Case Report

OCCLUSAL PLANNING. AIMING AT A COMPREHENSIVE APPROACH TO NEUROMUSCULAR AND ARTICULAR DISORDERS OF THE ORAL APPARATUS, SUPPORTED BY SEMIOTIC AND ELECTRONIC DIAGNOSTIC INSTRUMENTS

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ABSTRACT

Over the years, numerous research studies have been conducted on craniofacial disorders, highlighting differing opinions, largely due to the varying angles of professional practice employed. With the utmost respect for the well-grounded studies that deepen our understanding of the role of central engrams in the onset of temporomandibular joint (TMJ) and muscular disorders, as well as their therapies, our article aims to raise awareness about the anatomical structures involved in the maxilla-mandibular relationship and their impact on the neuromuscular health of the oral apparatus. Here, the procedures of occlusal therapy based on neuromuscular deprogramming, electronic detection of occlusal contacts, mandibular movements, muscle activity, and slight additional and subtractive corrections to the teeth are described, synthesizing the consolidated international literature.

KEYWORDS: *disorders, neuromuscular, temporomandibular joint, articular, craniofacial, mandibular, muscle, teeth*

INTRODUCTION

Due to its vital function tied to alimentation, the mandible, being a mobile body, interrupts the muscular continuity on the anterior side of the body, whose efficiency is achieved through a complex mechanism of muscles and tendons, which provide stable points of traction for the anterior muscles when needed.

We must take into account the masticatory muscles not only for their masticatory function, but as part of a system of muscles which, further than mastication, have the role of firmly anchoring the mandible to the upper jaw during the following functions:

- swallowing
- aid the anterior chain muscles through connection to the hyoid bone

During these fundamental functions, the mandible must hold a stable balance with the upper jaw. This relationship is mediated by the teeth when present. The teeth stop the jaw during its upward movement.

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Swallowing

During the oropharyngeal phase of swallowing, performed in apnea, the elevator muscles contract in order to push the mandible against the upper jaw, stopping at the intercuspation of the teeth. The position of the mandibular condyles in the TMJ depends on this stopping position. At the same time, the suprahyoid lowering muscles contract to lift the expanded tongue so as to push the food bolus towards the back of the pharynx and convey it towards the esophagus. The same thing happens thousands of times a day when swallowing liquids (1). At this moment, the teeth bear the maximum stress, and if this stress is not properly balanced, numerous consequences can occur, both on the teeth and on the muscles and temporomandibular joints (TMJs).

As an additional note, the expansion of the tongue that occurs during the oropharyngeal phase of swallowing invades all the empty spaces when teeth are missing and, therefore, it is especially critical for:

a) its interposition between the teeth, which prevents their correct eruption;
b) newly placed implants if they protrude into the mouth (2).

Aid the anterior chain muscles in traction on the hyoid bone

When an effort is performed, numerous muscles are regularly involved. When this effort regards arms and chest, the effectiveness of the anterior muscular chain requires the mandible to be firmly clenched to the upper jaw, so as to allow the hyoid bone to be stably blocked to mandible and cranium by the suprahyoid muscles, letting the infrahyoid muscles stabilize the clavicula and the sternum, on which the muscles of the chest can then exert an effective traction. If we watch the weightlifters during their performance, they clench their teeth. This happens when apical efforts involving the anterior muscular chain are performed (3).

Anterior muscle chain

When the human being makes an extreme effort involving the muscles of the chest, he tights the lower jaw against the upper one (4). This is due to the fact that, during this function, the suprahyoid muscles firmly anchor the hyoid bone to the mandible (mylohyoid, anterior digastric, geniohyoid) and to the temporal bone (posterior digastric, styloid), allowing the infrahyoid muscles (sternohyoid, omohyoid, thyrohyoid) to operate traction on an extremely stable bone, then stabilizing the lower bones (sternum, clavicle, scapula), so as to let the muscles of the chest and arms swell adequately to carry out their effort (Fig. 1).

Fig. 1. *During extreme efforts the teeth are tightened on the antagonists to allow the functionality of the anterior muscular chain.*

Balanced occlusion is necessary to ensure that the mandible is a stable traction point for the suprahyoid muscles. The mandible clenched on the maxilla represents the terminal part of the anterior muscle chain. If the contact between the upper and lower teeth is not well distributed, the lower jaw cannot reach a stable position and, consequently, the underlying muscles cannot work efficiently. This fact explains why weightlifters often wear a mouthguard during their exercises.

If the back teeth are missing, there is no fixed opposition to the elevation of the lower jaw. The condyles lift upward, compressing the joints. The relationship between the jaws is incorrect, and the elevator muscles suffer a loss of trophism due to a lack of functionality. Additionally, if the physiological dynamic movements of the jaw are hindered by interference from the teeth, a neuromuscular response is activated, which can lead to muscle and joint disorders (5).

The role of glial cells and the myelin sheath in traumatic occlusion is currently being studied. Clemente-Napimoga et al. demonstrated that experimental traumatic occlusion (ETO) induces altered neuronal patterns and suggestive activation of satellite glial cells (6).

MATERIALS AND METHODS

Treatments

The most commonly used therapy for unbalanced occlusion between upper and inferior teeth is the use of a bite capable of providing a better relationship between the jaws (7). Due to bite thickness, compatibility with any single patient should be carefully evaluated. A free-way-space higher than the average is suggested, not to produce clenching responses. One means to detect the amount of the patient's free-way space is mandibular kinesiography. A magnet is applied to the base of the crown of the lower incisors, and its movement, in relation to three other magnets, is converted into images on a screen using an oscilloscope (8). Normally, 2nd-class and deep-bite patients got a free-way-space higher than average (Fig. 2).

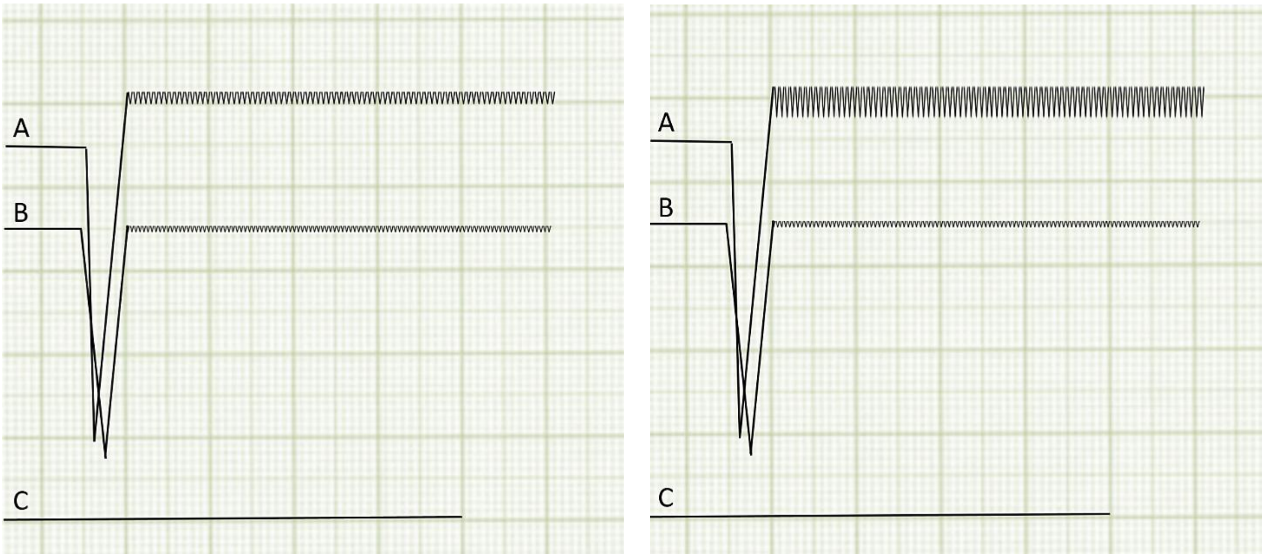

Fig. 2. *Mandibular Kinesiography (**scheme**). The patient on the left has a 2mm free-way space (A) and a 1 mm overjet (**B**). The patient at right has the same overjet (**B**), but a wider free-way space (**A**).*

Kinesiographies performed on 20 consecutive patients in the Dr. Dal Carlo dental office show that 65% (13/20) have 1 to 3 mm of free-way-space, and 35% have more than 4 mm of free-way-space. In approximately one-third of these cases, a shim may be applied between the teeth.

In situations of advanced craniomandibular disorders, particular bites have been studied to correct the harmful action of the tongue and train the patient to use new closing trajectories. The results of this therapy appear encouraging, although documentation on the long-term effects of altering the relationship between the jaws remains scarce (9).

Regardless of the type of bite used, the aim of the therapy should be to prosthetically restore the patient's physiological functions in a stable way. When planning new fixed prostheses that cover the entire arch, it is advisable to conduct a thorough study of each patient's correct jaw function to prevent pathologies associated with an incorrect jaw relationship. This is especially important when immediately loading dental implants.

Occlusal planning

When faced with a symptomatic patient in whom signs of parafunctions are evident, the treatment can follow different paths, depending on the indications of the different research schools.

The experience of the Spanish and Chilean university research group with selective grinding on occlusal splint aimed at obtaining a balanced static and dynamic occlusion was very encouraging, treating the symptoms of TMJ in most cases (10).

Extensive experience with immediate loading of full-arch implant cases (11, 12) has led our research team to ascertain the importance of correct centric relation and anterior guidance, especially when bone is sparse, and the upper jaw is smaller than the lower jaw (Fig. 3) (13).

Fig. 3. *Patient BK, age 55, Caucasian, female. Implant-prosthetic rehabilitation of the entire upper arch of a patient with poor bone and crossbite. Static and dynamic occlusion recording was followed for months.*

When facing a clinical case in which an implant rehabilitation is needed, it's also mandatory to analyze the position of the tongue during swallowing, so as to prevent harmful effects due to its expansion. The tongue is interposing between the teeth in open bite cases (14).

Occlusal therapy

In 1974, Niles Guichet published the following sentence in his book entitled "Occlusion": "The dentist can, by modifying the occlusion, eliminate irritating occlusal plugs, thus allowing the muscles to relax" (15).

The goal of the occlusal therapy should be to restore (or create, if it was not there) the organic occlusion in a patient who exhibits signs and symptoms of malocclusion. The symptoms that usually lead patients to visit the dentist generally concern toothache, muscle pain, joint pain, joint noises, and grinding noises. It is therefore necessary to ascertain: the absence of teeth, prosthetic materials, structural damage to the teeth, stability of the teeth, periodontal health, generalized or localized, muscle tone, right/left balance, and jaw movements.

Pathologies, drugs, and eventual vicious habits must be carefully considered. To obtain this information, anamnesis, semiotics, and electronic instrumentation are recommended. After this first phase, which is useful for defining the pathology, a therapy can be planned.

The primary objective is to reproduce in the patient the same conditions in which the pathology is expressed. If the pathology acts, as often happens, during sleep, we must reproduce similar sleep conditions with the patient awake. In fact, when the patient is awake, a CNS protection system is activated to avoid harmful contact, based on the proprioception of teeth and muscles. Alternative mandibular pathways are programmed and, therefore, the patient does not perceive the pathological contacts during the waking state. As soon as he wakes up, he retains the memory of these harmful activities for a while, and then the protection is activated. To achieve the objective of reproducing the sleep situation, we use a well-tested methodology: the Pasqualini Stopper.

Pasqualini Stopper

The Pasqualini stopper (Fig. 4) involves creating a little resin ball that is adapted only to the upper incisors, in order to create an anterior shield, to avoid posterior contact, and to let the inferior incisors slide on it (16).

Fig. 4. *The Pasqualini stopper.*

By eliminating contact on the teeth, the muscle tone is lowered. We can easily observe, with the patient seated in our dental chair, that the jaw gradually moves backward, which indicates muscle relaxation. We can add, keeping the Pasqualini stopper in the patient's mouth, the Tens, which helps to quickly relax the muscles. The Jankelson Myomonitor or a similar device is suitable for this use (17).

Static occlusion

The next step is to progressively reduce the stopper until the first pair of teeth comes into contact with each other. At this point, we can work by adding composite materials to the teeth that do not come into contact with the antagonist, or, if the excess contact is on a prosthetic reconstruction, we can reduce the tooth. If the excess contact is on a natural tooth, orthodontics should be evaluated before deciding to modify the tooth. Otherwise, we can collect the occlusal keys to plan a prosthetic rehabilitation at a higher level.

Dynamic occlusion

Once the intervention to balance the static occlusion is complete, we address the dynamic occlusion. Canines and incisors are often abraded. We add materials to recover the anterior guidance.

At the end of the therapy, a new session of diagnostic tests, including Kinesiography (Myotronics, U.S.A.), Electromyography (BTS, Italy), and T-Scan Electronic Occlusal Detection (Tekscan, U.S.A.), is useful for confirming the therapy's outcome and documenting it. To obtain a useful comparison, these tests are also suggested at the beginning of therapy.

Clinical case

A Caucasian patient, T.A., male, 26 years old, was seen to address his nocturnal teeth grinding habits and to investigate gingival recessions around several teeth (Fig. 5). The patient was seen on January 4, 2022. In addition to the patient's previous reports, a Class III occlusion was noted, no protected anterior guidance. The patient's head rotation was blocked to the left side. Neck and shoulder pain was reported. Due to obvious signs of occlusal imbalance, a Pasqualini stopper was constructed, an EMG was performed (BTS Bioengineering Milan, Italy), and the patient was scheduled for occlusal therapy.

Fig. 5. *January 4, 2022. Endo-oral occlusion at the first visit.*

February 01, 2022. After muscle relaxation, occlusal therapy was performed, slightly removing premature contacts in centric. The centric contacts were then detected by the T-Scan (Tekscan, U.S.A) device, which allows you to appreciate the minimal differences in contact of the teeth during clenching (Fig. 6) (18).

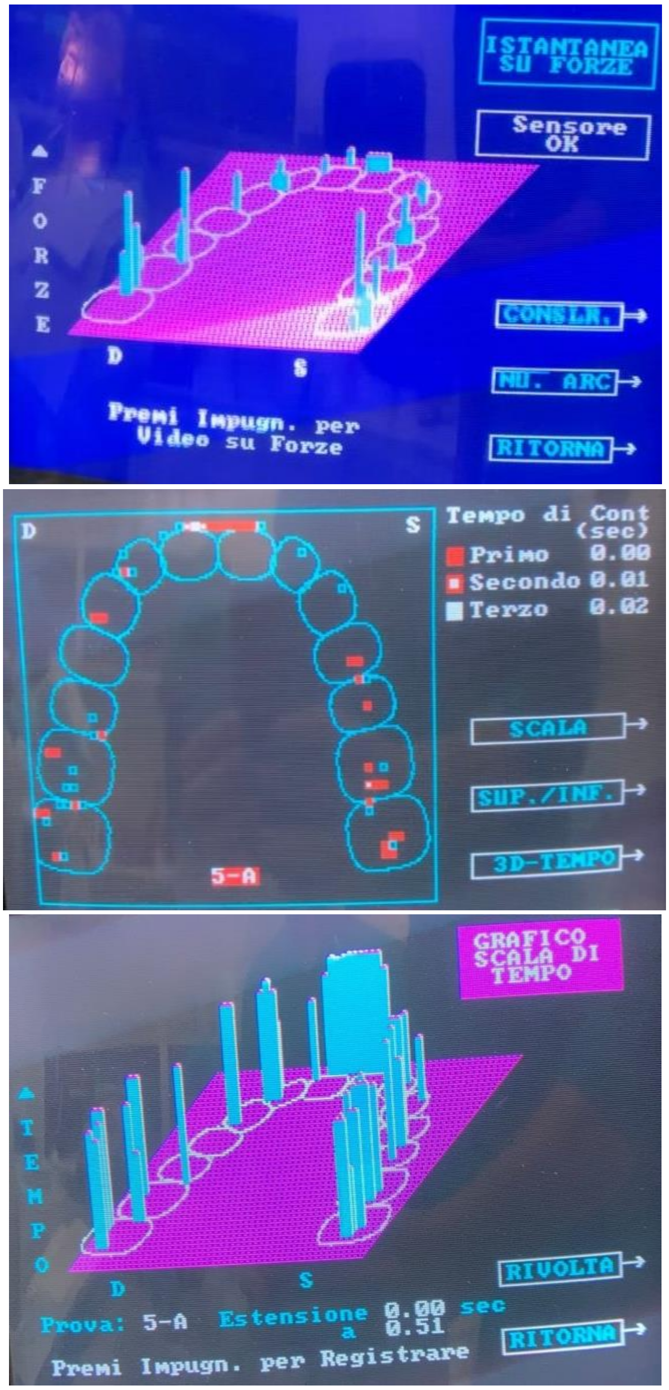

Fig. 6. *February 1, 2022. T-Scan after occlusal therapy.*

February 1, 2022. After confirming the positive outcome of the occlusal therapy in centric occlusion, we proceeded to restore the lateral guidance by adding composite to the canines on both sides (Fig. 7).

Fig. 7. *February 1, 2022. With additional restorations on the canines, the mandible is now able to move laterally without interference.*

February 24, 2022. The patient is scheduled for a follow-up session. He reports a reduction in nighttime grinding habits. Semiotics: bilateral head rotation is ok. Normal tone of the sternocleidomastoid muscles. An EMG is performed, which confirms a significant improvement in muscle balance (Fig. 8, 9) (19).

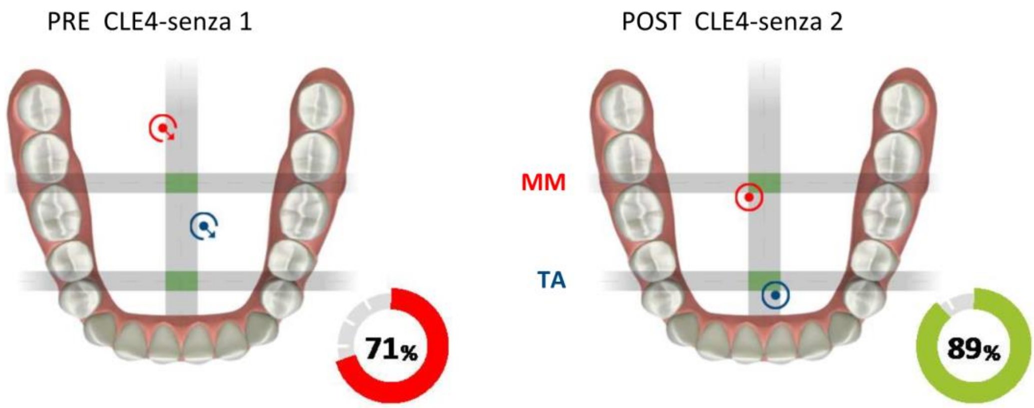

Fig. 8. *EMG before and after occlusal therapy.*

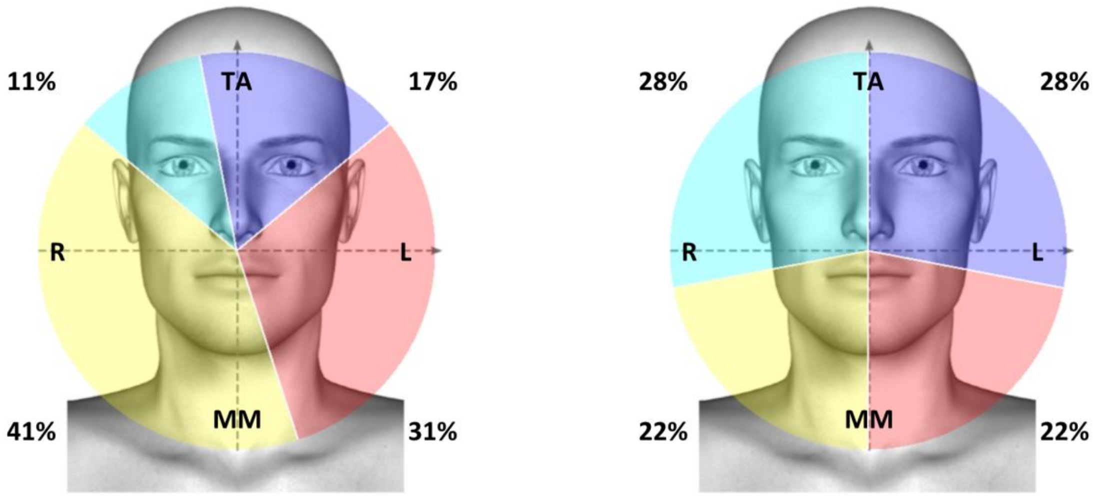

Fig. 9. *EMG before and after occlusal therapy.*

CONCLUSIONS

The relationship between the upper and lower jaw is a fundamental part of the anterior musculoskeletal chain. Therefore, any rehabilitation project must consider the physiological function of this apparatus. If this relationship is unbalanced, corrections are indicated. Prosthetic rehabilitations must be constructed taking care to respect the principles of physiological static and dynamic occlusion. Electronic tools can be useful in achieving this goal with the utmost precision. The occlusal therapy described here represents a proven procedure to increase the stability of the apparatus in non-edentulous patients.

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