



The midline diastema: a review of its etiology and treatment

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The continuing presence of a diastema between the maxillary central incisors in adults often is considered an esthetic or malocclusion problem.¹ For patients who consider a diastema unacceptable, active treatment is available. However, not all diastemas can be treated the same in terms of modality or timing. The extent and the etiology of the diastema must be properly evaluated. In some cases interceptive therapy can produce positive results early in the mixed dentition. Proper case selection, appropriate treatment selection, adequate patient cooperation, and good oral hygiene all are important.

The etiology, pathogenesis, and diagnosis of maxillary median diastema have been somewhat controversial over the years. The purpose of this paper is to review the published information and controversies regarding the etiology and treatment of the midline diastema in order to give the practitioner an overview to direct effective diagnosis and treatment.

Definition

The midline diastema is a space (or gap) between the maxillary central incisors (Fig 1). The space can be a normal growth characteristic during the primary and mixed dentition and generally is closed by the time the maxillary canines erupt.² For most children, the medial erupting path of the maxillary lateral incisors and maxillary canines, as described by Broadbent³, results in normal closure of this space. For some individuals, however, the diastema does not close spontaneously.³

Epidemiology

According to epidemiological investigations by Taylor⁴, Gardiner⁵, and Weyman⁶ (Table), the prevalence of median diastemas is high in children, decreases dramatically between 9 and 11 years of age, and continues a gradual decrease up to 15 years of age. Again, this pattern follows the

normal eruption pattern of the permanent maxillary lateral incisors and canines.⁷

Racial and gender differences also exist for diastemas. Lavelle and associates reported the prevalence of the maxillary median diastema was greater in Africans (West Africa) than in Caucasians (British) or Mongoloids (Chinese from Hong Kong and Malaya).⁸ Horowitz reported that black children, 10 to 12 years old, exhibit a higher prevalence (19%) of midline diastema than do white children (8%).⁹ Becker confirmed racial differences and stated that blacks and Mediterranean whites exhibit the midline diastema as an ethnic norm.¹⁰ In another study, Richardson and coworkers studied 5,307 children (2,554 blacks and 2,753 whites) 6–14 years old.

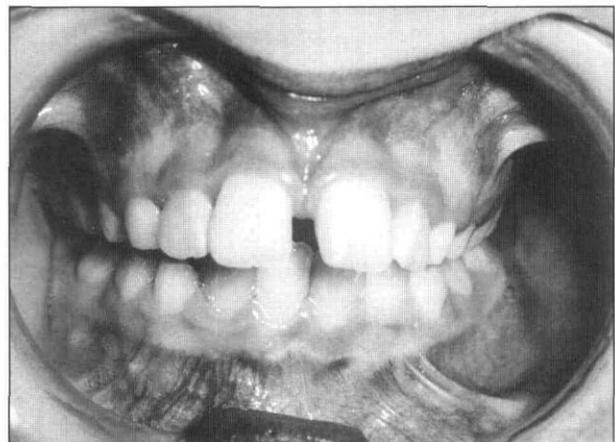


Fig. 1. An 8.5-year-old boy with a diastema between the maxillary central incisors.

TABLE. PREVALENCE OF THE MIDLINE DIASTEMA: SUMMARY OF CITED STUDIES

Prevalence in Population (%)	Age in Years									
	6	7	8	9	10	11	12	13	14	15
Taylor (1939)	97.0	87.7			48.7	48.7		7.0		
Weyman (1967)	44.4	52.0	49.1	45.8	17.7	21.2			7.4	5.3
Gardiner (1987)	46.0	48.0	43.0	33.0	10.0	11.0	18.0	12.0	20.0	7.0

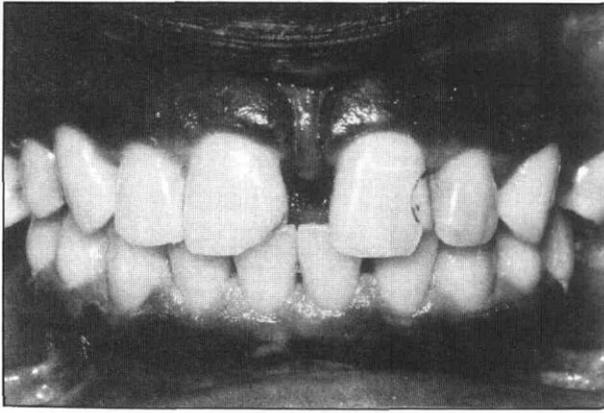


Fig 2. An 18-year-old African-American female with a midline diastema. Note: an enlarged and low frenum.

They found females in both races showed a higher prevalence than males at age 6; however, at age 14, males had a higher prevalence in both races.⁷

In general, maxillary midline diastemas occur in approximately 50% of children between 6–8 years of age but decrease in size and prevalence with age. Females exhibit a greater prevalence at this age; however, males show a greater rate by age 14.

The mandibular diastema is not a normal growth characteristic. The spacing, though seen less frequently than maxillary diastema, often is more dramatic. No epidemiologic data have been published on its prevalence. The primary etiologic factor in mandibular diastemas is tongue thrust in a low rest position.¹¹

Etiology

Frenum. The possible influence and treatment of the superior labial frenum in relation to the midline diastema have been of great interest to clinicians for many years (Fig 2). The superior labial frenum begins to form in the fetus at the tenth week of gestation. By the third month in utero the tectolabial frenum of the fetus — morphologically similar to the abnormal frenum of post natal life — extends as a continuous band of tissue from the tuberculum on the inner side of the lip, over and across the alveolar ridge to be inserted in the palatine papilla.^{2, 12–15} Before birth, the two lateral halves of the alveolar ridge unite and the continuous band of tissue becomes totally enclosed by bone. It is divided into a palatal portion (palatine papilla) and a labial portion (superior labial frenum) by this closure.¹⁶ With time the frenum appears to recede up the labial surface of the alveolar process. This movement actually is relative during the primary dentition, as new bone deposits increase the height of the alveolar ridge while the frenal attachment remains in place. With eruption of the permanent maxillary central incisors, the maxillary arch enters another period of vertical growth acceleration.^{16, 17}

The permanent maxillary central incisors are flared laterally at this time because the unerupted lateral inci-

sors constrain the roots of the centrals. The median diastema, which results from this flaring is normal and often is called the “ugly duckling stage” of the developing dentition. As the permanent maxillary lateral incisors and canines erupt, pressure is exerted medially, causing the space to close and the frenum to atrophy.¹⁶

In some cases the series of events just described does not occur. The two central incisors may erupt widely separated from one another and the rim of bone surrounding each tooth may not extend to the median suture. In such cases, no bone is deposited inferior to the frenum. A V-shaped bony cleft develops between two central incisors, and an “abnormal” frenum attachment usually results.^{16, 18} Transseptal fibers fail to proliferate across the midline cleft, and the space may never close.^{1, 18, 19}

In 1907, Angle suggested the frenum as a cause of midline diastema and outlined a method for its removal.²⁰ The assumption that an enlarged labial frenum was the sole etiologic agent led to advocating frenectomies in patients presenting with midline diastemas. By the middle 1900s, the abnormal labial frenum was believed to be an effect rather than a cause. In 1924, Tait stated that the frenum has no function and that its action, if any, in relation to the maxillary incisors is surely passive.²¹ Ceremello compared the frena of two groups, one with diastemas and the other without.¹⁷ He found no correlation between frenum attachment and diastema width, between frenum height and diastema, or between frenum height and frenum width. Dewel found the same results in a similar study.¹⁶

Enlarged and low frena do exist in the absence of a median diastema. Also, diastemas can exist without an abnormal frenum. Bergstrom and coworkers studied the effect of superior labial frenectomy and found that although closure progressed more rapidly in the frenectomized group than in the unoperated group, there was no difference in the final results after 10 years. These results intimate that frena may exert passive resisting mesial pressure, but are not an important etiologic factor in midline diastemas.²² Ceremello also demonstrated no relationship between diastema and the frena configuration.¹⁷

Midline bony clefts. V-shaped midline bony clefts may interrupt the formation of transseptal fibers and have been suggested as a cause of diastemas. Higley suggested that a slight cleft of intercrestal bone can hold the teeth apart.²³ Adams hypothesized that severe midline diastemas represent a mild fusion defect of bilateral embryonic elements and are a micro-type of midline cleft.¹ Bray found a high correlation between the pretreatment existence of “notching” and the relapse of orthodontically treated maxillary diastemas.²⁴ Stublely determined that transseptal periodontal fibers from the mesial side of the teeth proceed horizontally for a very short distance to the midline suture and then turn upward at 90°. ²⁵ This fiber pattern could account for the difficulty in the diastema closing spontaneously.

However, the infrequency with which such clefts appear in association with diastemas rules them out as a primary etiologic agent.

Multifactorial etiology. Researchers and clinicians now believe that multiple factors may contribute to a midline space^{13, 26-28} including oral habits, soft tissue imbalances, physical impediments, dental anomalies and/or dental/skeletal disharmonies, as well as normal dentoalveolar development as proposed by Becker,¹² Edwards,²⁶ Steigman,²⁹ Clark,³⁰ Bishara,³¹ and Campbell.¹⁹

1. Dentoalveolar diastemas associated with normal growth and development

The diastema can be a normal growth characteristic in some children as the permanent maxillary lateral incisors constrain the roots of the maxillary central incisors. The canines also can affect incisor roots in the same manner. It is also an ethnic norm for the races who have large dentoalveolar arches. Examples include: normal growth pattern in mixed dentition stage (Fig 3), and ethnic and familial tendency (particularly African and Mediterranean groups).

2. Pernicious habits

Prolonged pernicious habits can change the equilibrium of forces among the lips, cheeks, and tongue and cause unwanted dentofacial changes. The outward pressure from prolonged oral habits (light continuous force over 6 hr) with inadequate lips seal can cause the maxillary incisors to flare out, which leads to the midline diastema. Examples include: lower lip biting and digit sucking.

3. Muscular imbalances in the oral region

The dentition is in balance or equilibrium among various forces from the intraoral and extraoral soft tissues. The muscular imbalances in the oral region can break this balance and cause the teeth to move until the forces reach a new equilibrium. The soft tissues imbal-

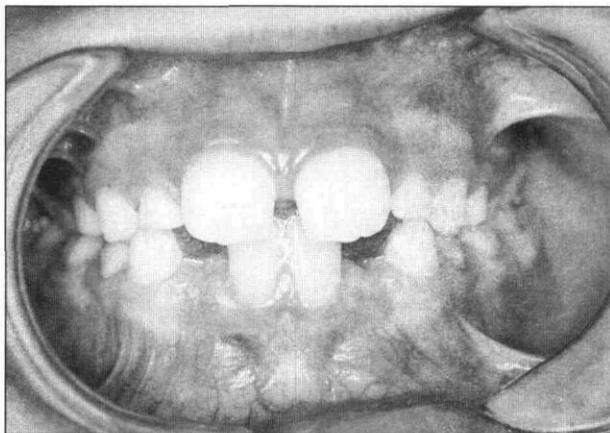


Fig 3. A 7-year-old with a midline diastema as part of normal growth and development in the mixed dentition. Note: the permanent central incisors are flared laterally because the unerupted lateral incisors place constraint on the roots of the centrals.

ances can be caused by: macroglossia due to a syndrome, or lymphangioma; flaccid lip muscles; and tongue thrust.

4. Physical impediment

An object can deflect the eruption pattern of the maxillary central incisors or physically move the incisors laterally to create midline spacing. Examples include:

- Supernumerary teeth (e.g., mesiodens), retained primary tooth (Fig 4)
- Persistent enlarged labial frenum
- Other midline pathology (cysts, fibromas)
- Foreign body and associated periodontal inflammation.

5. Abnormal maxillary arch structure

Tooth-size discrepancies are caused by excessively large maxillary arch size (rather than small teeth) or bony defects that inhibit approximation of the incisors. These abnormal maxillary arch structures include:

- Open suture, W-shaped, or spade-shaped
- Idiopathic midpalatal suture due to orthodontic or orthopedic treatment (e.g., rapid palatal expansion, Milwaukee Brace®)
- Excessive skeletal growth (associated with certain physical conditions such as cerebral palsy and endocrine imbalances such as acromegaly)
- Loss of bone support (periodontal disease, systemic disease).

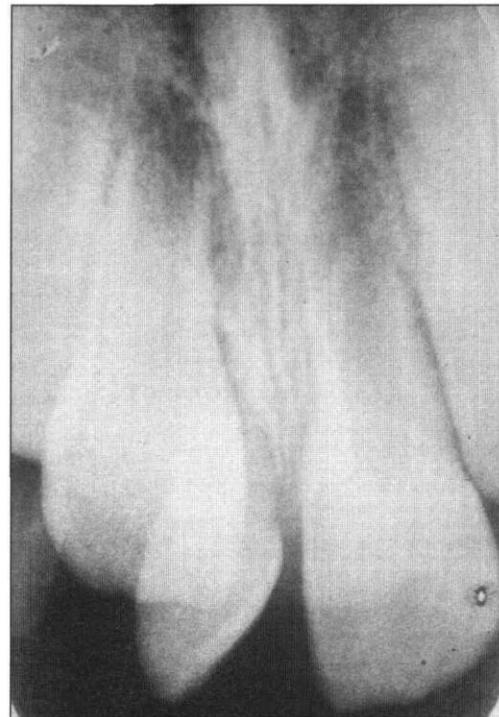


Fig 4. Periapical radiograph shows a developing midline diastema and a mesiodens between the maxillary permanent central incisors.

6. Dental anomalies and other malocclusions

Abnormal size, shape, or position of adjacent teeth can leave spaces between them that are not the result of other forces (e.g., muscular imbalances, excessive frenum tissue, etc.) These etiologies include:

- a. Tooth and/or arch size discrepancies including peg laterals (Fig 5),
- b. Missing teeth (congenital, from caries, or orthodontic treatment)
- c. Abnormal occlusal patterns such as rotated incisors, class II division 1 malocclusions (Fig 6).

Diagnosis and treatment

Because of the potential for multiple etiologies, the diagnosis of a diastema must be based on a thorough medical/dental history, clinical examination, and radiographic survey. Diagnostic study models also may be necessary for analysis and measurement when the diastema may be due to malocclusion, or tooth and/or arch size discrepancy. The medical/dental history should investigate any pertinent medical conditions (such as hormonal imbalances), oral habits, previous dental treatment and/or surgeries, and family history of diastemas or other related dental problems.

The clinical exam should include evaluation of possible pernicious oral habits, soft tissue imbalances (e.g., macroglossia), improper dental alignment (rotated teeth, excessive overbite/overjet), missing teeth, or other dental anomalies. The "blanching test" may be used to evaluate the frenal attachments.*

Panoramic and periapical radiographs are necessary to evaluate the patient's dental age and any physical impediments, abnormal suture morphology, missing teeth, dental anomalies, improper dental alignment, or abnormal eruption paths. In some instances, complete orthodontic records and a Bolton's analysis^{32, 33} may be necessary to rule out skeletal/dental malocclusions as well as possible jaw size and/or dental size discrepancies. Wise and Nevins have described examples using Bolton's analysis to develop appropriate treatment plans.³⁴

Proper treatment of a midline diastema will depend upon its etiology. Several treatment protocols have been proposed ranging from the classic frenectomy¹³ or orthodontic treatment,³¹ to even more radical procedures of subapical osteotomies, corticoectomies, septotomies,³⁵⁻³⁷ and reverse-bevel gingivectomies.³⁸ No single method can be used to treat all diastemas cases.

The success in closing diastemas depends upon the following treatment phases:

1. Accurate diagnosis of the specific etiology or etiologies
2. Pretreatment consideration of appropriate orthodontic objectives



Fig 5. A midline diastema due to tooth and/or jaw size discrepancies. Note: this patient had abnormally small permanent incisors.



Fig 6. Patient with class II division 1 malocclusion and a midline diastema. Note: this patient had a 7-mm overjet.

3. Treatment of the specific etiology or etiologies
4. Long-term retention and stability.

The etiologic categories described earlier are useful in determining appropriate treatment. This outline will be used to discuss some of these.

Because of racial and familial tendencies in some diastema cases, the practitioner should exercise sensitivity to the perception of the patient and his/her family when discussing a diastema and the need for treatment. Some may not see a diastema as a problem. For others, frustration at not being financially able to proceed with treatment should be handled professionally and compassionately.

1. Dentoalveolar diastemas associated with normal growth and development

In most cases, diastemas will close spontaneously as the canines erupt. Little disagreement can be found that intervention to close the diastema should be deferred until the canines have fully erupted.^{12, 31}

Diastemas of 2 mm or less will close on their own in the absence of a deep bite.²⁷ In a few instances, a diastema of 3 mm or more may indicate the need for

* In 1961 the "blanch test" was proposed by Graber to demonstrate a continuity of the tissue fibers of the labial frenum through the diastema to the palatine papilla.²⁰ This test is accomplished by lifting the upper lip upward and forward until the frenum is tightly stretched. If the procedure produces a blanching or change of contour in this area, the frenum is considered abnormal.

orthodontic closure with removable and/or fixed appliances prior to canine eruption.³⁹ Generally, diastemas more than 2 mm require active intervention. Removable appliances generally close diastemas by tipping the crowns of incisors, but there is a strong tendency toward relapse. Fixed appliances provide better control of dental alignment. In the mixed dentition, caution is necessary to avoid tipping the roots of lateral incisors distally such that they interfere with the erupting path of the canines. Orthodontic treatment will be described in more detail later in this article.

2. Pernicious habits

Closure of the diastema should be deferred until the oral habit stops. In most cases, the oral habit can be treated with the sequential application of increasingly aggressive treatments. Evaluating the emotional components of the habit will often reveal the timing and type of psychological approach necessary.⁴⁰

After discontinuing the oral habit, patients with persistent diastemas may require orthodontic treatment to correct the malocclusion. If appliance therapy becomes necessary to terminate the habit, consideration of any retention needs for the corrected diastema may affect the appliance design. Specially constructed devices such as oral screens, Hawley appliances with tongue restrainer, fixed-type tongue cribs or a modified Quad helix appliance (with a large tongue loop) can help to terminate a digit-sucking habit.⁴¹ Most of these devices use the maxillary teeth for anchorage and some form of wire as a deterrent to finger positioning. In cases of abnormal lip habits, functional appliances such as a lower lip bumper can inhibit the muscular pressure on the teeth.⁴¹ When the habit ceases, the appliances should be retained for approximately 3 months to ensure that the habit has truly stopped.⁴²

Diastemas caused by habits will gradually decrease in size after terminating the habit until forces from the intraoral and extraoral soft tissues reach a new equilibrium. Patients need to be observed closely during this time to determine if further tooth movement will occur spontaneously. Orthodontic appliances may be required to close the remaining space after the maxillary canines are erupted completely.

3. Muscular imbalances in the oral region

Midline diastemas can be caused by orofacial muscular imbalances such as macroglossia, tongue thrust, improper tongue rest position, and/or flaccid lip muscles. If these muscular conditions do not change, a dramatic reopening of the diastema immediately following any orthodontic closure of the space may occur. For long-term stability causative conditions should be eliminated if possible; otherwise, some type of permanent retention should be considered.¹¹

In cases of tongue thrust and/or improper tongue rest position, treatment may require the patient to wear an appliance such as a tongue crib appliance to learn to position the tongue properly. Again, the diastema may

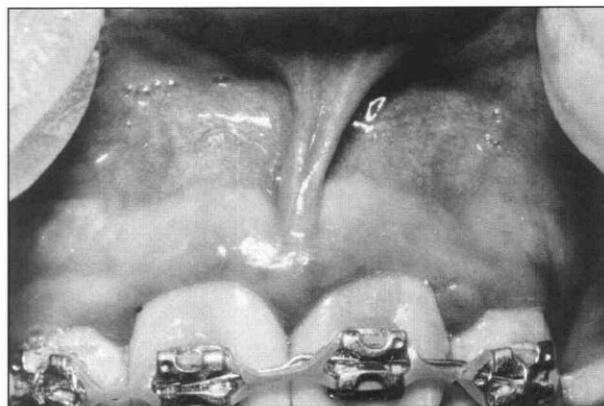


Fig 7. A maxillary midline diastema associated with an enlarged frenum closed by orthodontic treatment involving a sectional arch wire and a power chain elastic. The power chain is stretched from the mesial wing of one lateral incisor bracket through the brackets of the centrals to the mesial wing of the other lateral. Note: the surgical repair of the frenum has healed well, and orthodontic retention is maintained during healing.

decrease in size spontaneously following termination of the habit. Orthodontic appliances, such as an arch wire with closing loops or with power chain elastics, are often required to close any remaining space in the late mixed dentition or early permanent dentition. After closing the diastema, a fixed permanent retainer, such as a lingually bonded wire or a bonded casting lingual prosthesis, may be necessary to maintain long-term stability.

In some instances, patients should be evaluated for macroglossia. Partial glossectomy has been reported as a post-treatment alternative to maintain the stability after diastema closure.¹¹

In cases of flaccid lip muscle, patients should be referred for medical evaluation/surgical intervention. A fixed splint also may be required to maintain stability after the retraction of flared and spaced incisors.

4. Physical impediment

Physical impediments causing diastemas can be divided into two categories: 1) those not adjacent to the root apex of incisors, and 2) those adjacent to the root apex of incisors. For the former, the obstruction (mesiodens) should be removed upon detection. For the latter, however, surgical removal should be deferred until incisor root formation is almost complete. Orthodontic diastema closure may be needed later for patients whose diastemas do not completely close spontaneously after removing the physical impediment.

The role of the maxillary frenum in midline diastemas already has been discussed. The current consensus among clinicians is that the diastema needs to be corrected initially with orthodontic treatment and subsequent retention^{26,27,31,43} (Fig 7). When the diastema persists after eruption of the maxillary canines, excessive bunching of tissue continues once the diastema has been closed orthodontically, or the space reopens upon

removal of retention — then surgery is indicated. Frenectomy and circumferential supracrestal fibrostomy may be necessary to prevent relapse in conjunction with orthodontic treatment. Soft tissue surgery should be initiated only after the diastema has been reclosed. This sequence of treatment is necessary to avoid possible postoperative scar tissue that may interfere with orthodontic treatment.³¹ In some cases it may be difficult to close the space completely prior to a necessary frenectomy because the tissue becomes painful and traumatized. In these cases, after the surgery has been performed, the space should be closed immediately.⁴³ Permanent retention will be necessary in most frenum cases.

However, the current consensus among clinicians is that the diastema needs to be corrected initially with orthodontic treatment and indefinite retention. If the space reopens, it is not necessary to remove all the tissue from a low attached hyperplastic frenum. In the classical frenectomy, the frenum, interdental tissue, and palatine papilla are completely excised, which frequently results in unacceptable esthetic result (a dark space in the interdental area due to elimination of the interdental papilla). Edwards proposed a modified technique that consisted of: 1) apically repositioning of the frenum (with exposure of alveolar bone), 2) destroying the transeptal fibers in the interdental zone of the central incisors, and 3) excising excessive frenal tissues.^{26,27} With special functional and esthetic considerations, Miller reported a new frenectomy method combined with a laterally positioned pedicle graft.⁴⁴ This technique can provide a primary closure and form a contiguous collagenous band “scar” across the midline to prevent orthodontic relapse. This approach also averts esthetic loss (loss of the interdental papilla) by maintaining the interdental tissues.

Abnormal frena, though not representing a main factor in midline spacing, may cause inflammatory periodontal destruction. The efficient use of a tooth brush often is inhibited because of the close proximity of the frenal tissue to the margin of the gingiva or the interdental papilla.⁴⁵

Other physical impediments (e.g., cyst, fibroma) usually are diagnosed with radiographic surveys, but histological evaluation also may be indicated. Surgical intervention is indicated for the majority of these cases. In cases of very large diastemas (≥ 4 mm), orthodontic treatment may be initiated before eruption of the permanent canines after sufficient healing of the supporting tissues.

Midline diastemas also can be caused by a foreign body and associated periodontal inflammation. Platzer reported a case of a midline diastema resulting from a caraway seed positioned subgingivally. One month after its removal, the diastema was no longer present.⁴⁶

Iatrogenic diastemas also can occur. Besides the temporary diastemas caused by some maxillary expansion appliances (e.g., Rapid Palatal Expansion [RPE] appli-

ance), improper orthodontic techniques also can create a diastema, as well as other problems. Verluyten reported a case in which an elastic that had been placed around the central incisors to close a diastema had worked its way subgingivally toward the tooth apices.⁴⁷ The continuing constriction of the elastic towards the apices caused root approximation, an increased diastema, and a significant periodontal defect. Because of these potential deleterious effects, this technique is not recommended for diastema closure.

5. “Abnormal” maxillary arch structure

An open midpalatal suture or skeletal cleft may prevent normal space closure. In these cases, fixed-type orthodontic treatment is highly recommended following any surgical repair of the supporting tissues. Because of the high relapse tendency, several retentive devices and procedures have been proposed. These include staple pin,⁴⁸ hygienic V-shaped wire,⁴⁹ micro-magnets,⁵⁰ resin-bonded fixed prosthesis,⁵¹ and soft tissue surgery, particularly circumferential supracrestal fibrostomy.^{13,26,27} Permanent retention (e.g., lingually bonded twist wire or casting prosthesis) usually is required in patients with these types of diastemas.

Diastemas often are associated with endocrine imbalances such as acromegaly. Excessive maxillary growth can lead to spaces between the teeth. Corrective oral and maxillofacial surgery, such as mandibular osteotomy and partial glossectomy, may be implemented to improve the facial imbalance, but only if definitive treatment of the endocrine imbalance has occurred (e.g., surgery, irradiation, dopamine agonist).^{52,53} The oversecretion of growth hormone also can cause the soft tissue thickness that leads to the characteristic coarsening of facial features. The soft tissue imbalance can be reversed partially after the etiology (e.g., pituitary adenoma) is removed. Plastic surgical intervention usually is not required to reverse the soft tissue abnormalities.⁵⁴

Midline diastema also can result from orthodontic treatment (e.g., rapid palatal expansion) or an orthopedic appliance (e.g., Milwaukee Brace®). For the former, the spacing is temporary and will close without help. For the latter, after discontinuing the treatment, orthodontic closure should not be initiated until the dentition becomes more stable.¹²

6. Missing teeth, dental anomalies and other malocclusions (e.g., class II division 1)

Various occlusal problems often are associated with diastemas. These problems include missing teeth, dental anomalies, dental/jaw size discrepancies, and/or excessive overbite and overjet. Diagnosing these cases requires complete orthodontic records and cephalometric analysis as well as tooth-size analysis (e.g., Bolton's^{32,33}). Treatment plans also should consider the facial type, esthetics, treatment time, and cost.

Orthodontic closure of the midline diastema can be divided into four groups:

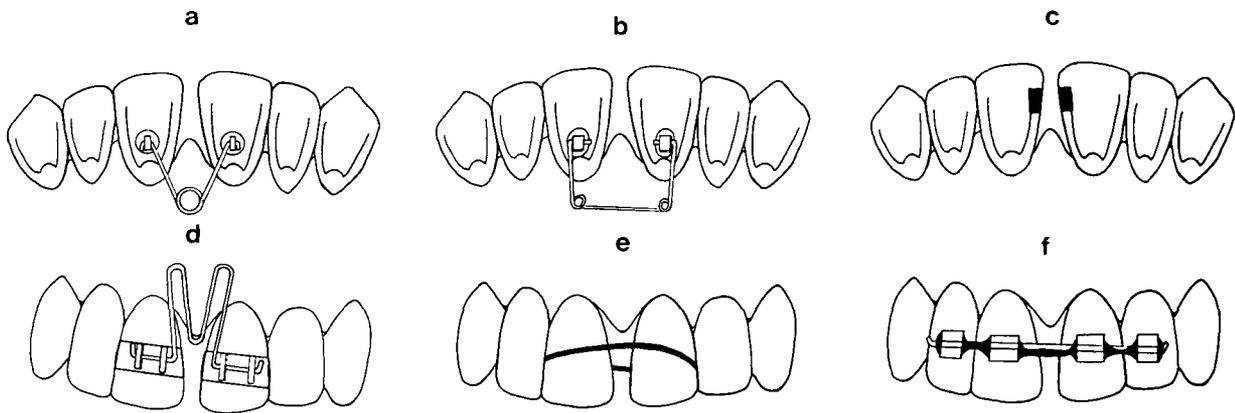


Fig 8. Tooth movement appliances to close the diastema.

Fig 8a,b. Lingually bonded diastema-closing systems. These devices involve a U- or V-shaped sectional wire and double helical closing loops, which are bonded directly to the incisors or attached to the tubes. These appliances can be used on either the labial or the lingual surfaces. After the space is closed, a straight sectional wire is placed, which serves as a retainer.

Fig 8c. Two small neo-dymium-iron-boron (NIB) magnets attached to the palatal surface of the central incisors serve as a fixed-type retainer. This technique includes: 1) placing a magnet on either side of an acetate strip, 2) placing the strip between the incisors and gently pulling it buccally to bring the magnets into contact with the palatal surface of the incisors, 3) placing composite resin

to ensure the fixation of the magnets, and 4) removing the acetate strip.

Fig 8d. An M-shaped diastema-closing device tied onto the bands carrying edgewise brackets. The M-shaped spring is narrower than the distance between these two brackets and is stretched for attachment onto the brackets. The compressive force from the activated spring will close the diastema.

Fig 8e. Use of an elastic around the clinical crowns. Although this was a common diastema-closing technique, patient compliance and treatment control is often difficult. *This technique is no longer recommended and is shown only for completeness.*

Fig 8f. A sectional wire and a power chain elastics are used to bodily close the midline diastema.

1. Treatment involving mesial tipping movement of incisors
2. Treatment involving mesial bodily approximation of the incisors
3. Treatment involving the decrease of an enlarged overjet
4. Closing the space as part of more comprehensive orthodontic treatment.

Treatment involving mesial tipping movement of incisors

In some cases, orthodontic closure of the diastemas is limited to the central incisors. In patients with good posterior occlusion or who have economic considerations, the diastema can be closed simply with removable orthodontic appliances. A removable Hawley appliance with finger springs is commonly used. Simple fixed appliances often have been used.^{55, 56} These devices involve a U- or V-shaped sectional wire and some double-helical closing loops and are bonded directly to the incisors or attached to lingually bonded tubes. Micromagnetic devices have been described.⁵¹ These fixed appliances also can serve as post-treatment retainers (Fig 8). Diastema closure in these cases should be deferred until the canines erupt.

Treatment involving mesial bodily approximation of the incisors

In certain instances closing a diastema requires bodily approximation of the incisors. Full banded/bracketed orthodontic arch appliances can move incisors bodily to close the space. However, if time or cost factors prohibit this type of treatment, or if the diastema is the only malocclusion needing treatment, sectional arch wire techniques are a useful alternative.⁵⁷ This technique involves bonding brackets directly on the four maxillary incisors and using a 0.018-in. sectional wire. An elastomeric chain or elastic thread should be placed from the mesial wing of one lateral incisor bracket through the brackets of the centrals to the mesial wing of the other lateral. Overstretching the elastomeric chain can cause unwanted mesial rotation of the lateral incisors if the elastomeric chain is connected from the distal wing of one bracket to the distal wing of the other. Treatment with a "2x4 appliance" or utility arch can provide better control of incisors during closure of the midline spaces and also can retract any minor incisor flaring. Although treatment is best delayed until canine eruption, it can be initiated after the lateral incisors have erupted.

Treatment involving the decrease of an enlarged overjet

Many cases of procumbent maxillary incisors demonstrate overeruption of the incisors in both arches. Decreasing the overjet by simply moving the incisors lingually can cause a significant increase in anterior overbite and may be difficult because the incisors may already be in occlusal contact. Removable appliances often will cause this unwanted overbite and should be used carefully and only in patients with minimal overbite and when the maxillary incisors are not in contact with mandibular incisors. Hawley-type retainers with a labial bow and clasps are useful for this limited therapy. In most cases of enlarged overjet, treatment requires the use of a full-arch fixed appliance technique to intrude the incisors while closing the diastema. Both arches may require treatment. In some of these cases headgear may be needed for appropriate anchorage.

Diastema closure as part of overall orthodontic treatment

In general, fixed-type appliances can provide better control in crown/root angulation, overbite, and overjet. Bracketed/banded appliances can close diastemas due to improper tooth inclination, deleterious occlusal patterns, posterior bite collapse, deep bite with insufficient torque, or skeletal and/or dental class II division 1 malocclusion. Some patients may need to wear a headgear or Class II elastics to distalize the posterior teeth. Class I relationships should be achieved before the diastema is closed. Removable orthodontic appliances can be used cautiously in diastema cases with Class I dental and/or skeletal relationship and mild or acceptable overbite.

In cases of midline diastemas caused by missing teeth, the spaces can be closed orthodontically and/or reconstructed with fixed/removable prostheses after redistributing the spaces with orthodontic treatment. In some other cases, the spaces can be closed with restorative intervention (e.g., tooth recontouring with composite resin).⁵⁸ Restorative corrections also should be deferred until after canine eruption in cases in which spaces exist between most teeth or the peg laterals are very narrow. Most cases of small teeth do not allow for complete space closure. After the space is redistributed, removable and/or fixed restorative treatment is needed to finish space closure as soon as possible. Permanent retention is necessary.

Since most maxillary midline diastemas recur after even the best-managed treatment, permanent retention is required in most cases. A lingually bonded fixed retainer is recommended. A flexible wire is bonded to the central incisors near the cingulum to keep out of occlusal contact. If necessary, the bonded wire may extend to the lateral incisors and even the canines. A removable retainer is not the treatment of choice because tooth movement that occurs as the appliance is removed (and subsequent drifting) and replaced (mov-

ing the tooth back into position) may be damaging over a period of time.⁵⁹ The importance of good life-long oral hygiene around the permanent retainer must be emphasized to the patient.

When a fixed retainer is not acceptable, use of a partial denture, a removable appliance with finger springs, prosthetic crowns (e.g., porcelain veneers, porcelain fused to metal), or composite build-ups may be necessary to close any space that has recurred. Prosthetic crowns or composite build-up techniques also can be used as treatment in lieu of orthodontics in mild cases.

Summary

A midline diastema usually is part of normal dental development during the mixed dentition. However, several factors can cause a diastema that may require intervention. An enlarged labial frenum has been blamed for most persistent diastemas, but its etiologic role now is understood to represent only a small proportion of cases. Other etiologies associated with diastemas include oral habits, muscular imbalances, physical impediments, abnormal maxillary arch structure, and various dental anomalies.

Effective diastema treatment requires correct diagnosis of its etiology and intervention relevant to the specific etiology. Correct diagnosis includes medical and dental histories, radiographic and clinical examinations, and possibly tooth-size evaluations. Appropriate treatment modalities have been described.

Timing often is important to achieve satisfactory results. Removal of the etiologic agent usually can be initiated upon diagnosis and after sufficient development of the central incisors. Tooth movement usually is deferred until eruption of the permanent canines, but can begin early in certain cases with very large diastemas.

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