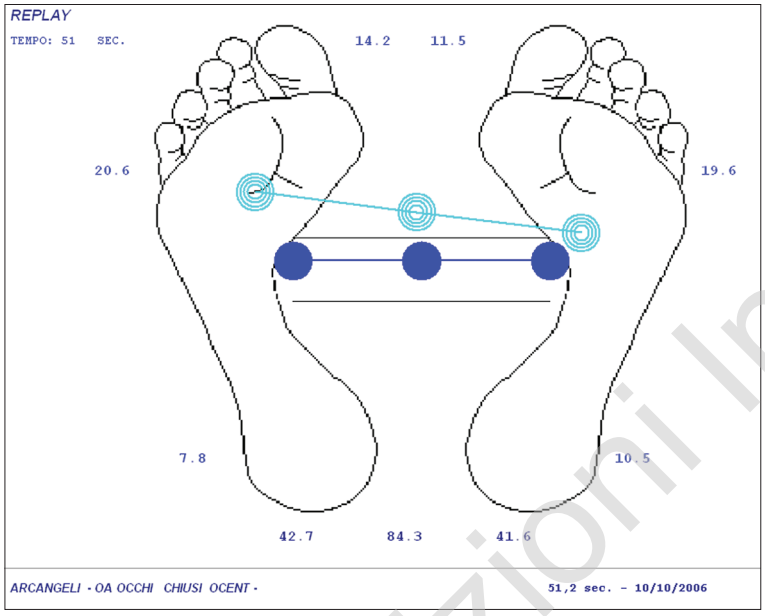

Figure 5 - Posturometry on force platform with accentuation of the projection of the loads towards the front in centric occlusion.

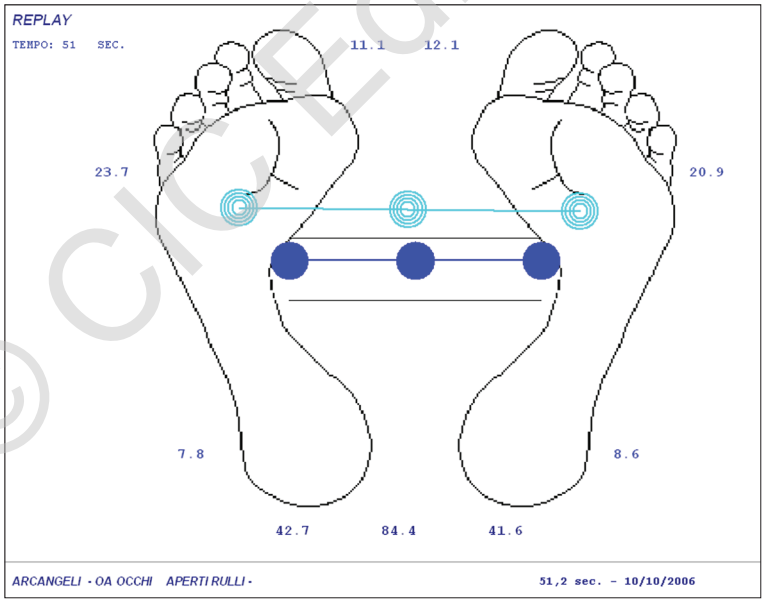

Figure 6 - Posturometry on force platform with improvement of postural position using cotton rolls.

This showed anteriorization of posturometric loads (Fig. 5), frequent finding in basketball players since it seems their postural structure can prepare the system for a jump or sprint, however with slight torsion. In particular, the postural structure improved, becoming more symmetrical when cottons rolls were inserted in the patient's mouth (thus eliminating occlusal interferences) (Fig. 6).
The force platform analysis showed that the postural system seemed perturbed when the teeth were in contact (Fig. 7).
Romberg index (R.I.) and the cervical interference index (ICS) were calculated in order to evaluate the cervical and ocular interference on posture: not significant values assessed the absence of these kinds of interferences (12).
The computerised occlusion analysis was carried out using the T-Scan III (Tek-Scan Boston, USA) a computerized system whose sensor, when inserted between the dental arches and connected to software, allows for the distribution of the masticatory forces to be evaluated thoroughly (13, 14).
Thus, the T-Scan III sensor was inserted between the athlete's dental arches, making three to four contacts between the dental arches to verify the test's repeatability, system seemed to suggest the occlusal system's interference related to the left molar sector, with the postural system (Fig. 8).
A stabilization splint, to be worn 15/16 hours a day, including during training sessions and matches, was fabricated for the athlete lower arch, allowing for the unobstructed excursive glides of the mandible in protrusive position and laterality and occlusal balance in centric position in order to achieve a better postural balance which would had been able to contribute in prevent the painful symptomatology to be frequent and improving sport performance.
The splint was designed in the laboratory by mounting models of the upper and lower dental arches to a semi-adjustable articulator.

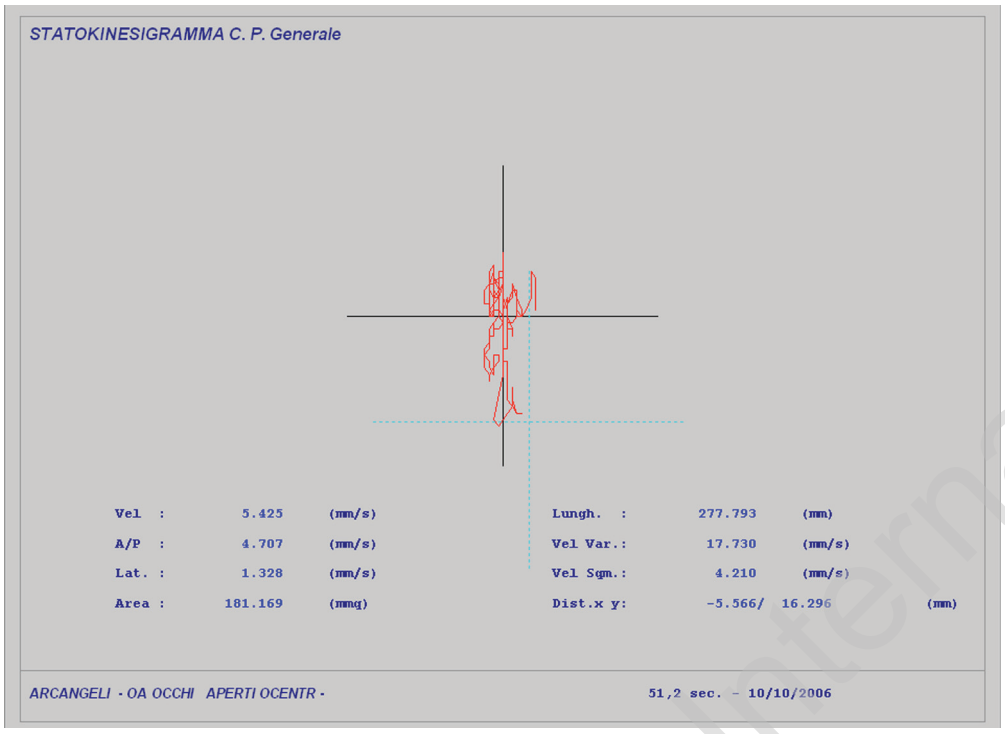

Figure 7 - Kinesiogram shows the perturbation of the postural system in centric occlusion.

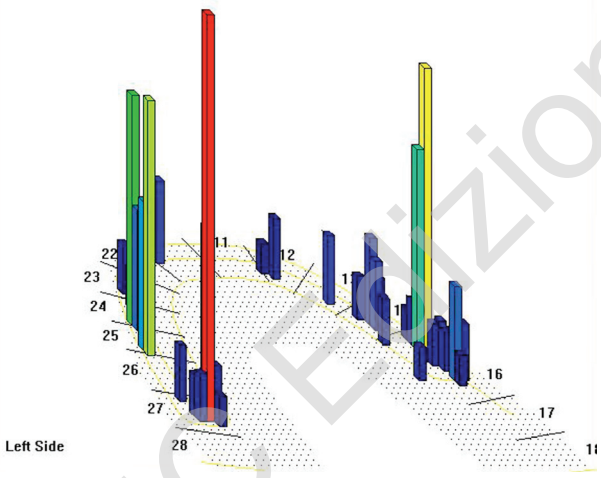

Figure 8 - T-Scan III shows the asymmetry of the occlusal loads.

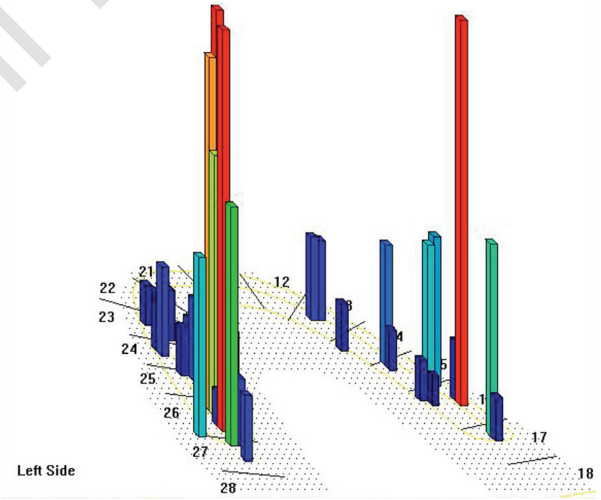

Figure 9 - T-Scan III shows a balance of the occlusal loads wearing the occlusal splint.

Wax bite registration was then taken, seeking centric relation with the Dawson's bilateral manipulation, which is a manual technique that allows the gnathologist to position the mandible and its condyles in a recordable and modifiable position, studies in literature concluded this technique to be trustworthy and reliable for recording the patient's centric relation position (15).

The operator has to stand behind the patient and place three fingers (first finger, middle finger, and ring finger) under the horizontal branch of the mandible with the thumb firmly positioned on the chin and the little finger on the rear of the vertical branch of the mandible so the operator can pull the mandible, allowing the condyles to return in the glenoid cavity (16, 17). Then the occlusal splint was balanced using the computerized occlusion system evaluation and clearly improved the patient's occlusion.

With the insertion of the occlusal splint in the oral cavity, the occlusal loads appeared more symmetrical and balanced (Fig. 9).

A posturometric analysis of the athlete was carried out using a force platform (Correkta DL Medica, Milan Italy) when he was wearing an occlusal splint inserted in the oral cavity resulting in better postural control with minor expenditure of energy; the centre of gravity appeared smaller and with a more homogeneous distribution (Fig. 10).

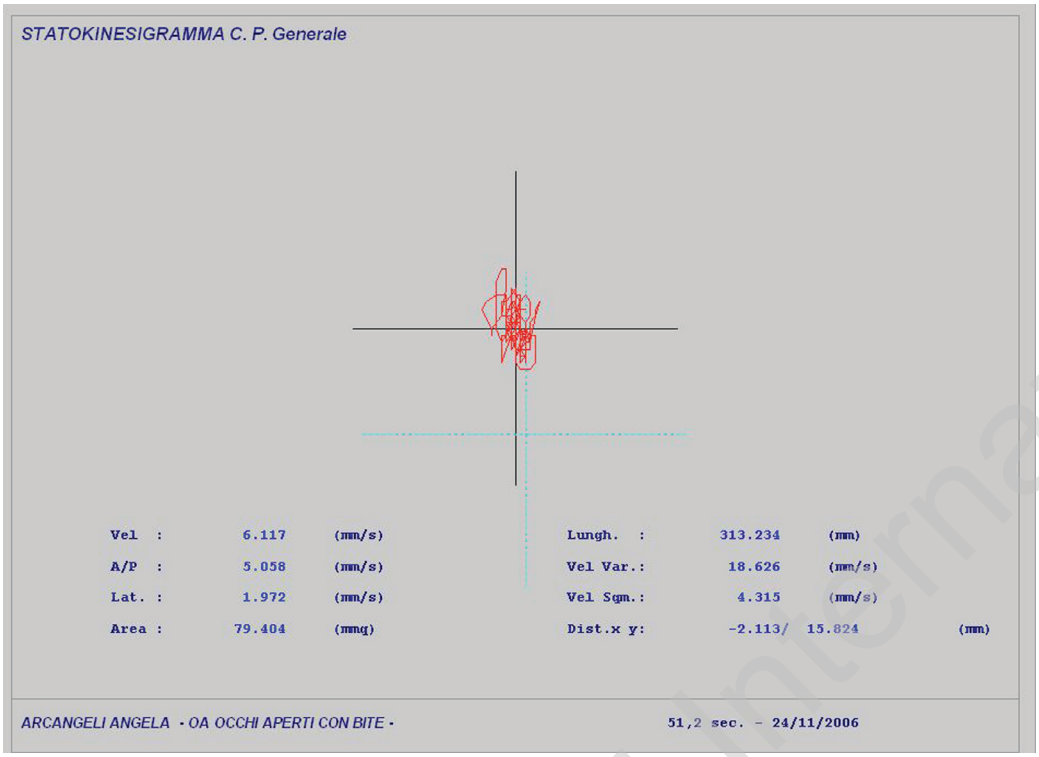

Figure 10 - Kinesiogram with bite shows more homogeneous distribution of postural loads.

The gnathological treatment was joined with the physiotherapy of the cervical and lumbar tract of the vertebral column and after six months of wearing the splint and doing physiotherapy, the patient no longer complained of episodes of low back pain or symptoms related to the stomatognathic apparatus.

In order to evaluate the effect of the splint on the muscular force also in areas distant from the stomatognathic apparatus the athlete underwent an isokinetic test wearing the splint.

The aim of this report is also to evaluate the effect on quadriceps' muscular efficiency of the custom fit instrumentally balanced splint compared to a semi-individual mouthguard (Powerguard Isasan) using an isokinetic machine.

Figure 11 - Isokinetic machine test.

After 10 minutes of warming up via bicycle, walking and leg muscle stretching exercises, the athlete underwent a muscular test in the "Isokinetic" Sports Medicine Department of Milan using an isokinetic machine (model REV9000, Technogym) in order to evaluate the concentric force expressed during the extension and flexion movements of the right and left knee joints with one 90° angle per second for 4 consecutive repetitions (Fig. 11).

The parameters considered were peak of force (Nm) and work done (W).

The analysis of the force was carried out in three different mandibular conditions: with teeth in contact, wearing the custom fit and instrumentally controlled occlusal splint and wearing a semi-individual adaptable mouthguard (Powerguard Isasan, Italy).

The results reported in the Tables (Table 1 and Table 2) in the average range of values of the other members of her team, show an improvement of the performance analysed by the isokinetic machine both wearing the custom fit occlusal splint and the semi-individual mouthguard compared with the "teeth in contact" condition.

Discussion

Different kinds of athletes (motorcycle racers, footballers, etc.) also wear occlusal splints during competitions in order to improve performance. Research and publications in medical and dentistry magazines assessed that oc-

	Occlusal situation		
	Centric occlusion	Mouthguard (powerguard)	Splint
	Peak of Force(Nm)		
Left			
Extensors	189	189	192
Flexures	95	98	101
Right			
Extensors	188	199	201
Flexures	100	105	120

Table 1 - Isokinetic test results (Peak of Force).

	Occlusal situation		
	Centric occlusion	Mouthguard (powerguard)	Splint
	Work(W)		
Left			
Extensors	744	720	762
Flexures	442	444	449
Right			
Extensors	750	775	784
Flexures	465	468	475

Table 2 - Isokinetic test results (Work).

clusal factors can influence body posture and that consequently sports performances of professional and non-professional athletes can increase.
This could be really important when the gnathological treatment could help the athlete to resolve frequent painful symptomatology that prevents him from having a correct and continuous training program.
The results achieved in this clinical case presented show how the gnathological postural protocol with the insertion of an intraoral device could bring to a reduction of the symptomatology related to both the lumbar system and the stomatognathic apparatus and a consequent better postural control and improvement of the performance of quadriceps' muscular force.
However, the conclusions of the different studies regarding the matter are not unanimous.
In particular the studies which analyse the relationships between occlusion and sports performance in sportspersons mainly consider two aspects: the fact that correct occlusion or wearing splints increases the muscular force also in areas which are some distance from the oral cavity (18) and the fact that wearing a splint improves postural balance and therefore as a consequence can prevent injuries and improve performance bringing to very contrasting results.
The first to carry out an significant study on the relationship between occlusion and sports performance were M. Greenberg et al (19), who, in 1981, published a controlled double-blind clinical study on the correlation between mandibular position and force of the upper part of the body, based on the principle that increasing the vertical dimension of occlusion with occlusal devices seemed to be able to increase muscular force.
The authors studied a selected sample of 14 members of a basketball team of the University of Pennsylvania who were not involved in a strengthening program during the observation period and with no evident TMJ problems.
Occlusal devices were constructed and applied to the posterior mandibular sectors and a shoulder adduction and abduction test was then carried out using an isokinetic dynamometer capable of evaluating the intensity of the muscular force. The athletes underwent a first session consisting of three series of five abductions followed by another three series of adductions at a distance of three minutes and a second session consisting of the same exercises this time using the occlusal device and the placebo.
Having processed the data via ANOVA statistical analysis ($p < 0.05$), no relevant differences were observed between the three conditions and consequently it appears that any increase of the muscular force due to the use of the occlusal device is correlated to the placebo effect rather than a direct relationship with the splint.
In 2000 P. Gangloff, J. Louis and P. Perrin implemented a different type of protocol, evaluating the repercussions dental occlusion has on postural control in a controlled study (20) based on a test sample of 8 professional shooters compared with a study of the same number of individuals with perfect oral health.
The protocol consists in using the force platform to record the variations of the center of foot pressure (CFP) in an interval of 20 seconds, showing the data with a statokinesiogram, and carrying out each test with and without the visual component. Four mandibular positions using occlusal splints were considered for both groups: maximum intercuspation, centric relation, lateral physiological occlusion and contralateral occlusion.
The best results were achieved with the jaw positioned in centric relation. The statistically significant difference between the various mandibular positions confirmed a relationship between occlusion and postural control and the authors confirm this emerged as better sports performances for the professional shooters included in the study.
A study carried out by Ferrario et al. in 2001 (21) analysed two groups of subjects, one group whose parameters of occlusion were in the norm and the other with recognisable alterations to the stomatognathic apparatus (one or more teeth missing, *crossbite*), in order to analyse the functional relationship between the stomatognathic apparatus and the muscles of other areas of the body and between various occlusal conditions and neuromuscular performance. 29 young men who regularly practised one or more sports were examined and for each of these subjects, six mandibular positions were considered: with mouth open, without teeth in contact, with slight dental contact, maximum intercuspation, maximum intercuspa-

tion with two cotton rolls (10 mm thick) placed between the posterior teeth, maximum intercuspation with only one cotton roll placed at the right or left side of the posterior mandibular teeth. For each position the patient had to use the dominant limb to lift a load of weight previously established on the basis of his build, for as long a time as possible. In the two groups analysed all the subjects more or less carried out the test with the same maximum weight but unexpectedly the group of subjects with malocclusion were able to do the task for a longer time than those with normal occlusion.

Lai's work (22) analysed the relationship between dental occlusion and physical performance via the Ergo-jump platform in order to highlight whether there are actually connections between occlusal correction and variations in sports performance.

Two groups of patients who did not practise sports competitively were selected for this study: one group with cranial-cervical-facial disorders and condylar-meniscus incoordination, initial clicking on opening the mouth, dental class I or II with occlusal instability and postural modifications related to occlusion, and a second group with no pathology or disorder. Following the gnathological examination, a resin splint with canine guidance and occlusal contacts was inserted. This was intended to correct malocclusion in the group of patients with pathologies/disorders, while in the others it provoked malocclusion, inserting a greater thickness of around 2 mm at the canine and the first right premolar.

The results showed the performance of the dysfunctional subjects to improve with the use of the *splint.* On the other hand, the performance of the patients with no TMJ pathology worsened with the occlusal corrections.

In 2008, Ebben et al. (23) noticed that during situations which require a particular muscular force or power it is somewhat common for athletes to clench their teeth, consequently developing facial and neck muscular tension, and to activate certain muscles also through a modified Valsalva manoeuvre, presumably in order to achieve a potential ergonomic advantage. 14 male and female athletes were chosen for this study. During the test these subjects did a countermovement jump on a force platform, which analysed the force developed in two conditions; *rest position* and maximum intercuspation. In particular, the percentage of force developed during maximum intercuspation was 19.5 % greater than in rest position.

M. Manfredi et al. published a controlled randomized experiment (25) in 2009. The study analysed the relationship between occlusion and athletic performance using a device similar (OPTOJUMP™) to the one used in the previous study and based on a sample of 15 professional basketball players from the Italian "serie A" Benetton Treviso team. The authors considered 2 groups, a survey group and a control group, composed respectively of 8 and 7 sportspersons not undergoing dental treatment or affected by problems in other parts of the body which could interfere with the postural system.

In order to identify the myocentric position useful for the construction of the splint, the players underwent electromyography and kinesiographical tests using the Transcutaneous Electrical Nerve Stimulation (TENS) technique. Using the OPTOJUMP™ equipment, the athletes carried out two functional evaluation tests: countermovement jump and stiffness jump. These tests were both carried out in two different sessions (with and without the splint) on just after the first wearing of the device (T0, T1) and two months after its first wearing (T2, T3). The data obtained were processed using the Analysis of variance ANOVA statistical analysis system and highlighted a statistically significant difference only between T3 and T0 and between T3 and T2. This has led the authors to conclude that the splint did not improve athletic performance, sustaining that the statistical differences detected were due only to an improvement caused by the players' training. Literature thus does not paint a very clear picture of the role which dental occlusion can have on the muscular force of areas which are distant from the oral cavity since the performance required vary greatly for each sport: in some sports which are considered stationary (shooting, for example), it appears fundamental to have better postural balance thus all devices which aim to improve stability would seem to improve performance.

On the other hand, the evaluations carried out in active sports, in which various factors can interfere with the performances, appear more complicated.

Conclusions

In conclusion, it seems that, in this clinical case as demonstrated in other scientific studies, it is really important for athletes to have good occlusal balance, in order to achieve a perfect postural balance which could bring greater results during competitions, prevent injuries, and maybe also increase muscular force (25, 26).

Gnathological treatment could be really important in some individuals, as an aid to physiotherapy in healing frequent painful symptomatology that prevents the athlete from having a correct and continuous training program, this could be the key of interpretation of the performance improvement assessed by this case report.

As stated in a revision of the literature (18), there is currently no scientific evidence that a splint can improve sports performance owing to the low number or published studies and their contrasting results.

All athletes must be individually and carefully analysed with clinical and instrumental analyses and possibly treated with reversible occlusal treatments in order to evaluate the real effectiveness of an occlusal splint in improving postural structure and sports performance because literature does not provide a clear picture of the role which occlusion can have on sports performance.

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