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Optimizing Orthodontics and Dentofacial Orthopedics

(A Review Study)

A Project Submitted to

the College of Dentistry , University of Baghdad, Department of Orthodontic in Partial Fulfillment for the Bachelor of Dental Surgery

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Certification of the Supervisor

I certify that this project entitled " **Optimizing Orthodontics and Dentofacial Orthopedics** " was prepared by the fifth-year student **zaid ammar zaid jwad** under my supervision at the College of Dentistry/University of Baghdad in partial fulfilment of the graduation requirements for the Bachelor Degree in Dentistry.

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Dedication

I would like to dedicate my humble effort to my supportive Father and Mother. Their affection, love, encouragement and prays at day and night made me able to succeed with honor.

Acknowledgment

First and foremost, praises and thanks to Allah Almighty for helping me fulfill my dream, for his blessings throughout my work to complete it successfully. I would like to extend my deepest respect and gratitude to the Dean of College of Dentistry, University of Baghdad, **Prof. Dr. Raghad Al-Hashimi**.

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List of abbreviations

FJO	functional jaw orthopedics
FM	Facial mask
RME	Rapid maxillary expansion
CVM	cervical vertebral maturation
TPA	Transpalatal Arch
TMA	titanium molybdenum alloy
MARA	Mandibular Anterior Repositioning Appliance
VPCC	vertical-pull chin cup
CS-1	First cevical stage
CS-2	Second cervical stage

Aim of the Study

This project aims to determine the best time for treatment intervention to decrease the duration of treatment .

Introduction

Describes the integration of various orthodontic and orthopedic protocols that can be used to treat the myriad of dentoskeletal problems seen routinely in orthodontic practice. Some malocclusions respond well when orthodontic treatment is begun in the mixed dentition; other conditions are treated optimally at the time of the circumpubertal growth spurt or even later.

The nature of the problem, as revealed by the process of proper differential diagnosis and treatment planning, determines whether intervention is best begun early (as in the early mixed dentition) or late (late mixed or permanent dentition). If a late treatment is initiated, a single phase of comprehensive orthodontic therapy usually is involved, the duration of which typically spans anywhere from 12 to 30 months. If treatment begins in the early mixed dentition, however, in most instances, a two-phase treatment protocol is anticipated, with a second phase of fixed orthodontic appliances required in the vast majority of such patients.

The goal of such early treatment is to correct existing or developing skeletal, dentoalveolar, and muscular imbalances to improve the orofacial environment before the eruption of the permanent dentition is complete **(Turley, P. and Turley, P., 2016)**. By initiating orthodontic and orthopedic treatment at a younger age, the overall need for complex orthodontic treatment involving permanent tooth extraction and orthognathic surgery presumably is reduced. **(Andley, Y., Saraf, B.G., Sheoran, N. and Nisha, D., 2019)**

Chapter one: review of literature

1.1 The timing of treatment intervention

Timing of treatment is a controversial area in orthodontics. Opinions among clinicians show great diversity; some recommend intervention in the early stages of occlusal development, and others argue in favor of treatment in the late mixed or early permanent dentition. It has been suggested that, although almost all types of malocclusion could benefit from early treatment, the effectiveness of intervention depends on malocclusion. For example, treatment of posterior crossbite in the deciduous or early mixed dentition is generally considered more beneficial than early correction of a Class II relationship. Clinical trials in the United States and the United Kingdom focused on the effectiveness of 2 alternative treatment modalities in Class II treatment. In these trials, 2-phase treatment that included an early growth modification phase and a second phase was compared with single-phase treatment in the early permanent dentition. **(Keski-Nisula and Varrela, J., 2008)**

1.1.1 Modification of Craniofacial Growth

During the past 45+ years, there has been much discussion among orthodontists and craniofacial biologists regarding the extent and location of therapeutically induced neuromuscular and skeletal adaptations throughout the craniofacial complex. Most would agree that the downward and forward growth of the maxillary complex of the growing individual can be influenced by such therapeutic techniques as extraoral traction and activator therapy.(**De Clerck, H.J. and Proffit, W.R., 2015)**.

The question of whether the mandible can be increased in length in comparison with untreated control.. A recent study of functional jaw

orthopedics (FJO) by Freeman and coworkers that considered the long-term effect of the function regulator (FR-2) of Fränkel showed that in late adolescence, the average increase in mandibular growth in the treatment group was 3 mm in comparison with matched untreated Class II subjects. (**Freeman, C.S., McNamara ., 2007)**

In contrast, there is limited evidence that the growth of the mandible can be diminished substantially either through the use of a chin cup or through orthopedic facial mask (FM) therapy, although a redirection of mandibular growth in a more vertical direction has been observed using a number of orthopedic techniques. **(De Clerck, H.J. and Proffit, W.R., 2015)**

1.1.2 Patient Cooperation

The ability to motivate a patient to comply is an essential ingredient of successful orthodontic therapy, whether initiated in the mixed or permanent dentition. One of the great fears of many orthodontists is that by beginning treatment in the mixed dentition, patient and parental cooperation will wane before fixed appliance therapy has been completed to the clinician's satisfaction **(Turley, P. and Turley, P., 2016)**. The orthodontist's relationship with both parents and adolescent patients is critical to ensuring successful results.
(Albino, J.E., 2000)

1.1.3 practice Management

It is obvious that when patients begin treatment in the mixed dentition, the time from the onset of treatment to the completion of the final fixed appliance phase will extend well beyond the duration of a typical orthodontic protocol initiated in the permanent dentition. Thus, more efficient and effective

early treatment protocols have evolved. In general terms, an initial phase of treatment is provided that is approximately 1 year in duration followed by intermittent observation during the transition from the mixed to the permanent dentition. .. After all of the permanent teeth have erupted fully into occlusion (except for, perhaps, the erupting second and developing third molars), fixed appliances then are used to align and fine detail the occlusion. **(McNamara, L. and McNamara Jr, J.A., 2014)**

1.2 The Cervical Vertebral Maturation Meethod

Before we begin a detailed description of the protocols that can be used to treat various malocclusion types, a discussion of the skeletal maturational level of the patient is in order. In some instances, it is desirable to treat the patient at the time when the patient is growing rapidly, as during the circumpubertal growth period, when FJO has been shown to be particularly effective. In other circumstances, we would like to know if a patient has reached his or her growth potential, as in planning corrective jaw surgery or the placement of endosseous implants, so that substantial further growth is not anticipated or desired. We also would like to know if a patient is early in the growth process and would respond skeletally rather than dentally to forces placed against the circumaxillary sutural system (e.g., RME, Facial mask (FM) therapy). One of the most inaccurate ways of determining a patient's maturational level is to use chronologic age as an indicator. **(Fishman, L.S., 1982)**. This scheme of using tooth eruption as an indicator certainly is more accurate than using chronologic age; however, other biological indicators can be used as well. Biological indicators of skeletal maturity refer mainly to somatic changes at puberty. Individual skeletal maturity can be assessed by means by several biological indicators including increase in body height skeletal maturation of the hand and wrist **(NANDA, S.,**

1971), and changes in the morphology of the cervical vertibrae. **(McNamara Jr, J.A. and Franchi, L., 2018)**

The cervical vertebral maturation (CVM) method remained relatively unused for the next 25 years, with few references made to it in the literature. The CVM method was reintroduced by first in 2000 with an updated and simplified version presented in 2005. **(Franchi, L., Baccetti, T. and McNamara Jr, J.A., 2000)**

The first three stages are differentiated from one another by the presence or absence of the notch. In the first cervical stage (CS-1), the inferior borders of vertebral bodies C2 to C4 are flat (or sometimes slightly convex; F From a practical standpoint, the notch must be at least 1 mm in depth at the center of the notching. The third and fourth cervical bodies are trapezoidal in morphology, assuming the shape of a typical wedge of cheese , with the posterior border of the vertebral body taller than the anterior border and the superior surface sloping forward and downward. This stage occurs from approximately the time of the eruption of the deciduous dentition until about 2 years before the peak in skeletal growth **(Franchi, L., Baccetti, T. and McNamara Jr, J.A., 2004)**

The second cervical stage (CS-2) is characterized by a notch present along the inferior border of the second cervical vertebra (odontoid process). The lower borders of the third and fourth vertebral bodies remain flat . Usually both C3 and C4 retain a trapezoidal shape, again the wedge of cheese appearance. CS-2 can be considered the “get-ready” stage because the peak interval of mandibular growth should begin within 1 year after this stage is evident. The third cervical stage (CS-3) is characterized by notching of the inferior borders of C2 and C3. C4 remains flat. At least one of C3 and C4 bodies still retains a trapezoidal shape while the other can assume a more rectangular horizontal shape. At this stage, the maximum craniofacial growth velocity is anticipated.

In the fourth cervical maturation characterized by the presence of a concavity at the lower borders of C2, C3, and C4. The bodies of both C3 and C4 now are rectangular horizontal in shape (100% of the subjects). . **(McNamara Jr, J.A. and Franchi, L., 2018)**

During this stage, continued craniofacial growth can be anticipated but at a lesser rate than is seen at CS-3. Placing an endosseous implant to replace a missing maxillary lateral incisor would be inappropriate at this stage of maturation because of anticipated growth in the future. The fifth cervical stage (CS-5) can be differentiated from CS-4 on the basis of the shapes of C3 and C4, with these bodies becoming square in shape. The patient can be evaluated for corrective jaw surgery or the placement of endosseous implants in the aesthetic region. It has been our experience that the most difficult stage to determine is the sixth cervical stage (CS-6). At CS-6, at least one of the third and fourth cervical bodies has assumed a rectangular vertical morphology. **(Baccetti, T., Franchi, L., & McNamara Jr, J. A. (2005)**

CVM staging should be used in concert with a thorough evaluation of the hard and soft tissue during the treatment planning process as well as other maturational indicators and the family history.(**McNamara Jr, J.A. and Franchi, L., 2018)**

1.3 WHEN TO INTERVENE

The initiation of our treatment protocols varies according to the type of malocclusion being treated. For example, tooth-size/arch-size discrepancy problems typically are treated when the patient is 8 or 9 years of age. Depending on the size of the permanent teeth, space maintenance, serial extraction, orthopedic expansion, or a combination of these protocols is used. In the instance of a Class III malocclusion, the onset of treatment usually is earlier

than for a Class I patient (e.g., orthopedic FM combined with a bonded acrylic splint expander to which have been attached FM hooks). This earlier intervention in Class III patients obviously will result in a longer period of time between the start of the initial phase of treatment and the end of the fixed appliance phase after the permanent dentition has erupted.

The timing of treatment of Class II malocclusions differs substantially from that described previously for Class I and Class III malocclusions. (**Moyers, R.E., 1976).**we typically recommend a delay until the circumpubertal growth period (i.e., cervical stage CS-3) before using FJO in patients with Class II malocclusions characterized in part by mandibular skeletal retrusion. Ideally, functional appliance therapy (e.g., Herbst, twin block, mandibular anterior repositioning appliance [MARA], bionator, FR-2 of Fränkel). **(Petrovic, A.G., 1975)**

1.4 Treatment of Tooth-size/Arch-size Discrepancy Problems

In the permanent dentition, discrepancies between tooth size and arch size usually are handled by one of three treatment modalities: extraction, interproximal reduction, or arch expansion. Additional methods of treating discrepancy problems in the mixed dentition that are not available for use in permanent dentition patients include techniques of space management (e.g., maintenance of leeway space). **(Spillane, L.M. and McNamara Jr, J.A., 1995)**

1.4.1Space Maintenance during the Transition of the Dentition

Significant differences exist between the sizes of the second deciduous molars and the succeeding second premolars. On average, 2.5 mm per side of arch space can be gained in the mandibular arch, and about 2 mm per side can be gained in the maxillary arch. Simply maintaining available arch space during

the transition of the dentition may be sufficient to resolve minor to moderate tooth-size/arch-size discrepancies. **(Moyers, R.E., 1976)**

1.4.2 Transpalatal Arch

Extends from one maxillary first molar along the contour of the palate to the molar on the opposite side. Although both fixed and removable types of TPAs are available, we routinely use the soldered TPA that is made from 0.036-inch stainless steel wire The major function of the TPA in the mixed dentition is to prevent the mesial migration and mesial rotation of the maxillary first molars during the transition from the second deciduous molars to the second premolars. **(McNamara, J.A., Brudon, W.L. and Kokich, V.G., 2001)** The TPA is often left in place until the final comprehensive phase of orthodontic therapy is completed. Interestingly, the TPA does not function well as an anchorage appliance in extraction cases. **(Zablocki, H.L., McNamara Jr, J.A., Franchi, L. and Baccetti, T., 2008)**

1.4.3 Lingual Arch

The lingual arch, usually used in the mandible as part of our early treatment protocol, has a similar function to the TPA in the maxilla . The lingual arch, also made of 0.036-inch stainless steel, extends along the lingual contour of the mandibular dentition from the first molar on one side to the first molar on the other. is an effective and conservative treatment modality to resolve mild to moderate lower incisor crowding in the mixed dentition. It maintains the lower arch perimeter by preserving leeway space. **(Joosse, M. W., Mungcal, J., Boero, R., Chambers, D., & Oh, H. (2022)**

1.5 Serial Extraction

Serial extraction or guidance of eruption is reserved for treatment of severe tooth-size/arch-size discrepancies. Due to variations in the timing and extraction sequence depending on the diagnosis. **(Ngan, P., Alkire, R.G. and Fields Jr, H., 1999) .** This treatment technique involves the sequential removal of deciduous teeth to facilitate the unimpeded eruption of the permanent teeth. Such a procedure often, but not always, results in the extraction of four premolar teeth. Typical serial extraction protocol is initiated about the time of the appearance of the permanent lateral incisors, which erupt in rotated positions or initially are prevented from eruption by the deciduous canines. In the most commonly used protocol, the first teeth to be removed are the deciduous canines . The removal of these teeth allows for the eruption, posterior movement, and spontaneous improvement in the alignment of the permanent lateral incisors. In about 6 to 12 months, the removal of the four deciduous first molars is undertaken. **(Dale, J.G., Dale, H.C., Graber, L.W., Vig, K.D. and Vanarsdall, R.L., 2011)**

Ideally, the root development of the four first premolars is ahead of that of the permanent canines, so that the first premolars will erupt before the canines. At this stage, if the canines are erupting close to the same time as the first premolars, some clinicians prefer to extract the first premolars at the same time that the first deciduous molars are removed. serial extraction may be indicated when there will not be enough space in the jaws to accommodate all the permanent teeth their proper alignment." Ringenberg predicted tooth-size/arch-size discrepancy of 7 mm or more **(Ringenberg, Q.M., 1964)**. the primary factor to be evaluated when making a treatment decision concerning serial extraction is large tooth size. In instances in which tooth sizes are abnormally large (e.g., maxillary central incisor width >10.0 mm), the initiation of serial extraction protocols may be appropriate **(Moyers, R.E., 1976)**

It is well known that serial extraction is not a panacea in all patients who present with dental crowding in the mixed dentition. **(Woodside, D.G., Rossouw, P.E. and Shearer, D., 1999)**

1.6 ARCH EXPANSION

1.6.1 Types of Expansion The types of expansions produced can be divided arbitrarily into three categories.

1.6.2 Orthodontic Expansion: Orthodontic expansion, produced by conventional fixed appliances as well as by various removable expansion plate, usually results in lateral movements of the buccal segments that primarily are dentoalveolar in nature. The resistance of the cheek musculature and other soft tissue remains, providing forces that may lead to a relapse. **(LITTLE, R., 1967)**

1.6.3 Passive Expansion : When the forces of the buccal and labial musculature are shielded from the occlusion, as with the FR-2 appliance of Fränkel a widening of the dental arches often occurs. This passive expansion produced by intrinsic forces (tongue). (**Fränkel, R. and Fränkel, C., 1989)**

1.6.4 Orthopedic Expansion : Rapid maxillary expansion appliances are the best examples of true orthopedic expansion, in that changes are produced primarily in the underlying skeletal structures rather than by the movement of teeth through alveolar bone. RME not only separates the midpalatal suture but also affects the circumzygomatic and circumaxillary sutural systems **(Haas, A.J., 1980)**

1.6.5 Rationale for Early Orthopedic Expansion

The cornerstone of the early orthopedic expansion protocol used in the treatment of patients with arch-length discrepancy problems is the actual RME itself. **(Moyers, R.E., 1976)**

1.6.6 Permanent Dentition

Maxillary intermolar width was of particular importance as an easily measured clinical indicator. In noncrowded male patients, the average distance between the upper first permanent molars, measured at the point of the intersection of the lingual groove at the gingival margin, was about 37 mm, a value that can be compared with a similar measure in the crowded males of 31 mm. **(Rathi, M.K. and Fida, M., 2014)**

1.6.7 Mixed Dentition

Longitudinal changes in an untreated population from 7 to 15 years of age were evaluated. The average increase in transpalatal width between the upper first molars was about 2.5 mm. **(Spillane, L.M., 1989).** of course, the dental arches cannot be expanded ad libitum because of the physiologic limits of the associated hard and soft tissues. It seems reasonable, however, to consider increasing arch size at a young age so that skeletal, dentoalveolar, and muscular adaptations can occur before the eruption of the permanent dentition.

1.6.8 Orthopedic Expansion Protocols

Our appliance of choice for use in patients with mixed dentition is the bonded acrylic splint expander This appliance, which incorporates a Hyrax-type screw into a framework made of wire and acrylic, is used to separate the halves of the maxilla. The acrylic-splint type of appliance that is made from 3-

mm-thick, heat-formed Biocryl, The posterior bite block effect of the bonded acrylic splint expander prevents the extrusion of the posterior teeth**.(Howe, R.P., McNamara Jr, J.A. and O'connor, K.A., 1983)**

1.6.9 Maxillary Adaptations

The morphology of a patient in the mixed dentition with an idealized (e.g., 34 to 35 mm) transpalatal width (can be compared with a patient with a narrow (e.g., 29 mm) transpalatal width. A goal of the orthopedic treatment initiated in the mixed dentition is to reduce the need for extractions in the permanent dentition through the elimination of arch-length discrepancies The screw of the expander is activated one-quarter turn (90 degrees, 0.20 to 0.25 mm) per day until the lingual cusps of the upper posterior teeth approximate the buccal cusps of the lower posterior teeth. **(Haas, A.J., 1961)**

After the active phase of expansion is completed, the appliance is left in place for an additional 5 months to allow for a reorganization of the midpalatal suture as well as other sutural systems affected by the expansion and to maximize the effect of the posterior bite block. At the end of the treatment time, the RME appliance is removed, and the patient is given a removable palatal plate to sustain the achieved resut The active expansion of the two halves of the maxilla produces a midline diastema between the two upper central incisors.. At 3 or 4 months after the initiation of RME treatment, brackets often are placed on the upper incisors to close the midline diastema and align the anterior teeth. (**McNamara Jr, J.A., Franchi, L. and McClatchey, L.M., 2019)**

1.6.10 Mandibular Adaptations

In patients whose lower arch exhibits moderate crowding of the anterior teeth or in whom the posterior teeth are tipped lingually, two types of appliances can be used before RME: the removable Schwarz appliance and the lip bumper.We assumed that expansion of the lower arch would not be stable

unless the expansion was followed by maxillary orthopedic expansion. **(McDougall, P.D., McNamara Jr, J.A. and Dierkes, J.M., 1982)**

1.6.11Mandibular Dental Uprighting and Expansion Appliances

1.6.12 The Schwarz Appliance

The Schwarz appliance is a horseshoe-shaped removable appliance that fits along the lingual border of the mandibular dentition . A midline expansion screw is incorporated into the acrylic, and ball clasps lie in the interproximal spaces between the deciduous and permanent molars. appliance is activated once per week, producing 0.20 to 0.25 mm of expansion in the midline of the appliance. Usually the appliance is expanded for 4 to 5 months, depending on the degree of incisal crowding, producing about 4 to 5 mm of arch length anteriorly**(Part, A., Turley, P.K., Turley, P.N., Part, B., McNamara Jr, J.A., McClatchey, L.M. and Graber, L.W., 2022)**

This movement is unstable if no further treatment is provided to the patient. Usually the Schwarz appliance is left in place until the maxillary orthopedic expansion phase is completed After a 5-month period of RME stabilization, which allows adequate time for the midpalatal suture and the adjacent sutural systems to reorganize and reossify, both appliances are removed, patient is given a simple maxillary maintenance plate with no retention provided in the mandible **(O'Grady, P.W., McNamara Jr, J.A., Baccetti, T. and Franchi, L., 2006)**

1.6.13 Lip Bumper

The lip bumper is a removable appliance that also can be used for mandibular dental decompensation.The lip bumper is particularly useful in patients who have very tight or tense buccal and labial musculature. This appliance not only increases arch length through passive lateral and anterior expansion but also serves to upright the lower molars distally, adding to the available arch-length increase **(Bjerregaard, J., Bundgaard, A.M. and Melsen, B., 1980)**. We tend to favor the use of the Schwarz appliance over the lip bumper. Only in patients with very constricted (tense) soft tissue is the lip bumper the appliance of choice. **(Cetlin, N.M., 1983. Nonextraction treatment. *J Clin Orthod*, *17*, pp.396-413)**

1.7 SPONTANEOUS IMPROVEMENT OF SAGITTAL MALOCCLUSIONS

Interestingly, there is another phenomenon that has been a serendipitous finding—"spontaneous" improvement of mild Class II and Class III malocclusions after RME.

1.7.1 Class II Patients: There are many patients in the mixed dentition who not only have intraarch problems but also have a Class II malocclusion or a strong tendency toward a Class II malocclusion. At the time of expander removal, these patients will have a buccal crossbite tendency, with only the lingual cusps of the upper posterior teeth contacting the buccal cusps of the lower posterior teeth. A maxillary maintenance plate typically is used to stabilize this relationship. It appears that the patient becomes more comfortable by positioning his or her lower jaw slightly forward, thus eliminating the tendency toward a buccal crossbite and at the same time improving the overall

sagittal occlusal relationship. **(Wendling, L.K., McNamara Jr, J.A., Franchi, L. and Baccetti, T., 2005)**

1.7.2 Class III Patients: The use of a bonded RME appliance also can lead to a spontaneous occlusal improvement in a patient with a tendency toward a Class III malocclusion. The placement of an acrylic splint expander that opens the bite vertically 3 mm not only provides an intrusive force against the maxilla, presumably because of the stretch of the masticatory musculature, but also may produce a slight forward repositioning of the maxilla. **(Wendling, L.K., McNamara Jr, J.A., Franchi, L. and Baccetti, T., 2005)** When contrasting the spontaneous improvement of both Class II and Class III tendency patients, it must be emphasized that any spontaneous improvement of a Class III malocclusion usually occurs (if it does occur) during the active phase of treatment (within the first 30 or 40 days). The spontaneous correction of Class II malocclusion usually is noted during the retention phase. **(Bass, N.M., 1982)**

1.8 THE TREATMENT OF CLASS II MALOCCLUSION

Number of treatments are available for correcting Class II malocclusions, including a variety of extraoral traction appliances, arch expansion appliances, extraction procedures, and FJO appliances. timing of treatment usually is most effective during the circumpubertal growth period, the late mixed to permanent dentition.

1.8.1 Available Class II Treatment Strategies

After the skeletal and dentoalveolar components of an individual Class II malocclusion are identified, using data gathered from the clinical examination and a radiographic evaluation as well as from study models, the appropriate

treatment regimen can be selected. two of the most commonly used treatment approaches.

1.8.2 Maxillary Distalization

In patients with a forward positioning of the maxillary dentition relative to the bony base of the maxilla, either extraction protocols (i.e., ultimately removing the upper first premolars) or dentoalveolar distalizing mechanics (e.g., Pendulum/Pendex appliance can be used . **(Hilgers, J.J., 1992)**

1.8.3 Extraoral Traction

Historically, the most common treatment for true maxillary skeletal protrusion has been extraoral traction.it can be used in either the mixed or permanent dentition. This appliances can be divided arbitrarily into two types: facebows and headgears. The cervical (low-pull) facebow is used most frequently in patients with normal or decreased vertical facial dimensions. Usually the outer bow of the facebow lies above the plane of occlusion (e.g., 15 to 20 degrees) so that the force is directed through the center of resistance to prevent distal tipping of the molars during treatment. Other type occipital (high-pull) facebow is used in individuals in whom increases in vertical dimension are to be minimized or avoided **(Hassel, B. and Farman, A.G., 1995)**

The forces produced by extraoral traction also can be attached anteriorly to the archwire through the use of a J-hook headgear. The use of the Interlandi-type headgear provides an additional treatment option with a variable direction of force. J hooks can be applied to the maxillary teeth in a variety of force vectors to retract and intrude the upper incisors. Virtually all of the extraoral traction appliances described earlier restrict the normal downward and forward movement of the maxilla and also may help retract the maxillary and mandibular dentitions to differing degrees depending on a non- extraction or

premolar extraction plan—and patient cooperation. **(Kloehn, S.J., 1947)** The direction of force (i.e., low pull, straight pull, high pull) is determined in part by the pretreatment vertical dimensions of the patient and treatment goals.These types of appliances are indicated in instances of maxillary skeletal protrusion, maxillary dentolaveolar protrusion, and mandibular dentoalveolar protrusion. **(McNamara Jr, J.A., Peterson Jr, J.E. and Alexander, R.G., 1996)**

1.8.4 Pendulum and Pendex Appliances

A popular method of molar distalization that requires no direct patient cooperation is the Pendulum appliance system . The Pendulum appliance consists of a large acrylic Nance button that covers the middle part of the palate. The acrylic pad is connected to the dentition by means of occlusal rests that extend from the lateral aspect of the pad and are bonded to the occlusal surfaces of the upper first and second premolars. Posteriorly directed springs, made of 0.032-inch titanium molybdenum alloy (TMA) wire, extend from the distal aspect of the palatal acrylic to form a helical loop near the midline, then extending laterally to insert into lingual sheaths on bands cemented on the upper first molars. When in a passive state, the springs extend posteriorly, paralleling the midpalatal raphe. When activated and inserted into the lingual sheaths, they produce a distalizing force against the upper first molars that moves the molars distally and medially. **(Hilgers, J.J., 1992)**

The design of the Pendex appliance is essentially the same as the Pendulum, except for the addition of a palatal expansion screw in the midline . In most instances, we use the Pendex design because of the tendency toward transverse maxillary constriction in patients with Class II malocclusion . After appliance removal, a Nance holding arch with a palatal button is delivered to the patient within the next 24 hours. The Nance holding arch is left in place until

proper distalization of the premolars and canines is achieved. **(McNamara, J.A., Brudon, W.L. and Kokich, V.G., 2001)**

1.8.5 Mandibular Enhancement: Functional Jaw Orthopedics

Second type of treatment modality aimed at correcting a Class II malocclusion focuses its mechanics on influencing the mandibular dentition and the growth of the mandible. This type of treatment is referred to as functional jaw orthopedic , like activator the bionator the function regulator (FR-2) appliance of Fränkel the Herbst appliance the MARA appliance and the twin block appliance. all work to achieve a Class I occlusion by posturing the mandible forward during a time of growth. There are a question of whether the mandible can be increased in length , one of the more rigorous studies of FJO that analyzed patients treated by Rolf Fränkel showed that the residual increase in mandibular length was on average 3 mm, not 5 to 8 mm (an amount that would be equivalent to a surgical mandibular advancement). The long-term effect on mandibular length remains open to question. **(Freeman, D.C., McNamara Jr, J.A., Baccetti, T., Franchi, L. and Fränkel, C., 2009)**

1.8.6 Appliance Selection

All FJO appliances have one aspect in common: they induce a forward mandibular posturing as part of the overall treatment effect. **(Byloff, F.K. and Darendeliler, M.A., 1997)**

1.8.7 Herbst Appliance

An appliance that has proved excellent in the treatment of Class II malocclusions in the permanent dentition is the Herbst appliance , a fixed or removable functional appliance depending on the anchoring system used. We have used many types of fixed Herbst appliances over the years, with the current preferred version incorporating stainless steel crowns on the maxillary first molars. Othr type The banded Herbst design as described by Rogers has a

number of features that prove helpful. In particular, there is no interference with the occlusion, it is easier to fit precisely, and removal of the appliance is easier. **(Herbst, E., 1910)** Generally speaking, about 50% of the treatment effect is due to tooth movement, primarily the backward and upward movement of the posterior maxillary dentition. The primarily skeletal treatment effect produced is a short-term increase in mandibular growth (i.e., 2.0 to 2.5 mm greater than normal values). **(Lai, M. and McNamara Jr, J.A., 1998, March)**

Herbst appliance is not the appliance of choice in mixed dentition patients, we have noted a significant tendency toward a relapse to the original malocclusion. Herbst appliance is not the appliance of choice in mixed dentition patients This appliance is used most effectively in patients who do not have profound neuromuscular imbalances. **(Pancherz, H., 1982)**

1.8.8 Mandibular Anterior Repositioning Appliance

Is a fixed tooth-borne appliance that is fabricated on stainless steel crowns commonly placed over the maxillary and mandibular first permanent molars . It has been used throughout the mixed and early permanent dentition stages, with similar indications as the Herbst appliance described earlier. The MARA acts by prohibiting the patient from closing in a natural.the MARA has been shown to produce less flaring of the lower incisors. **(Pangrazio-Kulbersh, V., Berger, J.L., Chermak, D.S., Kaczynski, R., Simon, E.S. and Haerian, A., 2003)**

The anteroposterior treatment effect of the MARA is achieved through both skeletal and dental changes. Studies on skeletal changes indicate that the MARA produces increases in mandibular length but exerts negligible skeletal effects on the maxilla. Whereas maxillary molar intrusion is a characteristic feature of Herbst use,this finding has not been reported with the MARA.

(Pancherz, H., 1982) The biggest drawback to using the MARA, however, is appliance breakage and initial patient perception of bulk, which can perceived as a significant problem. To mitigate this issue on patients with small mouths and tight cheeks, one can leave off the second premolar brackets so that the MARA arms may be constructed more closely to the dental arch. Small shields can also be placed to help keep tight cheeks away from the MARA arms. **(Pangrazio-Kulbersh, V., Berger, J.L., Chermak, D.S., Kaczynski, R., Simon, E.S. and Haerian, A., 2003)**

1.8.9 The Twin Block Appliance

Our choice of functional appliance selection for mixed dentition patients . is composed of maxillary and mandibular removable acrylic components that fit tightly against the teeth, alveolus, and adjacent supporting structures . Interproximal clasps are used bilaterally to anchor the maxillary appliance to the first permanent molars and premolars. **(Clark, W. and Clark, W.J., 2014).** We have modified the design of the twin block appliance slightly by adding a second midline screw in the midsagittal region of the appliance. Our experience has shown that in patients in whom significant expansion is desired during twin block treatment, the appliance becomes unstable and too flexible if only one midline screw is used. Each screw is activated once per week (≈0.2 mm) until adequate expansion is attained. The posterior bite blocks of the twin block appliance can be trimmed to facilitate the eruption of the lower posterior teeth in patients with a deep bite. **(McNamara, J.A., Brudon, W.L. and Kokich, V.G., 2001)**

One of the primary reasons why the twin block appliance is indicated in the treatment of Class II malocclusion is a reasonably high level of patient compliance. Because the twin block is composed of two parts, speaking typically is not a problem. The duration of treatment usually is 9 to 12 months followed by nighttime wear of the appliance . Phase II treatment with fixed

appliances usually is begun after the transition to the permanent dentition is complete. **(Radescu, O. D., Albu, S., Baciut, M., Bran, S., Coman, A. C., Bechir, E. S., Pacurar, M., & Todea, D. A. (2017)**

1.8.10 Treatment Timing for Class II Malocclusion

An early study by our group indicated that, when comparing two cohorts of patients who were treated with the FR-2 appliance of Fränkel, those patients who began treatment at an average of 11.5 years showed a greater mandibular growth response than did patients beginning treatment at approximately 8.5 years of age**. (McNamara Jr, J.A., Bookstein, F.L. and Shaughnessy, T.G., 1985)** In general, the onset of FJO therapy in a mild to moderate Class II patient typically is delayed until the middle or end of the mixed dentition.

In patients with a significant overjet and mandibular skeletal retrusion, treatment with the cantilever-type Herbst appliance or twin block appliance may be initiated in the early mixed dentition. **(Part, A., Turley, P. K., Turley, P. N., Part, B., McNamara Jr, J. A., McClatchey, L. M., & Graber, L. W. (2022)**

1.9 TREATMENT OF CLASS III MALOCCLUSION

One of the most difficult types of malocclusions to treat is a Class III malocclusion. The outcome of various early treatment protocols may or may not be successful, however, depending on the severity of the problem, the familial malocclusion and respiratory histories of the patient, and the age at which treatment is initiated. **(Yelampalli, M. R., & Rachala, M. R. (2012)**

1.9.1 Class III Treatment Strategies

When a patient first is diagnosed as having a Class III malocclusion in the permanent dentition, treatment options are limited, particularly if there is a strong skeletal component to the Class III occlusal relationship. Such treatment

usually includes comprehensive orthodontic therapy combined with extractions, orthognathic surgery, or both Available. **(Khan, M. B., & Karra, A. (2014)**

The treatment of Class III malocclusion in the primary and mixed dentition can be approached from a slightly different conceptual viewpoint.

For example, Fränke recommends the function regulator (FR-3) appliance in patients whose malocclusion is characterized primarily by maxillary skeletal retrusion. **(Fränkel, R., 1970)** On the other hand, the orthopedic chin cup has been used in patients whose malocclusions are characterized primarily by mandibular prognathism, a procedure that has its greatest effect when used in primary and early mixed dentition patients. **(Sugawara, J., Asano, T., Endo, N. and Mitani, H., 1990)**

1.9.2 Appliance Selection

1.9.3 The Orthopedic Facial Mask

The widest application and produces the most dramatic results in the shortest period of time. Thus, the orthopedic FM is our customary appliance of choice for most Class III patients seen in the early mixed dentition or late deciduous dentition **(Situ, L. S., Supreeth, S. M., Rejina, P., Alok, K. J., Bobrov, D., & Tchumacov, A. (2013)**

Importantly, the appliance system affects virtually all areas contributing to a Class III malocclusion (e.g., maxillary skeletal retrusion, maxillary dentoalveolar retrusion, mandibular prognathism, decreased lower anterior facial height) by manipulating force vectors **(Guyer, E.C., Ellis III, E.E., McNamara Jr, J.A. and Behrents, R.G., 1986)**

The orthopedic FM system has three basic components: the FM, a bonded maxillary splint, and elastics. The FM has been modified by petit and now is

available in various forms commercially. Although Petit has recommended a number of different intraoral devices, both fixed and removable, to which the elastics can be anchored, it is our strong preference to use a bonded maxillary expansion appliance that is similar in design to that discussed previously in the treatment of arch-length discrepancy problems. The major modification in the splint design is the addition of FM hooks in the region of the maxillary deciduous first molar. **(Petit, H., 1983)**

The expander/splint is activated 0.25 mm once per day at bedtime until the desired increase in maxillary width has been achieved. In patients in whom no increase in transverse dimension is desired, the appliance still is activated for 8 to 10 days to disrupt the maxillary sutural system and to promote maxillary protraction. **(Park, J. H., Cruz, C., & Alexander, R. G. (2010)**

A sequence of elastics of increasing force (200, 350, 600 g per side) is used during the break-in period until a heavy orthopedic force is delivered to the maxillary complex. Ideally, the FM is worn on a full-time basis (≈20 hours per day) for 4 to 6 months, and then it can be worn on a nighttime basis only for an additional period of time. **(McNamara, J.A., Brudon, W.L. and Kokich, V.G., 2001)**

In patients with mild to moderate Class III problems, a positive overjet of 4 to 5 mm is achieved before the time that the FM is discontinued. It is anticipated that there will be some regression of the overjet relationship during the early posttreatment period. **(Minase, R. A., Bhad, W. A., & Doshi, U. H. (2019)**

After the FM and the RME appliance have been removed, the patient can be retained using a number of appliances, including a simple maintenance plate an FR-3 appliance of Fränkel, or a chin cup (or a combination of these). Because the FM usually is used in the early mixed dentition, a substantial

amount of time may elapse before the final phase of fixed appliance treatment can be initiated. **(Pattanaik, S., & Mishra, S. (2016)**

1.9.4 The FR-3 Appliance of Fränkel

An intraoral appliance that has been used quite effectively in the treatment of Class III malocclusions in the mixed dentition is the function regulator FR-3 appliance of Fränkel**(Toffol, L. De, Pavoni, C., Baccetti, T., Franchi, L., & Cozza, P. (2008)**The appliance is designed to restrict the forces of the associated soft tissue on the maxillary complex, transmitting these forces through the appliance to the mandible. **(Fränkel, R. and Fränkel, C., 1989)**

Major advantage in using the FR-3 appliance of Fränkel is that it is relatively inconspicuous, especially compared with the orthopedic FM or chin cup. The FR-3 is worn intraorally, and often wearing the appliance actually improves the appearance of the patient by filling out the upper lip region in individuals with substantial maxillary skeletal retrusion. **(Mittal, M., Singh, H., Kumar, A., & Sharma, P. (2017)** major difference between the FR-3 appliance and the orthopedic FM is the duration of treatment. In a routine Class III patient, the orthopedic FM may produce a correction of the malocclusion within the first 6 months after initiating treatment. Normally, 12 to 24 months is necessary to produce a similar response with the FR-3 appliance **(Kerr, W.J.S., TenHave, T.R. and McNamara Jr, J.A., 1989)** This appliance was designed by Fränkel, based on the principles of Roux in that the primary action of the appliance is on the associated soft tissue, hopefully leading to a reprogramming of the central nervous system and a retraining of the craniofacial musculature. **(Roux, W., 1895)**

1.9.5 The Orthopedic Chin Cup

The oldest of the orthopedic approaches to the treatment of Class III malocclusion is the chin cup.Although a wide variety of chin cup designs are available commercially, in general, these appliances can be divided into two types. The occipital-pull chin cup is used in instances of mandibular prognathism, and the vertical-pull chin cup (VPCC) is used in patients with steep mandibular plane angles and excessive lower anterior facial height. **(CHATZOUDI, M. I. (2013).**

The occipital-pull chin cup frequently is used in the treatment of Class III malocclusions. This type of chin cup is indicated for use in patients with mild to moderate mandibular prognathism. Success is greatest in patients in the primary and mixed dentition who can bring their incisors close to an edge-to-edge position when in centric relation. This treatment is useful particularly in patients who begin treatment with a short lower anterior facial height because this type of treatment can lead to an increase vertical facial height **(Iida, Y., Deguchi Sr, T., & Kageyama, T. (2005)** If no increase in lower anterior facial height is desired, the VPCC can be used .

Pearsonhas reported that the use of a VPCC can result in a decrease in the mandibular plane angle and the gonial angle and an increase in posterior facial height in comparison with the growth of untreated individuals. **(Pearson, L.E., 2000)** One of the substantive concerns regarding chin cup therapy is whether the growth of the mandible can be retarded through a wearing a chin cup.Sakamoto and Wendell and coworkers have noted decreases in mandibular growth during treatment **(Sakamoto, T., 1981, Wendell, P.D., Nanda, R. and Nakamura, S., 1985)**

The orthopedic chin cup usually produces an increase in lower anterior facial height while correcting the anteroposterior malrelationship. It has been

our observation that the chin cup works best when used in the primary and early mixed dentition and when the adverse mandibular growth has been mild to moderate in nature **(Usman, A., Hegde, A. M., Shetty, R., & Manju, R. (2022)**Thus even the “corrected” patients need to be monitored at 4- to 6-month intervals until major growth has cease

Chapter two: Discussion

The timing of orthodontic and orthopedic treatment protocols varies with the underlying nature of the malocclusion. Some problems respond well to early intervention, others to late treatment. Implicit in initiating early treatment is that the overall treatment time of the patients will be extended from the normal 12 to 24 months generally needed for comprehensive treatment of an adolescent patient. Initiating treatment in a patient with mixed dentition, however, does not imply that treatment will be provided continuously from the time of eruption of the permanent incisors until the time that the permanent second molars are aligned with fixed appliances.In most Class II patients seen in the mixed dentition, we often start early treatment by managing the transverse dimension, with definitive Class II treatment rendered (if necessary) at the time of the circumpubertal growth period (the "spontaneous improvement" in Class II malocclusion is a frequently occurring phenomenon). There are a defined beginning and ending of the treatment that are known to the patient and to the parents before the protocol is started. Intermittent observation of the patient during the transition of the dentition is a prime component of early treatment. We generally prefer to see our patients every 4 to 6 months after the first phase of treatment is completed. The appliances used during this time are simple, usually consisting of only a removable palatal plate typically without a labial wire that is worn full time for at least 1 year. Almost all patients undergoing early treatment will require a final phase of fixed appliances. Usually the treatment time is reduced to 12 to 18 months because the majority of patients undergoing comprehensive therapy will be treated as nonextraction patients with Class I or near Class I molar relationships. Early treatment will not eliminate the need for corrective jaw (orthognathic) surgery in all patients with severe skeletal and neuromuscular imbalances. In these instances, orthognathic surgery in combination with fixed appliances is the treatment of choice.

Chapter three: Conclusion and Suggestions

It must be stressed that early intervention is not always necessary or appropriate. In some instances, early treatment does not change appreciably the environment of dentofacial development and permanent tooth eruption. In such instances, early treatment may serve only to increase treatment time and cost and may result in a lack of patient cooperation in later years. If every effort is made, however, to time the treatment appropriately so as to maximize the treatment benefit in the shortest period of time and if the implemented treatment protocol has a reasonably predictable duration and outcome, orthodontic and orthopedic intervention can be provided successfully.

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