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Conditions that May Require Molar Distalization in Children and Treatment Approaches

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ABSTRACT

It is of great importance that deciduous teeth remain in the mouth until the physiological age of eruption. One of the most important reasons for this is that they serve as placeholders for the permanent teeth that will come from emerge below, among their functions in chewing, speaking, and aesthetics. Therefore, significant problems arise with the early loss of these teeth. Teeth tend to fill the gaps in the arch and become mesialized. The length of the arch is shortened as a result of the mesialization of the teeth at the end of the arch when a placeholder is not utilized after the early loss of deciduous teeth. When the permanent teeth coming from below cannot find a place to erupt, various anomalies occur in the arch. These anomalies include impacted permanent teeth, ectopic eruptions, or crowding. The distalization method was developed to correct these anomalies. In this method, the mesialized teeth are pushed distally with various forces to regain the lost arch length. Patients who will undergo distalization procedures should meet certain criteria and be indicated accordingly. Many intraoral and extraoral methods are used in the process of gaining space by distalizing the teeth. Careful consideration should be given when choosing these methods, and monthly follow-ups should be performed.

Çocuklarda Molar Distalizasyonu Gerekebilecek Durumlar ve Tedavi Yaklaşımları

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ÖZET

Süt dişlerinin fizyolojik sürme yaşına kadar ağızda kalması büyük önem taşımaktadır. Bunun en önemli nedenlerinden biri çiğneme, konuşma ve estetikteki işlevlerinin yanı sıra alttan gelecek olan daimi dişler için yer tutucu görevi görmeleridir. Bu nedenle bu dişlerin erken kaybı ile önemli sorunlar ortaya çıkmaktadır. Dişler arktaki boşlukları doldurma ve mezialize olma eğilimindedir. Süt dişlerinin erken kaybından sonra herhangi bir yer tutucu kullanılmadığında ark dizisinin sonundaki dişlerin mezializasyonu sonucu ark boyu kısalmaktadır. Alttan gelen daimi dişler sürebilecek yer bulamadığında arkta çeşitli anomaliler meydana gelmektedir. Bu anomaliler arasında daimi dişlerin gömülü kalması, ektopik sürmesi veya çapraşıklık sayılabilir. Distalizasyon yöntemi bu anomalileri düzeltmek için geliştirilmiştir. Bu yöntemde mezialize olan dişler çeşitli kuvvetlerle distale doğru itilerek kaybedilen ark uzunluğu yeniden kazandırılmaktadır. Distalizasyon işlemi uygulanacak hastaların belirli kriterleri karşılaması ve buna göre endikasyon konulması gerekmektedir. Dişlerin distalize edilerek yer kazanılması işleminde intraoral ve ekstraoral birçok yöntem kullanılmaktadır. Bu yöntemler seçilirken dikkatli olunmalı ve aylık takipler yapılmalıdır.

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INTRODUCTION

Pediatric dentistry emphasizes the importance of keeping deciduous teeth healthy and functional in the mouth until they fall out physiologically.[1] In this way, chewing and speech disorders are prevented, the midline is preserved, abnormal tongue habits are prevented and the normal development processes of the jaw can continue while maintaining the length of the dental arch.[2-4]

In the "Managing Dental Occlusion in Pediatric Dentistry" guideline of the American Association of Pdiatric Dentists, it is accepted that it is an important task of the pedodontic specialty to guide the eruption and thus to ensure the correct formation of the development of deciduous and permanent dentition, and it has been reported that thanks to this guidance, it should have the knowledge and skills to identify, distinguish, and intervene at the right time with a functionally and aesthetically acceptable occlusion development and abnormal conditions and problems that may occur with it.[1,5]

Although the number of patients visiting pediatric clinics has increased due to modern advances in preventing tooth decay and growing dental care, the premature loss of deciduous teeth to decay remains a very common problem.[6, 7] As a result, it is very likely to cause loss of space in the dental arches and cause malocclusions in the future.[8,9] Advances in mechanical treatments and changes in treatment concepts have significantly reduced the necessity for extractions in severe dental discrepancies. Nowadays, various techniques are employed to treat numerous malocclusions without resorting to extraction. Additionally, molar distalization has emerged as an alternative method of gaining space in the arch.[10] Distalization is the process of gaining space by moving the terminal molar distally in arch.[11]

LOSS OF SPACE

The most common causes of space loss during deciduous and permanent dentition;

1. Untreated interfacial caries
2. Early loss of deciduous teeth
3. Loss of deciduous or permanent incisiors as a result of trauma
4. Congenital deficiency of teeth
5. Ectopic eruptions of permanent teeth
6. Ankylosis of deciduous molars
7. Delayed eruption of permanent teeth
8. Dental size anomalies such as macrodontia or microdontia.[12-16]

As a result of deciduous tooth decay, material loss may occur in the mesio-distal direction. As much as this amount is lost, the teeth physiologically move in this direction and narrow the space for permanent teeth to replace the deciduous teeth.[15,16]

Problems as a result of dental caries occur as a result of these physiological tooth movements. The movement of the teeth in the mesial direction is greater than in the distal direction.[12, 15] In neighboring teeth and further teeth, these movements take place towards the gaps to a decreasing extent.[15] These physiological movements are usually caused by tipping and tilting (tipping).[12,15] The physiologic movements of the teeth are greater in the upper jaw than in the lower jaw. This is because the upper jaw bone is more spongy while the lower jaw bone is more compact.[15,17]

Factors that cause early loss of deciduous teeth:

1. Caries with excessive loss of material
2. Trauma
3. Untreatable pulpal and dento-alveolar abscesses

4. Internal or external resorptions
5. Extraction of some deciduous teeth for interceptive orthodontic treatment to prevent ectopic eruption of permanent tooth germs
6. Orthodontic causes such as arch size mismatch and crowding
7. Infraocclusion.[7,9,12,14]

In a study conducted by Alsheneifi and Hughes in 2001, the reasons for the extraction of deciduous teeth in children aged 3-13 years and the frequency of extraction were investigated. According to the results, it was found that extractions were most frequently performed in the 6-9 age range 56%, the reason for these extractions was caries 53% and the second most common reason was orthodontic reasons. In addition, the question of which teeth were extracted the most was also asked. In the age range of 3-5 years, anterior incisors were extracted mostly due to early childhood caries, while in the 6-9 age range, first deciduous molars were extracted, and in the 10-13 age range, deciduous molars were extracted mostly due to the replacement of anterior incisor.[18]

In another study conducted in 2009, the age range of 3-13 years was taken into consideration and the most commonly extracted deciduous teeth and the reasons for extraction of these teeth were investigated. According to the results, the most common reason for extraction in the 3-5 age group was caries with 86.3% and in the 6-9 age group with 52.8%, while the most common reason for extraction in the 10-13 age group was the physiologic falling age of these teeth with 86.6%. When asked about the most frequently extracted tooth types, the respondents cited deciduous first molars, followed by deciduous second molars and deciduous incisors, respectively.[19]

When deciduous teeth are lost early, the consequences that may occur if a placeholder is not made on time are as follows:

1. A reduction in arch size is available for permanent dentition
2. Impacted permanent tooth germs due to loss of space
3. Crowding in permanent dentition
4. Deviation to the midline
5. Ectopic eruption
6. Closing problems
7. Degeneration and inflammation of tooth support tissues as a result of teeth falling into extraction cavities.[9,14,17]

MOLAR DISTALIZATION

Malocclusions can often develop as a result of the loss of deciduous teeth the physiologic age of falling. Two concepts early orthodontic and interceptive orthodontics, are prominent. While interventions are made at the very beginning of the early orthodontic dentition period, treatment starts as a result of eny suspicious situation seen after start of the dentition period in interceptive orthodontics.[20,21] In 1998, Hoffding and Kisling noted that premature separation of deciduous teeth from their position in the dental arch results in a subsequent loss of space for permanent teeth within arch.[22] As a consequence of space loss, the permanent tooth may become impacted or may erupt buccally or lingually.[22] When second deciduous molars are lost early, the rate of space closure is notably higher compared to the early loss of first molars. Consequently, a space regainer system in often necessary when space is lost. Various appliances are utilized during the eruption of the permanent tooth to both to regain the lost space and to preserve the lost space. At the first appointment and at follow-up appointments, the appliances are activated to distalize the terminal teeth in the arch. After gaining space for the teeth that cannot erupt, these appliances remain in the mouth as a placeholder until the teeth erupt.[23]

Diagnosis

Molars shifting mesially, crowding and space loss in both the upper and lower jaws often result often the mismatch between tooth and jaw size. When devising a treatment, clinicians should account for growth patterns, spacing, and factors such as facial profile and the size of the apical base.[24-26]

Radiographs and working models are utilized to assess the space required and the alignment within the arch. The forces necessary to straighten an overturned tooth are greater than the forces required to restore a body-moved tooth to its proper position. Therefore, it is crucial to determine whether the teeth that causing the loss of space moved to the edentulous area bodily or axially. Another aspect to consider in the diagnosis is the position of the permanent second molar. Since these teeth will be distalized during the distalization process, the condition of the tooth should be evaluated with periapical radiographs.[20,21]

The space regaining procedure necessitates careful consideration of tooth alignment factors, including tooth rotation, improper contacts and transverse relationship of the tooth. Working models serve as the most reliable source of data for assessing these aspects. They enable visualization of vertical, transverse and sagittal tooth relationships, which are crucial for ensuring the stability of Moyer's mixed dentition analysis. Furthermore, working models are invaluable in determining the extent of space loss and estimating of the space required by the unerupted permanent tooth.[27]

Space recovery procedures present various challenges. Generally, recovering minimal space loss is preferable. When considering the distalization process, it is crucial to recognize that it is may be suitable for every patient. Factors that positively affect this procedure include: Class 1 occlusion, sufficient anchorage, absence of the second permanent molar and, if present, a positive relationship with the first molar.[27]

Extraoral Molar Distalization Methods

Headgear

This appliance offers both orthodontic and orthopedic effects. The headgear can be used to direct or brake the growth of the upper jaw in the forward and downward directions. It is also commonly used to give distal movement to the teeth or to provide anchorage in fixed orthodontic treatments.[20,28]

The headgear is designed in three different configurations depending on the direction of force application: high pull (occipital), straight pull (occipital) or low pull (cervical). Occipital and cervical headgear define the point and direction of force application in relation to the center of resistance of the molar teeth or maxilla.[28,29] Among these configurations, cervical headgear is the most commonly utilized. It is effective in restraining maxillary growth and in distalizing maxillary molars. However, molar extrusion and distal crown tipping are recognized as potential side effects of this appliance.[26, 30] On the other hand, occipital headgear is effective in controlling vertical dimension of occlusion.[31,32]

Although the headgear can fulfill its purpose to a great extent, since the target patient group is adolescents, cooperation problems may arise due to aesthetic concerns. Additionally, because of the disadvantages of this appliance, such difficulty in use and prolonged duration of wear, patient compliance issues are experienced, leading to a decrease in the likelihood of success.[33]

Intraoral Molar Distalization Methods

Repulsor Magnets

In 1978, Blechman and Smiley conducted animal experiments, which led to its application in humans in 1985.[34] The samarium-cobalt alloy is utilized to render it biologically compatible. Since it is activated and managed by physicians, there is no need for patient compliance. Bondemark and Kurol achieved simultaneous distalization of the upper first and second molars using magnetic forces and employed a modified Nance appliance for anchorage. However, the limited understanding of the effects of magnetic fields generated by magnets on human oral cavity and dental tissues hinders the widespread adoption of these systems.[35]

Molar distalization with magnetic forces has reduced the risk of tooth decalcification, caries and gingival problems due to minimized patient compliance, easy activation, physiological forces, and short treatment time.[36] Disadvantages include their potential toxicity when isolation is not ensured, fragility, occupying significant space in mouth, lack of hygiene, and causing irritation of the cheek mucosa.[33]

Open Coil Springs

Open coil springs are very commonly used in clinics and are compression-activated systems that apply force from the center in two directions.[33]

Pieringer et al. achieved 5-10 mm molar distalization using open coiled springs placed on segmental archwires in 8 individuals who were anchored using the Nance appliance over a period ranging from 3 months to 18 months.[37]

Erverdi et al. compared magnets and open coil springs and found that molar distalization was achieved in both groups, but open coil springs were more effective.[38]

Superelastic Nitinol Wires

Nickel titanium was first introduced into orthodontic clinics by Andreasen and Johnson in 1971.[39] Miura et al. were the first to use them for alignment in dental arches.[40] Superelastic nickel-titanium braces are widely used in clinical orthodontic treatment.[40,41] These wires have many special properties such as shape memory effect and super elasticity.[42]

Gianelly compared nitinol open coil springs and superelastic wires, and reported that 1 mm distalization was achieved within a month with both methods, albeits with some loss of anchorage.The study found that the optimal time for molar distalization is during the mixed dentition period, as 1st molars can be distalized more rapidly and easily before the 2nd molars, and continuous forces result in faster movement compared to intermittent forces.[43]

Jones Jig Appliance

In the system developed by Jones and White, which includes a thick segmental arch and a nitinol open-coiled spring attached to it, a class 2 molar relationship was converted into a class 1 molar relationship by applying 70-75 grams of force with 1-5 mm activation of the spring. The open coiled spring was activated every 4-5 weeks.[44]

Haydar and Üner conducted a comparison study the Jones-Jig appliance and cervical headgear, finding that molar distalization averaged 2.5 mm per month with Jones-Jig and 10.7 mm per month with cervical headgear. The main disadvantage during molar distalization with the Jones-Jig appliance is the risk of anchorage loss; however, advantages include shorter treatment times and similar treatment effects as cervical headgears.[45]

Distal Jet Appliances

Carano and Testa stated that they achieved significant molar distalization with the distal jet appliance they developed, which offered a considerable advantage when used in conjunction with fixed treatments.[46] In this appliance, 2 tubular bands are positioned on the right and left sides, intended for connected to the nance button on the palate. Open-coiled springs are connected to the tubes of these bands with a screw system extending from the nance appliance. One end of this open coiled spring is on the 1st premolars and the other end is on the 1st molars.[11,47]

In their study comparing the effects of orthodontic treatment and distal jet appliance, Ngantung et al. observed that distalization with distal jet resulted in 2.1 mm and 3.3 degrees of distal tilting in the upper 1st molars, 2.6 mm mesial movement and 4.3 degrees of distal tilting in the 2nd premolars used as anchorage. After orthodontic treatment, 3.9 mm mesial movement and 6.1 degrees mesial tipping of the upper 1st molar, 0.9 mm distal movement and 2.1 degrees mesial tipping of the 2nd premolar were measured.[48]

Bolla et al. compared the distal jet appliance with other distalization systems and found 71% distalization and 29% loss of anchorage in molars, less loss of anchorage in patients with partially or fully erupted 2nd molars, and less distal deviation of the 1st molar.[49]

First-Class Appliance

Fortini et al. developed this appliance to reduce the anchorage loss of the distal jet and used it for distalization of maxillary molars. In their study, they obtained an average molar distalization of 4.8 mm in 42 days in 62 individuals with class 2 malocclusion with an average age of 8.7-14.5 years.[50]

This appliance can be utilized in both permanent and mixed dentition, and distalization can be achieved even in the presence of 2nd molars. Fortini stated that this appliance is suitable for dental and skeletal class 2 cases with maxillary protrusion near the end of growth, deep bites, cases where patient compliance, such as with bionators and twin-blocks cannot be achieved, individuals with maxillary arch insufficiency, and extreme crowding requiring space gain.[33]

IBMD (Intraoral Bodily Molar Distalizer) Appliance

Keleş and Sayınsu introduced an intraoral molar distalizer featuring a stem, which successfully completed the distalization of upper molars within an average period of 7.5 months.[51] For molar distalization, 0.032x0.032 inch TMA springs are manipulated and directed through acrylic. The springs consist of 2 components: the distalizing segment applies a tilting force to the crowns of the 1st molars, while the uprighting segment exert a force to align the roots. The IBMD appliance is cemented to the first premolars, with left unattached to the each other. Post-cementation, the hinge covers on the molar bands are opened. The springs are activated by pulling them distally to mesially using Weingart pliers, and then inserted into the sockets of the palatal hinge cap attachments. It has been reported that, due to the combined force application, an average distalization of 5.23 was achieved without distal tipping or extrusion of the upper molars. Furthermore, the upper first molars did not exhibit distopalatal rotation, and there was no increase inter-molar distance.[51]

The primary challenge in molar distalization is the risk of distal tipping of the molars. The only method to counteract this is by ensuring that the applied force passes close to the center of resistance of the tooth. Forces applied at the level of the trifurcation zone level move the crown and roots of the tooth distally or mesially without inducing any tipping. Therefore, molar tubes should be positioned as gingivally as possible.[33]

Bimetric Molar Distalization System

In the 3D bimetric distalization system introduced by Wilson, which necessitates patient compliance despite being an intraoral method, the arch can be utilized either alone in the mouth or with a bracketing system.[52,53] In this system, support is provided with a class 2 elastic extending from the lower 1st molar to the upper canine. In the study, it was observed that there was parallel distal movement in the upper 1st molars but there was no change in the lower incisors.[54]

In a study by Küçükkeleş and Doğanay, 1 boy and 3 girls with an average age of 13.5 years were treated in accordance with Wilson's principles and 3 mm distalization was achieved at the end of 3 months.[55] As a result of distalization, it was determined that the upper molars were crossbite, slightly intruded and tipped distally, while the lower molars were extruded and tipped mesially with the effect of intermaxillary class 2 elastics.[38,54]

In their study, Muse et al. found 2.16 mm distal movement of the upper 1st molars at an average of 14.9 weeks. No correlation was found between the presence of the upper 2nd molars and the amount of movement of the upper 1st molars or the resulting distal tilting movement.[56]

K-Springs

Kalra, with the assistance of the Nance appliance, fabricated a double-armed segmental arch in the shape of the letter "K" from the TMA wire, opened the arms of this letter “K”, and positioned the activated arch between the upper 1st molar and upper 1st premolar teeth. By activating the arch twice, each time by 2 mm, a total of 4 mm of upper molar distalization was achieved, while preventing distal and mesial tipping by anglulating the arms of arch at a 20 degrees.[57]

Pendulum Appliance

In this appliance developed by Hilgers, a modified Nance appliance was utilized, and TMA springs were incorpotaed into the acrylic component, transmiting a gentle and continuous force in the distal direction to the upper 1st molars. Activation was conducted every 3 weeks, and 5 mm of distalization was achieved within 3-4 months.[47]

The Pendulum appliance, one of the most commonly employed intraoral distalization methods, has been modified and employed by numerous researchers to eliminate the loss of anchorage induce by mesialization in the upper 1st and 2nd premolars, which serve anchoring teeth, and to prevent distal tipping in the upper 1st molars.[58,59]

Distalization Screw Removable Appliance

This orthodontic appliance, constucted on a working model, consists of Hawley ring (vestibular arch), three or four retaining clasps, a distalization screw located adjacent to the space loss, and an acrylic lingual plate. Patients and their families receive instructions on proper usage, insertion and removal of the appliance, as well as guidance on maintaining oral hygiene.[60] To optimize its effectiveness, patients are advised to wear the appliance full time, except during meals, brushing, and oral cleaning routines. The appliance should remain passive in the oral cavity for one week to allow children to acclimate to it. Subsequently, patients and their parents are instructed to activate the distalization screw by a quarter turn (0.25mm) twice a week. Monthly follow-up appointments are scheduled to monitor progress, during which the retaining clasps are adjusted until the necessary space for the eruption of the second premolar is achived.[61]

Lip Bumper Appliance

The equivalent of the lip bumper appliance used to gain space in the mandibular arch or to distalize the molars is the Denholtz appliance in the maxillary arch.[62] Molar bands are fabricated for the permanent first molars and welded to the buccal side of each molar band. Subsequently, the labial arch wire is attached to the buccal tube, and an acrylic button is prepared for the labial vestibule. To distalize the molar, the forces exerted by the lips are directly transferred to the buccal aspect of the first molar. This appliance is employed for minimal molar distalization in early deciduous dentition and is also beneficial for uprighting mesially tipped teeth to preserve arch space.[21]

Space Regainer and Space-Holder Appliance

The construction of the appliance is as follows: First, a band is custom-made fort he tooth to be supported, or a band of suitable dimensions is selected from ready-made sets. The band is then adapted to the mouth, and an impressions is taken using alginate impression material. To prevent overheating during the soldering process, the wire component to be placed in the edentulous area gap is positioned slightly away from the band on both sides of the tooth, with attention to the direction of tooth eruption. This "U" ring or the canine retractor is activated during the follow-up sessions to gain space. This appliance is indicated in cases where there is minimal space loss due to early loss of deciduous teeth. If there is loss of more than one deciduous tooth, the use of this appliance is not recommended.[63]

Orthodontic Implants and Mini Screws

Orthodontic implants utilized for anchorage are positioned in the palatal region for maxillary molar distalization. These implants can be utilized individually or in conjuction with other intraoral distalization appliances.[64-66]

Mini screws employed for distalization of the maxillary posterior segment are inserted between the 1st and 2nd molars in the palatinal region or between the 2nd premolar and 1st molar in the buccal alveolar bone. These screws facilitate distalization by exerting force on the 1st premolar or canine.[67,68] Mini screws are more commonly utilized due to their ease of insertion and removal, immediate loading capability, and affordable cost compared to mini-plates and palatal implants.[69,70] Mini screws can serve as anchors for maxillary molar distalization, either directly or indirectly. In direct anchorage, the forces involved in distalizing the upper molars act directly on the mini screw, potentially compromising anchorage. Conversely, indirect anchorage involves the mini screw supporting the teeth that receive the reactive forces, rather than traditional devices like the Nance button. However, this method may result to mesial tilting of the anchorage teeth and proclination of the anterior teeth, heightening the risk of anchorage loss.[71,72]

CONCLUSION

Early loss of deciduous teeth in children due to various reasons can lead to several significant issues in the future. If not identified and addressed early, this can result in mild to severe space loss.

There are various distalization systems that can be used for molar distalization, depending on the location, degree, and patient cooperation. However, it is important that each case be evaluated individually, providers make accurate indications, and that they regularly perform follow-up.

Ethical Approval

Since sources obtained from humans or animals were not used in this study, ethics *committee* approval was not obtained.

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Conflict of Interest

The authors deny any conflicts of interest related to this study.

Author Contributions

Design: MK, MM, Data collection and processing: MM, MK Analysis and interpretation: MM, MK Literatüre review: MM. Writng: MM, MK

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