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REVIEW ARTICLE

Musical instruments as etiologic factors for maloclussions

Instrumentos musicales como factor etiológico de maloclusiones

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ABSTRACT

Dental occlusion may be severely affected by the constant execution of musical instruments, since only less than 100 g of pressure is required to orthodontically move a tooth, and the force these instruments exert on oral tissues has been measured, some of them reaching the 500 g pressure. Wind instruments such as transverse flute, trumpet, trombone and tuba are in direct contact with the lips and it is necessary to play an internal air pressure to the nozzle of the instrument causing injury to the muscles but also affecting the position incisor and mandibular position that leads to play this type of instrument. There are also string instruments like the violin and viola that are in contact with the mandible and put pressure on it for the correct positioning of the instrument. This may cause mandibular deviation, joint and occlusion problems to the musician. The orthodontist must consider the force exerted by the musical instrument on the oral cavity as well as its position, time of execution and age at which the patient began practicing since having an external and repetitive direct force causes several changes in muscles, bones, teeth and joints. It is important that, from the beginning and during the use of the musical instrument, the musician visits the orthodontist regularly for prevention and control of malocclusions and thus, prevents the development of a dysfunction that may cause long-term inability to play. When the musician begins playing the instrument from an early age it is important to be observed and, if necessary, treated orthopedically, because this may cause skeletal and dental malocclusions during the stage of growth and development.

RESUMEN

El uso constante de la ejecución de los instrumentos musicales puede afectar gravemente a la oclusión dentaria, ya que, sólo se requieren menos de 100 g de presión para mover ortodóncicamente una pieza dentaria, y se ha logrado medir la fuerza con que se apoyan estos instrumentos sobre los tejidos orales, alcanzando algunos de ellos los 500 g de presión. Los instrumentos de aliento tales como flauta transversa, trompeta, trombón y tuba están en contacto directo con los labios y para ejecutarlos es necesario ejercer una presión interna del aire hacia la boquilla del instrumento, lo que provoca lesiones en los músculos, pero también influye en la posición de los incisivos y la posición mandibular que lleva al ejecutar este tipo de instrumentos. También hay instrumentos de cuerda como el violín y la viola que, al estar en contacto directo con la mandíbula y al ejercer presión sobre ella para la colocación correcta del instrumento, pueden causar una desviación mandibular, problemas articulares y de oclusión al ejecutante. Debemos considerar la fuerza que ejerce el instrumento musical sobre el aparato masticatorio, la posición, el tiempo de ejecución y la edad en que se inicia el estudio de éste; ya que, al haber una fuerza directa externa y repetitiva causa diversas alteraciones en los músculos, huesos, dientes y articulaciones. Es importante que, desde el inicio y durante el uso del instrumento musical, el músico acuda periódicamente al ortodoncista para la prevención y control de las maloclusiones y así evitar el desarrollo de una disfunción que pueda causarle a largo plazo la imposibilidad de tocar su instrumento. Cuando el músico inicia la ejecución de su instrumento desde edades tempranas es importante que sea observado y si es necesario, tratado ortopédicamente, debido a que éste puede causarle maloclusiones esqueléticas y dentales por encontrarse en etapa de crecimiento y desarrollo.

Key words: Musicians, orthodontic, malocclusion, temporomandibular dysfunction.
Palabras clave: Músicos, ortodoncia, maloclusiones, disfunción temporomandibular.

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INTRODUCTION

The dysfunction of the masticatory system, which includes the so-called temporomandibular joint disorders or craniomandibular dysfunction, is defined by Rodríguez as «the disruption of the biomechanics of the masticatory system and the cranio-facial unit, as a result of tissue damage in any of its functional units such as temporomandibular joints (TMJ), neuromuscular system, dento-occlusal system and cranio-cervical spine system, when it has exceeded the capacity of morphofunctional adaptation of its tissues».[1,2]

Clinically, this translates into signs and symptoms, such as: muscular-articular pain, noise and limitations in the temporomandibular joint movements, disturbance of the mandibular movements and alterations of the cranio-cervical positions as well as bruxism with its consequent damage to the periodontal and dental tissues.

A two-year study with 91 beginner musicians, whose ages ranged between 11 and 13 years of age, showed no statistically significant differences in the change of anterior teeth position when compared with the control group.[3]

Among the string instruments that are directly related to the masticatory system we find the violin and viola, and amid wind and metal instruments, the trumpet, horn, thrombi and tuba. In the group of windwood instruments, the most frequent are saxophone, clarinet, flute and oboe. These instruments may have a positive or negative influence on the lips, tongue, oral cavity, teeth and jaws.

It is important that the orthodontist performs an analysis prior to the assignment of the instrument so that the child with malocclusion may have an optimal musical performance and at the same time an orthodontic benefit. An incorrect choice of wind instrument could worsen the malocclusion, and even harm what the orthodontist is trying to correct.

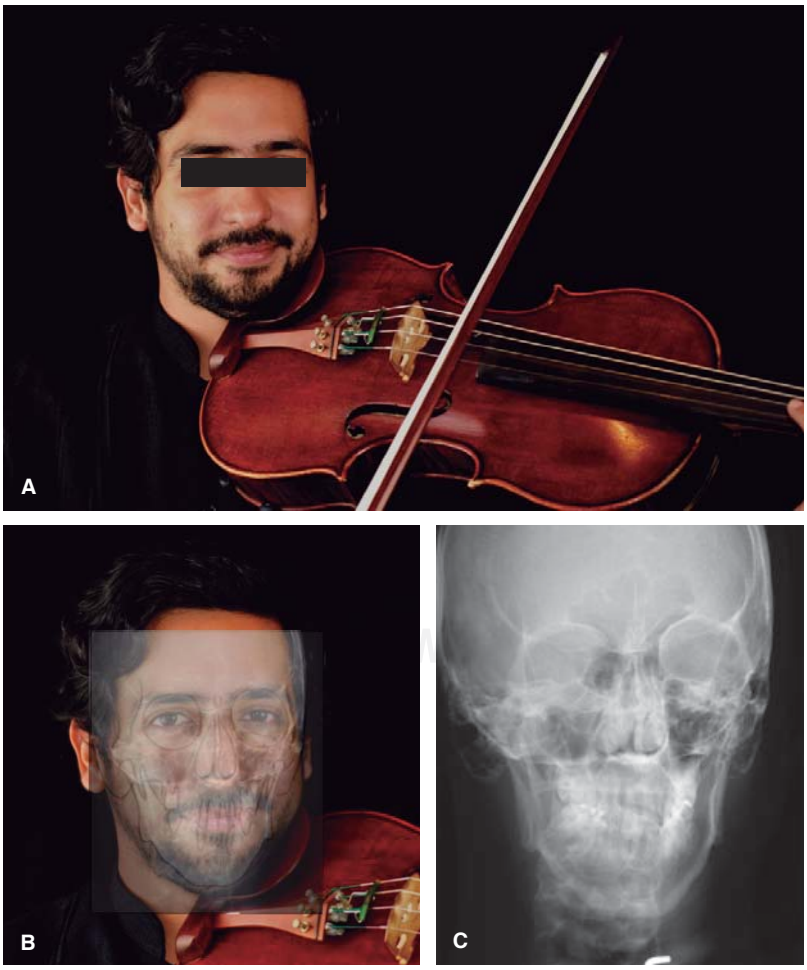

Figure 1.

A. Traditional technical position for playing the violin and viola. **B.** Transposition of postero-anterior (P-A) X-ray with the facial photograph and structure tracing while playing the instrument. **C.** P-A X-ray while playing the instrument (The radiolucency of the instrument in the X-ray is due to the material that is made of: spruce wood).

This is why music teachers should give importance to orthodontic examination in children who are going to play a wind instrument so as not to limit the potential of the student.

METHODOLOGY

The present research work focuses on a review of the literature about malocclusions caused by musical instruments depending on the type of instrument and its mouthpiece.

Tooth movement

According to Proffit's theory of balance, tooth position depends on the forces exerted by the tongue and lips, the forces of dental occlusion, the forces of the periodontal ligament and extrinsic forces (braces and habits, for example, digital suction).[4]

Tooth movement requires the application of a force that exceeds the minimum threshold of magnitude and duration, but there is little evidence of the optimal force to move a tooth.[5]

The force produced by wind instruments is higher than the minimum necessary force (35-60 g) to move a tooth (tipping, rotation, extrusion); brasswind instruments exert 500 g; woodwind with single and double reed, 270 g; and bevel instruments, 211 g.[6]

The pressure exerted by brasswind instruments has been documented to be as high or even higher than that of digital suction.[6] Moreover, the pressure to play an instrument is greater than speaking or eating.[7] that is to say, the force produced by a musical instrument is greater than that caused by the contraction of the perioral muscles and pressure levels associated with the maximum effort of the lip muscles.[6]

Therefore, tooth movement when playing a musical instrument depends on the type of instrument mouthpiece, the number of hours devoted to playing, the position of the teeth and the forces created by the tongue and facial muscles during practice. It should be borne in mind, that for tooth movement to be produced, these forces have to act more than 5-6 hours daily.[8] In various animal studies it has been shown that when a force is applied for eight hours a day, tooth movementoccurs.[9] Normally, musicians do not play so many hours a day. Duration is very variable and depends on the instrumentalist, but it can range between 30-60 minutes (concerts and classes not included)[6] to 5 hours a day.[10] However, it is possible that in times of intense rehearsals, this duration accumulates at the end of the day.

To produce tooth movement, what is most important is forceduration, while magnitude has a relative importance in speedmovement.

There are different types of forces: continuous, intermittent and interrupted. Those that produce greater impairment and more quickly, are the continuous type.[9] This is not the case of wind instruments, which are more akin to intermittent forces. Even so, Oppenheim[11] suggested that intermittent forces are more suitable for dental movement, because they provide a period of rest that allows regeneration of the periodontal tissues. Just like other authors who suggest that interrupted forces

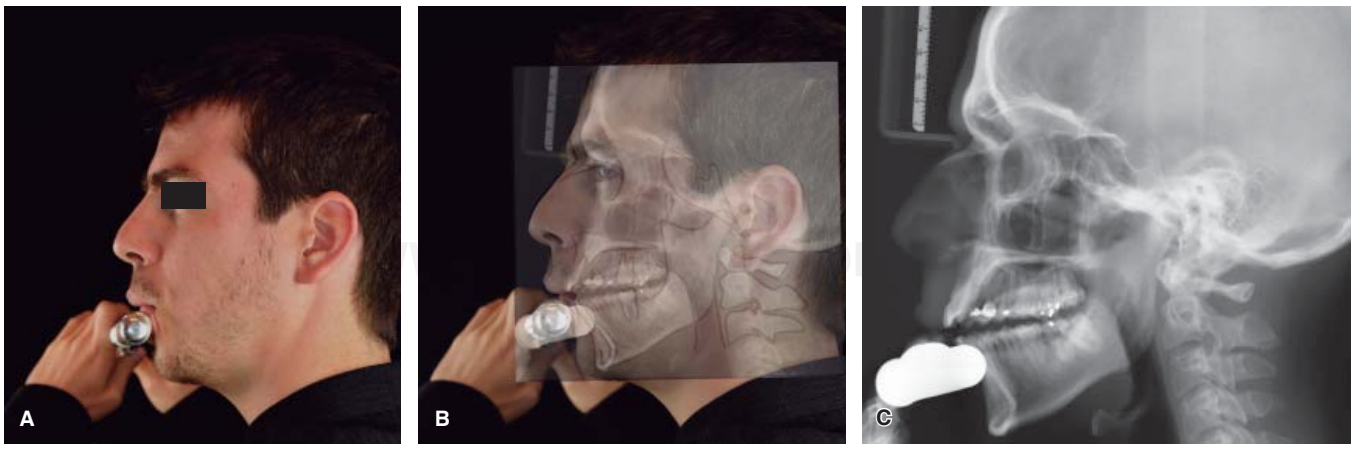

Figure 2. A. Position of the traditional technique for playing the transverse flute as seen from the patient's left profile. (The left side was chosen since on the right side the instrument and the interpreter's hands would cover the lip position). **B.** Transposition of the lateral left photograph, lateral headfilm and tracings while playing the flute. **C.** Lateral headfilm of the patient playing the instrument. The mandibular, lip and tongue positions may be observed during the interpretation of a musical note.

are the most optimal since theystop root resorption and allow the regeneration process to occur.[12-14]

The experience of many instrumentalists indicates that after a long period of practice, especially with metal instruments, tooth mobility may appear and that it increases with duration.[3] This fact had already been observed by Herman[3] and afterwards, by Alex[15] in 79% of their sample. Even further, Borchers[16] (1995) in his study measured the force exerted by brasswind instruments and observed horizontal deflections of the central incisors of 43-100 μm.

Nevertheless, there are authors who have found no effect on the dentition,[7] and argue that playing a wind instrument does not significantly affect the position of the teeth.[10]

Musical instruments directly related to the masticatory system

The musical instruments involved in this study are those directly related with the stomatognathic system such as: string instruments (violin and viola) and wind instruments.

Wind instruments may be classified depending on their mouthpiece: bezel, single reed, double reed and cup-shaped.

String instruments (violin and viola)

During the interpretation of the violin and the viola, the location of the instrument between the chin and the left shoulder and the pressure to hold it in position, requires a sustained craniocervical and mandibular muscular activity *(Figure 1).*[17]

Alanen and Kirveskari et indicated that this activity exceeds, in most cases, the normal physiologic function, and consider it a type of parafuncional activity that causes cranio-cervical and temporomandibular joint pathologies.[18]

On the other hand, Herman points out that some violinists and, especially, the interpreters of viola due to the increased size and weight of this instrument, may suffer headaches, neck stiffness and pain in the area of the right temporomandibular joint if they play continuously for three hours or more.[19]

Hirsch et al., compared 66 professional violinists with a control group and determined that mandibular movement limitation and deviation to the right during mouth opening was significantly higher in the study group.[20]

Bryant noted tenderness upon palpation of the left sternocleidomastoid muscle, trapezius and insertion of the temporal.

He also discovered an asymmetrical contraction of the left lateral pterygoid that advanced and deflected the mandible towards the right side, with «clicking» or «crackling» joint sounds. The latter is characteristic of degenerative joint disease.[21]

Rieder explains that changes occur due to the anterior position the skull adopts when playing the instrument and by the isometric contraction of the muscles to maintain the instrument stable with a

Figure 3. A. Traditional technique position for playing the clarinet as seen from the right profile of the patient. **B.** Transposition of the photograph on the right side, Lateral headfilmand structure tracing during the execution of the instrument. **C.** Lateral headfilm of the patient playing where the position of the instrument within the oral cavity as well as the tongue, lip and mandible positionsmay be observed while interpreting a musical note.

constant pressure between the chin and the left shoulder, especially in musical compositions that require nimble movements of the fingers of the left hand.[22]

Rieder reported the case of a young violinist of 20 years, in whom, throughoblique transcranial X-rays with the Schuller technique, degenerative changes in the ATM were observed on the right side: the opposite side to the chin support, due primarily to the mandibular deflection to the right side when playing this instrument.[22]

The radiographic findings in this group of patients were characterized by a decrease in the joint space and signs of irregularity in the condyle surface such as loss of cortical bone, erosions and flattening, compared to the opposite side.[23]

Könönen and Kovero agree with Herman that teeth clenching and/or grinding, especially the incisors, is common in these patients during lateroprotrusive movements towards the right and even becoming a unilateral crossbite while playing the instrument. This produces a severe damage in the teeth enamel.[23,24]

On the other hand, friction of the instrument while playing may cause irritation to the skin on the left side of the neck, in the area of support of the violin, and in some cases, a dermatological injury described as a lichenoid plate, which can be hyperpigmented or with erythematous papules and scarring in severe cases. The following conditions influence its manifestation: excessive sweating, increased pressure or more friction with the instrument, poor hygiene, as well as the size and weight of the violin. Peachey and Matthews have named this injury «fiddler's neck», hence many interpreters use a soft cloth between their neck and the instrument.[25]

The Paget-Scroetter syndrome caused by violas is characterized by redness, swelling, and pain due to the fact that the viola sits on the deltoid muscle compressing the brachiocephalic vein and in the chin support, it compresses the external jugular vein. In addition, the viola puts pressure on the collarbone and the costocoracoid ligament in the union of axillary and subclavian veins. The best preventive measure for this syndrome is not playing for hours at a time and use adequate protection.

Wind instruments

Bezel mouthpiece (transverse flute and piccolo)

It is a woodwind instrument in the shape of a cylindrical tube with holes and keys that is placedin a horizontal position, and to the right of the body.

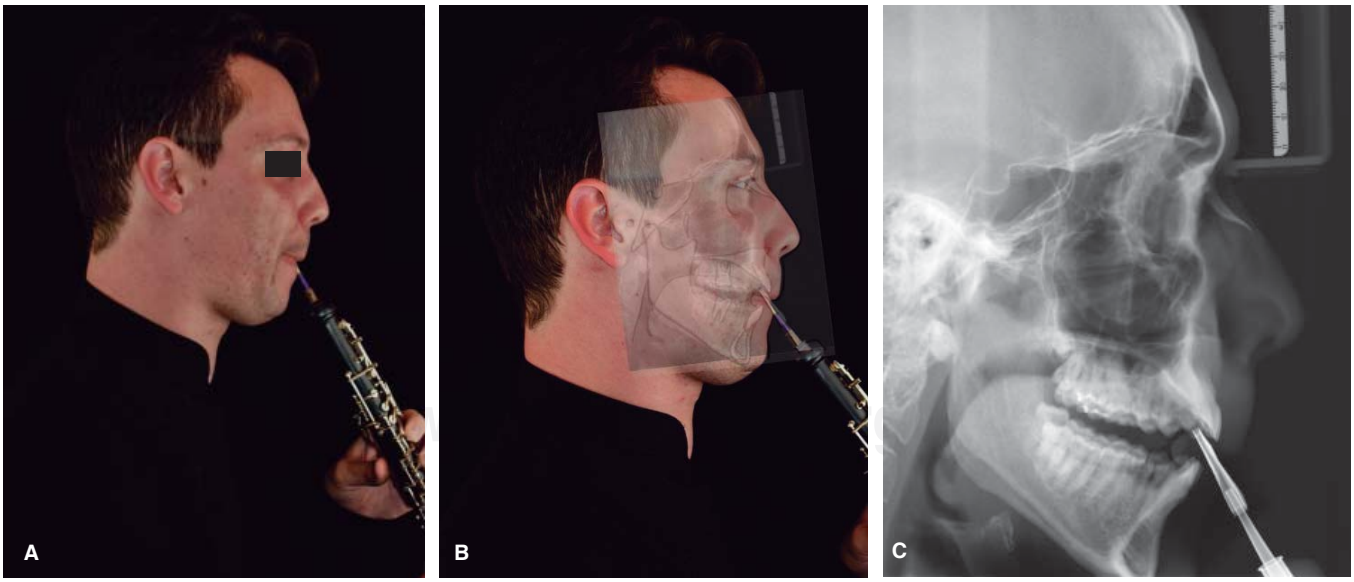

Figure 4. A. Traditional technique position for playing the oboe as seen from the patient's right profile. **B.** Transposition of the right lateral photograph, lateral headfilm and structure tracing while playing the instrument. **C.** Lateral headfilm of the patient playing the instrument where the lip, tongue, teeth and mandibular position used for executing a single note may be observed. The tongue of the instrument was covered with a lead film, since being made out of wood, it would appear radiolucid and its position inside the oral cavity would not be accurately observed.

While generally built with metal, it is classified as a wood instrument by its sound and because until the end of the decade of 1870 it was made with this material.[26]

The inside edge of the hole must be in contact with the edge of the lower lip. Usually, the musician tries to place the line that runs along the lower lip in the opening of the mouthpiece. Likewise, it must be supported on the plate and centered with respect to the middle of the hole. Visually the lips must be in the same proportion either to the right or to the left of the opening of the mouthpiece.

For the emission of sound, the lips must be placed parallel to the plate, slightly stressed towards the corners to make a small hole in the center of them. From this position air is sent against the bezel in order to produce a sound. This exercise may be performed holding the right end of the head open. Then the same process may be done closing this tip with the palm of the right hand *(Figure 2).*

Also, in any of the two situations the air speed may be modified to archieve register changes.[27]

In instrumentalists who use a bezel mouthpiece we find the «flautist's chin» which is a painful and persistent rash in the chin that may include papules, pustules and hyperpigmentation. It is caused by salivation and repeated friction with the instrument.[28]

We also found a mandibular retrusiondue to the fact that the issuance of air to the instrument must be in a downward direction and therefore problems in ATMamy arise.[29]

Single-reed mouthpiece (Clarinet and saxophone)

For playing this instrument, the embouchure (lip and facial muscles that surround it, required for the interpretation) is the heart of the execution of the clarinet; the nozzle should go to the mouth in a natural angle of 45 degrees; the upper teeth are supported on the nozzle; the muscles of the mouth around the mouthpiece are positioned in a wrap form, always staying firm and stable, accentuating the natural arch of the chin; the tongue is always relaxed and the throat, must constantly allow the passage of air; the upper teeth must be supported directly on the nozzle and the lower, covered slightly by the lower lips and the upper lip covers the front of the teeth and rests on the nozzle. The lower lip should not be fully placed either outside or inside; it must be totally relaxed, serving as a wall for the lower teeth. The mandible should be natural with firm and stable muscles.[30]

Instruments with acrylic wedge-shaped mouthpieces and with a single bamboo reed attached to the bottom surface of this, are placed between the upper and lower incisors in an angle that exerts a force towardslabial or buccalin the upper teeth and towardslingual the lower, thus increasing the overjet[31] *(Figure 3).*

In addition, due to the shape and hardness of this nozzle, in the upper teeth, especially the central incisors that make direct contact with it, endodontic problems may occur, for example In patients with

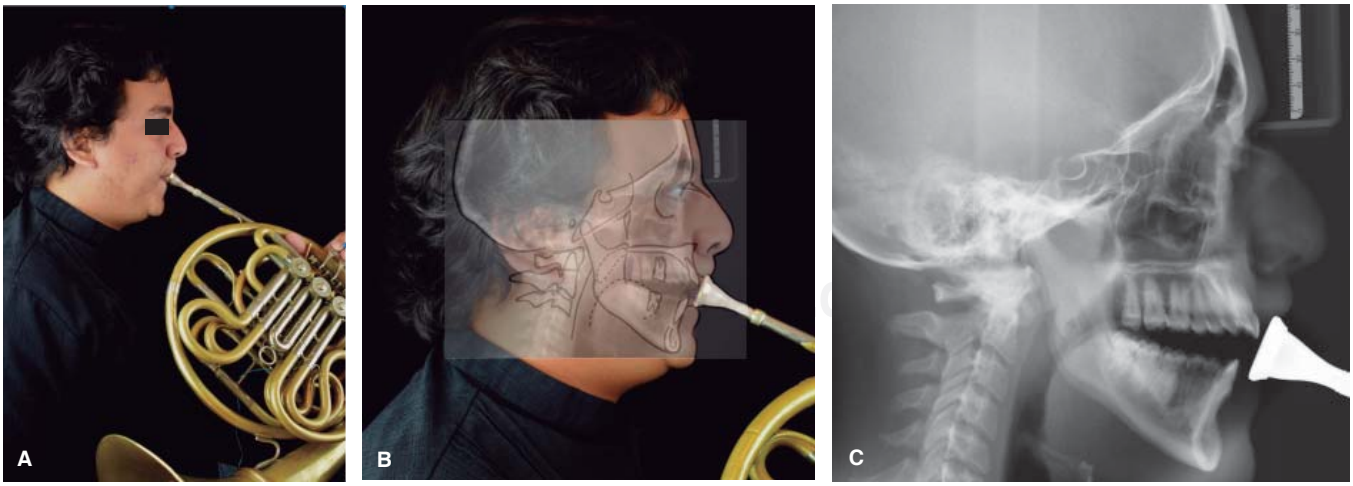

Figure 5. A. Traditional technique position for playing the French horn; view from the right profile of the patient. **B.** Transposition of the photograph on the right side, Lateral headfilmand structure tracing while playing the instrument. **C.** Lateral headfilm of the patientplaying his instrument where the mandibular, lingual and lip position that is used during the interpretation of a musical notemay be observed.

anterior open bite where excessive pressure is exerted toward apical on the central incisors, and suffer traumatic pulpo-periodontitis, reaching even devitalization.[32]

Another of the problems generated by this type of nozzle are lesions in the oral soft tissues, especially on the lower lip, because it must cover the incisal edges of the incisors towardslingual, so that when the instrument is played, the pressure generated on the nozzle impacts the lower incisors with the labial mucosa, causing pain, ulceration or hyperpigmentation.[33]

Double-reed mouthpiece (oboe, English horn and bassoon)

The reed must be placed between the lips looking for the tip of the cane. The tip of the tongue should be placed over the slim opening of the reed, in such a way that it blocks it.

Next and after inhaling air, the tongue is removed from the tip of the reed and the musician attacks with a blow of air.

This pressure of air on the reed makes it vibe and sound is produced. This is called "tonguing" and is done by placing and removing repeatedly the tongue at the end of the reed, in order to interrupt or leave free passage to the air *(Figure 4).*

As in single-reed instruments oral soft tissue lesions may be produced due to the impaction of the upper and lower incisors on the labial mucosa, causing pain, ulceration or hyperpigmentation. This probability is doubled in musicians who play the oboe, English horn and bassoon, since as a result of the bamboo double reed its execution technique requires to hold it between the upper and lower lips in tension and covering the incisal edges of the upper and lower incisors, respectively.[33]

In addition to these changes, we may also find retrognathism,[31] upper and lower incisor retroclination,[32] anterior open bite,[34] wear in the incisal edges of the upper and lower central incisors, TMJ dysfunction and malocclusions.[33]

Cup-shaped reed (trumpet, horn, trombone, and Tuba)

This group of instruments is interpretedextraorally, placing a metal reed with cup shape on the top and bottom lips pressing and transmitting such a force to the teeth. Skin and mucosa, in addition to exercising a protective function and moistening, are the structures that, together with the fatty tissue of the margin of the lip, produce the sound in brass instruments.

The lips vibrate inside the mouthpiece to produce the sound, while the muscles of the face will be in charge of the sealing, containment of the air and exert pressure on the cane *(Figure 5).* Brass instruments also cause tension over the skin, mucosa and fatty tissue to determine the frequency of vibration of these structures. It has been proved that for lipvibration, a double vibration is required: on the one hand the one that the fatty tissue of the lip margin (especially the upper) produces. It is a wave that closes the oral cavity from the ends toward the center. On the other hand, there is a much less obviousvibration, but equally important of skin and mucosa, which goes from the inside of the oral cavity out and overlaps the other.[35]

The frequency with which the lip and the mucosa vibrate and ultimately, the notethat will sound depend on the degree of tension on the skin and fatty tissue.

That tension, or the one that will be exerted on the cane, occurs thanks to the action of the muscles in the area. This area is located just under the skin and has two basic functions in the human being: open and close the eyes and mouth and give expression to the face.

None of these two functions requires large muscular power. What's more, a thick musculaturewould make this task impossible. For this reason, the so-called mimic musculature of the face is constituted by fine and delicate bundles of fibers.

The fact that these muscles, unlike what usually happens in the rest of the body, are not born or connect directly to the bone greatly complicates the situation.

Although some of them do have a solid insertion point, most are inserted to the skin or to other muscles forming a kind of muscle net.

This muscle network converges in the orbicular muscle of the lips, the muscle that surrounds the mouth and causes puckering of the lips. But the musician does not seek lip puckering buttheir tension. Therefore, it is necessary that the numerous muscles that connect with the orbicular muscle also contract. This contraction should be coordinated and as symmetric as possible to avoid injury.

The muscles that are activated when playing wind instruments, including those of metal or bronze, are: the orbicular of the lips, canines, triangular, square, zygomatic, and risorius as well as the chin muscles, the buccinator, masseter, cutaneous and supra and Infrahioid.

Many trumpeters in their mandibular push action to press the mouthpiece with their lips activate their medial pterygoid muscles and, particularly, the lateral.

Parker in a cephalometric study with trumpeters who had class II division 1 malocclusion, with mandibular retrusion, noted that, in order to maintain intimate contact of the lips with the reed, the mandible should be advanced greatly which may explain the presence of TMJ symptoms as a result of the lateral pterygoid muscle fatigue.[34]

On the other hand, Gualtieri clinically examined 150 subjects, comparing a group of professional wind instrumentalists with a control group and found a high incidence of clicking and crackling in the TMJ of trombone and tuba interpreters (31%), versus the control group (12%).[31]

With the addition of cephalometric analysis, Gualtieri in showed that when playing this type of instruments the mandible is displaced from a resting position to one upwards and backwardsrepetedly, favoring the posterior displacement of the mandibular condyle and increasing the likelihood of dislocation of the articular disc.[31] In all other kinds of instruments, the mandibular movement from the rest position was down and forwards or down and backwards, never up. In addition, in the same study, it was found an abnormal lingual inclination of the lower anterior teeth in the musicians group twice as frequently than the control group.

Engelman measured the pressure exerted on the lips and anterior teeth by wind instruments. Brass wind instruments showed the highest values (500 g).[6]

This confirms what was found by Herman: the more time the music played instrument, especially brass wind, the greater the mobility of the teeth.[36]

Other injuries associated with these instruments have been described in the oral soft tissues. Attramadoland Barkvoll studied the incidence of recurrent herpes labialis in 45 military interpreters of woodwind and brasswindinstruments compared with drummers and not -musicians soldiers as a control group.[31] They found twice the incidence of this lesion in the study group and in addition, a tendency to more frequent herpes lesions in the lower lip of woodwind players; while in brasswind players, the upper lip was more affected. The authors suggest that the sustained mechanical trauma that the lips receive while playing favors the recurrence and localization of herpes lesions.

Furthermore, more severe lesions have been described in soft tissues, such as rupture of the orbicularisorismuscle in trumpeters. The function of performing the embouchure falls mainly on a muscle called orbicularisoris; but its anatomical capabilities are far from the large demands required for playing the instrument, since being a tiny muscle (just a few millimeters thick) it is required to tense and vibrate at the same time it is pressed by the instrument's mouthpiece for long periods of time, making it susceptible to fiber tear or break.

The initial symptoms are lip weakness or fatigue, followed by great difficulty to perform high notes (which requires greater muscular contraction). According to the dimension of the rupture, will be the extension of the symptoms; it can be very localized when a small area is affected. Pain may be a sign of inflammation (and internal bleeding), and after the rupture of some of the muscle fibers, comes a natural healing process. When the rupture is large, surgery is almost always necessary. Although most of the cases, when they seek help from the onset of symptoms, are resolved with physical therapy. Physical agents such as cold, laser, electrotherapy along with specific exercises may be one way for an adequate healing and a speedy return to the musical performance.[37]

DISCUSSION

There are authors who claim not to have found any effect on lip tonicity[7] and that playing a wind instrument does not significantly affect the position of the teeth except in instrumentalists with cup-shaped reed, which show a tendency to anterior crossbites.[11]

It is important to note that musical interpretation through an instrument is a complex motor task, as it requires artistic creativity, emotional expression and musical interpretation with a remarkable level of sensory-motor control, dexterity, precision, muscular endurance. Therefore it is necessary to analyze execution time per day, the force of the instrument on the structures, the age at which the instrumentalist began playing this instrument, the movements that are required to play it; the tongue and lips movements required for playing it, the posture with which the instrument must be placed in order to carry out the emission of sound, the stress in which the musician is under to study for a presentation and the biomechanics used during the control and issuance of air.

Considering that playing a musical instrument is not performed with a natural body posture, as it requires an external attachment, which is the instrument as such, it is only logical that it causes an adverse effect when played frequently and with constant repetition.

By moving through the entire range of movement the musician can avoid extreme static postures and probably improve musical interpretation. Therefore upon orthodontic examination, the clinician should see him or her play and consider not only the static position, which could lead to errors, but look at the

entire performance. Only fixed, biomechanically outweighed positions (body or joints) that could be harmful must be corrected.[38]

CONCLUSIONS

Generally for treatment we must locate and eliminate the etiological factor that is causing the pathology; in the case of instrumentalists, this cannot be done due to the fact that the instrument is part of their job and cannot fail to practice it.

It is important to recognize the sings and symptoms that the patient shows when he or she plays the musical instruments and the way to prevent the adverse effects.

Faced with this situation, the orthodontist should work as a team along with other disciplines such as periodontics, oral surgery, rehabilitation, and with the same musicians.

Frederik Matthias Alexander described a preventive method called the Alexander Technique that suggests the good placement of the musical instruments as well as the body itself. Alexander not only focused on musicians but to all people to raise awareness of their own movements and use them ergonomically in the most natural way possible.[39]

In the case of musicians a specialty called Alexander technique has already been implemented to help them facilitate movement, prevent injuries and to deliver a better quality of sound depending on each musical instrument because many diseases are caused by poor posture to hold the instrument, when standing or by playing the same instrument.

For musicians who have already been affected it is necessary to provide them with the necessary treatment in an interdisciplinary manner to be able to return to a good function the masticatory system and intervening and correcting malocclusions.

When the musician is in the learning or initial stage of a musical instrument, it is important to recommend preventive treatment and follow-up appointments to avoid triggeringanomalies in the orofacial system afterwards. When the musician starts from early stages it is advisable to control this and, if necessary, intervene with dentalorthopedics.

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