Universidad Europea Madrid

TRABAJO DE FIN DE GRADO

Grado en Odontología

USING OF MINIPLATES IN GROWING PATIENTS FOR ORTHOPEDIC TREATMENTS

Madrid, 2020/2021

NÚMERO IDENTIFICATIVO **218**

SUMMARY:

Objectives: Evaluate the use of the miniplates in the orthopedic correction of skeletal class III malocclusion, evaluate the use of miniplate in the daily practice compared to other more conventional methods (facemask, functional appliances, chin cup) and evaluate the potential use of miniplates in the orthopedic correction of skeletal class II malocclusion.

Methodology: This work was a scientific review of articles selected from different database such Medline, Pubmed or Research gate. The following **keywords** were chosen: miniplate, orthodontics, dentofacial orthopedic, growing patient, temporary anchorage system, TADS, skeletal anchorage, class III, class II.

Results: From the initial research, 52 articles were selected. 19 were removed for the following reasons: they were about miniplate in adult patient and not with children or their date of publication were before 2004 and not enough recent. From the final selection, 33 articles were used: 21 about the miniplate in the class III correction, 8 about the miniplate in class II correction and 7 about the alternatives to the use of miniplates.

Conclusions: Thanks to an excellent anchorage, the miniplates can provide a treatment option in hard cases of class III malocclusion needing significant skeletal improvement, important bone's remodelling, important bone's redirection and reduced dentoalveolar side effects often seen with the use of facemask or functional appliances. It showed promising impact in the bone changes of skeletal class II inducing increased skeletal modification with decreased dental one compared to other appliances.

RESUMEN:

Objetivos: Evaluar el uso de las miniplacas en la corrección ortopédica de maloclusión clase III esquelética, evaluar el uso de miniplacas en la práctica diaria en comparación con otros métodos más convencionales (mascara facial, aparatos funcionales, mentonera) y evaluar el potencial uso de miniplacas en la corrección ortopédica de la maloclusión de clase II esquelética.

Metodología: Este trabajo fue una revisión científica de artículos seleccionados de diferentes bases de datos como Medline, Pubmed o Researchgate. Se eligieron las siguientes **palabras clave:** miniplaca, ortodoncia, ortopedia dentofacial, paciente en crecimiento, sistema de anclaje temporal, TADS, anclaje esquelético, clase III, clase II.

Resultados: De la investigación inicial se seleccionaron 52 artículos. 19 fueron retirados por las siguientes razones: eran sobre miniplaca en paciente adulto y no con niños o su fecha de publicación era anterior a 2004 y no suficientemente reciente. De la selección final se utilizaron 33 artículos: 21 sobre la miniplaca en la corrección de clase III, 8 sobre la miniplaca en la corrección de clase II y 7 sobre las alternativas al uso de miniplacas.

Conclusiones: Gracias a un excelente anclaje, las miniplacas pueden proporcionar una opción de tratamiento en casos duros de maloclusión de clase III que necesitan una mejora esquelética significativa, remodelación ósea importante, redirección ósea importante y efectos secundarios dentoalveolares reducidos que a menudo se observan con el uso de mascara o aparatos funcionales. Mostró un impacto prometedor en los cambios óseos de la clase II esquelética induciendo una mayor modificación esquelética con una disminución de la dentaria en comparación con otros aparatos.

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1. INTRODUCTION

Orthodontics is defined as a dental specialty dedicated to the correction of bad postures of the jaws (orthopedics) and the teeth (orthodontics) in order to optimize the occlusion as well as the development of osseous bases for an esthetic and functional purposes (1).

On the daily practice, the orthodontist is facing many types of malocclusions, most of them are coming from children, adolescent or young adult still in a skeletal growing or modifiable phase giving many opportunities for a better treatment management and a better treatment success. Through a subtle diagnosis of the patients, the practician will establish objectives and a treatment plan according to the malfunctions he has found. In order to achieve those goals, the practician can be thankful to many different tools that will allow him to perform the desired actions and the proper dental, skeletal or mixed correction.

1.1. The growing patient and orthopedic treatment

For growing patient, the opportunities for excellent treatment outcomes is made possible thanks to an adequate bone capacity to remodel itself (2). The dentofacial orthopedics aims to guide the facial bone growth by means of orthodontic appliance including expanding ones for space creation of underdeveloped jaws. In case of important bone defect, a patient early diagnosed can receive orthopedic treatment giving the orthodontist more freedom and possibilities in the realization of the treatment (3). According to Kircelli, there is a major importance of early diagnosis for avoiding postponing therapy until the obligation of performing orthognathic surgery at adult age (4). Facial growth is the main point of these orthopedic treatments that most of time deals with class II and III skeletal malocclusion associated or not with crossbite, overbite or underbite (5). It allows the management of dentofacial deformities and skeletal malocclusion. Depending on the deformities found, the orthodontist will have to find the right time for treating the patient trough a good growth evaluation. In the case of a skeletal class II malocclusion, the ideal period is during the pubertal growth phase which gives access to an effective combined growth modification with dentoalveolar changes. For the case of a class III malocclusion, the right time for starting its treatment is more challenging: the mandibular growth being highly unpredictable and complex, prediction about is growth is made and sometimes needs a lasting active treatment until growth cessation (6). Dentofacial orthopedic gets more outcomes when performed at young ages about the age of 8 years old when both primary and definitive dentition are present.

1.2. Definition of anchorage:

The basis of orthodontics treatments relies on its anchorage. The anchorage from and orthodontics point of view is defined as “resistance to unwanted tooth movement” (7). According to Newton’s third law: each action has an equal and opposite reaction (8). This is why when applying any forces on a tooth or group of teeth, the opposite force with the same intensity but reverse direction will be generated on this opposite supporting structure leading to unwanted tooth movements. This is where the role of anchorage takes place, trying to fully suppress or reduce at a maximum this forces to assure the stability of the teeth going through movement and involving other teeth, other structures. When planning a treatment, the orthodontist has to focus on both the teeth with the movement required and the reciprocal effect that will comes out from its action through a subtle analysis, evaluation and control for an optimization of the desired movement and a minimization of the side's effects (7). By a bone anchorage using the cortical, an absolute anchorage, meaning an absence of opposite movements to a force applied can be achieve and gives good treatment alternatives (9). Through this skeletal anchorage, temporary anchorage devices can be used for taking maximum benefit of this total and absolute anchorage.

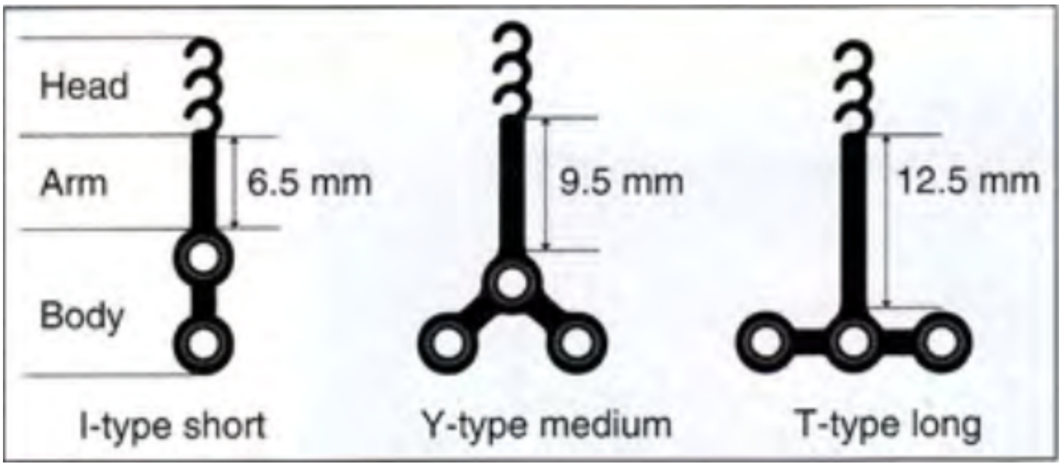
1.3. Temporal anchorage devices (TADS)

For years and years, many different tools have been used for orthopedic treatment of patient in a growing phase. From functional appliances such as the herbs appliance for a class II correction until the use of headgear face mask for the correction of a class III, orthodontist is free to decide which option would suit better his cases (7). From these conventional methods, some limitations have been observed such as dentoalveolar compensation due to an unperfect anchorage on teeth structures (10). For getting through this, new tools with bone's anchorage instead of teeth's anchorage was developed and are used for orthopedic treatment on growing patient, they are called temporary anchorage devices (TADS). They are defined as "any implant used during dentofacial orthodontics treatment as anchorage for orthodontics displacement" and provide a strong anchorage useful in the perspective of the hardest dental movement. They can take many different forms: mini screws, mini implant and miniplates (9)(11).

1.4. Miniplates: structure and different systems:

The miniplate is one of these TADS. It consists of an anchorage system that gives new opportunities to perform orthodontic corrections and push the limits that conventional method may have (5). In growing patient, the use of this miniplate device can help in the treatment of many malocclusion such as treatment of class II, class III or many other movements or replacements useful in the perspective of the orthodontic/orthopedic treatment (12).

The miniplates as its name say it is a plate made of titanium of second grade. 3 parts are composing the miniplate: the head, the body and the arm (9).



<u>Three components and three configurations of orthodontic miniplates</u>(13)

Its main part is the body which is perforated with different holes to permit through 5mm screws to fix into the bone in order to realize its osteosynthesis. The design of plaques leads to a 2 or 3 fixation's screws. The body of the miniplate present the advantage of being adaptable and modulable for getting a perfect fit with the morphology of the anchorage's bone. The body of the mini-plate gives rise to a stem (the arm of the miniplate) which present different length depending on the patient's case (length varying between 5, 7 or 10mm)(11). As the body, the stem is fully adaptable to the anatomy of the mouth. This arm is transgingival and go through the fibro mucosa at the mucogingival level, it has to be properly prepared for avoiding tissue damage or inflammation. This stem leads to the head of the miniplate where the connection is made with other orthodontics tools. The head is made of 2 parts: small hooks that serves for connection with elastics, coil spring and reamed oblong apertures for insertion of an extra cantilever or stabilization wire (the size of the wire is limited to 0,022 x 0,028 inches)(9). Different types of miniplates have been designed, depending on where the plate is going to be inserted and depending on the system we are using. Depending on the site of insertion, we can find vertical plaque in form of an I or horizontal plaques in form of L, T or Y (11). There are 3 miniplate systems that are mostly used: the SAS of Sugawara, the system of Hugo De Clerck and the C system.

1.5. Advantages and disadvantages of miniplates

ADVANTAGES

Success rate: Through the different studies, one of the main points that makes the miniplates a serious option in the treatment alternatives is its success rate. Different systemic reviews have been made and conclude to more than 90% of success and only about 7% of failure (9). Compared to its concurrent the miniscrew and the palatal implant, the miniplate is the best on achieving the treatment success (16,4% of failure for the mini-screw and 10,5% for the palatal implant)(12). From all this studies, it can be confirmed that miniplate is a reliable tool in the daily practice being used in the maxilla or the mandible.

Freedom of movement: The miniplate can be used for many corrections, this is what makes its fame. It gives wide range of possibilities with few limitations. It has both orthopedic and orthodontics utility. In orthopedic, it is used in growing patient for correction of skeletal class II or class III that are often combined with bite alteration such as anterior open bite or anterior crossbite that can be at the same time resolved benefiting of the skeletal remodelling pattern offered by miniplate anchorage system. From an orthodontics point of view, the miniplate gives possibility to all type of movement such as distal driving, mesial driving, intrusion, extrusion, protraction (12).

Stability: The success of miniplate is done through its anchorage effect and its stability being one of its most important advantage. This stability is made through its excellent mechanical properties: being screwed into the bone and more secondary to its osteointegration (9), thanks to its composition made of titanium, allowing a perfect adhesion into the bone (8). These 2 points are giving a strong anchorage value to the miniplate making it one of the best options among the temporary skeletal anchorage devices (9). Compared to its contestants, the miniplate shows a better stability than miniscrews thanks to the use of several screws instead of one (14). This stability is kept strong even when using heavy forces.

Compliance: An important aspect for good treatments outcomes is to get the patient motivated and compliant to the tools. In the case of miniplate, it is a really good tool that need a low compliance (12). Once set, for example in the case of children doing orthopedic treatment of class II or III, he will only need to be serious at putting the elastics and at oral hygiene (15)16)(17). Furthermore, the miniplate doesn't affect a lot the aesthetic (12). Compared to traditional tool such as the headgears or facemask which need a high motivation, compliance and that from an aesthetic and social point of view are more difficult to accept (3).

Rapidity of use: Compared to osteointegrated implants which need a proper osteointegration before loading. The miniplate present the advantages of being almost immediately loadable; De Clerk recommend to wait 14 days after the surgery and between 1 and 3 weeks according to the literature (14). The stability given by the osteointegration is only secondary and we look first for a primary stability delivered by its mechanical implantation into the cortical bone (11). The thickness of the cortical bone is of great important, a thicker bone often give a greater stability. Compared to miniscrews and mini implants, the miniplate can be placed on smaller cortical bone (18). Apart from tissue healing that last about 3 weeks or any swelling to resolve, we can rapidly load the miniplate (19). This low osteointegration is also responsible of the easy removal of it at the end of the treatment (11). Thanks to its use, shorter treatment times compared to conventional method are required (13).

DISADVANTAGES

Surgical act: The miniplate present the disadvantage of being more invasive than other tools such as the miniscrew (9). For being set, the miniplate needs a surgical act involving flap and with secondary effect such as swelling, this is why when choosing between a miniplate or miniscrew, the risk benefit balance has to be analysed (19). The cases where the miniscrew will give us the same result and involves a less invasive procedure have to be detected.

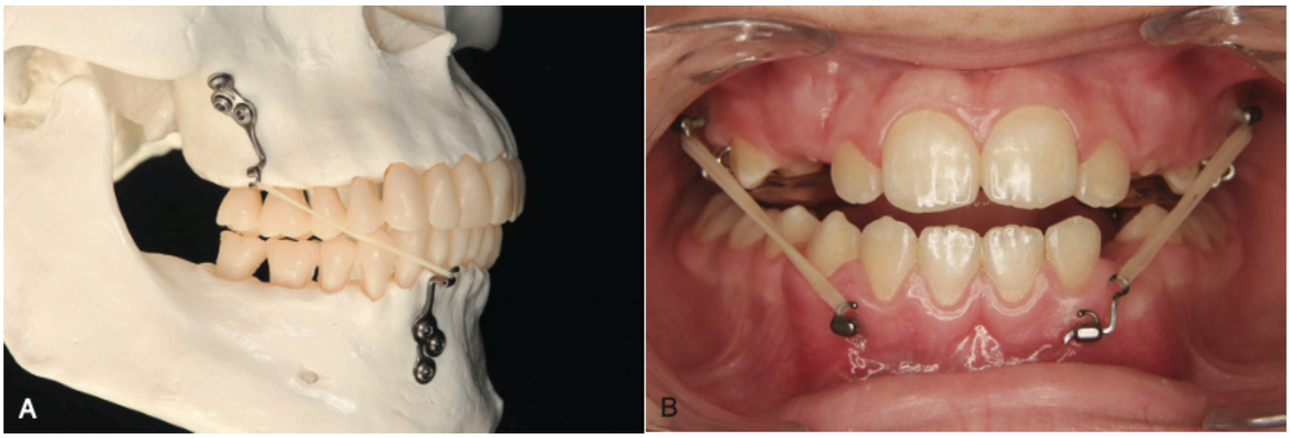
Cost: The miniplates usually increases the cost of the treatment compared to conventional treatments (20).

Extra help: The orthodontist is allowed to put miniplates or miniscrews but especially for the case of miniplate which need flap and more invasive procedure, the task of implantation can be and, in many cases, should be referred to an oral surgeon, implantologist or periodontist. Recently, new designs have raised and made them easier for being implanted by the orthodontist himself (9).

1.6. Indications and contraindications

Orthopedic treatment of skeletal Class III: In orthopedic treatment, the miniplates has shown good result in new protocols for treatment of skeletal class III. It's an alternative for patient presenting hypoplasia of maxilla and traditionally treated thanks to extra oral force of the facemask performing postero-anterior traction. This approach leads to several unwanted side effect: posterior rotation of the mandible, increase of vertical height of the face or dentoalveolar compensation that could be avoided by the miniplate option (7).

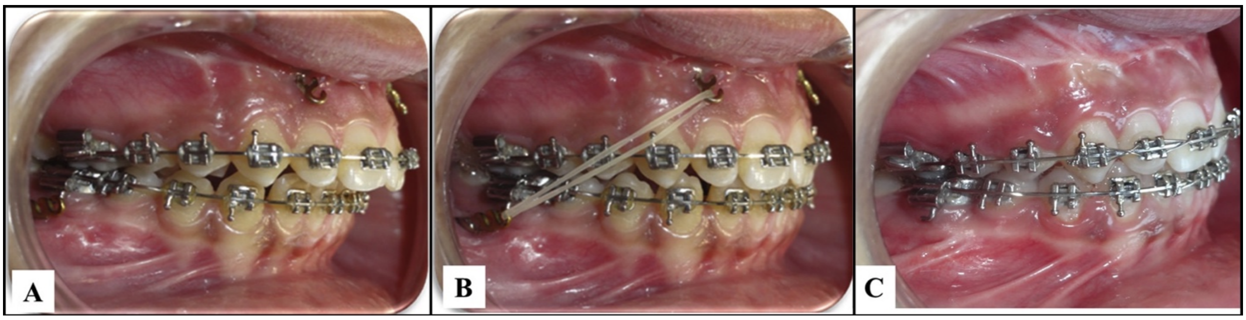
It has been reported by De Clerck and al and by Heymann and al, that orthopedic forces could be used connecting 2 miniplates through elastics (one being in the infrazygomatic crest to another located between 1st premolar and mandibular canines)(21)(22)(23). It promotes maxillary protraction, mandibular growth reorientation This method presents the advantage of reducing the dentoalveolar compensation which often result from classical method using the facemask. It requires less compliance and allows a 24 hours/day forces to be applied (21).



(A) Y-shaped miniplates on a skull, to show where they are placed high on the posterior maxilla at the base of the zygomatic arch and on the mandible mesial to the mandibular canines. **(B)** A maxillary-deficient child wearing Class III elastics to an earlier version of the mandibular miniplates that did not have an upward projection for the elastic hook. An auxiliary 21 × 25 archwire in the tube that penetrated the gingiva allowed adjustment of the position of the attachment for the elastic on the left side so that it did not press against the soft tissue. Being able to move the point to which force is applied, of course, is one of the advantages of miniplates. (7)

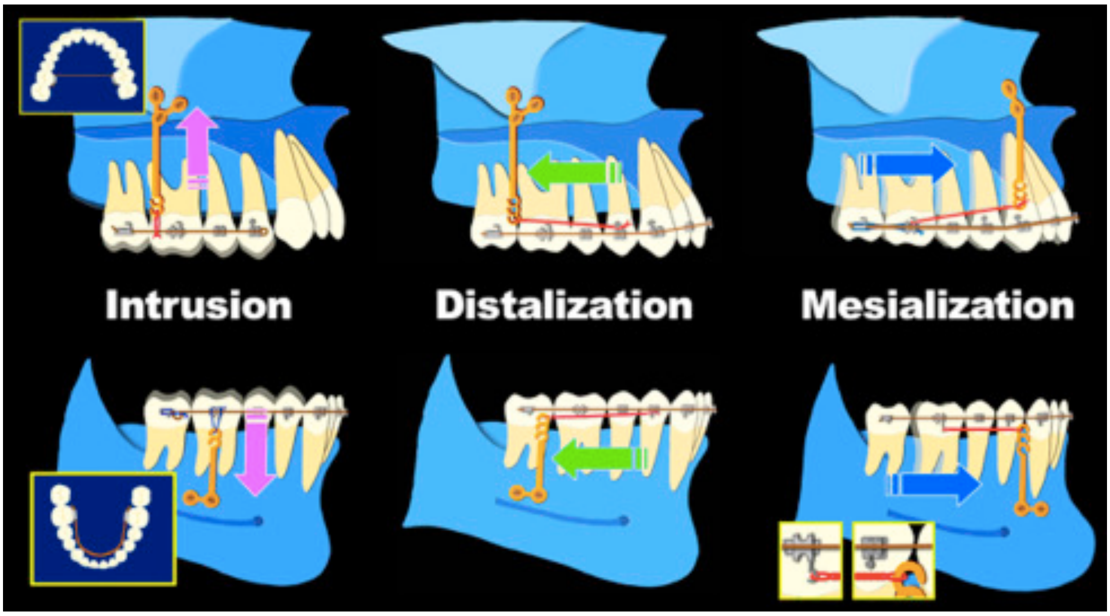
Treatment of class II: The miniplate has been used for correction of class II associated or not with extraction of first premolars. According to De Clerck, the class II can be corrected by using miniplates inserted at the infrazygomatic crest and associated with the extractions of premolars (24). This improving the efficacy and reducing the treatment time. When performed without extraction, a case has been described for the correction of a class II on adult patient by doing a distal driving of the maxillary teeth using 24 hours/day light forces and reducing the treatment time (25).

A recent more orthopedic approach has been described for correction of skeletal class II through the use of bilateral miniplates in both: anterior maxilla and posterior mandibular with elastics resulting in an increased growth modification and minimal dentoalveolar changes (5).



A: The miniplate after the healing period; B: Application of the intermaxillary elastic; C Finishing to class I molar and canine relationship (5)

Orthodontics treatment: The miniplate gives to the orthodontist a wide range of possible movements. They can realize movement of dental translation such as canine distal driving, maxillary and mandibular molars distal or mesial driving (12). They also allow movements of ingression which is one of the hardest orthodontic movement but can be achieved thank to the strong bone anchorage delivered by the device. Small tooth replacement such as intrusion or buccolingual movement can also be considered.



Intrusion, Distalization and Mesialization though miniplates (26)

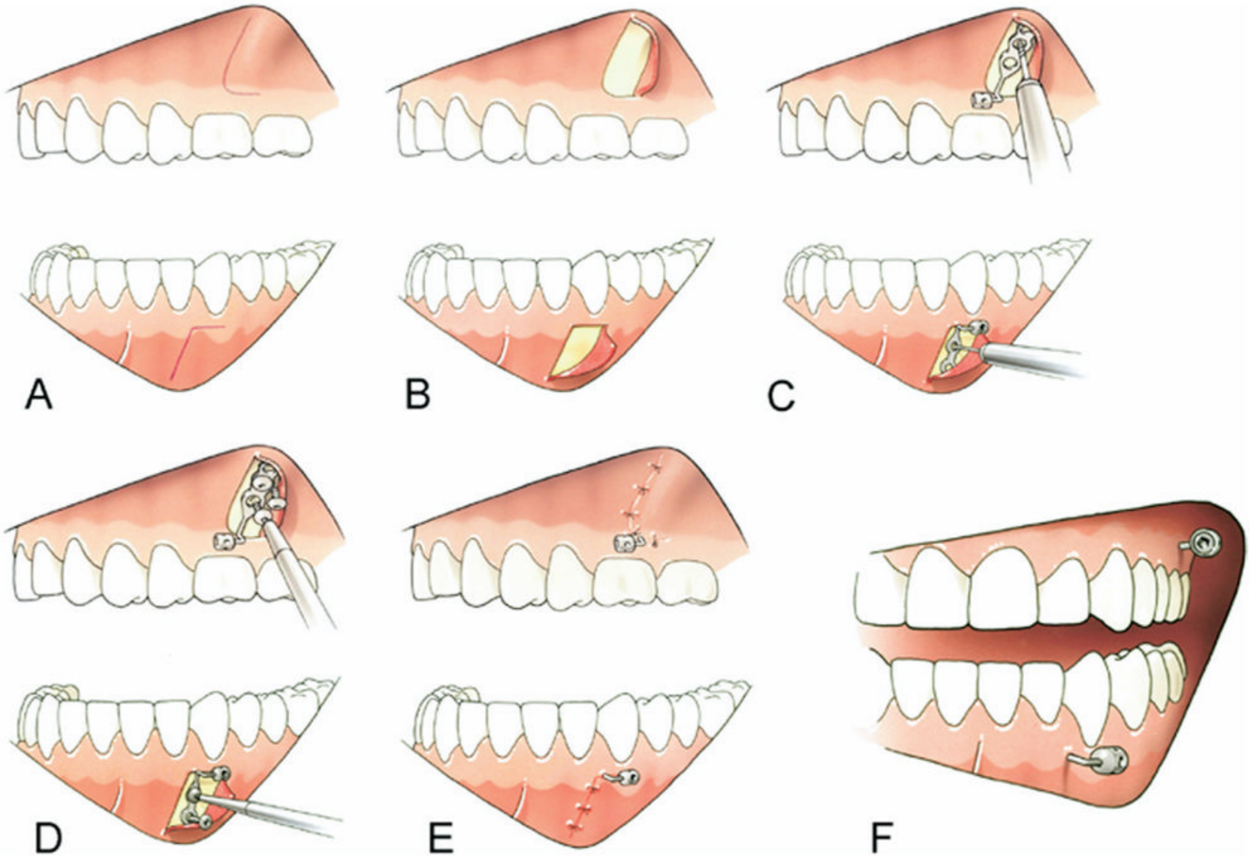
Ortho chirurgical treatment: Sugawara described the correction of skeletal class III patient by surgery first technique (9). This protocol consists of performing orthognathic surgery on first treatment phase for transforming a skeletal class III temporarily into a skeletal and dental class II. Then a postsurgical orthodontic treatment associated with the use of miniplate is done (for distalization and intrusion of maxillary teeth and protraction of mandibular arcade). The miniplate are being placed in zygomatic buttress in the maxilla and mandibular body for the jaw. The idea of this protocol is to reduce the treatment time and avoid premolars extraction.

Alternative to other TADS: The miniplate is indicated as a backup system to miniscrew placement when no area is adequate for its placement (9). Unlike the miniscrew, the miniplate can be placed on area of low bone density where to the miniscrew could fail repeatedly (19)(27). Nowadays the use of miniplates is reduced due to the evolution of miniscrew's design but miniplate keeps having specific indications where its use shows better efficacy and shorter treatment time.

Contraindications: As any treatment, the use of miniplate is subject to some general or local contraindications (28). The general contraindications are the same as any surgical act: the general state of the patient has to be good; it's contraindicated for patient receiving head and neck radiation, patient at high risk of endocarditis, patient with uncontrolled affectations such as diabetes, with patient taking drugs which would affect the outcomes of the miniplate (bisphosphonate, anticoagulant, antiplatelet, immunosuppressor, antiepileptic) and patient with high tobacco consumption. Concerning the local contraindication: a good oral hygiene is the key for a good treatment issue, gingival inflammation is one of the major causes of miniplate failure.

1.6. Protocol:

Several parameters have to be considered for choosing the site of insertion of the miniplate. The miniplate has to be put far from the roots and far from any anatomic obstacles for avoiding movement's interferences (19). The fixation screws are placed apically to the root and shouldn't exceed the cortical thickness (11). For insertion of the miniplate, a flap is performed. This act should be done by a skilful practician even if it's considered to be an easy operation in most of the cases. It's done under local anaesthesia and should be done at the same time with other surgical act if needed for better psychological acceptance. In case of really young patient, it might be recommended to perform the act under general anaesthesia or local anaesthesia associated with the use of sedation (14). Prior to the surgery, an antibiotic prophylaxis is generally recommended as well as chlorhexidine mouthwash for reducing bacteria (29). For reducing post-operative complications, anti-inflammatory and antalgic drugs are prescribed to the patient (11). After incision of the gingiva, the body of the plate is adapted to the anatomy of the bone. The first screw is placed without being forced for allowing rotation before insertion of other screws which are later properly screwed for ensuring strong and stable retention. Once inserted, the incision is closed using resorbable sutures after saline cleaning (11). Post instructions are given to the patient: putting ice on the wound, regular chlorhexidine mouthwashes during one week and excellent oral hygiene (14)(16). The miniplates can be directly charged starting with light forces for not hindering stability while bone is still inflamed. Forces are gradually increased and can be spread thanks to elastic for performing the desired traction. Once the treatment is achieved, miniplates are removed under local anaesthesia trough an incision. After saline cleaning, the incision is sutured and the patient is asked to perform chlorhexidine mouthwash during 3 days (30).



Placement surgery in maxilla and mandible: L-shaped incisions with horizontal part of the incision being 1 mm into attached gingiva (*A*), mucoperiosteal flap (*B*), drilling of middle hole (for 3-hole plates) or hole located closest to attachment unit (for 2-hole plates) (*C*), insertion of screws (*D*), and closure with resorbable sutures (*E*). *F*, Bollard device with attachment units facing anterior in posterior maxilla and posterior in anterior mandible.(30)

1.7. Complications

As previously explained, the result of the use of miniplate is highly predictable but in many cases, we can face mild complications such as the inflammation and swelling of the soft tissue which is usually a common side effect of the surgery (40% of the cases) or infections in about 14% of the cases which is easily treated with antibiotics and only in few exceptions need the treatment to be stopped (12). These swelling have an average lasting of 5 days and were associated to cheek irritation in 1/3 of the cases (4). A correlation has been established between these and the oral hygiene which has to be properly done and can be associated to antiseptic rinses (12). Another complication which is the most undesirable is the miniplate breaking or the fracture of its components (screws, arm) (16). For avoiding them, several features have to been taken into consideration such the location: the cortical has to be thick enough, the torque insertion and the bone quality for ensuring a perfect stability and absence of mobility (12).

1.9 .

COMPARATIVE OF MINIPLATE TO OTHER ORTHOPEDIC ALTERNATIVES FOR SKELETAL CLASS III CORRECTION IN GROWING PATIENT

TECHNIQUE	TREATMENT FEATURES	RESULTS
Miniplate with intermaxillary elastics (De Clerck) (7) (31) 	**Class III elastics** between temporary anchorage devices **miniplates** bone supported between upper zygoma and anterolateral surface of mandible (7) **Indications:** - Maxillary deficiency - When the patient is too old for facemask therapy **Limitations:** - True mandibular prognathism - Require enough bone density	- Highly effective approach - Lighter forces compared to facemask - Important skeletal change without dentoalveolar implication - Shorter treatment time - Mandibular growth redirection - Additional growth can produce recurrence but less than facemask because doing at older ages
Functional Appliance for maxillary deficiency (7) (32) (33) (34) 	**Frankel's FR III** functional appliance: A lip pad prevent restrictive force of lip over the underdeveloped maxilla to allow its growth. A protrusion bow is placed behind the incisors to stimulate forward advancement of theses teeth **Indications:** - Mild cases - Maxillary deficiency	- Significant change in maxillary size and position - Improved mandibular positioned with chin back and down and more lingual lower incisor position - Rotation of the occlusal plane thanks to higher upper molar eruption (molar relationship goes to class I) - Little true forward movement of the mandible, more dental changes than skeletal (upper incisors more facial and lower more lingual) - Only mild cases due to the limited skeletal modification
Reverse Pull headgear (facemask) (7) (32) (33) (35) (36) (37) (38) (39)	**Facemask:** Exert anteriorly directed forces on the maxilla trough an appliance (removable splint or fixed	- True skeletal changes if started at young ages (Skeletal modification declines after 8 and clinical

	appliance). It can be associated with maxillary expansion **Indications:** - Minor to moderate skeletal problem - True maxillary deficiency	success declines after 10/11 years old) - Noticeable facial aesthetics improvement - Unavoidable tooth movement - High compliance required - Higher forces required than miniplates - High rate of recurrence due to mandibular growth in adolescence
Facemask traction to TADS (miniplate, miniscrews) (7) (31) (39)	**Indications:** - Moderate maxillary deficiency needing higher growth modification - From the age of 11 when the bone is mature	- Greater skeletal change - No dentoalveolar changes compared to conventional face mask - Need to wait bone maturity around the age of 11 compared to 8/10
Chin-Cup Appliances: Restraint of Mandibular Growth (7) (35) (32) 	**Indication:** - Excessive mandibular growth	- Change the direction of mandibular growth by rotation of the mandible back and down - Little growth inhibition - Increase facial anterior height - Lingualization of lower incisors
Functional Appliances in Treatment of Excessive Mandibular Growth (7)	- Rotate the mandible down and back and guide teeth eruption. Put more lingual the lower incisors and more facial the upper incisors **Indications:** - Excessive mandibular growth	- Doesn't restrain mandibular growth

OBJECTIVES:

The main objective of this scientific review of articles was to evaluate and understand the working of miniplates in the orthopedic treatment of growing patient. Secondarily objectives are study the characteristics of the miniplate: its indication, contraindication, structure, advantages, disadvantages, its protocol of application and the complications resulting of it.

Main Objectives:

1: Evaluate the use of the miniplates in the orthopedic correction of skeletal class III malocclusion

2: Evaluate the use of miniplate in the daily practice compared to other more conventional methods (facemask, functional appliances, chin cup)

3: Evaluate the potential use of miniplates in the orthopedic correction of skeletal class II malocclusion

METHODOLOGY:

For the realization of this work, a research of articles has been done through different database such as Medline, PubMed or Researchgate. For making the research, the following keywords have been chosen: miniplate, orthodontics, dentofacial orthopedics, growing patient, temporary anchorage system, TADS, skeletal anchorage, class III, class II. A preselection of article has been made. The selection criteria were established: articles from 2004 until nowadays, from international renowned newspaper. From the preselection many articles were removed for different reasons: articles from non-recognized or reliable newspaper, articles with patients sample not corresponding to the subject about growing patient (non growing adult patients are excluded). Information have been taken from different type of support: scientific articles or books. Were removed from the selection all articles dated from before 2004, samples treating adult patient and late adolescent with few bones growing pattern as well as patients not treated by orthopedic forces but by exclusive orthodontic sequence. The different texts were from different language: English, French, or Spanish.

Inclusion criteria's:

- Studies realized on children or young adolescent still in a growing or modifiable bone phase
- Healthy patient without diseases, without dental anomalies or syndrome
- Patient in mixed dentition or recent permanent dentition
- Patient of different ages and girls as well as boys

- Only published articles were used
- Were selected articles about miniplates as well as other articles about temporary anchorage devices in general
- Were selected articles about alternatives to miniplates in order to compare all of them
- Were selected articles about orthopedic treatment using miniplates

Exclusion criteria's:

- Adult patient for not being in a growing bone phase allowing orthopedic correction
- Articles with published before 2004 (most of them not having more than 10 years)
- Articles about permanent anchorage

Keywords: miniplate, orthodontics, dentofacial orthopedics, growing patients, temporary anchorage system, TADS, skeletal anchorage, dentofacial orthopedics, class III, class II

RESULTS:

From the initial research, 52 articles were selected. 19 were removed for the following reasons: they were about miniplate in adult patient and not with children or their date of publication were before 2004 and not enough recent. From the final selection, 33 articles were used: 21 about the miniplate in the class III correction, 8 about the miniplate in class II correction and 7 about the alternatives to the use of miniplates. The articles presenting concrete cases with cephalometric analysis have been resumed in the following table.

Authors	**Subjects**	**Age**	**Malocclusion**	**Technique**	**Treatment time**	**SNA before/after**	**SNB before/after**	**ANB before/after**	**Dentoalveolar changes before/after**
Skeletal class III correction by different techniques using miniplates									
Cha et al 2011 (2)	1 girl	8 YO	Skeletal class III	Maxillary miniplate to facemask		81,8/92,3	84/89,4	-2,2/3,0	Reduced labial tipping of maxillary incisors and lingual tipping of lower incisors
De Clerck et al 2009 (21)	3 girls	10 to 11 YO	Skeletal class III with maxillary deficiency	Elastic intermaxillary traction between miniplates	Between 9 and 19 months	85/92 81,5/86 72/79	87/87 81,5/80 77/76,5	-2/5 0/6 -5/2,5	Mx1-PP 116/120 101/106 115/114 Md1 MP 93,5/100 95/101 89/94
Buyukcavus et al 2020 (39)	18 9 boys and 9 girls	11,96+-0,92 year	Skeletal class III from maxillary retrognathia	Facemask with miniplates	0,57 +- 0,21 year	76,62/80,01	78,81/76,15	-2,07/3,99	U1/PP 113,72/115,7
Heymann et al 2009 (23)	3 boys 3 girls	From 10 to	Skeletal class III with maxillary deficiency	Intermaxillary elastic to miniplates	12,5 months	80,3/82,35	81,6/75,8-	-1,35/3,05	

		13 YO							
Martinez Smit et al 2019 (3)	1 girl	11 YO	Skeletal class III malocclusion	Hybrid hyrax to mandibular minipate	20 months	77/84	83,5/85	-6,5/-1	U1-PP 124/123 L1-MP 89/84
H.-Y. Lin et al 2020 (31)	2 girls 1 boy	10 to 11 and 9 months YO	Skeletal class III	Miniplate anchored facemask		83/88,5	86,5/88,5	-3,5/0	U1-SN 101/130 L1-MP 82/94
Skeletal class II correction by technique using miniplates									
Al-Dumaini et al 2018 (5)	14 boys and 14 girls	11,83 YO	Skeletal class II	Intermaxillary elastic between upper anterior miniplates and lower posterior miniplates		80,79/79,38	73,83/76,73	7,10/3,10	

<u>Cephalometric analysis of different cases using miniplate for class III and class II correction</u>

DISCUSSION:

Miniplate for growing patient in orthopedic treatment of skeletal class III:

Through the literature, it's made clear that the diagnosis when facing a class III in a growing patient is primordial. Components of these discrepancies have to be carefully analysed (6). The skeletal has to differentiated from the dental which can be properly managed through a full orthodontics sequence. When in front of skeletal pattern, if the age of the patient allows it, orthopedic treatment can be undertaken for growth modification (2)(4)(22). The etiology is studied for understanding whereas it's associated to maxillary hypoplasia, mandibular excessive growth or combination of both (7).

In orthopedic treatment, the miniplates has shown good result in a new protocol for treatment of skeletal class III. It has been reported by De Clerck and co-workers that orthopedic forces could be used connecting 2 miniplates through elastics (one being in the infrazygomatic crest to another located between 1st premolar and mandibular canines) (16)(3)(9). The miniplate being properly anchored into the bone and not tooth borne, it avoids any unwanted dentoalveolar compensation thanks to forces spreaded to the jaws instead of the teeth. The treatment timing differs from the recommended one using the classical facemask. With this protocol, 2 conditions are required: an adequate bone density usually achieved around the age of 11 years old and with the permanent mandibular canine erupted (around the age of 9 years old) (7)(9)(11). This is why this technique is a strong option: as first option if the patient is too old for expecting good outcome with use of facemask and as alternative if the patient is still in an acceptable age for facemask but can wait to complete the conditions of the miniplate's use. The perfect treatment is usually situated between the ages of 12 and 14 years old for an average time of 1 year. Complication such as relapse have to expected (2). It could be advisable to leave the miniplate for extra months in mouths in case of needed adjustments in a lasting growth. While it's getting close to the end of the adolescence, the growth is slowing down and stopping (6). The forces are kept for about 12 months with 24 hours/day light strength of about 150mg (7). If the patient class III etiology is about maxillary deficiency, at the end of the orthopedic intermaxillary traction, they can be used for distalizing maxillary molars in order to leave space for maxillary canines. The miniplates have shown significant statistical and qualitative differences compared to the use of facemask: about 3mm more of maxillary advancement, midface changes in over 1/3 of cases to nothing for the facemask, about 1 or 2 years later for treatment starting and twice more changes in the intermaxillary elastic method. Lighter forces are required, about 150gm in contrast to the 300 to 500gm of the facemask (7). For positive evaluation of its use: this protocol is considered highly effective, allows important skeletal changes thank to a good anchorage and prevent dentoalveolar changes which are common consequences of the conventional methods (3)(4)(9). Furthermore, its use is more comfortable from a patient point of view, asking less compliance by a reduced or suppressed need of headgear facemask, giving a better aesthetic, permitting a good oral hygiene and less invasion into the mouth (11)(12). It can be considered as a safe and effective method in the daily practice of the orthodontist (11). However, this recent protocol shows some limitations: the growth cessation is highly unpredictable and longer mandibular growth can influence the long-term result of the treatment. This technique hasn't been used for long and treated patients are only getting late teen now for evaluating the stability or relapse (4)(6)(7).

It has been reported another case of orthopedic class III correction doing maxillary protraction by the mean of miniplate. A 8 years old growing patient girl with maxillary deficiency (hypoplasia, retrusion) was successfully treated (2). On diagnosis she were presenting anterior crossbite and low anterior tongue posture. Through cephalometric analysis was confirmed the mandibular prognathism with ANB of minus 2,2°. After few time with removable appliance for regaining space loss by early loss of temporary teeth, the orthopedic action is started. Miniplate are placed under local anaesthesia at both sides: being at the infrazygomatic crest for the maxilla with final hook for elastics between canine's and 1st premolar's gingiva with elastic connection at the level of incisors with help of the facemask for the mandible. It was asked to the patient an activation of 12/14 hours a day by the setting of elastics. In 10 months, a class II premolar/molar relationship was observed. As combination, the wear of headgear was given to the patient only as retainer for night time and finally the treatment was completed by fixed brackets for 18 months. The treatment outcome was successful. An early diagnosis is important for treating class III malocclusion allowing a good orthopedic management. The anterior crossbite is then corrected doing maxillary incisor protrusion and lower incisors retrusion. The authors have treated more than 30 patients using this appliance and have seen and important difference compared to conventional method using rapid maxillary expansion device and headgear. By using temporary anchorage system, they have a way stronger anchorage that led to better skeletal changes, greater than from other techniques. Studies give to the association of miniplate/facemask evidence of better stability for avoiding relapse.

A unique protocol has been proposed by Martinez Smit for treatment of a severe class III malocclusion caused by maxillary hypoplasia on an 11 years old girl (3). It consists of simultaneous orthopedic maxillary expansion and constriction by the mean of hybrid hyrax with mandibular miniplate and associated to an orthodontic treatment. The particularity of this protocol is that both orthopedic and orthodontics maneuver are done at the same time instead of 2 separates sequences. Other treatment alternatives were eliminated: the facemask for its dentoalveolar compensation such as molar mesialization or incisor proclination and the orthognathic surgery for future deterioration of the facial appearance. The treatment was completed after 20 months of treatments and excellent outcomes with the class III corrected adequately and excellent aesthetic. After 2 years of control, the correction remains stable without relapse. Again, this case has shown that the miniplate is a good alternative to the use of facemask even in a modified protocol with only mandibular miniplate compared the one studied by De Clerck (miniplates presents in both jaws) (9)(16). Compared to conventional facemask therapy, there were a significant decrease in the treatment time; the treatment was achieved in 20 months where it can last about 3 years in classical methods. This hyrax/mandibular plate technique through the use of elastic showed excellent modalities for this class III that has been corrected and has improved the physical appearance perceived bringing self-esteem and quality of life to the patient. However, this modified way to the use of miniplate need further applications for being considered as an evident option on everyday clinic.

Different techniques are used by the authors: De Clerck and Heymann (21,23) with the intermaxillary elastics traction associated to both jaws miniplate has shown excellent treatment outcome with maximal skeletal modification and minimal dentoalveolar compensation (reduced labial tipping of maxillary incisor and reduced lingual tipping of lingual incisors). Trough the cephalometric analysis of his technique, the SNA shows a good maxillary advancement, the SNB shows sign of mandibular advancement restriction, the

ANB gets back to positive normal range of skeletal class I in many cases and the dentoalveolar cephalometric measures shows decreased dental implication.
Another technique implicating the miniplate to facemask was used by many authors (Cha, Buyukcavus, Ling) (2,39). Thanks to a good anchorage this technique trough cephalometric analysis confirms to give important skeletal modification with few dentoalveolar modification. Again, important maxillary advancement is seen with limited dental alteration.

The miniplate compared to conventional alternatives in the orthopedic treatment of skeletal class III

Associated to Maxillary deficiency

When facing the skeletal class III being mostly from maxillary deficiency and if associated to mandibular excessive growth not being too excessive: 3 main approaches can be considered. The functional appliance, the face mask or the miniplate associated to elastics (7). The functional appliance is considerable only in mild case. The functional appliance of choice is the Frankel FR III. A change is observed in the maxillary size and position, but the outcomes differs highly from the one given by the miniplate. The Frankel FR III shows a limited true forward growth advancement of the maxilla with dental movement compensation with more buccal upper incisors and more lingual lower incisors where the miniplates has paradoxal result with important skeletal changes and reduced dental movement. The Frankel appliance can improve mild cases of maxillary deficiency with little mandibular excessive growth where the miniplate can enhance harder cases of maxillary deficiency (7)(34)(39). Another approach is the facemask which has been the conventional method of choice in the treatment of class III. The facemask gives true skeletal changes if performed in the right conditions, at the good timing when the child is between 8/10 years old and with a good compliance. The reverse pull headgear is responsible of dentoalveolar compensation due to a dental anchorage (33)(37)(39). Compared to it, the miniplate presents an absolute bone anchorage which eliminate any dental movement. For being implanted, the compliance is not required, this improving the outcomes. The facemask has been used for long time and its action is well known but need to be undertaken at early time where the miniplate gives opportunity to treatment at older age (12/14 years old). For being quite brand new, long term outcomes of miniplate still have to be study. But from all options, its results are promising and if furtherly confirmed might stay or become the treatment of choice in the indicated cases (11).

Associated to Excessive mandibular growth

The skeletal class III patient explained previously were axed on the maxillary deficiency pattern of the patient. But in many cases, even if it can be due to a combination of both, a mandibular excessive growth is the main pattern of the malocclusion which is highly challenging for its correction. 3 mains approaches can help in its resolution: functional appliance, extraoral chin cup and elastics to skeletal miniplate (7). The elastics to miniplate is the one used for maxillary hypoplasia, but it has a direct impact on the mandibular growth. From its utilisation could be observed: backward movement of the chin due to growth redirection and modelling of fossa/condyles or growth inhibition by backward movement of the condyles, the chin staying at the same location. The management of the mandibular growth stays limited. The success point of the De Clerck protocol seems to more about forward growth of the maxilla. It is a limitation of this protocol in a true mandibular prognathic patient. No perfect alternatives could restrain and control the mandibular excess properly; the mandibular functional appliance being unable to inhibit the growth (only allowing downward backward rotation allonging the facial thirds) and the chin cusp no spreading the forces adequately (light lasting continuous forces for inducing growth modifications). If the mandibular pattern is primary, the miniplate technique is hardly controlled: the maxillary growth should be limited when desired and relapse is hardly predictable. This challenging pattern has to be considered with a potential need of orthognathic surgery (35).

Miniplates as an option for skeletal class II correction trough orthopedic forces

In orthodontics, about 1/3 of the malocclusions the practician is facing are class II (5). There are several manners for making the correction of a class II in a growing patient, depending on where the malocclusion is coming from. In the case of a skeletal class II, most of the time it's comes from a mandibular deficiency or retrusion. Most of the skeletal class II are corrected only by orthodontics sequence and the skeletal pattern is left with minimal correction (6). When treated at young ages, orthopedic appliances can try to correct the skeletal malformation by the mean of functional appliances or headgear. But this often result to important dentoalveolar changes and not highly significant bone changes. A novel approach has been introduced by Al Dumaini to overcomes these limitations with miniplate skeletal anchorage (5). It consists of placing miniplates bilaterally in the upper anterior sector and lower posterior sector joining them through elastics (the treatment is completed with 2 stainless steel arch wires of 0,017 x 0,025). A study was realized with 28 growing patient that were part of this project with an average age of 11,83 years old. The treatment outcome of this study was generally successful, a 3mm mandibular length's increase has been observed with a forward advancement and a body/ramus length increase. The overjet was reduced of 4,26mm and few dentoalveolar changes was observed (compared to conventional methods that give less skeletal change for more dentoalveolar modifications). A maxillary base length decrease was observed (average of - 1,18mm). It showed bone changes greater than 2 removable functional appliances considered as the most superior by systemics reviews: the twin block and the Frankel II appliance. Both mandibular growth promotion and maxillary forward growth restriction have permit to correct this type of class II. The miniplate can be considered as a good alternative to extra oral appliance such as headgear gear which need the patient compliance or to other functional appliances for the orthopedic treatment of skeletal class II malocclusion due to mandibular retrusion. As opposition to its opponents (functional appliances and headgear), the correction of this class II was more skeletal than dental. Modified protocols has been published in the literatures for the correction of class II trough skeletal modifications undertaking different techniques such as both arches miniplates or the mandibular miniplate associated to the forsus fatigue resistant device (10). These are promising, offering increased skeletal changes and limiting the dental movement. However, these protocols are not standardized and need further investigations.

<u>Miniplate in the daily practice</u>

Through the scientific literature, the miniplate has shown to be used in high number of different ways. From the simple orthodontics/orthopedic movement to the hardest one thanks to its excellent anchorage (11)(13). As previously explained, the miniplates offers good possibilities of growth modification in the perspective of the orthopedic skeletal corrections (9). The balance benefit risk of its insertion is to be thought. It often gives increased therapeutics effects but involves a surgical invasive procedure, special requirement for its implantation, an increased overall treatment's cost and possible further complications (10). Compared to alternatives, we have to know if its placement would increase significantly the treatment outcome. While the use of miniplate in the correction of skeletal class III is being more and more recognized as an evident option in many cases where it would definitely increases the treatment expectations (7), its uses for class II correction has shown to be quite efficient but is not in mind as evident option in theses malocclusion mostly treated with orthodontics brackets through dental movement and functional appliances (5).

CONCLUSIONS:

When facing a malocclusion, several options are possible. The choice is made by the orthodontist depending on the severity, age and demand of the patient. In the case of growing child, the most severe deformities being skeletal have to be early managed for allowing proper correction and gives opportunities to orthopedic forces to solve the problem. For being effective and limiting the undesired impacts, the orthopedic treatment need to lean on an excellent anchorage. This anchorage can be provided by miniplates, a TADS with many good properties (absolute anchorage, stability, compliance free, high success rate, etc…) in the perspective of the orthopedic treatment.

1° In the correction of skeletal class III, case reports proved that it uses gives excellent treatment outcomes with significant skeletal improvement, proper bone remodelling, proper bone redirection and reduced side effect such as the dentoalveolar compensation, an indirect consequence of the use of most of conventional methods (facemask, functional appliances). An important maxillary advancement is observed with a restrained mandibular advancement and a limited tipping of incisors.

2° Compared to the conventional options (facemask and functional appliance), the miniplates present the advantage of its bone anchorage allowing it to be used in more severe cases when needing important skeletal modifications with reduced dentoalveolar movements. It has an impact on both maxillary advancement and mandibular restriction and compare to the facemask needs less compliance, shorter treatment time and lighter forces.

3° It also showed positive impact in the bone changes for the correction of skeletal class II usually corrected through orthodontics sequences mainly. The correction observed was more skeletal than dental where opposite action was seen with the use of functional appliance and facemask for class II correction.

The use of miniplates in orthopedic is recent, it still needs further investigation for its universal uses, but many protocols have been established and allows it to be considered as a strong option in the treatment of growing patient needing orthopedic correction.

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Maxillary protraction with miniplates providing skeletal anchorage in a growing Class III patient

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Maxillary protraction headgear has been used in the treatment of Class III malocclusion with maxillary deficiency. However, loss of dental anchorage has been reported with tooth-borne anchorage such as lingual arches and expansion devices. This side effect can be minimized with skeletal anchorage devices such as implants, onplants, mini-implants, and miniplates. The use of miniplates for maxillary protraction in the mixed dentition has not been reported in the literature. This case report describes the treatment of an 8-year-old girl with a Class III malocclusion and maxillary deficiency. Miniplates were used as skeletal anchorage for maxillary protraction followed by phase 2 orthodontic treatment with fixed appliances. Skeletal, dental, and facial changes in response to orthopedic and orthodontic treatment are reported to illustrate the esthetics, function, and stability of treatment with this new technique. (Am J Orthod Dentofacial Orthop 2011;139:99-112)

Maxillary protraction headgear has been used in the treatment of Class III patients with maxillary retrusion. Clinical studies have shown that 2 to 4 mm of maxillary advancement can be obtained with 8 to 12 months of maxillary protraction. This is the result of a combination of forward movement of the maxilla, downward and backward rotation of the mandible, labial tipping of the maxillary incisors, and lingual tipping of the mandibular incisors.[1-5] Most of these studies used tooth-borne anchorage devices such as a lingual arch, quad helix, or maxillary expansion appliance.[1-3] The disadvantages of tooth-borne anchorage devices are loss of anchorage, especially when preservation of arch length is necessary, and the inability to apply orthopedic force to the maxilla directly. Many investigators have attempted to design an absolute anchorage system for maxillary protraction including the use of intentionally ankylosed maxillary deciduous canines, osseointegrated titanium implants, onplants, miniscrews, and miniplates.[6-9] Each implant system has strengths and weaknesses. Miniplates, for example, have been used with success for a variety of orthodontic anchorage needs including intrusion of posterior molars, correction of anterior open bite, retracting mandibular molars, and treatment of patients with maxillary hypoplasia.[10] Surgical or titanium miniplates are gaining popularity as an orthodontic implant anchor because they have been proven safe and effective for fractures and osteotomies, and they can be placed above the tooth roots to facilitate orthodontic tooth movement. The use of miniplates in the treatment of maxillary hypoplasia in growing Class III patients has not been reported in the literature. This case report illustrates the use of surgical miniplates as anchorage for maxillary protraction in the mixed dentition.

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DIAGNOSIS AND ETIOLOGY

The patient, an 8-year-old girl, came to the Kangnung National University Orthodontic Clinic in Gangneung, South Korea, with a chief concern of "my bite is not right." Clinically, she had a concave facial profile, and acute nasolabial angle, and a protrusive mandible

Case Report

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Correction of Class III malocclusion with alternate rapid maxillary expansions and constrictions using a hybrid hyrax–mandibular miniplate combination and simultaneous orthodontic treatment: A case report

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In this report, we describe the successful use of alternate rapid maxillary expansions and constrictions with a hybrid hyrax–mandibular miniplate combination and simultaneous orthodontic treatment for the management of severe Class III malocclusion due to maxillary hypoplasia in an 11-year-old girl. The devices were removed after 20 months of treatment, and the family was instructed about a careful control and retention program that should be followed in accordance with the patient's growth. The final result included the correction of Class III malocclusion with adequate function and excellent facial esthetics, which restored the patient's self-esteem and provided personal motivation. The outcomes showed good stability after 24 months of retention. The decrease in the duration of active treatment is the most important finding from the present case. Considering that facial esthetics in adolescence is a determining factor for the development of a personality and interpersonal relationships, we recommend the use of this protocol for growing patients, who will exhibit not only an improved physical appearance but also a better quality of life.
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Key words: Orthopedics, Bone anchorage, Maxillary protraction, Class III malocclusion

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Maxillary Protraction at Early Ages. The Revolution of New Bone Anchorage Appliances

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Purpose: *An update is provided on the different types of early treatment for class III malocclusions of maxillary origin. There is an increasing tendency to prescribe maxillary orthopedic treatment with skeletal anchorage, with the purpose of enhancing the skeletal and reducing the dentoalveolar effects – offering a management option for children with important deformations that otherwise would have to wait until adult age to receive surgical treatment.* ***Method:*** *A literature review has been made of maxillary bone orthopedic traction appliances in growing children with class III malocclusions. A Medline (PubMed) search was made using the following MeSH terms: Cephalometric, Child, Malocclusion class III / therapy, Extraoral traction appliances, Palatal expansion, Bone plates, Skeletal anchorage, Orthodontic anchorage.* ***Results:*** *Many articles show that the greatest maxillary advances are obtained at very early ages, though with a greater tendency towards relapse. However, skeletal anchorage has been seen to afford a lesser relapse rate and greater dentofacial orthopedic efficiency due to its low dentoalveolar impact. In any case, further randomized clinical studies are needed to firmly establish the quantifiable differences in terms of maxillary advance, optimum traction age, optimum traction appliance and potential side effects. At present, the incorporation of surgically inserted bone anchorage appliances (miniplates and miniscrews) offers a purely orthopedic approach to treatment, with minimization of the undesirable side effects of traditional dentofacial orthopedic compensation based on dentoalveolar anchorage. Nevertheless, further studies are needed to consolidate the supporting scientific evidence in this field.*

INTRODUCTION

Class III malocclusion is characterized by maxillary deficiency (or set back position) or mandibular prognathism, though in most cases both conditions are seen to coexist.[1] Because of this anomalous relationship, the incisors may present anterior cross-bite, edge-to-edge contact or, in the case of dentoalveolar compensation, retro-inclination of the lower incisors and proinclination of the upper incisors. Among the different class III malocclusions we can distinguish between dental, functional or pseudo-class III problems and skeletal or true problems. In skeletal presentations the origin of the malocclusion often consists of maxillary hypoplasia – maxillary orthopedic protraction presently being one of the most widely used treatment options in such cases.

The incidence of class III malocclusion varies according to the ethnic origin of the population. Different epidemiological studies have found the greatest prevalence of class III malocclusions to correspond to the Asian population, particularly of Chinese origin. According to some authors, 14% of the population is affected,[2-5] while others report a range of 9-19%.[6-7] In turn, in 70% of the cases the condition is attributable to maxillary retrognathia with a normal mandible, or to alterations of both maxillae.[8] The incidence in the Caucasian population is 1-5%,[9-11] and in this case two-thirds of all class III malocclusions are of maxillary origin or involve both maxillae combined12. Other studies in European populations have reported a prevalence of 3-8%.[9,10,13] In the Latin population the prevalence of class III malocclusions is reported to be 5%.[14]

The treatment of class III malocclusion in growing patients remains a challenge in orthodontic practice. The literature describes a range of orthodontic and orthopedic management approaches to these malocclusions, such as class III functional appliances,[15] chin guards,[16] splints with class III elastics[17] and cervical extraoral mandibular anchoring,[18] among others. Despite the many treatment options available, their individual therapeutic objectives and the skeletal, dentoalveolar and dental structures upon which they act differ considerably from one technique to another. In turn, although

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A novel approach for treatment of skeletal Class II malocclusion: Miniplates-based skeletal anchorage

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Introduction: The objective of this study was to evaluate the effect of a new approach—bimaxillary miniplates-based skeletal anchorage—in the treatment of skeletal Class II malocclusion compared with untreated subjects. **Methods:** The study (miniplates) group comprised 28 patients (14 boys, 14 girls) with skeletal Class II malocclusion due to mandibular retrusion, with a mean age of 11.83 years. After 0.017 × 0.025-in stainless steel archwires were placed in both arches, 4 miniplates were fixed bilaterally, 2 in the maxillary anterior areas and 2 in the mandibular posterior areas, and used for skeletal treatment with elastics. Twenty-four Class II untreated subjects (11 boys, 13 girls), with a mean age of 11.75 years, were included as controls. Skeletal and dental changes were evaluated using pretreatment and posttreatment or observational lateral cephalometric radiographs. The treatment changes were compared with the growth changes observed in the control group using independent *t* tests. **Results:** Compared with the minimal changes induced by growth in the control group, the skeletal changes induced by miniplates were more obvious. The mandibular length increased significantly (3 mm), and the mandible moved forward, with a significant restraint in the sagittal position of the maxilla ($P < 0.001$). The overjet correction (−4.26 mm) was found to be a net result of skeletal changes (A-Y-axis = −1.18 mm and B-Y-axis = 3.83 mm). The mandibular plane was significantly decreased by 2.75° ($P < 0.001$). **Conclusions:** This new technique, bimaxillary miniplates-based skeletal anchorage, is an effective method for treating patients with skeletal Class II malocclusions through obvious skeletal, but minimal dentoalveolar, changes. (Am J Orthod Dentofacial Orthop 2018;153:239-47)

A Class II malocclusion is one of the most common problems in orthodontics. It accounts for approximately one third of the patients seeking orthodontic treatment.[1] About 37% of Syrian[2] and 20% of Egyptian[3] schoolchildren have this malocclusion. Several studies have stated that a Class II skeletal pattern is caused by a mandibular deficiency in most patients.[4-6]

Treatment of mandibular deficiency can be achieved by growth modification through stimulation of mandibular growth and inhibition of maxillary growth.[4,6] For this purpose, appliances such as extraoral headgears and removable or fixed functional appliances may be used.[7]

Evidence on the efficiency of removable functional appliances is controversial. Some researchers have reported favorable treatment effects on mandibular growth, either as an increase in mandibular length[8-10] or as effective condylar growth.[11,12] Others found that these appliances have no significant effect on the

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Conflict of interest: Abdullsalam Abdulqawi Al-Dumaini and Mohamed Youssef invented and patented the technique (Word Intellectual Property Organization) in 2012 under number WO2012096633 at: https://patentscope.wipo.int/search/en/detail.jsf?docId5WO2012096633&recNum51&maxRec52&office5&prevFilter5&sortOption5Pub1Date1Desc&queryString5Al-Domaini1Abdulsalam&tab5PCT1Biblio.
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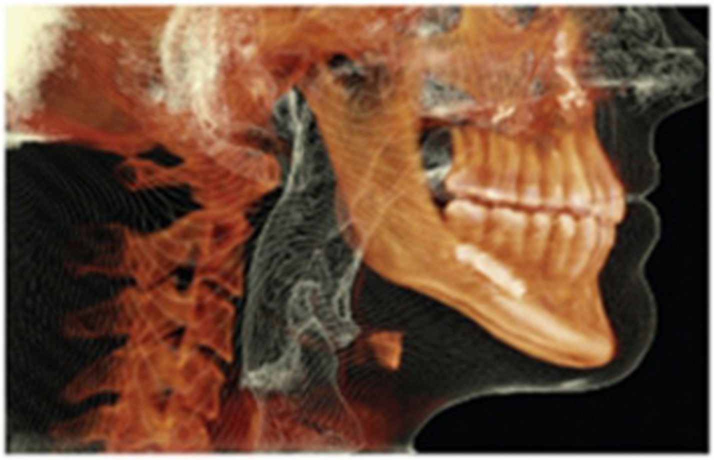
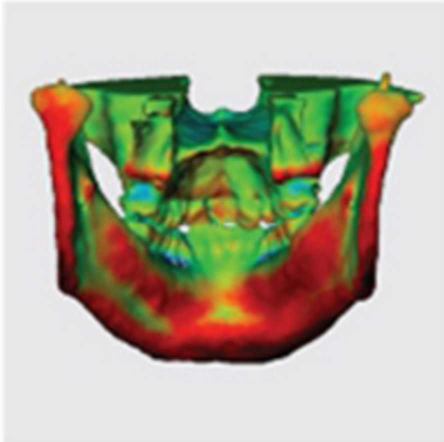

CONTEMPORARY ORTHODONTICS

Sixth Edition

ELSEVIER

Interceptive Dentofacial Orthopedics (Growth Modification)

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KEYWORDS

• Dentofacial deformity • Skeletal malocclusion • Growth modification • Growth assessment
• Dentofacial orthopedics • Orthognathic surgery

KEY POINTS

- Considering growth when managing dentofacial deformities is key, especially when determining the timing and type of treatment.
- The clinician must be familiar with growth evaluation and interceptive orthopedic options for the management of dentofacial deformities.
- Understanding the options available for growth modification and the ideal timing for correction of various dentofacial deformities allows the clinician to provide the most appropriate care for patients.

INTRODUCTION

Facial growth is a key consideration in the management of dentofacial deformities and skeletal malocclusions. Some deformities may be intercepted and managed during growth, whereas others can only be definitively managed after cessation of growth. The clinician must be cognizant of the significance of growth, and not view the dentofacial deformity as a snapshot. This article focuses on clinical considerations of growth in managing dentofacial deformities, and discusses methods to evaluate the status of growth, and management considerations for different types of dentofacial deformities in the context of growth modification.

GROWTH EVALUATION

Evaluation of growth is critical in determining the timing and type of treatment of dentofacial deformities. In the growing patient growth modification can be considered, which may minimize surgical movements, or even obviate surgery altogether. In the nongrowing patient, verifying cessation of growth is essential in minimizing relapse of Class III correction from latent mandibular growth.[1]

This section discusses evaluation of growth as it pertains to clinical management: anteroposterior growth of the mandible and anteroposterior and transverse growth of the maxilla (Table 1).

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CLINICAL SECTION

Skeletal anchorage systems in orthodontics: absolute anchorage. A dream or reality?

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This article examines the concept of orthodontic anchorage and focuses on ways skeletally derived anchorage is gained. A brief history of the different skeletal anchorage systems to date is given. The article gives an emphasis on the use of one particular skeletal anchorage technique—the micro-implant—to assist with orthodontic anchorage and active tooth movement. Advantages and disadvantages of this new technique are discussed. An illustration of the use of micro-implants is given with reference to a case where they have been used in a novel manner to provide distal movement of maxillary molars.

Key words: Orthodontics, skeletal anchorage, micro-implant, mini-implant, distal movement

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Introduction

Newton's third law of motion states 'each action has an equal and opposite reaction'. This is particularly relevant to orthodontics where such 'action' is favourable tooth movement, and the equal and opposite reaction is often an unwanted tooth movement. Anchorage is defined as the resistance to such unwanted tooth movement. To illustrate this further, consider the situation where an increased overjet is reduced by retraction of the maxillary incisors and canines. In this case, the maxillary molars will tend to move forwards as the maxillary anterior segment is retracted, as dictated by Newton's third law (Figure 1).

Not all malocclusions will have the same anchorage demands and it is up to the skill of the orthodontist to manage all the available anchorage sources to bring about full correction of the malocclusion. Anchorage may be gained:

- extra-orally using headgear or a facemask;
- intra-orally from teeth, bone, soft tissue and appliance mechanotherapy.

Occipital headgear supplements posterior anchorage by using the bones of the posterior skull to resist the unwanted tooth movement, thus preventing or reducing the forward movement of the maxillary posterior dentition. Similarly, facemasks use the bones of the face and chin to supplement anterior anchorage by resisting the backwards movement of the maxillary anterior dentition as the buccal segments are protracted. However, the use of such extra-oral appliances is not without problems. Poor compliance and ocular damage has been reported in the literature.[1] Intra-oral methods of anchorage control are numerous, but the majority result in a degree of anchorage loss. Absolute anchorage is a concept implying no movement of the anchorage unit, which may be required in the treatment of a maximum anchorage case (Figure 2).

If the anchor point (anchorage unit) in the force system is situated directly within bone, then the reactionary forces that always occur will theoretically result in no unwanted tooth movement (Figure 3). Skeletal anchorage is a technique utilizing some form of bony anchor in an attempt to provide absolute anchorage.

Sources of skeletal anchorage

- Endosseous implants
- Zygomatic wires

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Temporary skeletal anchorage devices: The case for miniplates

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The desire to have complete control over anchorage is no doubt universal among orthodontists. About 100 years after orthodontists first started using tooth-borne anchorage for orthodontic treatment, temporary skeletal anchorage devices appeared. It was clear that orthodontics would be a completely new ball game; soon temporary skeletal anchorage devices had become indispensable modalities in modern orthodontic practices for adults. Beyond that, temporary skeletal anchorage devices are at the center of innovations of surgical orthodontics for jaw deformities and the orthopedic treatment of growing patients with skeletal disharmonies.

As temporary skeletal anchorage devices were being developed in the 1990s, 2 types were widely put into use. There were great expectations for those that could osseointegrate with bone. This type included retromolar implants,[1,2] palatal implants,[3] and mini-implants.[4] The other type, developing in parallel, was the mechanical retention type and included miniplates[5-7] and miniscrews.[8] Extensive clinical experience for a wide range of orthodontic problems and detailed evaluations of these modalities over the years have brought us to where we are now: the temporary skeletal anchorage devices in use are miniplates and miniscrews, and both offer mechanical retention.

These 2 types of devices actually function best when they are working in collaboration with each other. They function differently, but both are indispensible in cutting-edge orthodontic treatment. Although the focus of this Counterpoint article is on miniplates, miniscrews also have a valuable role in modern orthodontics.

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STRUCTURE OF MINIPLATES

Miniplates are made of titanium or titanium alloys and come in various shapes and sizes. All miniplates have 3 parts: head, arm, and body. The head portion is intraorally exposed and positioned outside the dental arches. The head comes in a variety of shapes: circular,[9] hooked,[10-12] and tubular.[13,14] Some are like bendable sticks that can be manipulated into the desired shape.[15] The arm portion is transgingival or transmucosal and tends to be rectangular or round. The body portion is positioned subperiosteally, and its surface is attached to the bone. The body portions are classified into 4 basic shapes: T, L, Y, and I (straight). The body portion is fixed on the bone surface of the zygomatic buttress or the mandibular body with 2 or 3 miniscrews. Although there are many variations in miniplate heads, there are fewer variations in the body portions.

SUCCESS RATES AND STABILITY

Perhaps the greatest advantage of miniplates is their high success rate. In a systematic review of temporary skeletal anchorage devices by Schätzle et al,[16] the average failure rates of various devices were 7.3% for miniplates, 10.5% for palatal implants, and 16.4% for miniscrews. The authors concluded that based on the available evidence in the literature, miniplates provided reliable absolute orthodontic anchorage. In another report, Nagasaka et al[17] reported that just 3 of 107 miniplates had to be replaced; this is equivalent to a failure rate of 2.8%. In another report by Choi et al,[18] an average failure rate of 7% was reported for miniplates. The failure rates of miniplates were 6% according to Takaki et al[19] and just 3% in a study by De Clerck and Swennen[20] when miniplates were used as bone-anchored maxillary protraction for growing Class III patients. Clearly, although the numbers vary, all of these reports indicate the overwhelming success of miniplates, whether used in the maxilla or the mandible.

Since miniplates are made of pure titanium or titanium alloy, they exhibit onplant effects on the bone surface, and the screws inserted into the cortical bone exhibit implant effects in addition to the mechanical retention effects. This means that in addition to their

Original Article

Evaluation of the miniplate-anchored Forsus Fatigue Resistant Device in skeletal Class II growing subjects: *A randomized controlled trial*

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ABSTRACT

Objectives: To evaluate the use of direct miniplate anchorage in conjunction with the Forsus Fatigue Resistant Device (FFRD) in treatment of skeletal Class II malocclusion.

Materials and Methods: Forty-eight females with skeletal Class II were randomly allocated to the Forsus plus miniplates (FMP) group (16 patients, age 12.5 ± 0.9 years), Forsus alone (FFRD; 16 patients, age 12.1 ± 0.9 years), or the untreated control group (16 subjects, age 12.1 ± 0.9 years). After leveling and alignment, miniplates were inserted in the mandibular symphysis in the FMP group. The FFRD was inserted directly on the miniplates in the FMP group and onto the mandibular archwires in the FFRD group. The appliances were removed after reaching an edge-to-edge incisor relationship.

Results: Data from 46 subjects were analyzed. The effective mandibular length significantly increased in the FMP group only (4.05 ± 0.78). The mandibular incisors showed a significant proclination in the FFRD group (9.17 ± 2.42) and a nonsignificant retroclination in the FMP group (−1.49 ± 4.70). The failure rate of the miniplates was reported to be 13.3%.

Conclusions: The use of miniplates with the FFRD was successful in increasing the effective mandibular length in Class II malocclusion subjects in the short term. The miniplate-anchored FFRD eliminated the unfavorable mandibular incisor proclination in contrast to the conventional FFRD. (*Angle Orthod.* 2019;89:391–403.)

KEY WORDS: Class II malocclusion; Forsus; Miniplates; Anchorage; Growth; Fixed functional appliance

INTRODUCTION

Dimensional mandibular retrusion was shown to be the most common characteristic of skeletal Class II malocclusion.[1] The Forsus Fatigue Resistant Device (FFRD; 3M Unitek, Monrovia, Calif)[2] is an example of hybrid fixed functional appliances (FFAs), which are used for treatment of mandibular retrusion in growing subjects in which the factor of patient cooperation is controlled.

Recently, evidence[3,4] concluded that the skeletal effects of FFAs were minimal and of negligible clinical importance. Reduced skeletal correction was associated with the anchorage loss caused by these appliances that could also jeopardize the stability of the results. Several attempts were proposed to counteract the unwanted dentoalveolar side effects of FFAs, including the use of skeletal anchorage. Studies[5–7] showed that mini-screw anchorage reduced mandibular incisor proclination but was not able to enhance the skeletal changes.

Titanium miniplates were introduced for use in orthodontics in 1999.[8] They were shown to be well accepted by patients and became popular for use in various applications.[9–11] Recently, they were used for direct loading of FFRD for correction of skeletal Class II

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A review of the literature
Revue de littérature

The benefits of using anchorage miniplates. Are they compatible with everyday orthodontic practice?

Intérêt de l'utilisation des plaques d'ancrage. Sont-elles compatibles avec une pratique orthodontique quotidienne ?

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Summary

Nowadays, it is difficult to ignore the major role played by orthodontic anchorage. Given our convictions and after several years of using these systems, we believe it is time to take stock. Is there any real benefit to using them? And if so, when? What systems should we use? Miniscrews or miniplates? What are the indications for each of these systems? Are they compatible with everyday orthodontic practice? In a nutshell, are these orthodontic anchorage devices myth or practical reality?

Key-words

- Orthodontics.
- Anchorage.
- Miniscrews.
- Anchorage miniplates.
- Delaire analysis.

Résumé

Il semble aujourd'hui difficile d'ignorer l'importance des ancrages orthodontiques. Compte tenu de nos convictions et après plusieurs années d'utilisation de ces systèmes, un bilan s'impose. Y a-t-il un intérêt réel à les utiliser ? Si oui, quand les utiliser ? Quels systèmes employer ? Minivis ou miniplaques ? Quelles sont les indications de chacun ? Ces systèmes sont-ils compatibles avec une utilisation quotidienne en orthodontie ? Au total, ces ancrages orthodontiques sont-ils un mythe ou une réalité applicable ?

Mots-clés

- Orthodontie.
- Ancrage.
- Minivis.
- Plaques d'ancrage.
- Analyse de Delaire.

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Original Article

Success rates of a skeletal anchorage system in orthodontics: *A retrospective analysis*

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ABSTRACT

Objectives: To evaluate the premise that skeletal anchorage with SAS miniplates are highly successful and predictable for a range of complex orthodontic movements.

Materials and Methods: This retrospective cross-sectional analysis consisted of 421 bone plates placed by one clinician in 163 patients (95 female, 68 male, mean age 29.4 years ± 12.02). Simple descriptive statistics were performed for a wide range of malocclusions and desired movements to obtain success, complication, and failure rates.

Results: The success rate of skeletal anchorage system miniplates was 98.6%, where approximately 40% of cases experienced mild complications. The most common complication was soft tissue inflammation, which was amenable to focused oral hygiene and antiseptic rinses. Infection occurred in approximately 15% of patients where there was a statistically significant correlation with poor oral hygiene. The most common movements were distalization and intrusion of teeth. More than a third of the cases involved complex movements in more than one plane of space.

Conclusions: The success rate of skeletal anchorage system miniplates is high and predictable for a wide range of complex orthodontic movements. (*Angle Orthod.* 2018;88:27–34.)

KEY WORDS: Orthodontic anchorage; Bone plate; Skeletal anchorage; Miniplate

INTRODUCTION

Temporary skeletal anchors have become a routine component of the contemporary orthodontists' clinical armamentarium. The clinician can use them to develop force systems directly from the device and/or prevent unwanted side effects by indirectly connecting the device to dental anchor units. The range of force application has extended beyond historical antero-posterior movements to include more complex vertical and transverse movements previously considered problematic. In addition, these devices do not rely on patient compliance and do not affect aesthetics, which is a major disadvantage with the traditional headgear or facemask. The stability of these devices makes it possible to obtain complete anchorage to address the wide range of reciprocal forces in orthodontic mechanotherapy.

Historically, temporary anchors were first documented in the early 1980s by placing a surgical fixation screw in the maxillary alveolus to support direct force to the dentition.[1] Similarly, Roberts et al.[2] demonstrated the application of osseointegrated implants as indirect anchorage to protract posterior teeth in the mandible. Following these reports, numerous applications of osseointegrated fixtures were demonstrated.[3] Notably, Konomi[4] reported intrusion of anterior teeth using an osseointegrated mini bone screw 1.2 mm in diameter and 6 mm in length.[4] This generated great interest in small microscrews as a source of orthodontic anchorage.

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Temporary anchorage devices in orthodontics

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Abstract

Anchorage control is one of the main aspects of orthodontic treatment plan. A good appliance system should put minimum taxation of anchorage on the anchor units. The structures present with in the confinement of oral cavity are very less in number. In such cases the anchor unit gets its reinforcement from extraoral structures or intraoral appliances. Extraoral anchorages have their inherent drawbacks and most of them rely on patient cooperation. The use of implants in orthodontics to reinforce the anchorage is a recent concept. The purpose of this article is to review the implants in the context of orthodontics which are called as TAD- temporary anchorage devices.

Key words: Temporary anchorage devices, Orthodontics, Implants.

Introduction

Anchorage control is one of the most important aspects of orthodontic treatment. The success of orthodontic treatment hinges on the anchorage protocol planned for a particular case. Use of extraoral anchorage devices such as headgears requires full patient cooperation, which is sometimes not possible and is unpredictable. Introduction of implants in orthodontics have solved this problem. Implants have become one of the best sources of reliable anchorage. Mini implants have revolutionized the field of anchorage in orthodontics.[1-3] **(Table-I)**

This new modality has been called by several names, some of the popular ones are

- Mini implants
- Microimplants
- Skeletal anchorage
- Temporary anchorage Device

Use of implants as a source of anchorage has number of advantages as compared to traditional anchorage such as no patient cooperation, easy to use, shortening of treatment time, good control on tooth movements.

Branemark and co-workers" (1965) reported the successful osseointegration of titanium implants in bone; many orthodontists began investigating in using implants for the purpose of orthodontic anchorage. Gainsforth and Higley (1945) placed metallic vitallium screws in dog ramus, Linkow (1969, 1970) used mandibular blade-vent implants in a patient to apply class II elastics, Sherman' (1978) placed the first orthodontic implants. Block and Hoffman (1995) introduced the onplant to provide orthodontic anchorage.

CLASSIFICATION OF IMPLANTS FOR ORTHODONTIC ANCHORAGE[4] (Table-II)

1. According to the shape and size:

I) Conical (Cylindrical)
 a) Miniscrew Implants
 b) Palatal Implants
 c) Prosthodontic Implants
II) Mini plate Implants
III) Disc Implants (Onplants)

2. According to Implant bone contact:
 I) Osteointegrated
 II) Non-osteointegrated

3. According to the application:
 I) Used only for orthodontic purposes. (Orthodontic Implants) or TAD (temporary anchorage devices)
 II) Used for prosthodontic and orthodontic purposes.

MINISCREWS(Fig.1) Of all orthodontic implants, miniscrews have gained considerable importance due to less surgical procedure and easy installation. Titanium

Original Article

Surgical Difficulties, Success, and Complication Rates of Orthodontic Miniplate Anchorage Systems: Experience with 382 Miniplates

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Abstract

Purpose: The aim of this study was to evaluate the complications and success rates of the miniplates using both maxilla and mandible for orthodontic anchorage in growing patients. **Materials and Methods:** One hundred and fifty-five consecutive patients (range 8.7–13.8 years) with Class II and III malocclusion without congenital or acquired deformities were included in this study. A total of 382 titanium miniplates were placed by the same surgeon. All miniplates were inserted under local anesthesia. Loading of the miniplates with a force of 200 g with the help of elastics or functional devices were initiated 3 weeks after surgery. **Results:** The overall success rate of miniplate anchorage in terms of stability was 96.8%. Twenty-one patients reported irritation of the mucosa of the cheeks or lower lip after the surgery in the mandible group. Twelve miniplates needed to be removed and were successfully replaced. **Conclusion:** Skeletal anchorage miniplates is effective for correcting malocclusions. Success depends on proper presurgical patient counseling, minimally invasive surgery, good postsurgical instructions, and orthodontic follow-up.

Keywords: *Miniplates, oral surgery, orthodontic anchorage*

Introduction

Conventional orthodontics for the treatment of dental and facial skeletal discrepancies often involves intraoral appliances and extraoral appliances. In situations in which patients are partially edentulous or have oligodontia, the lack of teeth can often pose challenges for the orthodontist in devising a treatment plan with the existing dentition to provide sufficient anchorage.[1] Orthodontic anchorage is a term which explains the nature and degree of resistance to displacement offered by an anatomic unit. Anchorage is one of the important and factors in orthodontics, and its control is essential for successful treatment outcomes.[2] Implants and miniplates placed into the maxillo-mandibular skeleton enable the orthodontist to provide additional anchorage and exert predictable force in all three spatial planes transverse, vertical, and sagittal. There is a vast amount of literature on the use of anchorage devices in orthodontics to treat Class II and III malocclusion, malaligned teeth by uprighting, extrusion, intrusion, mesialization, and distalization. Traditionally, orthodontic therapy use teeth, extraoral and/or intermaxillary appliances for anchorage. For orthodontic anchorage, orthodontic implants (retromolar implants, miniscrews, pins, and palatal onplants) miniplates, fixation wires have been used frequently.[3] Over several years, bone-anchored orthodontic chin movement without corticotomy or osteotomy with the use of orthodontic elastics between miniplates in the upper and lower jaw was introduced.[4] Usually, different kinds of miniplates are inserted between the lateral and canine region in the mandible and the first molar region in the maxilla for skeletal anchorage for the treatment of various malocclusions. On the other hand, several problems such as loosening of the plates, inflammation, soft tissue changes, and fractures of the plates may be encountered during the surgical and orthodontic

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Original article

Microradiographic and histological evaluation of the bone-screw and bone-plate interface of orthodontic miniplates in patients

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Summary

Objectives: To describe the tissue reactions at the bone-titanium interface of orthodontic miniplates in humans.

Materials and methods: Forty-two samples, consisting of tissue fragments attached or not to miniplates or their fixation screws, were collected from 24 orthodontic patients treated with miniplate anchorage, at the time of removal of their miniplates. The samples were embedded in methylmethacrylate and cut into undecalcified sections which were submitted to microradiographic analysis. The sections were also stained and examined under ordinary light.

Results: Three types of reactions were observed both on the histological sections and on the microradiographs. 1. The majority of the stable miniplates were easy to remove (34/42). The tissue samples collected consisted mainly in mature lamellar bone with some medullary spaces containing blood vessels, 2. two screws were highly osseointegrated and required the surgeon to remove them by trephining (2/42). They were surrounded by bone tissue which extended to the miniplate. The histological features were similar to the previous group, though the bone-screw contact was higher, and 3. in six samples obtained after unstable miniplate removal during the treatment, we observed either some woven bone trabeculae or loose connective tissue, without any histological sign of inflammation.

Limitations and Conclusion: For evident ethical reasons, our data were limited by the size of the tissue fragments and the limited number of patients and variety of clinical presentations. The healing reactions consisted mainly in mature lamellar bone tissue sparsely in contact with the screw or the miniplate, with signs of a moderate remodelling activity.

Introduction

Skeletal anchorage is now part of contemporary orthodontics because of its advantages over traditional anchorage systems (1, 2). Conventional orthodontics relies on the use of several teeth as an anchorage unit to move other teeth. Additional compliance-dependent devices such as intermaxillary elastics or headgear are often necessary to reach therapeutic success. Furthermore, traditional anchorage tools reach their limitation when dental anchorage is

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ORIGINAL ARTICLE

Sagittal skeletal correction using symphyseal miniplate anchorage systems

Success rates and complications

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Abstract

Objectives Aim of this study is to evaluate success rates and complications related with symphyseal miniplate anchorage systems used for treatment of Class 2 and Class 3 deformities.

Methods A total of 58 miniplates applied to 29 growing patients were evaluated. The first group comprised 24 symphyseal miniplates applied to 12 patients and Forsus Fatigue Resistant Devices were attached to the head of the miniplates for mandibular advancement. The second group consisted of 34 symphyseal miniplates applied to 17 patients and intermaxillary elastics were applied between acrylic appliances placed on the maxillary dental arch and the symphyseal miniplates for maxillary protraction. Success rate and complications of the symphyseal plate–screw anchorage system were evaluated.

Results The overall success rate of symphseal miniplates was 87.9%. Six miniplates showed severe mobility and 2 miniplates broke during orthodontic treatment. Infection, miniplate mobility and mucosal hypertrophy were statistically different between the two groups.

Conclusions Symphyseal miniplates were generally used as successful anchorage units in most patients. Infection, mobility, and mucosal hypertrophy occurred more frequently in Class 2 deformity correction. However, the success rates regarding the two treatment modalities were comparable.

Keywords Skeletal orthodontic anchorage · Symphyseal miniplate · Success rate · Forsus fatigue resistant device · Class II and III malocclusion

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Temporary skeletal anchorage devices: The case for miniplates

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The desire to have complete control over anchorage is no doubt universal among orthodontists. About 100 years after orthodontists first started using tooth-borne anchorage for orthodontic treatment, temporary skeletal anchorage devices appeared. It was clear that orthodontics would be a completely new ball game; soon temporary skeletal anchorage devices had become indispensable modalities in modern orthodontic practices for adults. Beyond that, temporary skeletal anchorage devices are at the center of innovations of surgical orthodontics for jaw deformities and the orthopedic treatment of growing patients with skeletal disharmonies.

As temporary skeletal anchorage devices were being developed in the 1990s, 2 types were widely put into use. There were great expectations for those that could osseointegrate with bone. This type included retromolar implants,[1,2] palatal implants,[3] and mini-implants.[4] The other type, developing in parallel, was the mechanical retention type and included miniplates[5-7] and miniscrews.[8] Extensive clinical experience for a wide range of orthodontic problems and detailed evaluations of these modalities over the years have brought us to where we are now: the temporary skeletal anchorage devices in use are miniplates and miniscrews, and both offer mechanical retention.

These 2 types of devices actually function best when they are working in collaboration with each other. They function differently, but both are indispensible in cutting-edge orthodontic treatment. Although the focus of this Counterpoint article is on miniplates, miniscrews also have a valuable role in modern orthodontics.

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STRUCTURE OF MINIPLATES

Miniplates are made of titanium or titanium alloys and come in various shapes and sizes. All miniplates have 3 parts: head, arm, and body. The head portion is intraorally exposed and positioned outside the dental arches. The head comes in a variety of shapes: circular,[9] hooked,[10-12] and tubular.[13,14] Some are like bendable sticks that can be manipulated into the desired shape.[15] The arm portion is transgingival or transmucosal and tends to be rectangular or round. The body portion is positioned subperiosteally, and its surface is attached to the bone. The body portions are classified into 4 basic shapes: T, L, Y, and I (straight). The body portion is fixed on the bone surface of the zygomatic buttress or the mandibular body with 2 or 3 miniscrews. Although there are many variations in miniplate heads, there are fewer variations in the body portions.

SUCCESS RATES AND STABILITY

Perhaps the greatest advantage of miniplates is their high success rate. In a systematic review of temporary skeletal anchorage devices by Schätzle et al,[16] the average failure rates of various devices were 7.3% for miniplates, 10.5% for palatal implants, and 16.4% for miniscrews. The authors concluded that based on the available evidence in the literature, miniplates provided reliable absolute orthodontic anchorage. In another report, Nagasaka et al[17] reported that just 3 of 107 miniplates had to be replaced; this is equivalent to a failure rate of 2.8%. In another report by Choi et al,[18] an average failure rate of 7% was reported for miniplates. The failure rates of miniplates were 6% according to Takaki et al[19] and just 3% in a study by De Clerck and Swennen[20] when miniplates were used as bone-anchored maxillary protraction for growing Class III patients. Clearly, although the numbers vary, all of these reports indicate the overwhelming success of miniplates, whether used in the maxilla or the mandible.

Since miniplates are made of pure titanium or titanium alloy, they exhibit onplant effects on the bone surface, and the screws inserted into the cortical bone exhibit implant effects in addition to the mechanical retention effects. This means that in addition to their

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Fully customized placement of orthodontic miniplates: a novel clinical technique

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Open-Bite Treatment Using Maxillary and Mandibular Miniplates

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The development of temporary anchorage devices (TADs) has offered new options for treating orthodontic problems such as anterior open bite by means of molar intrusion, Class II malocclusion by maxillary molar distalization, Class III malocclusion by maxillary protraction or mandibular distalization, deep bite by anterior intrusion, and spacing from missing posterior teeth with mesialization.[1-7] The slightly lower reported success rate of miniscrews (about 86.5%[8]) compared to miniplates (91-96%[5,9]) is due to the tendency of miniscrews to loosen when orthodontic force is applied.[9] On the other hand, the ease of insertion and removal of miniscrews under local anesthesia gives them an advantage over miniplates, which require flap-raising surgery for insertion and removal. Still, there are certain clinical situations in which miniplates may be preferable—for example, in open-bite patients or when en masse distalization is required—because they allow efficient tooth movement without the need for removal and reinstallation.[4,5]

Conventional therapies for the correction of skeletal open bite[10,11] have included high-pull headgear,[12] fixed appliances such as the Multiloop Edgewise Arch Wire (MEAW),[13] tongue cribs,[14] posterior bite blocks,[15] posterior magnets,[16] and vertical elastics.[17] All of these rely on patient compliance and are less effective in adult patients. More severe cases of anterior open bite have traditionally required orthognathic surgery. As an alternative, several authors have recently had success in treating open bite with skeletal anchorage from TADs.[18] This article shows how an open bite with a canted palatal plane can be treated with a combination of maxillary and mandibular miniplates.

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Original Article

Evaluation of the effects of skeletal anchoraged Forsus FRD using miniplates inserted on mandibular symphysis:

A new approach for the treatment of Class II malocclusion

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ABSTRACT

Objective: To evaluate the skeletal, dentoalveolar, and soft tissue effects of the Forsus Fatigue Resistant Device (FRD) appliance with miniplate anchorage for the treatment of skeletal Class II malocclusion.

Material and Methods: The prospective clinical study group included 17 patients (11 girls and 6 boys; mean age 12.96 $\pm$ 1.23 years) with Class II malocclusion due to mandibular retrusion and treated with skeletal anchoraged Forsus FRD. After 0.019 $\times$ 0.025-inch stainless steel archwire was inserted and cinched back in the maxillary arch, two miniplates were placed bilaterally on the mandibular symphysis. Then, the Forsus FRD EZ2 appliance was adjusted to the miniplates without leveling the mandibular arch. The changes in the leveling and skeletal anchoraged Forsus FRD phases were evaluated by means of the Paired and Student's *t*-tests using the cephalometric lateral films.

Results: The success rate of the miniplates was found to be 91.5% (38 of 42 miniplates). The mandible significantly moved forward ($P < .001$) and caused a significant restraint in the sagittal position of the maxilla ($P < .001$). The overjet correction (−5.11 mm) was found to be mainly by skeletal changes (A-VRL, −1.16 mm and Pog-VRL, 2.62 mm; approximately 74%); the remaining changes were due to the dentoalveolar contributions. The maxillary and mandibular incisors were significantly retruded ($P < .001$).

Conclusion: This new approach was an effective method for treating skeletal Class II malocclusion due to the mandibular retrusion via a combination of skeletal and dentoalveolar changes. (*Angle Orthod.* 2015;85:413–419.)

KEY WORDS: Class II malocclusion; Forsus FRD; Skeletal anchorage

INTRODUCTION

Class II malocclusion, one of the most commonly observed problem in orthodontics, affects approximately one-third of the patients seeking orthodontic treatment.[1–3] Patients with Class II malocclusions can exhibit maxillary protrusion, mandibular retrusion, or both, together with abnormal dental relationships and profile discrepancy.[4] According to McNamara,[5] mandibular retrusion is the most common characteristic of this malocclusion.

In patients with Class II malocclusions due to mandibular retrusion, removable and fixed functional appliances are used to stimulate the mandibular growth by forward positioning of the mandible.[6–10] Various fixed functional appliances[4,6,8–13] have usually been used for the treatment of those patients to eliminate the disadvantages of removable appliances; removable appliances are bulky and loose in the mouth, so they are not easy for patients to use; thus, insufficient patient cooperation occurs.[10] Of the various fixed functional appliances, Forsus Fatigue Resistance Device (FRD) EZ (3M Unitek, Monrovia, Calif) is one of the newest popular appliances that do not need patient cooperation and is reported to be more comfortable for patients.[14]

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Orthopedic Traction of the Maxilla With Miniplates: A New Perspective for Treatment of Midface Deficiency

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Class III malocclusion is a consequence of maxillary deficiency and/or mandibular prognathism, often resulting in an anterior crossbite and a concave profile.[1] Young patients with maxillary hypoplasia are usually treated with a facemask: heavy anterior traction is applied on the maxilla to stimulate its growth and to restrain or redirect mandibular growth. Forward and downward movement of the maxilla as well as favorable changes in the amount and direction of mandibular growth has been reported.[2-5] However, these forces generally result in a posterior rotation of the mandible and an increased vertical dimension of the face.[2,4,6] Moreover, dental compensations (proclination of the upper incisors and uprighting of the lower incisors) are observed as a consequence of the application of forces on the teeth,[4,7] and facemask wear is usually limited to 14 hours per day at best.

Titanium miniplates used for anchorage now offer the possibility to apply pure bone-borne orthopedic forces between the maxilla and the mandible for 24 hours per day, avoiding any dentoalveolar compensations.

Summary of Cases and Diagnosis

Three girls (aged 10 to 11 years) presenting with a severe skeletal Class III relationship with a maxillary deficiency and concave soft tissue profile were treated according to the same treatment plan (Figs 1A, 2A, 3A). Two of them had an anterior crossbite without anterior shift of the mandible (cases 2 and 3). One had an edge-to-edge incisor occlusion in centric relation, with a forward posture into maximum intercuspation (case 1).

Pretreatment cephalometric evaluation of the 3 cases showed a skeletal Class III relationship with hypoplasia of the maxilla combined with a normal or increased mandibular size and normal or slightly decreased vertical dimensions (Table 1). The patients' upper incisors were proclined or retroclined, and the lower incisors were normal or proclined.

Treatment Objectives

The main treatment objective was to achieve a reduction of the facial concavity, maximize skeletal maxillary changes, and minimize dentoalveolar movement.

Treatment Plan

The 3 patients were treated exclusively by intermaxillary traction between miniplates placed in the maxilla and in the mandible, in combination with a bite plane to jump the crossbite (Fig 3D).

Treatment Alternatives

The skeletal deformity of these patients was judged too severe to consider treatment by dentoalveolar compensation alone, and the degree of maxillary hypoplasia and age of the patients were not favorable for facemask therapy. Orthognathic surgery after growth completion was offered to the patients. However, to avoid retaining such severe facial deformity until adulthood, each of the 3 patients and their parents preferred to try orthopedic traction from skeletal anchorage, even though they had been informed

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Dentofacial effects of bone-anchored maxillary protraction: A controlled study of consecutively treated Class III patients

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Abstract

Introduction—In this cephalometric investigation, we analyzed the treatment effects of bone-anchored maxillary protraction (BAMP) with miniplates in the maxilla and mandible connected by Class III elastics in patients with Class III malocclusion.

Methods—The treated sample consisted of 21 Class III patients consecutively treated with the BAMP protocol before the pubertal growth spurt (mean age, 11.10 ± 1.8 years) and reevaluated after BAMP therapy, about 1 year later. The treated group was compared with a matched control group of 18 untreated Class III subjects. Significant differences between the treated and control groups were assessed with independent-sample *t* tests ($P<0.05$).

Results—Sagittal measurements of the maxilla showed highly significant improvements during active treatment (about 4 mm more than the untreated controls), with significant protraction effects at orbitale and pterygomaxillare. Significant improvements of overjet and molar relationship were recorded, as well as in the mandibular skeletal measures at Point B and pogonion. Vertical skeletal changes and modifications in incisor inclination were negligible, except for a significant proclination of the mandibular incisors in the treated group. Significant soft-tissue changes reflected the underlying skeletal modifications.

Conclusions—Compared with growth of the untreated Class III subjects, the BAMP protocol induced an average increment on skeletal and soft-tissue advancement of maxillary structures of about 4 mm, and favorable mandibular changes exceeded 2 mm.

The literature reports a series of treatment approaches regarding orthopedic treatment in Class III malocclusion.[1] However, effective maxillary protraction remains limited to the deciduous or early mixed dentition.[2] Preliminary studies have indicated success of maxillary protraction in the late mixed or permanent dentition phase (ages, 10–12 years) with innovative treatment techniques that use bone anchors and Class III elastics.[3,4] The use of temporary anchorage devices in maxillary protraction has increased over recent years,[3–8] but they have not yet been assessed in controlled studies.

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Three-dimensional analysis of maxillary protraction with intermaxillary elastics to miniplates

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Abstract

Introduction—Early Class III treatment with reverse-pull headgear generally results in maxillary skeletal protraction but is frequently also accompanied by unfavorable dentoalveolar effects. An alternative treatment with intermaxillary elastics from a temporary anchorage device might permit equivalent favorable skeletal changes without the unwanted dentoalveolar effects.

Methods—Six consecutive patients (3 boys, 3 girls; ages, 10–13 years 3 months) with Class III occlusion and maxillary deficiency were treated by using intermaxillary elastics to titanium miniplates. Cone-beam computed tomography scans taken before and after treatment were used to create 3-dimensional volumetric models that were superimposed on nongrowing structures in the anterior cranial base to determine anatomic changes during treatment.

Results—The effect of the intermaxillary elastic forces was throughout the nasomaxillary structures. All 6 patients showed improvements in the skeletal relationship, primarily through maxillary advancement with little effect on the dentoalveolar units or change in mandibular position.

Conclusions—The use of intermaxillary forces applied to temporary anchorage devices appears to be a promising treatment method.

Treatment of young Class III patients with maxillary deficiency is generally directed toward achieving positive overjet through a combination of dentoalveolar and skeletal effects. Protraction face-mask therapy or reverse-pull headgear (RPHG) is perhaps the most common approach for early treatment of these patients. This approach is limited in that the forces are applied to the teeth, resulting in uncertain skeletal and often unwanted dentoalveolar effects. Even with appliance modifications to minimize tooth movement and maximize orthopedic correction, some dentoalveolar effects seem inevitable. For satisfactory clinical improvement, excellent compliance with a somewhat cumbersome

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Biomechanics of Skeletal Anchorage
Part 1 Class II Extraction Treatment

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The outcome of orthodontic treatment often depends on the preservation of posterior anchorage. In recent years, "absolute" skeletal anchorage has been introduced,[1] with conventional dental implants,[2] palatal implants,[3] miniscrews,[4,5] and miniplates[6,7] used successfully in clinical cases. Most of the reports on skeletal anchorage, however, have focused on the implant design, the surgical insertion technique, and the stability of the implants after orthodontic loading.[8] Descriptions of the biomechanical principles of various clinical applications have been limited.[9]

Skeletal anchorage is most commonly used in adult Class II treatment after the extraction of two upper premolars. For indirect anchorage, a midpalatal implant is usually connected to two premolars or molars with a transpalatal arch.[10,11] For direct anchorage, a miniscrew or miniplate is inserted near the upper first molar during retraction of the anterior segment, and nickel titanium coil springs or elastics are used to connect this bone anchor with the anterior segment.[12] In most cases, the incisors and canines are distalized simultaneously by sliding mechanics.

Skeletal anchorage has also been recommended for closure of a skeletal open bite by intrusion of the buccal segments and subsequent autorotation of the mandible,[13] for preprosthetic molar uprighting or intrusion,[14] and for space closure in cases with agenesis of the lower second premolars.[15]

This two-part series describes the biomechanics of skeletal anchorage in Class II treatment with and without premolar extractions.


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Appliance Design and Technique

Our bone anchor has three parts: a two- or three-hole titanium miniplate, .7mm thick; a neck made from a round bar, 1.4mm in diameter; and a cylindrical fixation unit with a locking screw (Fig. 1A). Monocortical titanium screws, 5mm or 7mm in length and 2.3mm in diameter, are inserted through the holes in the miniplate (Fig. 1B). All bone anchors are inserted under local anesthesia. A pilot hole, 1.6mm in diameter, is drilled before the insertion of each screw.

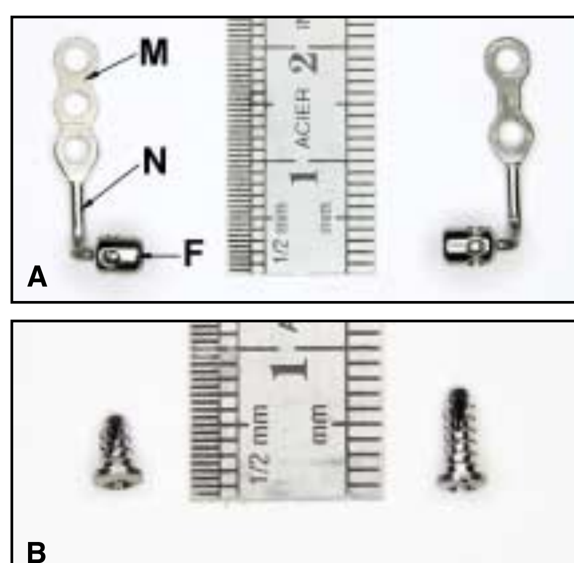

Fig. 1 A. Three-hole miniplate (M) with neck (N) connected to cylindrical fixation unit (F). B. Titanium miniscrews, 5mm and 7mm long.

Biomechanics of Skeletal Anchorage
Part 2 Class II Nonextraction Treatment

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Skeletal Class II cases are often corrected by dentoalveolar compensation after extraction of the upper first premolars. Extractions are also used in some patients to eliminate anterior crowding. Many of these extractions could be avoided, however, by moving the posterior segments distally.

Extraoral devices such as headgear depend on patient compliance and are often rejected by adults for social and professional reasons.[1] In addition, because headgear is usually not worn during the day, some of the beneficial effects obtained during the night are lost. Fixed intraoral auxiliaries such as Nance appliances,[2] lip bumpers,[3] transpalatal arches,[4] and Pendulum appliances[5] can apply distalizing forces without the need for special patient cooperation, but they generally neutralize only a portion of the reactive forces. Therefore, they tend to produce flaring of the incisors and increase the overjet.

This article demonstrates how bone anchors placed on the infrazygomatic crest can support molar distalization with light, continuous forces that act 24 hours a day and create no adverse effects in the anterior segments.[6]

Technique

Over a period of four and a half years, we have placed 153 bone anchors, as described in Part 1 (JCO, April 2006), in the infrazygomatic crests of adult patients to correct Class II malocclusions without premolar extractions. Because orthodontic forces must be loaded two to three weeks after surgery, a fixed appliance is placed two months before surgery to level the upper arch.

All our patients are bonded with .018" × .025" standard edgewise brackets, with a Ricketts torque prescription for the upper incisors and canines. In adult cases, preadjusted ceramic brackets (Roth prescription) are used from canine to canine. If the anterior teeth are crowded, only a few of the incisors are bonded to support the anterior portion of the archwire. Incisor rotations are corrected only when sufficient space becomes available after canine retraction. Both upper canines are bonded, but the premolars are not. After leveling, a sliding jig or a closed-coil spring with a sliding hook (closed, round section) is placed on an .016" round or .016" × .016" stainless steel wire between each molar tube and canine bracket (Fig. 1B). The sliding jig or closed-coil spring is pushed against the mesial side of the molar tube by an elastic attached to an extension of the bone anchor's fixation unit. These elastics, producing a force of 100-130g, should be changed at least daily by the patient.

Once the first molars are in a Class I relationship, the premolars and remaining incisors are bonded. After a short leveling stage, elastics are attached from the canines to the bone anchors to close the remaining spaces between the canines and first molars (Fig. 1C). An .016" × .022" stainless steel archwire with T-loops distal to the lateral incisors is placed to intrude the incisors and to reduce the sagittal overbite (Fig. 1D). Continuous arches are used for finishing.

Biomechanics

With skeletal anchorage, contrary to conventional Class II biomechanics, the canines are distalized along with the molars, helping to reduce the overjet. This can be explained by the "friction hypothesis". The coil spring is pushed against the molar tube at a distance from its center of resistance, which is located at the root bifurcation.[7] The moment initially tips the molar crown distally. The upper mesial and lower distal parts of the inner molar tube are pushed against the archwire, increasing friction at the tube-archwire interface (Fig. 2). Because of this friction, the archwire is

AJO-DO

Failure rates and associated risk factors of orthodontic miniscrew implants: A meta-analysis

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Introduction: Risk factors concerning orthodontic miniscrew implants have not been adequately assessed. In this systematic review, we summarize the knowledge from published clinical trials regarding the failure rates of miniscrew implants used for orthodontic anchorage purposes and identify the factors that possibly affect them. **Methods:** Nineteen electronic databases and reference lists of included studies were searched up to February 2011, with no restrictions. Only randomized controlled trials, prospective controlled trials, and prospective cohort studies were included. Study selection and data extraction were performed twice. Failure event rates, relative risks, and the corresponding 95% confidence intervals were calculated. The random-effects model was used to assess each factor's impact. Subgroup and meta-regression analyses were also implemented. **Results:** Fifty-two studies were included for the overall miniscrew implant failure rate and 30 studies for the investigation of risk factors. From the 4987 miniscrew implants used in 2281 patients, the overall failure rate was 13.5% (95% confidence interval, 11.5-15.8). Failures of miniscrew implants were not associated with patient sex or age and miniscrew implant insertion side, whereas they were significantly associated with jaw of insertion. Certain trends were identified through exploratory analysis; however, because of the small number of original studies, no definite conclusions could be drawn. **Conclusions:** Orthodontic miniscrew implants have a modest small mean failure rate, indicating their usefulness in clinical practice. Although many factors seem to affect their failure rates, the majority of them still need additional evidence to support any possible associations. (Am J Orthod Dentofacial Orthop 2012;142:577-95)

Orthodontic miniscrew implants have been popularized because of their simplicity of placement and removal, low cost, and minimal need for patient compliance.[1] The value of miniscrew implants is in the prerequisite that they remain relatively stationary in the bone, their ability to increase anchorage capacity, and the absence of adverse effects or complications that could endanger health or treatment outcome.[2]

Their clinical effectiveness lies in their ability to maintain close bone contact,[3] thus resisting reactive orthodontic forces.[1] The term *orthodontic anchorage* describes the nature and degree of resistance to displacement provided by an anatomic unit and is crucial for the maximization of tooth movement and the minimization of undesired effects.[4] Conventional orthodontic anchorage often results in anchorage loss, which is considered a significant potential side effect of orthodontic mechanotherapy. More than 2 mm of anchorage loss can undermine treatment efficacy, especially in critical situations.[5] Anchorage reinforcement with miniscrew implants is associated with 2.4 mm less anchorage loss compared with conventional anchorage means.[6] In addition, miniscrew implants seem to be more effective in supporting anchorage when they are used in the mandible, between the second premolars and the first molars, when 2 miniscrew implants are inserted into a patient's jaw, when they are directly connected, when they are used in adults, and when treatment lasts more than 12 months.[6]

Several complications during the use of miniscrew implants have been reported.[1,7,8] Lack of initial stability is often observed in case of inadequate cortical bone thickness. If insertion results in injury to

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Risk factors and indications of orthodontic temporary anchorage devices: a literature review

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Aims: The aims of this review are twofold, firstly, to give an overview of the general and local risk factors when using temporary anchorage devices (TADs) and the prerequisites for placement and, secondly, to illustrate the orthodontic indications of various TADs.
Methods: The PubMed database was searched for original articles on: 'orthodontics and miniscrews/mini-implants/miniplates/temporary anchorage devices/titanium screws/skeletal anchorage', 'miniscrews/mini-implants/miniplates and risk factors/biomechanics/placement procedure'. Only articles published between 2001 and December 2007 were used. In addition, each article was hand searched for references that may have been missed by the PubMed search.
Results: General risk factors are factors concerning general health. Bone quality and oral hygiene are local risk factors. Aspects of the placement procedure discussed were: primary stability, loading protocols, pre-drilling diameter and whether or not to make an intra-oral incision. A selection of published case reports is given to illustrate some orthodontic indications of TADs.
Conclusions: Temporary anchorage devices have a place in modern orthodontics. Careful treatment planning involving radiographic examination is essential. Consultation with an oral surgeon is advisable if a soft tissue flap is required. Excellent patient compliance, particularly avoidance of inflammation around the implant, is an important consideration for successful use of TADs.
(Aust Orthod J 2008; 24: 140–148)

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Introduction

Secure anchorage is a fundamental requirement for successful treatment of many malocclusions. Factors such as inadequate patient compliance may contribute to loss of anchorage, which can be defined as unwanted movement of the anchor teeth and usually occurs when the posterior teeth move forward relative to the anterior teeth. Anchorage can be classified as: Type A or absolute anchorage, i.e. no movement of the anchor teeth occurs; Type B anchorage, i.e. movement of the anterior and posterior units toward each other; Type C anchorage, total loss of anchorage, i.e. the anchor teeth are free to move, usually anteriorly.[1] Intra-oral temporary anchorage devices (TADs) were developed to provide Type A anchorage, because this form of anchorage is difficult to accomplish with conventional biomechanics. Different types of TADs are available with the proponents of each type claiming that their device is superior to other systems. The aim of this review is twofold, firstly, to give an overview of the general and local risk factors when using TADs and the prerequisites for the placement of TADs and, secondly, to illustrate the orthodontic indications of various TADs.

Material and methods

The PubMed database was searched for original articles on 'orthodontics and miniscrews/mini-implants/miniplates/temporary anchorage devices/titanium screws/skeletal anchorage', 'miniscrews/mini-implants/miniplates and risk factors/biomechanics/placement procedure'. Only articles published between 2001 and December 2007 were used. The search retrieved 224 articles. After reading the titles

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FEATURES SECTION

Current Products and Practice

Bone anchorage devices in orthodontics

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Bone anchorage is a promising new field in orthodontics and already a wide variety of bone anchorage devices (BADs) are available commercially. This review aims to assist clinicians by outlining the principles of bone anchorage and the salient features of the available systems, especially those that may influence the choice of a specific BAD for anchorage reinforcement.

Key words: Orthodontic anchorage, orthodontic implants, mini-implants, mini-screws, mini-plates

Refereed paper

Introduction

Orthodontic anchorage control is a fundamental part of orthodontic treatment planning and subsequent treatment delivery. On one hand, research has focussed on the efficient movement of teeth to minimize anchorage loss by improvements in orthodontic materials, bracket designs (e.g. self-ligating brackets or Tip-Edge™) and friction-less treatment protocols (e.g. segmented arch technique). Alternatively, the methods used to reinforce orthodontic anchorage traditionally involve the use of extra-oral (headgear, protraction headgear) and intra-oral (transpalatal arch, quadhelix, etc.) appliances. However, it is recognized that these conventional anchorage systems are limited by multiple factors such as patient compliance, the relative number of dental anchorage units and periodontal support, allergy, iatrogenic injuries and unfavourable reactionary tooth movements.

In recent years, numerous publications have introduced novel ways of reinforcing anchorage using a variety of devices temporarily anchored in bone. Orthodontic bone anchorage (OBA) is indicated when a large amount of tooth movement (e.g. labial segment retraction or mesial/distal movement of multiple posterior teeth) is required or dental anchorage is insufficient because of absent teeth or periodontal loss. Such devices may also be useful in asymmetric tooth movements, intrusive mechanics, intermaxillary fixation/traction and orthopaedic traction and appear to be rapidly gaining acceptance in routine orthodontic practice. In an effort to improve and distinguish their products, manufacturers have produced systems with innovative design features and differing clinical protocols.

Given that there is no clear consensus on nomenclature, these devices are referred to by a confusing array of names including mini-implants,[1] micro-implants,[2] microscrew implants,[3] miniscrews[4] or temporary anchorage devices (TADs).[5] Whilst some of these synonyms refer to similar devices, the terminologies used are either vague or inaccurate. For example, the word 'micro' is not ideal, since it infers that a device has extremely small dimensions. The term 'mini-implant' does not represent all of the systems currently available, and 'TAD' is non-specific since all supplementary anchorage devices are temporary and bone anchorage is not clearly denoted. Since the distinguishing feature common to all of these devices is that they provide anchorage through either a mechanical interlocking or biochemical integration with bone, we suggest that they are best referred to as orthodontic bone anchorage devices (BADs).

In view of the rapidly evolving and complex nature of this topic, this paper aims to assist the orthodontist by reviewing the various design features of currently available BADs, and outlining principles of bone anchorage and the clinically relevant factors that influence the choice of a specific BAD.

Types of bone anchorage

There are three distinctly different approaches to bone anchorage in terms of the devices' backgrounds and

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Modified Miniplates for Temporary Skeletal Anchorage in Orthodontics: Placement and Removal Surgeries

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Abstract

Purpose—Skeletal anchorage systems are increasingly used in orthodontics. This article describes the techniques of placement and removal of modified surgical miniplates used for temporary orthodontic anchorage and reports surgeons' perceptions of their use.

Patients and Methods—We enrolled 97 consecutive orthodontic patients having miniplates placed as an adjunct to treatment. A total of 200 miniplates were placed by 9 oral surgeons. Patients and surgeons completed questionnaires after placement and removal surgeries.

Results—Fifteen miniplates needed to be removed prematurely. Antibiotics and anti-inflammatories were generally prescribed after placement but not after removal surgery. Most surgeries were performed with the patient under local anesthesia. Placement surgery lasted on average between 15 and 30 minutes per plate and was considered by the surgeons to be very easy to moderately easy. The surgery to remove the miniplates was considered easier and took less time. The patients' chief complaint was swelling, lasting on average 5.3 ± 2.8 days after placement and 4.5 ± 2.6 days after removal.

Conclusions—Although miniplate placement/removal surgery requires the elevation of a flap, this was considered an easy and relatively short surgical procedure that can typically be performed with the patient under local anesthesia without complications, and it may be considered a safe and effective adjunct for orthodontic treatment.

One of the most challenging problems in orthodontics is to find sufficient anchorage to achieve planned tooth movements. Conventional approaches take advantage of the differential anchorage potential in the dentition, where a larger number of teeth can resist movement of a smaller number. This often requires the additional use of compliance-dependent auxiliary

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Case Report

Three-phase treatment concept for skeletal Class III growing patients with severe space deficiency: A report of three cases with skeletally anchored maxillary protraction

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KEYWORDS
Class III;
Maxillary protraction;
Skeletal anchorage

This report provides three-phase concept for treating skeletal Class III growing patients with severe space deficiency. Three cases are presented. All had received miniplate-anchored facemask treatment and followed till near completion of growth. Infrazygomatic miniplates were used for both facemask protraction and distalization of the dentition to relieve crowding. With the aid of bone-anchored facemask, maxillary protraction may be continued independent of the orthodontic tooth movement even in late postpubertal growth peak stage. With cephalometric superimpositions using the structural method, we have demonstrated how vertical dental change could affect the skeletal changes and overall clinical outcomes. The persistent mandibular growth during pubertal growth spurt plays a main role in decreasing the effects of maxillary protraction. To keep up with the mandibular growth, we recommend using skeletally anchored facemask long-term till the end of growth spurt. Applying maxillary protraction from infrazygomatic miniplates exposed at the molar area has the merits that it avoids unwanted palatal rotation and that the miniplates maybe used as orthodontic anchorage when indicated. We emphasize the importance of planning the treatment contemplating the skeletal developmental stage and the completion of dental arches. This prolonged orthopedic treatment may contribute to greater long-term effects and stability.

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Original Article

Treatment outcomes of the various force applications in growing patients with skeletal Class III malocclusion: *A comparative lateral cephalometric study*

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ABSTRACT

Objectives: To evaluate skeletal, dentoalveolar, and soft tissue changes between intraoral light force application and extraoral heavy force application in growing patients with skeletal Class III malocclusion.

Materials and Methods: A retrospective study was conducted with pretreatment and posttreatment lateral cephalometric data from 50 subjects with skeletal Class III malocclusion. In the first group (15 boys, 10 girls; 8.67 $\pm$ 2.13 years old), each subject wore a biocreative horseshoe appliance (CHS) with two Class III elastics that exerted a force of 200 g. In the second group (13 boys, 12 girls; 8.96 $\pm$ 1.82 years old), each subject wore a Petit-type facemask and a lingual arch with hooks fixed to the maxillary arch with a total force of 700 g. Both groups of patients were instructed to wear the appliance approximately 14 hours a day, and 22 linear measurements and 8 angular measurements were evaluated. Changes of measurements from each group were compared by paired *t*-tests, considering a 5% significance level.

Results: Forward growth of the maxilla, improvement of the maxilla–mandible relationship, and upper incisor flaring were achieved in both groups without any statistically significant difference between them. Lateral cephalometric analysis also showed that U1 exposure, IMPA (Angle between mandibular plane and mandibular incisor axis), FMIA (Angle between FH plan and mandibular incisor axis), and L1-APog (Angle formed by the intersection of tooth axis of lower incisor and A-Pog line, Distance from lower incisor edge to A-Pog line) showed statistically significant differences. Lower incisors were inclined lingually in the CHS group.

Conclusions: During treatment of skeletal Class III malocclusion, the CHS with light Class III intermaxillary elastics therapy exhibits similar orthopedic changes to the maxillary complex and more dental changes to the lower anterior teeth compared with facemask therapy. (*Angle Orthod.* 0000;00:000–000.)

KEY WORDS: Class III malocclusion; Growing patient; Facemask; Biocreative strategy; Horseshoe appliance; Intermaxillary elastics

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INTRODUCTION

Growing patients with Class III malocclusion typically have complex skeletal and dental factors.[1,2] Therefore, the concepts of diagnosis and treatment modalities for these patients are different from those for patients without any skeletal discrepancies. Treatment options are limited when growing patients are diagnosed with a Class III malocclusion compared with patients with normal growth patterns.[3] Functional appliances such as the Frankel III appliance have been chosen for patients with a retruded maxilla,[4] and chin cups have been used for patients with a protruded mandible.[5]

Correction of skeletal Class III in a growing male patient by reverse pull facemask

Abstract

The following case report describes the management of a 6-year-old male patient in early mixed dentition with a mesial step molar relation, an anterior reverse overjet, and skeletal Class III due to a slightly deficient maxilla. The treatment plan included protraction of the maxilla by a reverse pull Petit type facemask for 10 months followed by 15 months of active retention by a Frankel III appliance.

Key words

Class III, maxillary deficiency, reverse pull facemask

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Introduction

Individuals with Class III malocclusion may have combinations of skeletal and dentoalveolar components. These characteristics could be summarized as follows: Skeletal components with underdeveloped maxilla, overdeveloped mandible or a combination of both, dentoalveolar components with proclined maxillary incisors, and retroclined mandibular incisors, to achieve dentoalveolar compensation.[1] Early treatment of Class III malocclusion has been advocated for many years, and the goal is focused on providing a more favorable environment for normal growth and on improving the psychosocial development of the child.[2] Early orthopedic treatment, using a facemask or chin cup therapy, improves the skeletal relationships, which in turn minimize excessive dental compensation such as overclosure of the mandible and retroclination of the mandibular incisors. Also correction of the anterior crossbite often helps in eliminating centric occlusion/centric relation (CO/CR) discrepancies, and avoids adverse growth potential. Most importantly, in mild and moderate Class III patients, early orthodontic or orthopedic treatment may eliminate the necessity for orthognathic surgery treatment. Studies have shown that treatment with facemask and/or a chin cap improves the lip posture and facial appearance.[3,4]

Turpin[5] recommended that early treatment should be considered for young patients who present with positive factors such as convergent facial type, anteroposterior functional shift, symmetrical condyle growth, mild skeletal disharmony, some remaining growth, good cooperation, no familial prognathism, and good facial esthetics.

Case Report

A 6-year-old growing male patient in acceleration stage of CVMI, came to the Orthodontic clinic with chief complaints of lower front teeth overlapping the upper teeth.

Extraoral examination revealed an apparently symmetrical mesoprosopic face with a straight but pleasant profile and apparently slightly deficient maxilla [Figure 1].

Intraoral examination revealed the presence of mixed

ORIGINAL ARTICLE CE

Treatment effects of Fränkel functional regulator III in children with Class III malocclusions

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The purpose of this study was to evaluate the skeletal and dental effects produced by the Fränkel functional regulator III appliance in growing children with Class III malocclusions. Thirty preadolescents (initial mean age, 8.0 ± 1.2 years; mean treatment duration, 1.3 ± 0.6 years) treated with the Fränkel functional regulator III appliance were compared with 20 matched untreated Class III controls (initial mean age 8.2 ± 1.1 years; mean observation period, 1.5 ± 0.6 years). The treatment effects were mainly from backward and downward rotation of the mandible and linguoversion of the mandibular incisors. (Am J Orthod Dentofacial Orthop 2004; 125:294-301)

In children with Class III malocclusions, it is important to identify whether the etiology is dental, functional, or skeletal. If the problem is skeletal, then it must be determined whether the cause is an underdeveloped maxilla, an overdeveloped mandible, or a combination of both. In children with an underdeveloped maxilla, maxillary growth can be promoted by means of an orthopedic force with a protraction device.[1,2] However, for patients with overdeveloped mandibles or severe skeletal discrepancies, it is wise to plan for orthognathic surgery after growth is complete.[3]

According to the functional matrix theory of Moss,[4] functional appliances are effective in treating children with mild or pseudo (functional) Class III malocclusions. Andresen's Class III activators are known to show relatively good prognoses in pseudo Class III patients, particularly when used in the early mixed dentition.[5] In 1966, Fränkel modified the activator and designed the Fränkel functional regulator (FR). He stated that the main cause of a malocclusion is the improper habitual position and the abnormal activity of the oral and facial muscles, thus emphasizing the importance of guiding the jaws and the dentition to develop normally by altering or controlling the muscular environment.[5,6]

In children with an underdeveloped maxilla, the FR III appliance is expected to redirect mandibular growth and stimulate forward growth of the maxilla through the muscle-blocking effects and stretching of the periosteum.[6] There is almost no dispute among authors who have studied the FR III appliance[5-13] about the redirection of mandibular growth in a backward and downward direction, but there is some controversy about the skeletal effects in the maxilla. Fränkel[6] originally reported that bone apposition at point A increases with the use of the FR III appliance, whereas McNamara and Huge[7] found that it caused forward and downward movement of the maxilla. Kohmura et al[8] reported that significant forward movement of point A and lateral expansion of both arches were observed with the FR III appliance. In addition, histologic studies by Graber et al[5] on squirrel monkeys suggest that the shields exert indirect tension on the periosteum overlying the bone, thus enhancing osseous proliferation.

However, Ülgen and Firatli[9] reported that the forward displacement of the maxilla is insignificant, and most of the improvement is due to the downward and backward rotation of the mandible, the decrease in SNB, and the retrusion of the mandibular incisors. Loh and Kerr,[10] Kerr and Ten Have,[11] and Kerr et al[12] also stated that there is no significant increase in SNA, and the major effects are from the mandible. In addition, Proffit[13] agreed that little true forward movement of the upper jaw is obtained with the FR III appliance, and most of the improvement is from dental change.

As mentioned, there are diverse opinions regarding the treatment effects of the FR III. Most previous

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REVIEW ARTICLE

Treatment of Mandibular Prognathism

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Mandibular prognathism (MP) or skeletal Class III malocclusion with a prognathic mandible is one of the most severe maxillofacial deformities. Facial growth modification can be an effective method of resolving skeletal Class III jaw discrepancies in growing children with dentofacial orthopedic appliances including the chincup, face mask, maxillary protraction combined with chincup traction and the Fränkel functional regulator III appliance. Orthognathic surgery in conjunction with orthodontic treatment is required for the correction of adult MP. The two most commonly applied surgical procedures to correct MP are sagittal split ramus osteotomy (SSRO) and intraoral vertical ramus osteotomy. Both procedures are suitable for patients in whom a desirable occlusal relationship can be obtained with a setback of the mandible, and each has its own advantages and disadvantages. In bilateral SSRO, the intentional ostectomy of the posterior part of the distal segment can offer long-term positioned stability. This may be attributable to reduction of tension in the pterygomasseteric sling that applies force in the posterior mandible. While various environmental factors have been found to contribute to the development of MP, heredity plays a substantial role. The relative contributions of genetic and environmental components in the etiology of MP are unclear. The recent identification of the genetic susceptibilities to MP constitutes the first step toward understanding the molecular pathogenesis of MP. Further studies in molecular biology are needed to identify the gene–environment interactions associated with the phenotypic diversity of MP and the heterogenic developmental mechanisms thought to be responsible for them. [*J Formos Med Assoc* 2006;105(10):781–790]

Key Words: dentofacial orthopedics, environmental factors, genetics, mandibular prognathism, morphogenetic basis, orthognathic surgery

In the early 1900s, Angle,[1] the father of modern orthodontics, described three basic types of malocclusion for dental occlusion: Class I, II and III malocclusions. Class III malocclusion is defined by the mandibular first permanent molar being "mesial", i.e. forward to normal in its relationship with the maxillary first molar. Lischer[2] later termed Angle's Class III malocclusion as *mesio-occlusion*. This method of categorization, however, does not provide information about the developmental mechanisms by which the observed occlusal relationship has been reached. A relatively high prevalence of Class III malocclusion, from 15% to 23%, has been observed in Asian Mongoloid populations of Taiwanese, Japanese, Korean and Chinese.[3–6] In contrast, most studies reported an incidence of this class of malocclusion in American, European and African Caucasian populations below 5%.[7–9] Class III malocclusion is thus a common clinical problem in orthodontic patients of Asian or Mongoloid descent.[10–12]

Studies indicate that 63–73% of Class III malocclusions are of skeletal type.[4,13] Such skeletal cases result from growth disharmony between the mandible and maxilla, thus producing a concave

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Miniscrew-anchored maxillary protraction in growing Class III patients

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Abstract

The aim of this article is to report a case series of a miniscrew-anchored maxillary protraction therapy (MAMP). Two male patients presenting with Class III malocclusion were included in this report. The treatment consisted of a hybrid expander and two miniscrews at the anterior region of the mandible anchoring Class III elastics for maxillary protraction. Effective maxillary length, ANB angle and Wits appraisal increased after treatment. Slight dental effects were observed. MAMP therapy produced substantial skeletal effects and might be a good treatment option for Class III growing patients.

Keywords

orthodontics, interceptive, malocclusion, angle Class III, palatal expansion technique

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Introduction

Treatment options for Class III individuals in the early permanent dentition are limited. Facemask therapy is more effective in early age groups (Baccetti et al., 1998; Franchi et al., 2004; Kapust et al., 1998) and promotes downward and forward movement of the maxilla with slight counterclockwise rotation of the palatal plane (Kim et al., 1999). A clockwise rotation of the mandible and an increase of the anteroinferior face height are expected with this therapy (Kim et al., 1999). In adolescence, facemask therapy produces mostly dental effects with clockwise rotation of the mandible (Kapust et al., 1998).

Recently, a new treatment option for Class III malocclusion patients in the early permanent dentition were proposed using miniplates as anchorage (De Clerck et al., 2009). Bone-anchored maxillary protraction (BAMP) therapy using miniplates offered the possibility of applying orthopaedic forces directly to the maxilla and mandible, avoiding dental effects (De Clerck et al., 2009, 2010). A CBCT three-dimensional analysis of BAMP therapy showed a mean maxillary and zygomatic forward displacement of 3.7 mm (Nguyen et al., 2011). BAMP therapy also produced slight posterior displacement of the posterior ramus, condyles and chin whereas posterior remodeling of the glenoid fossae occurred (De Clerck et al., 2012). No rotation of the palatal and mandibular planes were produced by BAMP therapy. Other treatment options were described in order to replace the miniplates with miniscrews and simplify the technique (Wilmes et al., 2011).

Miniscrews show lower costs and are less invasive than miniplates. Miniscrew placement can be performed by the orthodontist. The Hybrid Hyrax (Wilmes et al., 2010) in the maxilla and two miniscrews in the mandible can be used to replace the miniplates in a BAMP-derived therapy. Therefore, the aim of this article is to present a miniscrew-anchored maxillary protraction (MAMP) therapy and describe the dentoskeletal effects of this therapy in two case reports.

Clinical technique

Two case reports treated with MAMP therapy are presented (Figures 1–8). In the maxillary arch, a pre-manufactured

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Correction of Class III malocclusions through morphological changes of the maxilla using the protraction face mask by three different therapeutic approaches

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Abstract

Face mask (FM) therapy used for maxillary protraction improves the facial profile in patients with Class III malocclusion. The aim of this study was to compare the sagittal morphological changes of the maxilla through three different therapeutic approaches, respectively using removable appliances (RA), rapid maxillary expansion (RME) and surgically assisted rapid maxillary expansion (SARME), each of them in combination with the FM therapy in growing and non-growing patients. The sample, consisting of 42 orthodontic patients aged 7–21, was divided into four groups, according to their age. The first group of patients, aged 6–9 (RA + FM group), received treatment with RA in combination with FM, the second group of patients, aged 10–13 (RME + FM pubertal group), received treatment with RME in combination with FM, the third group of patients, aged 14–16 (RME + FM postpubertal group), received treatment with RME and FM, and the fourth group of patients, aged 17–21 (SARME + FM group), underwent SARME in combination with FM. To assess the sagittal skeletal changes of the maxilla, the sella–nasion–A point (SNA) and A point–nasion–B point (ANB) angles were measured at the beginning and after the FM therapy. The differences in the evolution of the SNA angle between the groups were statistically significant ($p<0.001$). *Post-hoc* analysis showed that patients aged 6–9 had the highest evolution, statistically higher than patients aged 14–16 ($p=0.007$) or patients aged 17–21 ($p<0.001$). The evolution of the SNA angle was significantly higher in patients aged 10–13, in comparison to patients aged 17–21 ($p<0.001$). The efficiency of the FM therapy alone or associated with RME depends on patients' growing period. In non-growing patients, the FM therapy is efficient when associated with SARME.

***Keywords*:** Class III malocclusion, face mask therapy, rapid maxillary expansion, surgically assisted.

Introduction

The global prevalence of Class III malocclusion reported in the literature ranges from 0% to 26.7% for different populations. Prevalence rates of 15.69–16.59% were reported for the Southeast Asian countries (China and Malaysia). For Japan, the prevalence rate was around 14%. In Caucasians, prevalence ranged from 3% to 5% [1]. Prevalence rates of 2% to 6% and ~5% have been found in European and Latin populations, respectively [2].

Class III skeletal malocclusions imply not only mandibular prognathism (mandibular skeletal excess), as it was considered in the past, but very often a maxillary deficiency [3–6]. Thus, Class III skeletal malocclusions may consist of maxillary retrognathism, mandibular prognathism, or a combination of both, along with several dento-alveolar and soft tissue compensations expressed in various morphological manners [7–9]. According to Pattanaik & Mishra (2016), there are various combinations for the occurrence of such malocclusions: mandibular prognathism – 20%, maxillary retrusion – 25%, a combination of the two – 22%, remainder – no antero-posterior skeletal imbalances [10].

Depending on the severity of facial aesthetics alterations, Class III patients experience dento-maxillary functional disturbances, periodontal problems [11], psychological problems, poor self-esteem and other psychological variables – stress, anxiety, coping, current thoughts related to themselves with implications for the quality of life [12–14]. Considering these aspects, the treatment plan for Class III malocclusions should address the skeletal regions that have been altered and should be conducted in complete dependency on the skeletal maturation, the timing of the treatment, being therefore, of utmost importance [15].

Literature offers many therapeutic methods for Class III malocclusion. Correction of the skeletal maxillary deficiency may be obtained using various devices with an orthopedic effect: face mask (FM)/orthopedic mask [8, 16], protraction headgear/reverse headgear, chin cup, reverse twin-block, skeletal anchorage systems [17]. All these orthopedic appliances are effective in ameliorating the skeletal maxillary deficiency in growing patients. However, many studies show that the effects depend largely on the timing of the treatment: the earlier the treatment is applied, the more pronounced the orthopedic effects on the maxillary growth are (orthopedic effect) and the dental changes (orthodontic effect), often unwanted, are diminished [18–21]. Disadvantages of early treatment are related to the difficulty of collaboration with the patient and the need for long-term follow-up of the patient, throughout the entire growth period, to prevent relapse [8].

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Le traitement interceptif des malocclusions de classe III par masque facial : quelle incidence sur les voies aérifères supérieures ?

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MOTS CLÉS :
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Voies aérifères supérieures

Résumé – Introduction : L'objectif de cette étude rétrospective était de décrire les effets dento-squelettiques du masque facial de protraction maxillaire et de déterminer leur incidence sur les dimensions des voies aérifères supérieures. **Matériels et méthodes** : L'échantillon était composé de 40 enfants présentant une classe III squelettique et traité par un masque facial de protraction maxillaire. Sur chaque téléradiographie de profil de début et de fin de traitement orthopédique, les auteurs ont réalisé un tracé céphalométrique avec la détermination de différents points et lignes. L'analyse statistique a été réalisée à l'aide du logiciel SPSS version 23,0. Les changements entre T1 (début de traitement orthopédique) et T2 (fin de traitement orthopédique) ont été comparés par le test T pour échantillons appariés. Enfin, pour montrer la corrélation entre les changements squelettiques et ceux des dimensions des voies aérifères supérieures, les auteurs ont utilisé le test de corrélation de Pearson. Le niveau de significativité était de P < 0,05. **Résultats :** Les résultats montrent une augmentation significative de la croissance du maxillaire, une rotation postérieure de la mandibule et une augmentation significative des dimensions des voies aérifères supérieures. On note aussi une corrélation positive entre les changements squelettiques et ceux des voies aérifères supérieures. **Discussion** : Les dimensions des voies aérifères supérieures peuvent être améliorées avec une protraction maxillaire chez les enfants présentant une classe III squelettique.

KEYWORDS :
Malocclusion /
Class III /
Orthodontics /
Interceptive /
Upper Airway Space

Abstract – *Early treatment of Class III malocclusion by maxillary protraction facial mask: effects on craniofacial structures and upper airway dimensions*. Introduction: *The aim of our study was to evaluate the effect of treatment with a maxillary protraction appliance on the development of the craniofacial structures and to describe the correlation between the skeletal changes and the sagittal airway dimension associated with tongue, soft palate, and hyoid bone position in skeletal Class III children.* **Materials and Methods:** *A total of 40 patients with Class III malocclusions were evaluated by the use of lateral cephalograms. Pretreatment and posttreatment cephalometric radiographs were analyzed; linear and angular measurements were performed by the same orthodontist. The effect of treatment with a maxillary protraction appliance on the development of the craniofacial structures were evaluated by Student's T test and the correlation between treatment changes in craniofacial morphology and those in upper airway, tongue, soft palate, and hyoid position was evaluated by Pearson's correlation test.* **Results:** *A significant increase in maxillary forward growth, inhibition of mandibular forward growth, and clockwise rotation of the mandible were observed. The statistical analysis revealed that maxillary growth had a significant positive effect on the superior upper airway sagittal dimension.* **Conclusion:** *The nasopharyngeal airway dimensions can be improved in the short term with maxillary protraction in skeletal Class III children.*

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Comparison of treatment effects of different maxillary protraction methods in skeletal class III patients

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Abstract

Objective: The aim of this study was to compare treatment outcomes with different maxillary protraction methods in patients with skeletal Class III malocclusion resulting from maxillary retrognathia.

Setting and Sample Population: A total of 55 individuals consisting of 29 females and 26 males with a mean age of 11.4 ± 1.06 years were included in this study.

Material and Methods: Fifty-five treated maxillary retrognathic patients who underwent different protraction facemask methods were evaluated. Eighteen patients treated with RME were in the first group, and 19 patients treated with a modified Alt-RAMEC protocol were in the second group; eighteen patients on whom face masks with miniplates were applied were included in the skeletal anchorage (SA) group. Thirty measurements were made on lateral cephalometric radiographs before and after treatment. Differences between the groups were assessed with the ANOVA test.

Results: The mean age was higher in the SA group (11.96 ± 0.92 years) compared with the other groups. The mean ANB angle increased by 2.96°, 4.91° and 3.86° in the RME, Alt-RAMEC and SA groups, respectively. The forward movement of the maxilla was similar between the groups. However, while the rate of protraction was higher in the modified Alt-RAMEC group, a greater skeletal effect was found in the SA group.

Conclusion: The most effective method in terms of skeletal effect is the application of the face mask with skeletal anchorage; the modified Alt-RAMEC protocol can be applied before face mask to obtain faster protraction.

KEYWORDS

Alt-RAMEC, face mask, RME, skeletal anchorage

1 | INTRODUCTION

Class III malocclusions are skeletal deformities caused by the effect of genetic and environmental factors on the regular development process of the jaws. These deformities occur when the development of the maxilla is affected negatively, or the mandible is overdeveloped, or when a combination of the two occurs.[1,2]

During patients' growth and development, this deformity can be corrected by the stimulation of maxillary growth. For this purpose, an acrylic appliance is bonded to the teeth, and a face mask is applied to this acrylic appliance. However, in these treatment techniques, the success rate of the orthopaedic effect is arguably relative. The most important reasons for this are the partial loss of force in tooth support during the use of tooth-supported appliances, relapses of

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Treatment of Class II malocclusion with mandibular skeletal anchorage

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Introduction: The aim of this case report was to present the dentofacial changes obtained with bone anchorage in a Class II patient with moderate to severe crowding. **Methods:** A boy, aged 14.5 years, with a dolichofacial type, convex profile, and skeletal and dental Class II relationships was examined. After evaluation, functional treatment with bone anchorage and 4 first premolar extractions was decided as the treatment approach. Miniplates were placed on the buccal shelves of the mandibular third molars. The hook of the anchor was revealed from the first molar level. After surgery, the 4 first premolars were extracted to retract the protrusive mandibular incisors. The maxillary and mandibular first molars were banded, and a lip bumper was inserted to apply elastics and to help distalize the maxillary first molars. Orthodontic forces of 300 to 500 g were applied immediately after placement, originating from the miniscrews to the hooks of the appliance to advance the mandible. **Results:** After 20 months of treatment, the patient had a dental and skeletal Class I relationship, the mandible was advanced, the maxilla was restrained, and overjet was decreased. **Conclusions:** The combination of a bone anchor, Class II elastics, and an inner bow is a promising alternative to functional treatment, along with extractions, in Class II patients. (Am J Orthod Dentofacial Orthop 2017;151:1169-77)

Class II malocclusion, a common orthodontic problem, occurs in approximately one third of the population.[1-3] Class II correction techniques include a variety of extraction protocols, palatal expansion mechanisms, extraoral traction, and functional appliances.[4] The selection of appliance varies according to the clinician's priorities, type of anomaly, and patient's growth pattern.[5,6]

Mandibular retrusion is the most common feature of Class II malocclusion.[4] The objective of early Class II malocclusion treatment is to correct a skeletal disproportion by altering the pattern of mandibular growth.[7] Removable or fixed functional appliances could be used to advance the mandible. The efficiency of fixed functional appliances has been analyzed in previous studies. However, some disadvantages of fixed functional appliances, such as distal and intrusive movements of maxillary molars, mesial movement of mandibular molars, retrusion of maxillary incisors, and protrusion of mandibular incisors, have been reported.[6,8] Alternatively, Class II elastics can cause similar side effects.[9] The use of skeletal anchorage systems to eliminate these side effects and accelerate orthodontic treatment has become widespread.

Shortening the duration of orthodontic treatment has become a trend in recent years. Patients who receive treatment in more than 1 phase are occupied for a considerably longer time in active treatment.[10] The duration of both functional and premolar extraction treatment is prolonged. Is it possible to combine the 2 phases and shorten the treatment time?

The aim of this case report was to present the treatment of a patient with a skeletal Class II malocclusion with mandibular retrusion and moderate crowding, using Class II elastics with miniplate anchorage. Treatment duration would be shortened by combining the 2 phases.

DIAGNOSIS AND ETIOLOGY

A boy, aged 14.5 years, was referred to the Department of Orthodontics of Inönü University in Malatya, Turkey, for orthodontic treatment. His chief complaint was maxillary anterior crowding. The pretreatment clinical examination showed that he had a Class II Division 1 malocclusion associated with mandibular retrusion and an increased overjet. His facial photographs showed a symmetric face, a slightly convex profile with an

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