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TREATMENT MODALITIES IN PATIENTS WITH MALOCCLUSION CLASS II DIVISION 1 WITH ORTHODONTIC APPLIANCES

ТРЕТМАНСКИ МОДАЛИТЕТИ КАЈ ПАЦИЕНТИ СО МАЛОКЛУЗИЈА II КЛАСА 1 ОДДЕЛЕНИЕ СО ОРТОДОНТСКИ АПАРАТИ

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Abstract

Malocclusion Class II division 1 is a sagittal anomaly characterized by distinctive extraoral appearance. In malocclusion Class II division 1, in addition to the distal position of the mandible, there is also a protrusion of the maxillary anterior teeth with varying degrees of expression. The choice of treatmentfor malocclusion Class II division 1depends on several factors, includingthe degree of the antero-posterior discrepancy, the degree of expression of the malocclusion, the patient's ageandtheir level ofcooperation. Nowadays, if there is an indication, treatment without extraction is increasingly used. For this purpose, appliances (extraoral or intraoral) that perform distalization of the maxillary molars are used, thereby creating space distally and correcting the Class II division 1 malocclusion. The **aim** of this study was to gather sufficientdata through the searched literature that will help us in evaluating the variations of malocclusion Class II division 1, as to make a treatment plan according to the type of malocclusion, to assess whether there are indications for the use of a fixed appliance for distalization of the maxillary molars, as well as to choose the appropriate fixed orthodontic appliance for orthodontic therapy. Whilst searching through the literature, we found through the modern scientific databases PubMed, Google Schola, Embase, Cochrane Central Register of Controlled Clinical trials, PMC, NLM, Web of Knowledge, Scopus, LILACs,that we will use to achieve our goal.Both recent andolderliterature publications about this problem, special emphasis was given to the different approaches and the use of appropriate devices for the distalization of the maxillary molars and thus the correction of malocclusion Class II division 1. Mobile and functional orthodontic appliances are often preferredfor mild or moderate Class II malocclusion during the patient's growth period. In patients in whom it is necessary to distalize the maxillary molars, to correct a malocclusion Class II division 1, foruncooperative patients and for those in whom the growth period has passed, fixed appliances for distalizing the maxillary molars are the right choice for orthodontic therapy. The selection of afixed appliance for maxillary molardistalizationin the correction of Class II malocclusion depends on the orthodontist. All appliances achieved molar distalization, created additional space and Class II malocclusion correction. Fixed distalization appliances for maxillary molars that have skeletal anchorage have been shown to be more stable with no loss of anchorage, than fixed distalization appliances that have dental anchorage. **Keyword:** malocclusion Class II division 1, molar distalization, fixed functional appliances.

Апстракт

Малоклузија II класа 1 одделение претставува неправилност во сагитален правец, со изразен екстраорален изглед на пациентот. Кај малоклузија II класа покрај дисталниот однос на мандибулата, постои и протрузија на максиларните фронтални заби со различен степен на изразеност. Која терапија кај малоклузија II класа 1 одделение ќе ја примениме зависи од повеќе фактори, меѓу кои се степенот на антеро-постериорната дискрепанца, степенот на изразеност на малоклузијата , возраста, како и соработката на пациентот.Денес, доколку постои индикација, се повеќе се употребува третман без екстракција. За таа цел се користат апарати (екстраорални или интраорални) кои вршат дистализација на максиларните молари, со што се создава простор дистално и се коригира малоклузијата. Главна **цел** на овој ревијален труд, ни беше да преку пребараната литература се здобиеме со доволно податоци кои ќе ни помогнат во проценување на варијациите на малоклузија II класа 1 одделение, да се направи план на третман според видот на малоклузијата, да се процени дали постојат индикации за употреба на фиксен апарат за дистализација на максиларните молари, како и да се направи правилен избор на фиксниот ортодонтски апарат. Од пребарувањето на литературата, податоците што ги пронајдовме преку современите научни бази PubMed, Google Schola, Embase, Cochrane Central Register of Controlled Clinical trials, PMC, NLM, Web of Knowledge, Scopus, LILACs, ќе ни послужат за да ги реализираме нашите цели. Проследувајќи литературни публикации за оваа проблематика постари и понови, посебен акцент е даден на различните пристапи и употреба на соодветни апарати за дистализација на максиларните молари и со тоа корекција на малоклузија II класа 1 одделение. Мобилните и функционалните ортодонтски апарати може да бидат избор на терапија кај благо или умерено изразена малоклузија класа II во период на раст на пациентот. Кај пациенти кај кои е потребно да се дистализираат максиларните молари, да се коригира малоклузија II класа 1 одделение, пациенти кои не соработуваат и кај кои е поминат периодот на раст, фиксните апарати за дистализација на

максиларните молари се правиот избор за ортодонтска терапија. Кој вид на фиксен апарат, кој овозможува дистализација на максиларните молари, ќе се употреби при коригирање на малоклузија II класа 1 одделение според Angle зависи од возраста на пациентот, степенот на изразеност на малоклузијата и од одлуката на ортодонтот. Сите апарати постигнале дистализација на моларите, создавање простор и корекција на малоклузија II класа 1 одделение. Се покажало дека фиксните апарати за дистализација на максиларните молари кои имаат скелетна анкаража се постабилни во однос на загубата на упориштето, од фиксните апарати за дистализација кои имаат дентална анкаража. **Клучни зборови:** Малоклузија II класа 1 одделение, дистализација на молари, фиксни функционални апарати.

Introduction

Crowding, protruded teeth and other irregularities have affected humanssince ancient times. Historical evidence showsattempts and efforts to correct these irregularities, as demonstrated by Corruccini et al.[1] Orthodontic appliances that were made during that period have been found among both the Greeks and the Etruscans.

Nowadays, the need and demand for orthodontic therapy is increasing. People are becoming increasingly aware of dental irregularities, especially facial deformities that occur due to the inharmonious ratio of the jaws, which will have significant consequences on appearance.

Malocclusion is a condition that includes both morphological and functional irregularities of the masticatory system. Milić et al.[2] emphasize the importance of accurate diagnosis to identify the type and cause of the malocclusion, which is essential for providing effective treatment.

Communication among therapists was significantly facilitated when Edward Angle first introducedthe classification of malocclusions in 1899. He divided them into 3 groups: malocclusion Class I, malocclusion Class II, which was divided into 2 subgroups: malocclusion Class II division 1, malocclusion Class II division 2 and malocclusion Class III. Bishara et al.[3] made a classification system is based on the correlation of the mandibular first molars to the maxillary first molars.

Many authors considered this division to groups to be unreliable because Angle took only the molar correlation as the main criterion, and each malocclusion has many variations that affect the choice of therapy. But despite its limitations, the Angle classification is still used worldwide for communication between dentists and orthodontists.

Class II malocclusion is an irregularity in the sagittal direction, with a pronounced extraoral appearance of the patient. Angle, according to the placement of the maxillary incisors, divided it into Class II, division 1 and Class II, division 2.

In Class II malocclusion, division 1, in addition to the distal relationship of the mandibular dental arch, there is also a protrusion of the maxillary anteriorteeth, which can be of varying degrees of severity, as stated by Kanurkova[4]. It can be with an overjet, which can be slightly increased (greater than 3 mm), moderately increased (5-6 mm) and extremely increased (greater than 10 mm), while in the vertical direction it can be with an open bite or a deep bite.

The molar relationship is describedby occlusion of the mesiobuccal tubercle of the maxillary first molar with the distal surface of the mandibular second premolar and the mesial surface of the mandibular first molar.Additionally, the maxillary canine occludes with the distal surface of the second mandibular incisor and the mesial surface of the mandibular canine.

As explained by Kanurkova[4], the maxillary dental arch is usually narrow, irregular, elongated, and V-shaped. It has a narrow, underdeveloped apical base, and sometimes a crossbite is observed due to the underdeveloped maxilla in the transverse direction. The maxillary incisors are protruded, which can be variably expressed with crowding or spacing.

Patient's profile is convex, the head shape is doligocephalic, the lips are incompetent, the upper lip is protruding forward and is short, which makes most of the maxillary incisors visible. The maxillary incisors are protruding and often lie on the lower lip. These patients often also have oral breathing due to the presence of nasal obstruction.

In addition to the anamnesis, clinical examination and cephalometric analysis, the analysis of dental casts are particularly important, which will help with making the correct diagnosis of malocclusion more easily. Dental castsprovide a detailed overview, athree-dimensional view in sagittal, transverse and vertical directions and are of great importance if they are taken during the period of mixed dentition, (ages 8 to 11), when we need to see if there will be space for the permanent canines and premolars.

As a cause of the occurrence of malocclusion II Class, division 1, in addition to heredity which is a dominant factor, there are other etiological factors such as compromised breathing and swallowing functions, tongue thrusting, impaired TMJ function, the presence of pathological processes in the TMJ as well as the presence of bad habits - thumb sucking. When these habits occur during the primary dentition, the probability of it occurring in the permanent dentition is very high. Lip muscles activity also influences the retroclination of the maxillary and mandibular incisors.

The use of formula feeding - bottles with soft nipples in infancy can contribute to formation of retrognathism of the mandible and orthodontic irregularity - protrusion of the maxillary incisors., as explained by Radumilo et al.[5]

Furthermore, from the primary dentition, the malocclusion is transferred to the mixed and then to the permanent dentition.

As demonstrated by Tehranchi[6], the most common therapeutic options used in patients during the growth period are functional appliances, which can be mobile (Activator, Bionator, Frankel and Twin block appliance) or fixed (MARA appliance, cemented Twin block appliance, Herbst appliance), which stimulate the mandibular growth in the condyle area, or further in the treatment plan, a facial arch can be included - Headgear appliance, which can be with a support at the Cervical level - Cervical headgear or a with a high support - High pull headgear or a combination of both types can be used.

In patients where growth is complete, a fixed orthodontic appliance can be used as camouflage method, without tooth extraction, using intermaxillary elastics for Class II or with distalization of the maxillary first permanent molars (Pendulum appliance, Headgear facial appliance and mini-screw therapy for distalization of the maxillary molars).

The choice of orthodontic appliance primarily depends on the type and severity of the Class II malocclusion and the patient's coopeartion with the orthodontists.

Literature provides extensive data on the different morphological variations of Class II malocclusions, the reason for their occurrence and treatment options.

Children with chronic rhinitis, adenoid hypertrophy, tonsillar hypertrophy, and deviated nasal septum may develop oral breathing due to partial or complete upper airway obstruction, as reported by Lyu et al.[7]. Oral breathing alters the structure of the temporomandibular joint and periarticular muscle group, often leading to mouth breathing. This often results in Class II malocclusion and changes in the maxillofacial hard and soft tissues, affecting maxillofacial appearance and development.

As demonstrated by Cozza et al.[8], the presence of thumb sucking and the presence of a positive mandibular angle in mixed dentition are closely associated with transverse occlusal disharmony. This disharmonyis characterized by reduced maxillary intercanine and intermolar width, increased transverse intermaxillary discrepancy, and increased frequency of crossbite.

In the longitudinal studies of Vasquez et al.[9] the incidence of malocclusion II Class divison 1 in mixed dentition, if it is a maxillary protrusion, is 14.8%, which is similar to the previous study by McNamara[10] which is 13.8%. While in mandibular retrusion the prevalence is much higher, about 60% of the examined group with malocclusion II class. The prevalence of malocclusion II Class division 1 is 18-34% globally.

Hereditary factors play a dominant role in the formation of Class II division 1 malocclusion, which, combined by environmental factors, can lead to forming more severe expression of this malocclusion, as concluded by Uribe et al.[11].

According to the longitudinal study conducted by Bacetti et al.[12] it is emphasized that in the examined group in the deciduous dentition with diagnosed Class II malocclusion is expressed in a more severe degree in mixed dentition with pronounced molar and canine relationship in Class II and with an increased overjet.

It is necessary to have a good knowledge of the cause of the occurrence of malocclusion Class II division 1 and according to this knowledge to give an appropriate treatment plan.

In addition to the history and clinical examination, it is necessary to have a cephalogram, photographs, as well as a studio model, on which a gnathometric analysis will be performed. All these data obtained will help us in the correct choice of therapy.

There are six possible morphological variations of Class II malocclusion, described by Fisk[13]: the maxilla and teeth are anteriorly positioned in relation to the cranium, the teeth in the maxilla are anteriorly positioned in relation to the normally positioned maxilla, the mandible may be of normal size but distally positioned, or a condition where the mandible is positioned normally but the teeth in the mandible are positioned distally, or there may be a condition where there is a normally positioned mandible and a prognathic-anteriorly positioned maxilla, or combinations of all these conditions.

Aim of the study

The aim of this study is to analyze treatment approaches in patients with malocclusion Class II division 1, as perceived through data gathered from the literature.

Material and methods

The data obtained from our literature will supportus in achieving our goals. The studies analyzed spanthe last 20 years, with the exception of the original older publications that all newer studies use as a basis.

By following the literature publications on malocclusion Class II division 1, through a search of the modern scientific databases PubMed, Google Schola, Embase, Cochrane Central Register of Controlled Clinical trials, PMC, NLM, Web of Knowledge, Scopus, LILACs, we aim to deepen and broaden ourknowledge, i.e. expand the already existing knowledge and understanding of the different morphological variations of malocclusion II class, the etiology of their occurrence, and thus to determine the correct treatment plan and provide appropriate treatment.

The studies have been systematically organized to analyzeand compare the results obtained by various authors on

the effects of fixed orthodontic appliances for distalization of maxillary molars, as appliances for the correction of Class II division 1 malocclusion.

Following older and newer literature publications on this issue, special emphasis is given to the different approaches and use of appropriate appliances for distalization of maxillary molars and thus correction of Class II division 1 malocclusion.

We reviewed the literature publications through the scientific databases PubMed, Google Schola, Embase, Cochrane Central Register of Controlled Clinical trials, PMC, NLM, Web of Knowledge, Scopus, LILACs with keywords: Malocclusion Class II division 1, etiological factors of malocclusion II class, maxillary prognathism and mandibular retrognathism, distalization of maxillary molars, treatment of malocclusion Class II division 1.

Discussion

Class II division 1 malocclusion is a complex malocclusion that can manifest as dental, skeletal or combined. The main dental features are proclination of the maxillary incisors, while skeletal changes include a distal position of the mandible in relation to the cranial base and a prognathic position of the maxilla. Thedistal mandibular position can occur due to insufficient development of the base of the lower jaw, while prognathism of the maxilla is formed due to an increased elongated apical base due to the increased dimension of the spinal plane, which is diagnosed when measuring a profile cephalogram. The overjet in this class can be very pronounced, as notedby Moyers[14].

All the features of Class II division 1 malocclusion diagnosed in the primary dentition tend to persist intomixed dentition stage, and when the malocclusion is not corrected, they are transferred to the permanent dentition, as pointed out by Baccetti et al.[12]. In Class II division 1 malocclusion, due to the proclination of the maxillary incisors and skeletal disorders in the orofacial region, the lips are incompetent. Thesepatients attempt to close their lips by activatingcircumoral muscles that cause the mandible to move forward, but at the same time they pull the lower lip under the maxillary incisors, causing the lower lip to rest on the maxillary teeth, and they place the tongue between the incisors to touch the lower lip, which causes the formation of an open bite. Strong contraction of the muscles of the lower lip, retroclination of the mandibular incisors may occur[4].

The sagittal relationship of the upper jaw, i.e. the angle of maxillary prognathism (SNA), and the results obtained indicate that there may be a correctly positioned maxilla in relation to the cranial base, while the angle of mandibular prognathism (SNB) in Class II malocclusion is significantly lower than 80 degrees, as analyzed by Pavlović et al.[15]. This indicates that the mandible is positioned retrognathic position in relation to the cranial base. The angle of the sagittal relationship of the maxilla to the mandible is significantly higher, greater than 2 degrees in Class II malocclusion. This angle in Class II malocclusion cannot be corrected during growth, but it can become increasingly pronounced, therefore orthodontic therapy is required as soon as possible.

According to the results of the study, Radumilo et al.[5] found that the mandible and maxilla are rotated backward and downward, resulting in a steep occlusal plane and several morphological variations of this malocclusion. Due to this type of placement of the maxilla and mandible, there are several morphological variations of this malocclusion.

According to the results of the studies by Latorre et al.[16], there are no significant differences between the male and female populations in the measurements of cephalography skeletal parameters in Class II malocclusion.

Therapy of Class II division 1 malocclusion begins in early childhood. For this purpose, mobile, functional appliances, fixed or fixed orthopedic devices for the correction of maxillary prognathism and mandibular retrognathism can be used. Which type of orthodontic appliance will be used will depend on the patient's age, the degree of severity of the orthodontic malocclusion, the direction of jaw growth, as well as the patient's cooperation.

There are a number of treatment modalities used in the correction of Class II malocclusion, which depend on many factors: the type of malocclusion, the motivation of the patients, the presence of diseases and the expertise of the orthodontist.

Whether a non-extraction treatment or an extraction approach is chosen will depend not only on the degree of crowding, but also on the direction of growth of the orofacial structures, the facial profile, and the sagittal and vertical relationship of the jaws.

If an extraction approach is chosen, then 8 rules should be observed, as stated by Nielsen[17]: the patient should be postpubertal, i.e. when growth and development are minimal, the sagittal relationship of the jaws (ANPog) should be less than 5 degrees, the sagittal relationship of the apical bases (ANB) should be less than 6 degrees, with minimal protrusion of the mandibular incisors, mild to moderate crowding of the mandibular incisors, adequate distance between the apices of the teeth and the palatal cortical plane to allow for proper torqueing of the maxillary incisors, there should be normal size of the maxillary incisors, and there should be no pronounced curve of Spee. If possible, the extraction approach should be avoided, and the primary goal should be distalization of the molars, i.e. to bring the teeth to a Class I relationship.

Distalization of the maxillary first molars is conservative and increasingly popular non-extraction treatmentto correct Class II malocclusion and that non-extraction treatment has become quite popular as a treatment option in the last decade if there is an indication for it, as noted by Alogaibi et al.[18]. According to McNamara[10], mandibular retrognathism is the most common feature of Class II division 1 malocclusion in growing children and ideally, treatment should focus on correcting the skeletal discrepancy with the use of functional appliances while the individual is still in intensive growth and development. This will ultimately result in the achievement of a beautiful smile, excellent functional occlusion, and a beautiful facial profile for the patient.

The functional appliance activate the neuromuscular reflex that leads to jaw development and eruption of the teeth in normal relationship of the upper and lower jaw, notes Long and Casamassimo[19].

The distalization of the first permanent molars and their influence on the position of the second and third molars have been investigated. If the second and third molars are erupted and distalization is initiated, they will also move distally, reports Bowman[20]. He notes that this movement can lead to loss of anchorage or the appearance of tipping of the teeth.

In addition to the distal displacement of the molars, what happens next is also of particular importance. According to Bowman[20], once the molars are distalized, they should be held in that position to allow for the movement of the remaining maxillary teeth to reduce the protrusion of the maxillary anterior teeth, correct the overbite, close the spaces that will be created by these movements, and achieve a Class I placement of the canines.

Indications and contraindications for appliances for distalization of maxillary molars have been outlined by Almuzian et al.[21]. The indications are: Class II relationship, weak to moderate overjet, deviation of the medial line, mild crowding, interceptive therapy for canines placed more to the palatum, correction of mesial displacement of molars due to premature extraction of primary molars. Contraindications are: protrusive profile or proclined incisors, increased overjet, thin labial gingival biotype, buccally placed molars, pronounced crowding (more than 6 mm), and posterior crossbite.

As analyzed and reported by Kinzinger et al.[22], appliances are much more effective when the second permanent molars have not erupted, but distalization is still possible after the eruption of the second molars.

The choice of appliance to be used to correct Class II, mandibular retrognathism, and control maxillary overgrowth will depend on the patient's age and the orthodontist's choice. The plan for orthodontic or orthopedic treatment depends on the severity of the malocclusion and the age of the patient.

Appliances used for mandibular growth modification during the active growth period:

1. Removable appliances

Removable appliancesconsist of a base or acrylic plate withretention hooks placed to stabilize the appliance, active elements such as orthodontic screws are also incorporated into the appliance, which will allow correction of the transverse underdevelopment of the upper jaw. When using these appliances, the forces are intermittent and they act on the teeth and alveolar ridges reports Mitchell[23].

Therapy can continue further in mixed dentition with the application of the function regulator or Fränkel appliance. It is a bimaxillary functional appliance constructed by Fränkel in 1967 and the most optimal time for its application is mixed and early permanent dentition.

This appliance consists of acrylate shields and pads placed in the vestibule of the oral cavity.These components function to separate, the lips and soft tissues from the cheeks. Wire elements of the appliance connect the vestibular shields with the pads and provide better stability of the appliance, and stimulation of certain orofacial functions, it has the ability to eliminate pressure on the muscles of the orofacial region, and at the same time it can enhance growth, which leads to development of the narrow apical base of the maxilla[4].

Among the very orthodontic options for the treatment of Class II malocclusion, the Fränkel appliance has remained one of the most commonly used appliances for many years in patients during the growth period, as reported by Sanz et al.[24]. Despite the widespread use of this appliance, apart from the changes that may occur in the mandible, there is still limitedinformation in the literature on other dentoskeletal changes when using Fränkel appliance for the correction of Class II malocclusion.

2. Twin-Block

TheTwin-Block appliancefirst introduced by William J. Clark in 1982 is among the most widely used appliances for correction of Class II malocclusion. As many as 75% of British orthodontists claim that this appliance is their firstchoice[25].

Treatment with this appliance is carried out in two phases: active correction of the anteroposterior relationship and establishment of vertical dimensions; and retention phase, which maintains the achieved corrected incisor relationship until intercuspation of the buccal segments is achieved.

What distinguishesthis appliance is that it consists of two separate parts, one appliance for the maxilla and one appliance for the mandible. Thecorrection of the malocclusion is achieved by transmitting forces with occlusally inclined planes at an angle of 70 degrees, which cover the posterior

teeth and force the mandible to slide forward during closure. This brings the intermaxillary relationship to normal.

The primary purpose of the Twin Block appliance is to induce elongation of the mandible by stimulating growth of the condylar cartilage of the TMJ and slowing down the growth of the maxilla, reported Bacceti et al.[26].

3. The bionator

The bionator is a removable functional appliance designed by Wilhelm Balters in the 1950s. It works by influencing orofacial muscles and promotin ganterior positioning of the mandible. For its fabrication, it is necessary to take a construction bite, in tet-a-tet. Patient cooperationis also of great importance[27].

There are several types of bionators: type I, II and III. In Angle Class II malocclusion, a type I bionator is used. The standard shape consists of an acrylic body, which extends from the oral side of the lower dental arch, up to 2mm above the mucosa in the area of the premolars and molars of the upper dental arch[4].

The use of theBionator, promotestongue positioning, which helps establish a functional oral cavity that is essential for the proper development of the orofacial system and directs the activity of the muscles for proper growth and development[27].

4. The Herbst

The Herbst appliance was first introduced by Emil Herbst in 1905 at the Berlin Dental Congress, and Panchers mentioned it in a discussion of several papers published in the late 1970s. This is a fixed functional orthodontic appliance for the correction of Class II malocclusion and for distalization of the first permanent maxillary molars, which with its light continuous forces slows down the growth of the maxilla and stimulates the growth of the mandible. The purpose of this appliance is to transition the maxilla and mandible from an irregular to a normal occlusion[28].

The Herbst appliance consists of bendscemented onto the first maxillary and mandibular permanent molars. These bends are connected to a set of telescopic mechanisms with metal obstacles, which apply a light force to the maxilla that acts upward and backward, and a strong force to the mandible that acts forward, stimulating its growth and development[29].

5. The Mandibular Anterior Repositioning Appliance-MARA

The Mandibular Anterior Repositioning Appliance[30] - MARA is a fixed functional appliance designed to correctthe overjet and Angle's Class II malocclusion. It was designed by Douglas Toll in 1991.

The basic mandibular anterior repositioning appliance consists of stainless steel crowns that are placed on the first permanent maxillary and mandibular molars. The lower appliance has a horizontal arm that extends laterally from the crown of the lower molar, and the upper molar crown has a vertical arm that guides the lower jaw forward into the desired position by sliding it. When properly placed, the only way for the patient to bite is to slide the lower jaw forward so that the lower horizontal arm slides in front of the arm of the appliance[30].

The mandibular anterior repositioning appliance reduces the overjet by moving the teeth. In Class II corrective appliances such as the mandibular anterior repositioning appliance, the mandibular teeth are proclined in the front, while the maxillary teeth are retroclined, thus camouflaging the different size of the jaws. In patients with a deep bite, it leads to a lift of the overbite and an increase in the lower third of the face.

This appliance is ideal for patients with minimal cooperation and in whom the mandible is underdeveloped. It is worn for about 7 months and during this time it gently repositions the lower jaw forward. If the patient has previously had problems with the temporomandibular joint or headaches and ear problems, with this therapy these problems will fade away.

6. The Forsus

The Forsus appliance is a fixed functional appliance that is used in combination with fixed appliances and allows for distalization of the molars. It works by moving the maxillary teeth distally and the mandibular teeth mesially, moving the mandible into the desired position. It is used instead of a headgear or instead of using elastics.

The appliance consists of a spring which is fixed at one end to the bends of the first permanent maxillary molars on each side, and at the other end is placed on the arch of the fixed appliance on the mandible in the space between the canine and the first premolar. These springs move the mandible into the desired anterior position. The orthodontist will determine the size and strength of the appliance in the same way as he would for the elastics. He will also determine at what period of treatment it will be used states Bishara[31].

The Forsus appliance corrects Class II malocclusion by moving maxillary teeth distaly and mandibular teeth mesialy. It replaces headgear or elastics. It also reduces the ANB angle, overjet, overbite, while improving molar relationships and facial height.

7. The Jasper Jumper

The Jasper Jumper appliance is a fixed functional orthodontic appliance, regarded asan effective alternative option for the treatment of Class II malocclusion. It consists of an intraoral flexible power element and an anchorage part. It is an appliance that is well tolerated by patients. This appliance uses light continuous forces for Class II cor-

rection, according to the principle of dentoalveolar changes, and is useful if the growth and development of the jaws is nearing completion or has already been completed.Itsonly significant skeletal effect is theinhibitionof maxillarygrowth[32].

In their study, Patel et al.[32] compared the effects of the Jones jig appliance and the pendulum appliance, and concluded that when using both appliances, the maxillary central incisors had labial tipping, protrusion, and mild extrusion, and the maxillary premolars had mesial displacement in both groups, but in the group using the Jones jig appliance, the mesial displacement was more pronounced, and extrusion of the premolars also occurred, which means a greater loss of anchorage during distalization of the molars. In both groups, distal displacement, distal tipping, and mild intrusion of the maxillary first molars occurred. The average value of distalization of the molars at each month, as well as at the end of treatment, was similar in both groups.

8. Frog

Frog is an appliance designed for distalization of the maxillary first molars, which corrects Class II malocclusion. The classic Frog appliance includesof bends for the maxillary first molars and occlusally wire rests on the premolars fixed with composite on the occlusal surface.A palatal acrylic button that connects the wire elements and a screw. It resembles a frog, hence its name. It contains a special expansion screw that is activated from the anterior[33].

Burhan A.S.[33] conducted a study in which he included 2 groups of subjects. In the first group, the subjects wore only a Frog appliance, while in the second group, in addition to the Frog appliance, a high-traction headgear was included. He concluded that in the first group, the Frog appliance enabled: distalization of the maxillary first molars but with a large loss of anchorage, axial tipping of the maxillary molars occurred, mesial movement of the premolars that served as anchorage, and posterior rotation of the mandible occurred. While in the other group, these side effects were minimal or even completely eliminated due to the use of the headgear.

These appliances have the disadvantage that when worn, the anchorage can loosen, leading to molar tipping, extrusion with the appearance of an open bite, and an increased overjet.

Appliances used for distalization of maxillary first molars:

1. The headgear

The headgear was first introduced in 1860 by William Kingsley. It consists of two main components: a facebow and support elements that can be worn either around the neck - neck strap or overthe head - head cap. The facebow is divided into an outer bow and an inner bow that are interconnected by elastic traction. The inner bow is usuallyattachedto the first permanent molars, but can also be securedwith splints or functional appliances[31].

Thekey mechanismof orthopedic treatment with a headgear is the compression of the maxillary sutures, which modifies the growth and type of bone apposition in the sutures of the maxilla. As a result, the normal downward and forward development of the maxilla is suppressed or prevented, allowing the mandible to grow and develop normally[29].

The most appropriate type of headgear for the distalization of maxillary molars and the correction of Angle Class II malocclusion is one with occipital traction, with a force of 400 to 600 grams, and worn for 12 to 16 hours per day, pointed out Bishara[31]. The force vector should be directed distally and pass through or above the center of resistance of the maxillary molars.

2. Pendulum

In 1992, James Hilgers introduced and described the pendulum as an orthodontic appliance used for distalization of the first maxillary molars, correction of Angle's dental Class II, correction of rotated maxillary first permanent molars, and transversal expansion of the maxilla by placing an ortodontic screw[4].

The pendulumappliancemaybe usedindependeltyor inconjunctionwith a fixed appliance. The appliance contains an acrylic plate and two types of wire elements: pendulum springs and anterior retention elements. The reduced acrylic plate, or Nance acrylic button, rests on the palate, and springs are connected to it, which are a source of light, continuous forces with a posterior direction of action. The bandscemented onthe first permanent molars have palatal tubes for attaching the springs from the appliance[27].

According to Byloff and Darendeliler34the pendulum appliance distalizes the maxillary molars by 1.2 mm per month with a force of 200-250 grams on each side of the dental arch. Diaz et al.[35] conducted a study in which a patient wearing a pendulum appliance distalized the maxillary molars by 1 mm per month, using a force of 200-250 gr.

Indications for using the pendulum appliance are: in patients who need to provide space in the sagittal and transverse directions, correcting Class II according to Angle and providing space for accommodating the maxillary canines, derotation of the maxillary permanent molars and when it is necessary to correct the mesial position of the maxillary first molar during premature extraction of the second deciduous molar[23].

3. The Distal Jet

The Distal Jet is an appliance consisting of a pair of bilateral tubes connected to an acrylic Nance button and NiTi springs that generate a force of 240 grams. The wire from the Nance button is connected to the premolars' anchorage metal bends. Bends are also placed on the maxillary first molars[14].

The Distal Jet appliance requires minimal patient cooperation because it is fixed, acts with a constant force on the molars, resulting in a smaller distal tipping of the maxillary molars during their distalization than other appliances, concluded Ferguson et al.[36]. In comparison, the headgear, although more hygienic, requires greater patient cooperation. Both appliances have an almost equivalent value of distalization of the maxillary molars, but the Distal Jet appliance has better control of changes in facial height[36].

Conclusion

The treatment of patients with malocclusion Class II division 1 depends of morphological variations of the malocclusion itself and the time period in which the patient consulted an orthodontist.Treatment may begin with removable appliances Twin block appliance during the patient's intensive growth period. This appliance guides the maxilla and mandible in a direction which will allow for easier correction of the malocclusion.

Fixed orthodontic appliances play a crucuial role in the correction of Angle Class II division 1 malocclusion by addressing both skeletal and dental discrepancies. These modalities include devices such as the headgear, pendulum appliance, Herbst appliance, distal jet, Jusper Jumper, MARA, Forsus appliance, frog and other distalization techniques, which work by modifying jaw growth, repositioning teeth and improving occlusal function.In some cases, in addition to the use of fixed appliances, it is necessary to extract premolars in the maxillary dental arch.

Advancements in fixed orthodontic therapy have ledto more effective, stable and predictable outcomes, often reducing the need for extractions or surgical intervention.However, whenlarge skeletal discrepancies are present, an orthodontic-surgical approach may be required.

The choice appropriate appliance depends on the severity of malocclusion, patient compliance and treatment goals. Ongoing research and technological improvements in fixed modalities will continue to enhance treatment efficacy and long-term stability.

Reference

1. Corruccini RS, Paciani E. "Orthodontistry" and dental occlusion in Etruscans. Angle Orthod. 1989. 59:61–64.
2. Milić J, Perović T, Radojičić J, Stojanović Z, Aleksić E, Vučinić P, Čupić S. 2017. Osnovi ortopedije vilica. Stomatološki fakultet, Pančevo: Knjiga
3. Bishara SE. Class II Malocclusion: Diagnostics and Clinical Considerations Withand Without Treatment. Semin Orthod. 2006.12: 11-24
4. Кануркова Л. Ортодонција (втор дел). Стоматолошки факултет. 2021. Скопје: Книга.
5. Radumilo D, Vučinić P, Ivić S, Petrović Đ. Procena rizika za nastanak ortodontskih nepravilnosti kod dece u prigradskim naseljima. Acta Stomatologica Naissi, 2021. 37(84): 2241-2255.
6. Tehranchi A, Behnia H, Younessian F, Hadadpour S. A Textbook of Advanced Oral and Maxillofacial Surgery: Advances in Management of Class II Malocclusion. 2016 Chapter 20.
7. Luy L, Zhao Z, Tang Q, Zhao J, Huang H. Skeletal class II malocclusion caused by mouth breathing in a pediatric patient undergoing treatment by interceptive guidance of occlusion. J Int Dent Med Res. 2021. 49(6).
8. Cozza P, Bacceti T, Franchi L, Mucedero M, Polimeni A. Transverse features of subjects with sucking habits and facial hyperdivergency in the mixed dentition. Am J Orthod Dentofacial Orthop. 2007. 132:226-9
9. Vasquez MJ, Bacceti T, Franchi L, McNamara JA. Dentofacial features of Class II malocclusion associated with maxillary skeletal protrusion: A longitudinal study at the circumpubertal growth period. Am J Orthod Dentofacial Orthop. 2009. 135: 568.e1568.e1-568.e7.
10. McNamara JA Jr. Components of Class II malocclusion in children 8-10 years of age. Angle Orthod. 1981. 51:177-200.24.
11. Uribe LM, Howe SC, Kummet C, Vela KC, Dawson DV, Southard TE. Phenotypic Diversity in Caucasion Adults with Moderate to Severe Class II malocclusion. Am J Orthod Dentofacial Orthop. 2014. 145(3): 305-316.25.
12. Baccetti T, Franchi L, McNamara J Jr, Tollaro I. Early dentofacial features of Class II malocclusion: A longitudinal study from the deciduous through the mixed dentition. Am J Orthod Dentofacial Orthop. 1997. 111: 502-509.
13. Fisk GV, gilbert MR, Grainger RM, et al. The morphology and physicology of distocclusion. Am J Orthod 1953. 35:3-12.
14. Moyers Robert E. Handbook of Orthodontics. 1988. United States of America; Book
15. Pavlović J., Simić S., Vukićević V., Vujačić A. Morfološke karakteristike malokluzija II. Stomatološka klinika, Medicinski fakultet, Univerzitet u Prištini, Kosovska Mitrovica, Srbija. 2015. : 44(3) 43-47.
16. Latorre FV, Julia CB, Chang RH, Manriquez G, Munoz AD. Morphological distribution of Class II malocclusion according to skeletal pattern in an adult sample of the School of Dentistry of the University of Chile. Odontoestomatologia. 2022, 24.
17. Nielsen L. Class II, Division 2 Malocclusion: What the Clinician Should Know About Treatment of This Malocclusion (PART II). Taiwanese Journal of Orthodontics, 2021. 33(2):44-52.
18. Alogaibi YA, Al-Fraidi AA, Alhajrasi MK, Alkhanthami SS, Hatrom A, Afify AR. Distalization in Orthodontics: A Review and Case Series. Hindawi Case reports in Dentistry. 2021. 8843959
19. Long JR, Casamassimo PS. Corrective methods for Class II Patients. Pediatric Dentistry: December, 1988. 10(4).
20. Bowman J. Upper-Molar Distalization and the Distal jet. 2016. JCO, L(3): 159-169.
21. Almuzian M, Alharbi F, White J, McIntyre G. Distalizing Maxillary Molars- How do you do it? Ortho Update, 2016. 9:42-50.
22. Kinzinger GSM, Diedrich PR. Biomehanic of a modified pendulum

appliance-theoretical considerations and in vitro analysis of the force system. Eur J Orthod. 2007. 29:1-7.
23. Mitchell L. Introduction to Orthodontics. 2013. University of Oxford; Book.
24. Alió-Sanz JJ, Iglesias-Conde C, Lorenzo-Pernía J, Iglesias-Linares A, Mendoza- Mendoza A, Solano-Reina E. Cranial base and maxillary changes in patients treated with Frankel's functional regulator (1b). Med Oral Patol Oral Cir Bucal. 2012 Jul 1;17 (4):e689-96.
25. Hanoun A, Al-Jewair T, Tabbaa S, Allaymouni MA, Preston C. A comparison of the treatment effects of the Forsus Fatigue Resistance Device and the Twin Block appliance in patients with class II malocclusions. Clinical, Cosmetic and Investigational Dentistry 6; 2014. 57-63.
26. Baccetti T, Franchi L, Toth LR, McNamara JA Jr. Treatment timing forTwin-block therapy. Am J Orthod Dentofacial Orthop. 2000. Aug;118(2):159-170
27. Proffit WR,Fields HW, Larson B, Salver D. Contemporary Orthodontics. 2019. Elsevier, 6nd edition.
28. Pancherz H, Malmgren O, Hagg U, et al. Class II correction in Herbst and Bass therapy. Eur J Orthod. 1989. 11:17–30.
29. Neves LS, Janson G, Cançado RH, Rodrigues Santiago de Lima KJ, Fernandes TMF and Henriques HFC. Treatment effects of the Jasper Jumper and the Bionator associated with fixed appliances. Progress in Orthodontics. 2014. 15:54.
30. McClaran TR. Cephalometric evaluation od MARA therapy in the treatment of class II malocclusions. 2010. University of Tennessee. Thesis.
31. Bishara SE. Textbook of Orthodontics. 2001. Philadelphia, Pennsylvania. Book.
32. Patel M, Janson G, Henriques JFK, Almeida RR, Freitas MR, Pinzan A, Freitasa KMSS .Comparative distalization effects of Jones jig and pendulum. 2009
33. Burhan AS. Combined treatment with Headgear and the Frog appliance for maxillary molar distalization: a randomized controlled trial. Korean J Orthod. 2013. 43(2):101-109.
34. Byloff FK, Darendeliler MA. Distal molar movement using the pendulum appliance. Part 1:clinical and radiological evaluation. Angle orthod. 1997. ;67:249-260.
35. Diaz IV, Yanez LD, Katagiri MK. Use of pendulum for molar distalization: Case report. Revista Mexicana de Ortodoncia, 2016. 4(1): e35-e41.
36. Ferguson D, Carano A, Bowman J, Davis EC,Vega MEG, Lee SH. Acomparison of two maxillary molar distalizing appliances with the distal jet. World J Orthod. Winter. 2005. ;6(4):382-90.