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Case Report

Management of Midline Diastema Using Removable Orthodontic Appliances Combined with Frenectomy: A Case Report

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KEYWORDS

Midline diastema, removable orthodontic appliance, frenectomy

ABSTRACT

Introduction: A midline diastema is a gap between the maxillary central incisors that can lead to aesthetic, psychological, and social issues. Its etiology is multifactorial, with one contributing factor being a high-attachment superior labial frenulum, which may cause relapse following orthodontic treatment.

Case: A 22-year-old female patient presented with the chief complaint of a 1.5 mm gap between her upper front teeth, which significantly disturbed her appearance. The patient also had a habit of biting pencils and a history of relapses after previous orthodontic treatment.

Case Management: The patient was treated with removable orthodontic appliances consisting of active maxillary and mandibular plates. The active components included finger springs, a labial arch, and continuous springs, which were gradually activated during each follow-up visit. At the eighth follow-up visit, a frenectomy was performed at the Department of Periodontics due to the high attachment of the superior labial frenulum, which posed a potential risk for relapse. Removable orthodontic appliances have been reported to be effective in closing mild to moderate midline diastema, particularly through the tipping movement of anterior teeth. Patient compliance, controlled activation, and appropriate appliance design are critical determinants of success. Frenectomy also contributes to the stability of the outcome by eliminating soft tissue tension that could potentially reopen the diastema gap.

Conclusion: The combination of removable orthodontic treatment, frenectomy, and a retention phase with a retainer can yield optimal results in midline diastema cases. Comprehensive evaluation of etiological factors, patient adherence, and long-term monitoring are strongly recommended to prevent relapses.

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INTRODUCTION

In adults, after the eruption of permanent teeth, all interdental spaces should be closed according to the six keys of occlusion. According to Andrews (1972), the six keys of normal occlusion include: a molar relationship where the mesiobuccal cusp tip of the permanent maxillary first molar contacts the buccal groove between the mesial and central aspects of the permanent mandibular first molar in the sagittal plane, appropriate crown angulation and inclination of teeth, absence of tooth rotation, tight interproximal contacts, no gaps or crowding, and a flat curve of Spee. [1,2] However, in some cases, this space does not close and is referred to as a diastema. A diastema refers to a space between two adjacent teeth resulting from a discrepancy between tooth size and arch length. The presence of a gap in the anterior teeth, particularly between the maxillary central incisors, is termed a midline diastema. This condition may negatively affect dental aesthetics and facial harmony, resulting in an unattractive smile. Consequently, patients may experience psychological and social disturbances, including decreased self-confidence in daily activities.[3]

The etiology of midline diastema is multifactorial. Contributing factors include an enlarged labial frenulum, small tooth size (microdontia), the presence of supernumerary teeth such as mesiodens, small or missing lateral incisors, and cysts in the midline region.[4] Additionally, harmful habits such as thumb sucking, tongue thrusting, or lip sucking can also lead to the formation of a diastema.[5] Other influencing factors include tooth abnormalities, genetic factors, excessive inclination of maxillary incisors, jaw-tooth size discrepancies, and imperfect fusion of the interdental septum.[6]

Based on several studies, the prevalence of midline diastema in adults is reported to range from 1.6% to 25.4%. In children, the incidence is higher, approximately 98% at age 6, 49% at age 11, and decreasing to about 7% at ages 11–18 years. Midline diastema is more frequently found in males compared to females and is more common in Black populations compared to White, Asian, or Hispanic populations.[3]

Orthodontic treatment is one of the effective methods for correcting diastema. Although it requires a relatively longer time and higher cost, orthodontic treatment is highly appreciated by patients because it can provide optimal aesthetic and functional results.[7] One method that can be used is removable orthodontic appliances. These appliances consist of several components: an acrylic plate, springs, and expansion screws.[6,8] The main advantage of removable orthodontic appliances is that they can be removed and inserted by the patient themselves, thus maintaining better oral hygiene and appliance cleanliness. [8,9] One disadvantage of this appliance is that the tooth movement achievable is limited, with the primary movement being tipping or tilting of the tooth along its long axis.[8] Unlike fixed orthodontic appliances that can control tooth movement in three dimensions, the force delivered by removable orthodontic appliances is mediated by springs, elastics, or acrylic components that only make point contact with the teeth. Since no reactive force or couple is formed, in this condition, the removable appliance can only produce simple tipping movement of the teeth, while apical or bodily movement is not possible.[10]

CASE

A 22-year-old female patient presented to the Soelastri Dental Hospital in Surakarta with a chief complaint of a gap in her upper front teeth, which she felt significantly disturbed her appearance. The patient admitted to feeling less confident when interacting with others. She had experienced this

complaint for approximately twelve years. The patient had previously undergone treatment using a removable orthodontic appliance, but after the treatment was completed, a relapse occurred, and the gap reopened. The patient's history of harmful habits included a habit of biting pencils, which she had engaged in since junior high school. Regarding oral hygiene, the patient stated that she brushes her teeth regularly twice a day, in the morning after breakfast and at night before bed.

Extraoral examination results showed that the patient had a convex facial profile with a hyperbrachycephalic head shape, indicated by a cephalic index value of 93.9 mm, and a leptoprosopic facial type with a facial index value of 90.6. Simon's line examination on the maxilla revealed that the right side was retrusive at ½ canine, while the left side showed retrusion at the mesial ⅓ of canine. For the mandible, the right side was in a normal condition at the interdental area of canine and first premolar, while the left side showed retrusion at the distal ⅓ of canine. The patient's free way space examination showed normal results with a value of 3.8 mm.

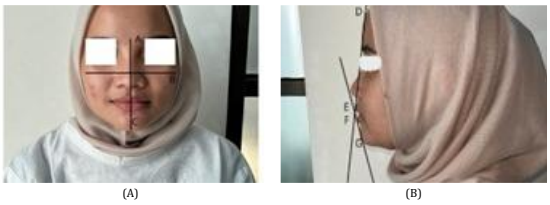


Figure 1. (A) Patient's facial profile from the front view, (B) Facial profile from the side view

Intraoral examination revealed an interdental gap between the maxillary central incisors (teeth 11 and 21) measuring 1.5 mm. The patient also had a high labial frenulum attachment, with a positive blanch test result. Additionally, an edge-to-edge relationship was found between teeth 23 and 33, with an overjet value of 2.5 mm and an overbite value of 2 mm. The first molar relationship on both the right and left sides was Angle Class I, as was the canine relationship on the right and left, which also showed a Class I relationship.

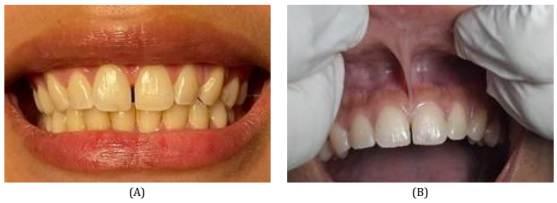


Figure 2. (A) Initial condition of midline diastema, (B) Condition of high labial frenulum attachment

Figure 3. (A) Initial condition of maxillary occlusal view, (B) Initial condition of the patient's mandible

Figure 4. (A) Patient's canine and first molar bite in the right region, (B) Canine and first molar bite in the left region

The study model analysis showed that the shape of the patient's maxillary and mandibular arches was parabolic. Several individual tooth malpositions were found, including tooth 16 in palatoversion, tooth 14 in mesiopalatoversion, teeth 11 and 21 in distolabiotorsiversion, tooth 25 in distolabiotorsiversion, tooth 33 in mesiolabiotorsiversion, teeth 31 and 41 in mesiolinguotorsiversion, and tooth 43 in mesiolabiotorsiversion. Furthermore, model analysis also

revealed a midline diastema between teeth 11 and 21 of 1.5 mm.

Based on the study model calculations, the Pont method results indicated growth and development towards mild lateral distraction in the first premolar region with a value of +0.9, and mild constriction in the first molar region with a value of –1.07. The Korkhaus method revealed protrusion of the dental arch growth in the anterior direction by 1.2 mm. Howes' method calculations showed a P index of 45.98%, indicating that the dental arch can accommodate teeth in an ideal and stable condition, while the FC index was 45.24%, indicating that the basal arch can also accommodate teeth in an ideal and stable condition. However, the canine fossa index was smaller than the premolar index, suggesting an inclination of posterior teeth showing divergence towards the occlusal, which is a contraindication for expansion. Meanwhile, the arch length discrepancy (ALD) measurement results showed that in the maxilla, there was an excess space of +1.6 mm, while in the mandible, a space deficiency of –0.8 mm was found.

Figure 5. (A) Study model of maxillary cast, (B) Study model of mandibular cast

Panoramic radiograph examination results showed periodontal tissues within normal limits, and no periapical lesions were found. Steiner analysis showed SNA angle (referred to position of the maxilla relative to the cranial base) values of 84°, SNB angle (referred to position of the mandible relative to the cranial base) values of 82°, and ANB angle (referred to the sagittal /anteroposterior relationship between the maxilla and mandible) values of 2°, indicating a Class I skeletal relationship. Interincisal measurement results showed INA (inclination of the upper incisors relative to the maxilla) values of 25° and INB (inclination of the lower incisors relative to the mandible) values of 31°, describing a tendency towards bidental protrusion. Soft tissue analysis revealed that the patient's upper and lower lips were located in front of the Steiner line, indicating a protrusive lip profile.

Based on these analysis results, the Steiner diagnosis was Class I skeletal relationship with bilateral protrusion and protrusive interincisal relationship, accompanied by a convex lip profile. The final diagnosis in this case was Angle Class I malocclusion type 1 according to Dewey, with a Class I skeletal pattern accompanied by bidental protrusion, convex lip profile, an edge-to-edge relationship between teeth 22 and 23 against tooth 33, and individual tooth malpositions. The malpositions found included tooth 16 in palatoversion, tooth 14 in mesiopalatoversion, teeth 11 and 21 in distolabiotorsiversion, tooth 25 in distolabiotorsiversion, tooth 33 in mesiolabiotorsiversion, teeth 31 and 41 in mesiolinguotorsiversion, and tooth 43 in mesiolabiotorsiversion. A midline diastema was found between teeth 11 and 21 with a gap size of 1.5 mm. The harmful habit factor contributing to this malocclusion condition was the pencil-biting habit that the patient had had since adolescence.

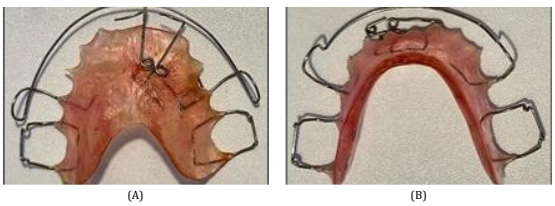
The prognosis for treating the midline diastema in this patient is good. Success largely depends on patient compliance, appropriate appliance design and activation, and control of etiological factors. The risk of failure or relapse may occur if the patient is non-compliant or if the main causative factors, such as the high-attachment labial frenulum, are not optimally managed.

(A) (B)

Figure 6. (A) Patient's panoramic radiograph, (B) Patient's cephalometric radiograph

CASE MANAGEMENT

The treatment plan for this case was carried out using a removable orthodontic appliance in a single stage, specifically an active plate. The orthodontic appliance design for the maxilla consisted of an acrylic plate with active components, including a labial arch with a reverse U-loop on teeth 15 and 25, finger springs on teeth 11 and 12, and a T-spring on tooth 14, along with retentive components such as Adam's clasps on teeth 16 and 26. Correction of the maxillary midline diastema was primarily achieved using finger springs, which were activated by holding the coil with pliers and moving the spring arm towards the target tooth using half-round pliers, thereby generating a mesial force to close the gap. In the mandible, the active components consisted of a labial arch with a U-loop on teeth 34 and 44, a continuous spring on teeth 31 and 41, and a Z-spring on tooth 42, with retentive Adam's clasps on teeth 36 and 46.



(A) (B)

Figure 7. Patient's removable orthodontic appliances (A) maxillary and (B) mandibular

The maxillary and mandibular removable orthodontic appliances were inserted on October 8, 2024, with the initial condition of a 1.5 mm midline diastema between teeth 11 and 21, and individual malpositions on teeth 14, 11, 21, 25, 32, 31, 41, and 42. At insertion, retention, stabilization, occlusion, soft tissue condition, and sharp parts of the appliance were checked, followed by patient education regarding usage instructions, minimum wear duration of 12 hours per day, cleaning methods, storage methods, and control schedule. The patient was also given direct practice instructions for inserting and removing the appliance with the aid of a mirror.

At the first control visit, periodic activation was performed on the finger springs on teeth 11 and 12 to move the teeth mesially, and activation of the labial arch to help reduce the diastema and correct anterior tooth malpositions. The spring was activated by opening the coil 1–2 mm or by moving the arm in the desired direction. For distal movement, the coil was placed on the mesial side of the tooth, while for mesial movement, the coil was placed on the distal side of tooth 11. A few days after the first control, the patient reported pain in the soft tissue area, so sharp areas were reduced and adjustments were made at the second control visit. Activation was continued gradually until the fifth control visit. At this stage, the diastema gap decreased from 1.5 mm to 0.8 mm, although some tooth malpositions persisted.

Figure 8. Method of finger spring activation

At the eighth control visit, the midline diastema was rechecked using a caliper. Measurement results showed that the diastema gap had reduced to 0.3 mm and most anterior tooth malpositions had been corrected. At this stage, it was decided to perform a frenectomy, considering the high-attachment labial frenulum still posed a potential risk factor for relapse, and to ensure complete gap closure.

Figure 9. Initial condition of midline diastema at the eighth control visit

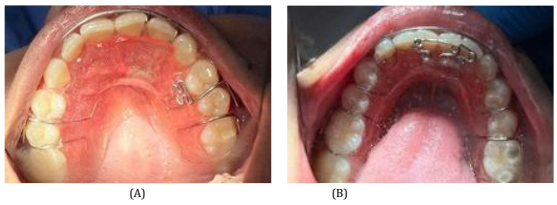


Figure 10. Condition of tooth malpositions at the eighth control visit: (A) maxilla and (B) mandible

The procedure was carried out by referring to the Department of Periodontology for definitive frenectomy management according to standard procedures. This procedure aimed to eliminate the excessive pull of the labial frenulum so that it would no longer be a causative factor for diastema reopening after orthodontic treatment. Frenectomy also supports the success and stability of treatment outcomes, as the tissue binding in the interdental area is removed. After the surgical procedure, the patient was advised to continue regular orthodontic check-ups and use a retainer as instructed, to ensure stable tooth positions and prevent relapse.

Figure 11. Clinical condition of the frenulum after frenectomy

At the tenth control visit, the midline diastema was rechecked, and examination results showed that the diastema gap had closed completely. The soft tissue condition post-frenectomy appeared well-healed, with no signs of inflammation or excessive scar formation. The previously high-attached labial frenulum no longer exerted any pull, thus supporting the stability of the correction results and reducing the risk of relapse.

Figure 12. Results of diastema gap and frenulum examination at the tenth control visit

As a documentation step, at this control, a study model impression was taken, which would also be used as the basis for fabricating a retainer. The subsequent retainer stage was planned to maintain the treatment results, considering that a history of midline diastema has a tendency to reopen if stabilization with a retainer appliance is not performed.

Figure 13. Results of midline diastema treatment at the tenth control visit

Figure 14. Treatment results in occlusal view (A) maxilla and (B) mandible

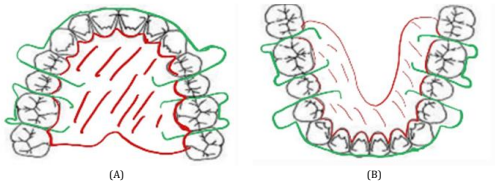


Figure 15. Retainer design (A) maxillary and (B) mandibular

DISCUSSION

Midline diastema is a relatively common malocclusion anomaly in the maxillary anterior teeth, characterized by a gap between the maxillary central incisors.[3] The etiology of diastema is highly varied, ranging from genetic factors, the presence of supernumerary teeth (mesiodens), harmful habits such as thumb sucking, jaw and tooth size discrepancies, to soft tissue factors such as a low-attached or thickened labial frenulum.[4,5,12]

In this case, the patient presented with a chief complaint of a midline diastema gap and individual tooth malpositions in both the maxilla and mandible. Clinical examination results showed a diastema of 1.5 mm between teeth 11 and 21 and tooth malpositions in the anterior region, so it was decided to perform treatment using removable orthodontic appliances in the form of maxillary and mandibular acrylic active plates.

The use of removable orthodontic appliances remains an option in simple cases that do not require complex tooth movements.[7,8] These appliances primarily work by producing tipping-type tooth movement through active components such as finger springs, Z-springs, T-springs, or modified labial arches. In this patient, the finger springs placed on teeth 11 and 12 functioned to provide a mesial force to close the diastema gap, while the labial arch with reverse U-loop and continuous spring helped correct teeth labially or lingually.[8] The principle of gradual activation at each control visit allows teeth to move slowly according to the biological capacity of the periodontal tissues, thus minimizing the risk of root resorption and patient discomfort.[13]

Treatment results showed a reduction in diastema size, from 1.5 mm to 0.8 mm at the fifth control visit and subsequently decreased to 0.3 mm at the eighth control visit, and the gap closed at the tenth control visit after frenectomy was performed post-eighth control. The initially crowded individual tooth malpositions began to correct towards a more ideal position. This demonstrates that the use of removable active plates is quite effective in managing simple midline diastema cases, provided proper activation is performed, and the patient is cooperative in wearing the appliance. The effectiveness of removable appliances also depends on patient compliance, as treatment success requires a minimum wear time of 12 hours per day.[4] Patient non-compliance in wearing the appliance can lead to treatment delays or even therapeutic failure.[14]

An obstacle encountered in this case was pressure from the acrylic baseplate after the first

control, which necessitated a reduction. This problem illustrates one of the disadvantages of removable orthodontic appliances, namely their susceptibility to exert pressure on soft tissues, potentially causing discomfort, irritation, or even ulceration if not promptly addressed.[15] This condition can reduce patient compliance in using the appliance, as patients tend to be reluctant to wear an appliance that causes pain.[15] Imprecise design and adaptation of the baseplate can also affect appliance stability, thereby reducing the expected effectiveness of tooth movement. Therefore, regular check-ups and good communication with the patient are essential to ensure the appliance remains comfortable to wear, while also monitoring treatment progress.[14]

Another aspect that requires attention is the risk of relapse in midline diastema cases, which is relatively high compared to other malocclusion cases. Relapse generally occurs when the underlying etiology is not addressed, especially the presence of a high and thick labial frenulum.[12] Several studies state that if the labial frenulum is left untreated, there is a tendency for teeth to return to their original positions even after orthodontic correction. In certain conditions, frenectomy is indicated to eliminate the mechanical obstacle posed by the frenulum.[16] In orthodontics, this procedure is recommended when the diastema is almost completely closed. The reason is that the frenulum can generate a repulsive force against mesial pressure, so ideal tooth movement is more easily achieved when the frenulum has not fully regenerated.[17] The retention phase also plays a crucial role in maintaining treatment results.[12] Removable or fixed retainers need to be used after active treatment is completed, with the aim of maintaining the stability of corrected tooth positions.[4,18] In this case, retainer fabrication was planned after taking study model impressions at the 10th control visit, when the diastema gap was fully closed.

Fundamentally, effective diastema treatment requires a multidisciplinary approach, especially in cases related to the frenulum, because interdisciplinary collaboration can enhance treatment success and reduce the risk of relapse.[17] In this case, the use of removable orthodontic appliances in the form of active plates proved capable of managing mild to moderate midline diastema, particularly when accompanied by anterior tooth malpositions that could still be corrected through tipping movement, with results showing closure of the diastema gap and improvement of tooth malpositions after 10 control visits. Frenectomy on the high-attached labial frenulum played an important role in preventing gap reopening, as it eliminated the tissue pull that is one of the etiological factors for relapse, thereby making the treatment results more stable.[16,19] Long-term success remains influenced by patient compliance, continuity of the retention phase, and comprehensive management of etiological factors so that treatment results can be maintained and relapse can be prevented.

CONCLUSION

The treatment of midline diastema with removable orthodontic appliances in the form of maxillary and mandibular active plates, in this case, proved effective in closing the diastema gap and correcting anterior tooth malpositions. The closure of the gap from 1.5 mm to complete closure within ten control visits indicates that appropriate appliance design, controlled activation, and patient compliance are key factors in therapeutic success. Frenectomy on the high-attached labial frenulum was an essential part of managing etiological factors, as it eliminated the tissue pull that could potentially cause relapse. This procedure supports

the stability of orthodontic treatment results and ensures that gap closure can be maintained in the long term. Colleagues are advised to always conduct a thorough evaluation of underlying etiological factors, ensure the retention phase with retainer use proceeds optimally, and perform long-term monitoring to prevent diastema recurrence.

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