Differential Diagnosis and Combined Treatment of Maxillary Midline Diastema Caused by Labial Fraenum and/or Intermaxillary Suture

SUMMARY

Midline diastema between maxillary central incisors is a common occurrence, especially in primary and mixed dentition. Its presence has been attributed to genetic and/or environmental factors. However, it is often a normal characteristic of growth. Many times the development of upper midline diastema is related to the presence of hypertrophic or inferiorly attached upper labial frenum and/or imperfect fusion at the midline of premaxilla. These 2 conditions are frequently confusing in clinical practice, thus the diagnosis and treatment of the problem would be false. The probable therapeutic approaches for the maxillary midline diastema provoked by abnormal labial frenum and/or intermaxillary suture include orthodontics, restorative dentistry, surgery or various combinations of them. The necessity of treatment is mainly conducted by aesthetic and psychological rather than functional reasons. Irrespectively of the optional treatment, permanent retention of the result should be adapted in most cases. The purpose of this study was to analyze the relation between hypertrophic or inferiorly attached upper labial frenum and imperfect fusion at the midline of premaxilla, with the maxillary midline diastema. Additionally, appropriate clinical and laboratory examinations are described, plus therapeutic alternates, which are proposed in each case.

Keywords: Maxillary Midline Diastema; Upper Labial Fraenum; Intermaxillary Suture

INTRODUCTION

In 9-year-old children the prevalence of maxillary midline diastema is high, with a 48.8% rate of children presenting diastema larger than 0.5 mm, but this rate is decreased with age. In adults, the prevalence of upper midline diastema is considered to range between 1.6% and 25.4%. In the majority of studies the predominant opinion is that the upper midline diastema occurs under the effect of multiple environmental factors. Moyers examined 82 patients with upper midline diastema and reported the following causative factors: (a) imperfect fusion at midline of premaxilla (32.9%); (b) enlarged or malposed upper labial frenum (24.4%); (c) midline diastema as part of normal growth (23.2%); (d) congenitally missing lateral incisors (11%); (e) supernumerary teeth at the midline (3.7%); (f) unusually small teeth (2.4%); and (g) combination of imperfect fusion and congenitally missing lateral incisors (2.4%). Furthermore, additional causes for the development of upper midline diastema have been reported in the literature, such as para-functional oral habits, increased overbite of anterior teeth, or pathologic teeth migration due to periodontal disease.

IMPERFECT FUSION AT MIDLINE OF PREMAXILLA

The relationship between the imperfect fusion at the midline of premaxilla and the upper midline diastema has
been recognized over the past years, but it did not gain too much emphasis. The discontinuity of the bony plates may be superficial or extend deeper in the alveolar process. The gap within the maxilla is occupied by epithelial and connective tissue. Often fraenum or gingival fibres (especially interdental fibres) are attached at that site. Normally, interdental fibres functionally contribute in the retention of the teeth in position. Because of the disturbance of the continuity and arrangement of the interdental gingival fibres, their ability to resist in expressed forces to teeth is compromised. As a result, there is a tendency for distal movement of upper central incisors, leading in some cases to the development of midline diastema. For the same reason, this diastema is usually accompanied by rotation of upper lateral incisors and ectopic eruption of canines. Moyers stated that imperfect fusion at the midline of premaxilla is the most common cause of maxillary midline diastema, with a rate of 32.9%. Also, Popovich et al suggested that the combination of imperfect fusion with several other predisposal factors is the most significant cause of maxillary midline diastema.

The diagnosis of imperfect fusion at midline is performed radiographically. It is fundamental for the central ray to be precisely perpendicular to the alveolar process. The normal radiographic image of the suture is a V-shaped structure (Fig. 1). The suture is characterised pathologic: (a) when it is displayed wider than normal (approximately 2mm) (Fig. 2); (b) when a circumscribed irregular ovoid area (spade-shaped) is displayed in this region (Fig. 3); or (c) when the alveolar process is W-shaped in the region between the maxillary central incisors, in cases with extended separation of the bone plates (Fig. 4a). The latest 2 instances are often accompanied by abnormal labial fraenum.

Management consists of orthodontic closure of the diastema, followed by a surgical intervention in the suture. The orthodontic closure of the diastema is performed first, so that tissue healing and fibre remodelling take place in the new position, where we desire to retain the final treatment outcome. In cases where the imperfect fusion makes the diastema closure impossible, the surgery must be performed before the closure of the midline diastema. During the surgical procedure, a trapezoidal flap with 2 perpendicular incisions (bilaterally to the midline interdental papilla), which are joined with a horizontal incision at the interdental gingiva, is created. After the
remains the same independently to the implementation of diastema closure in patients with abnormal fraenum, cause of the maxillary midline diastema. Several authors do not differentiate from this aspect, as Moyers does. He supports that the upper labial fraenum is the second commonest cause of this condition, with an incidence of 24.4%. Referring to the fraenum composition, it consists of epithelium, collagen fibres, blood vessels and nerves, and sometimes few elements of minor salivary glands and isolated stratified muscle fibers. Henry et al. in the remarkable histological study concluded that, except from the elements mentioned above, there are also elastic fibres, which extend sometimes to the whole length of the fraenum, even perforating the periosteum. Those authors considered that the harmful effect of the fraenum is due to the presence of the elastic and collagen fibres, while no evidence of substantial differences in composition of normal and abnormal fraena were identified.

There is controversy among researchers concerning the presence of an immediate causative relation between hypertrophic or inferiorly attached upper labial fraenum and the maxillary midline diastema. Several authors do not support the existence of this relation. Tait considered that the fraenum has no effect to the maxillary central incisors, while Ceremelo concluded that the fraenum is not related to the presence or the width of the diastema. Bergstrom et al. stated that the long term potential for spontaneous diastema closure in patients with abnormal fraenum, remains the same independently to the implementation of a previous surgical intervention. Popovich et al. suggested that the presence of the diastema leads to the abnormal fraenum and not the adverse.

In contrast, several authors stated that the fraenum is involved in the pathogenicity of the midline diastema. Adams suggested that a specific type of fraenum, which is not necessarily large but interrupts the continuity of interdental fibres, forms the factor that inducts the reactions for the development of the diastema. Otherwise, this author supports that diastema develops only when there is additional presence of other predisposing factors. Campbell et al. supported the same statement as well. The disruption of the interdental (trans-septal) gingival fibres continuity, due to the fraenum, is considered by several studies as presupposing for the development of a pathological diastema. Edwards supported the presence of a strong but not absolute correlation between the fraenum and the upper midline diastema. Shashua and Artun failed to confirm the relation between relapse and imperfect fusion at midline of premaxilla.

**Hypertrophic or Inferiorly Attached Upper Labial Fraenum**

The hypertrophic or inferiorly attached upper labial fraenum is considered for many years the commonest cause of the maxillary midline diastema. Several authors do not differentiate from this aspect, as Moyers does. He supports that the upper labial fraenum is the second commonest cause of this condition, with an incidence of 24.4%. Referring to the fraenum composition, it consists of epithelium, collagen fibres, blood vessels and nerves, and sometimes few elements of minor salivary glands and isolated stratified muscle fibers. Henry et al. in the remarkable histological study concluded that, except from the elements mentioned above, there are also elastic fibres, which extend sometimes to the whole length of the fraenum, even perforating the periosteum. Those authors considered that the harmful effect of the fraenum is due to the presence of the elastic and collagen fibres, while no evidence of substantial differences in composition of normal and abnormal fraena were identified.

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Regarding the physiology of the upper labial fraenum and its relation with age, the fraenum found to be smaller in length, thicker and more inferiorly attached in infants. Normally, the fraenum does not follow the growth of the alveolar process that occurs during tooth eruption, since the erupting central incisors exercise pressure on it. This fact makes the fraenum appear to be at a more nasal position with age, while in fact, it remains more or less in the same position. In certain instances, the fraenum attachment does not obviously “migrate nasally” by the elapse of time, but continues to develop between the 2 upper central incisors and remains there forming a residual fibre zone. More detailed, these fibres can be attached to the periosteum and to the connective tissue of the abnormal intermaxillary suture, or only disrupt the continuity of the interdental gingival fibre system. Under these circumstances, we must not expect spontaneous correction of the diastema with the eruption of the maxillary lateral incisors and canines. It is obvious that the nearer to the incisive papilla and the deeper within the tissues the fraenum is attached, the more possible for it to cause a diastema. The sum of these clinical data should be always taken under consideration, concerning the age and the other parameters which affect the problem. Popovich et al. supported the presence of an adverse relationship between the inferiorly attached and/or hypertrophic fraenum and maxillary midline diastema. They stated that due to the presence of the diastema the fraenum still develops coronally, along with the alveolar process, as teeth erupt. This happens because the dentition exerts minor or zero pressure on the fraenum.

Occasionally, when the fraenum fibres are inserted quite deep, the hypertrophic or inferiorly attached upper labial fraenum could be diagnosed by simple clinical observation (Fig. 5) or by observing ischaemia provoked at the interdental papilla when stretching the upper lip (Fig. 6). According to Miller, the fraenum should be judged as pathological when it is uncommonly wide, when there is insufficient attached gingival zone in the midline (Fig. 7), and when the interdental papilla moves by stretch of the fraenum. However, the evaluation of the fraenum is sometimes difficult, especially in borderline cases.
This specific pathological situation is treated with orthodontic closure of the maxillary midline diastema, followed by surgical intervention\textsuperscript{22,27,41}. The orthodontic appliances must be kept in place during the whole phase of healing (Fig. 8,a-c). With this approach, the new scar tissue that is going to be formed will contribute in the desirable retention of the result of treatment\textsuperscript{69}. The above should be advocated only if the diastema remains open after the eruption of permanent canines\textsuperscript{19,26,39}. Nevertheless, in specific cases, when the fraenum is significantly hypertrophic and so inhibits the orthodontic closure of the diastema, surgical intervention is required at an earlier stage than usual\textsuperscript{69}.

Various surgical techniques have been described for the management of the abnormal upper labial fraenum that causes a midline diastema. Those include: (a) the classic technique of frenectomy, in which the fraenum, the interdental soft tissue, and the palatal interdental papilla are completely removed, leaving uncovered bone or periosteum; (b) osteotomy of alveolar process under the apices of the teeth\textsuperscript{10}; (c) corticotomies\textsuperscript{33}; (d) septotomies\textsuperscript{62}; (e) “Z-plasty” technique, which does not reposition the fraenum but aims to reduce the traction that is exerted from the fraenum to the interdental soft tissues\textsuperscript{36}; (f) reverse-bevel gingivectomy; (g) circumferential supracrestal fibrotomy technique\textsuperscript{16}; and (h) frenectomy in combination with free gingival graft from palate. This technique seems to create aesthetic problems because of a difference in the colour between physiological gingiva...
and transplantation site. Possibly, the most effective and less invasive surgical technique for the treatment of the hypertrophic or inferiortly attached upper labial fraenum still is the one proposed by Edwards. This technique includes 3 different steps: (1) apical reposition of the fraenum with apicalisation of alveolar bone; (2) distraction of interdental (transseptal) fibres between approximated central incisors; and (3) gingivaloplasty or re-contouring of gingiva at the labial or palatal interdental papilla when it is necessary. Moreover, with purpose to further decrease the potential for relapse, it is seemingly important to remove the elastic fibres that impregnate the periostium underlining the fraenum, because nowhere in the normal human periodontium is there such an elastic tissue involvement with attached gingiva. The major purpose of the current procedure is to reposition the fraenum from the site of diastema by a triangle incision which is performed from the top to the base of the fraenum. The remaining area is healed within 7-10 days, with full epithelization completed in 2-3 weeks. In cases with more aesthetic expectations, the technique proposed by Bagga et al. seems to be really effective. This technique includes the coverage of the bony surface by 2 triangle laterally repositioning partially thickness flaps, but it presupposes the presence of adequate width of the attached gingiva in order to be performed. It must be noted that occasionally the pressure provoked to the fraenum fibres during the orthodontic approximation of maxillary central incisors leads to avascular necrosis along with fraenum and gingival fibres remodelling, so making the surgical intervention useless.

Management of the Maxillary Midline Diastema

The clinician before selecting the appropriate treatment plan must definitely define a sound diagnosis. The diagnosis requires the evaluation of several factors, as age, stage of growth, relations of teeth with adjacent, their antagonists and their skeletal base, possible presence of malocclusion, tooth-size relationship, other pathological conditions, and the presence of diastemas in other segments of the arch. Consequently, the selection of the appropriate management for the diastema between the maxillary central incisors is often difficult, as it presupposes a sound diagnosis and mainly the recognition and treatment of the aetiology of the problem. In a study of Almog et al., 87.5% of the subjects mentioned that they prefer the method of computer-imaging simulation for the acceptance of the proposed treatment plan, concerning the closure of diastema in the anterior segment of the maxilla, because they understood better the treatment plan that way.

The treatment of the diastema is usually postponed until the eruption of permanent canines, but it may start earlier, depending on the cause of the problem and in cases with a very extensive diastema. As a general principle, only for diastemas between maxillary central incisors larger than 2 mm, there is a danger for not spontaneous closure with the eruption of lateral incisors and canines, while for a diastema smaller than 2 mm it is almost impossible to remain open. The early closure of a diastema (during the mixed dentition) is performed when: (a) the diastema creates severe aesthetic problem to the patient and (b) the position of central incisors inhibits the eruption of lateral incisors or canines, as the lateral incisors may have been displaced in the space which is normally occupied by canines.

In the period of permanent dentition, when the diastema is smaller than 2 mm it can be treated successfully by the orthodontist, probably by simple tipping of the maxillary central incisors. This can be performed with a removable appliance with clasps, finger-springs and, possibly an anterior bow. When this approach is selected, there is a strong need for retention as it often leads to relapse. The use of elastic bands around teeth for the closure of the diastema is strictly prohibited because the bands may move apically and destruct the periodontal ligament, provoking even loss of teeth. When there is a diastema larger than 2 mm, in the majority of cases there is a need for bodily movement of teeth, and a more complicated treatment with fixed orthodontic appliances is required.

In recent years, various authors suggested that the closure of the diastema between the upper central incisors or other diastemas in the anterior segment of the maxillary arch (whether created by the orthodontic therapy or pre-existed) may be achieved with the placement of crown veneers or with teeth restorations with resin composite. Nevertheless, the long-term prognosis in these cases should be further investigated. In specific cases, this approach can be adopted when the patient does not desire to be treated with orthodontics, when there are other coexisting aesthetic problems (i.e. amelogenesis imperfecta), and when the treatment demands a combined orthodontic and restorative approach, in cases with large diastema.

Retention of the Treatment Result

The retention after treatment of the maxillary midline diastema is considered to be necessary, especially if lateral incisors and canines have not yet erupted. The prevalence of relapse according to Sullivan et al. is 34%, while according to Shashua and Artun it approaches approximately 50%. The reason for relapse is the placement of teeth in a position where the teeth are not in equilibrium.
with their functional environment. Thus, a balance between the external forces exerted to teeth and internal forces that retain teeth in position is not preserved. The main reason for this is the inability for exception of the factor that disturbs this equilibrium. For instance, this disturbance may occur with the disruption of the continuity of the interdental gingival fibres, whose functional role is the preservation of teeth position, like in cases with an abnormal upper labial frenum. Moreover, the equilibrium may be disturbed when the interdental fibres are compressed by the orthodontic closure of the diastema, so exerting distal forces to maxillary central incisors.

The main risk factors for relapse include: (a) increased pre-treatment width of the maxillary midline diastema; (b) the presence of another member of the family with a diastema; and (c) more than one diastema in the maxillary anterior region. However, according to other authors, prognostic factors for relapse can not be defined. Taking under consideration recent studies, the cases with a risk for long term relapse can not be safely predicted. Consequently, it would be wise in almost every case to select permanent retention for the preservation of the therapeutic outcome and the avoidance of undesirable clinical and legal matters. The retainer may be used for a specific period of time or for the patient’s whole life. According to Lang et al., the time for retention must in every case exceed 2 years.

The most appropriate solution for permanent retention is the bonding of a multi-stranded stainless steel wire, constructed by 6 strands of wire, with a 0.0215 inch diameter each. The basic advantage of this retainer is that its flexibility permits teeth to retain their physiologic movement, plus it is placed and bonded easily. The multi-stranded wire is bonded with resin composite, usually from canine to canine in the middle of the palatal surface of anterior teeth (Fig. 9). In cases where the retainer interferes in functional movements of the mandible, it can be bonded cervically or within a shallow rim constructed to the enamel of the teeth.

### Figure 9
(a) Maxillary midline diastema; (b) Lingual retainer fabricated by multi-stranded stainless steel wire and bonded to maxillary anterior teeth for retention after orthodontic treatment.

Conclusions

1. The imperfect fusion at midline of premaxilla and the abnormal labial frenum are the commonest causes of the maxillary midline diastema.
2. The differential diagnosis and the appropriate management of these 2 conditions require careful evaluation of a variety of parameters.
3. The most effective treatment for the maxillary midline diastema is the treatment that faces the cause of the diastema.
4. The optional treatment often requires a multidisciplinary approach.
5. The need for permanent retention of the result of treatment, in almost all cases, is inevitable.

### References


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