The Maxillary Interincisal Diastema and its Relationship to the Superior Labial Frenum and Intermaxillary Suture

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A diastema between the maxillary central incisors is a relatively common finding during the deciduous and mixed dentitions. The majority of these close spontaneously by the time the maxillary canines appear, but a few persist into the mature permanent dentition. Where the diastema persists, it may be accompanied by a thick superior labial frenum. Because of this association many clinicians have concluded that the frenum causes the diastema to persist, but the contrary relationship is also possible, i.e., the diastema persists; the developing dentition exerts minimal or no pressure on the frenum and thus produces little or no atrophy of the frenum.

The frenum is a fold of mucous membrane consisting of highly vascularised connective tissue covered with epithelium.[1] It contains a variable amount of collagenous fibrous tissue and its size varies from individual to individual but it should never be called a "muscle" or "ligament."[2] The frenum is passive in its relationship to the maxillary alveolar process and the pattern of their related development depends on the growth and development of the alveolar ridge.

The intermaxillary suture is a midline suture seen clearly on roentgenograms between the maxillary central incisors. It is the line of junction of the two halves of the maxilla.

The purpose of this paper was to study the interrelationship of the maxillary interincisal diastema, spacing and crowding to the type of superior labial frenum and the type of intermaxillary suture in an attempt to shed further light on the most practical method of management of a common dental problem.

Review of Literature

The literature contains many references to diastema and to the value of frenectomies in its closure, but it makes little mention of the intermaxillary suture and of any role it may play in diastemal closure or persistence.

In 1907 Angle[3] described the superior labial frenum and outlined a method for its removal. This method is still used with little change today. In 1924 Tait[4] stated "the frenum has no function, and its action, if any, in relation to the upper incisors is purely passive—that of resisting mesial pressure." He also believed that the frenum is sometimes associated with, but not the cause of, separated maxillary central incisors. It was noted that the frenum itself is not a cause of the persisting diastema, but in certain circumstances, in conjunction with other factors, it may determine the spacing of the maxillary central incisors.[5] Other writers have suggested that frenectomies hasten the closing of the space without providing proof of this effect or showing that such treatment was warranted.[6,7] James also suggested that frenectomy should be part of a comprehensive treatment plan in certain cases, most notably those with missing central or lateral incisors, or when a diastema develops during orthodontic treatment.

Higley[8] felt that the slight cleft of interseptal bone does much to hold the teeth apart, and that removal of the periosteal lining of the cleft would permit bone to develop in the cleft and

enable the teeth to come together. Bishara[9] found that diastemas will close in some cases spontaneously but that treatment is necessary in other cases. The nature of this treatment depends on the cause of the diastema, and he lists a large frenum as one of the etiological factors. Bishara treats diastema by approximating the central incisors and holding them together to produce pressure atrophy of the frenum followed by a frenectomy if excess tissue remains.

In general, most authorities have suggested that the natural process of growth and development will remedy most cases of thickened labial frenum.[10,11] However, the frenum is still included in the lists of causative factors of diastema along with habits, malformed teeth, pathological conditions and heredity.[12,13] Many frenectomies are still performed without any proven basis as to necessity for such treatment in cases of spaced central incisors.

Method

The 471 cases in the present study are part of the Burlington Growth Centre and were the total number of children with records available at age 9 years and again at 16 years. All measurements were made using a Boley gauge on the plaster casts at these ages for the 471 children and for the 230 children from the 471 who had annual records from 9 to 16 years of age and a diastema > 0.5 mm at 9 years.

The authors employed a system of frenum typing which consisted of six types, namely: thick and thin and either high, medium or low attachments. Types 1 and 2 were high, thin and thick attachments; types 3 and 4 were medium, thin and thick attachments; types 5 and 6 were low, thin and thick attachments. Low is taken to be at or just above the gingival margin, and high is taken to be high up on the alveolus approximately at the level of the apices of the incisor teeth.

Intermaxillary sutures were classified into four types based on their appearance in the posteroanterior cephalograms (Fig. 1). The sutures were typed as follows: type 1—normal V-shaped bone bisected by the intermaxillary suture; type 2—bone with a wider than normal open suture for approximately 2 mm (may be a shallow trough); type 3—spade-shaped bone between centrals bisected by an intermaxillary suture; type 4—W-shaped bone with a deep open suture.

The sample chosen to achieve a normal population distribution for frenum and suture typing was a random sample of 131 from the 471 cases. Frenum and suture typing was also carried out for the diastema group of 230 cases at 9, 12, 14 and 16 years of age. These 230 children with diastemas of > 0.5 mm at 9 years were also assessed for dental spacing and crowding.

Results

The distribution of diastema at 9 and 16 years of age is shown in Table I. Of the 230 cases with a diastema > 0.5 mm at 9 years, 159 cases closed completely by age 16. Since there was no sex specificity of the occurrence of a diastema, the sex-specific data were combined. There was a significant association ($x^2 = 65.2$; d.f. = 2; $p < 0.01$) between the diastema size at ages 9 and 16 years (Table I).

Of the 230 cases with a diastema > 0.5 mm at age 9, 33 (20.8%) had a frenum with a high attachment compared with the 29 cases with a diastema of less than 0.5 mm and with two out of 42 (4.8%) cases with a diastema of 0.5 mm or greater at 16 years.

The low thin and thick (types 5 and 6) frenum attachments were found in 28 of the 42 cases (66.6%) in those children where the space was > 0.5 mm at 16 years of age, but in only 12 (7.5%) of the 159 cases that closely completely.

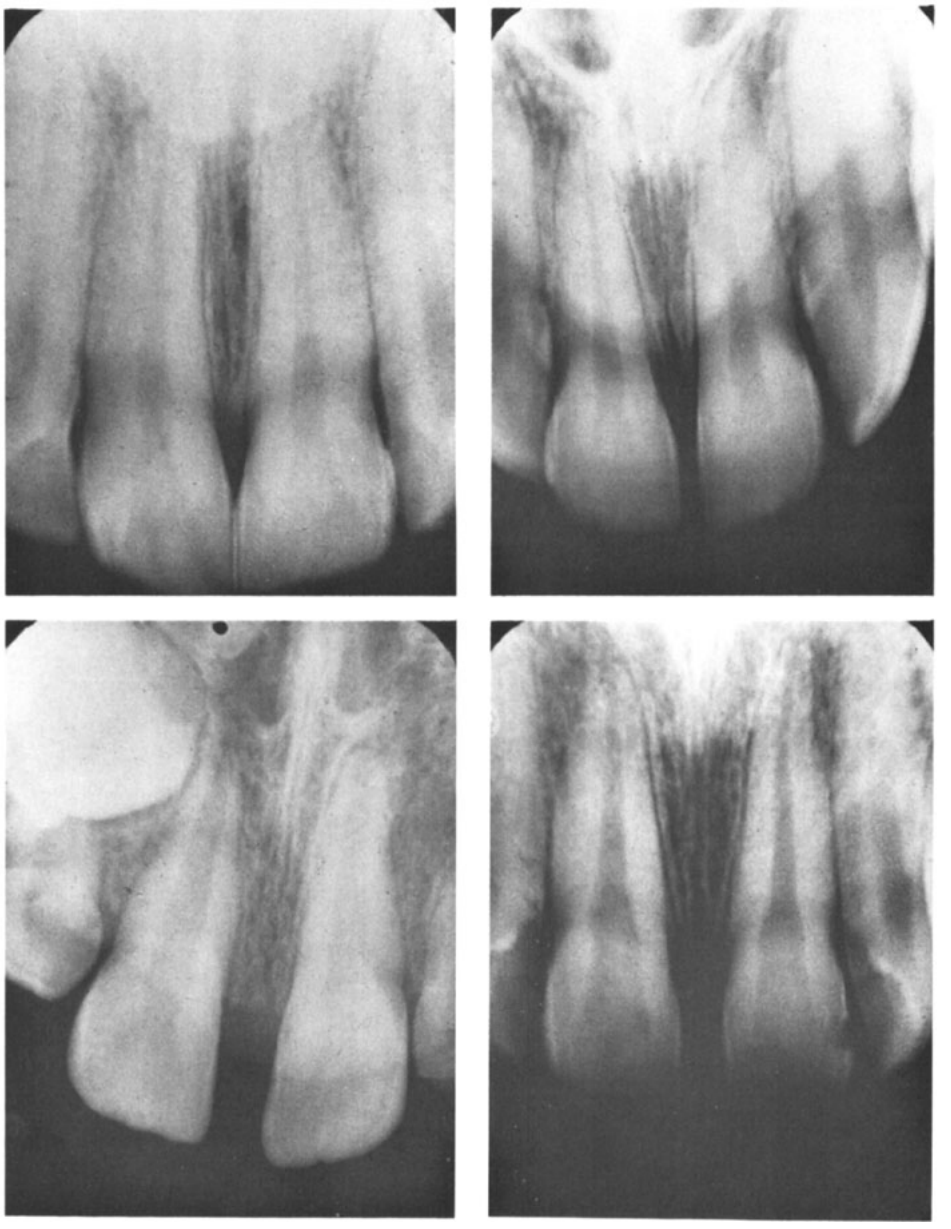

Fig. 1 Classification of suture types: (1), upper left, normal bone. (2), upper right, wide and shallow suture. (3), lower left, spade-shaped bone. (4), lower right, W-shaped bone.

TABLE I

Distribution of Diastema at Ages 9 and 16 Years

Age 9 Diastema (mm)	Sex	0 mm n	0 mm (%)	< 0.5 mm n	< 0.5 mm (%)	≥ 0.5 mm n	≥ 0.5 mm (%)	Total
< 0.5	male	114	(95.8)	4	(3.4)	1	(0.8)	119
	Female	119	(97.6)	2	(1.6)	1	(0.8)	122
		233	(96.7)	6	(2.5)	2	(0.8)	241
≥ 0.5	Male	89	(66.9)	20	(15.0)	24	(18.1)	133
	Female	70	(72.2)	9	(9.3)	18	(18.5)	97
		159	(69.1)	29	(12.6)	42	(18.3)	230
Total		392	(83.2)	35	(7.4)	44	(9.4)	471

TABLE II

Association of Diastema and Frenum Type at Age 16 Years in the 230 Children Who Had a Diastema ≥ 0.5 mm at Age 9 Years

Diastema Size (mm)	Frenum Type 1 + 2 n	1 + 2 (%)	3 + 4 n	3 + 4 (%)	5 + 6 n	5 + 6 (%)	Total
0	33	(20.8)	114	(71.7)	12	(7.5)	159
< 0.5	0	(0.0)	17	(58.6)	12	(41.4)	29
≥ 0.5	2	(4.8)	12	(28.6)	28	(66.6)	42
Total	35	(15.2)	143	(62.2)	52	(22.6)	230

$X^2 = 77.2$ d.f. = 4 $p < 0.01$

TABLE III

Association of Diastema Size and Suture Type at Age 16 Years in the 230 Children With a Space ≥ 0.5 mm at Age 9 Years

Diastema Size at Age 16	Suture Type 1 n	1 (%)	2 n	2 (%)	3 n	3 (%)	4 n	4 (%)	Total
0	105	(66.0)	51	(32.1)	0	(0.0)	3	(1.9)	159
< 0.5	18	(62.1)	10	(34.5)	0	(0.0)	1	(3.4)	29
≥ 0.5	22	(52.4)	13	(31.0)	5	(11.9)	2	(4.7)	42
Total	145	(63.1)	74	(32.2)	5	(2.2)	6	(2.5)	230

There was a significant association between the diastema size and frenum type (Table II).

When the 131 children in the random sample were compared with the 230 children with diastemas > 0.5 mm at age 9 years, frenum type distribution showed no significant difference in the population distribution. The ratio of suture type 1 to suture type 2 in the random sample group was 3:1 and in the diastema group 2:1. This difference was not statistically significant.

The diastema group (230 children) shows that suture types 3 and 4 occur most frequently in the persistent diastema cases (Table III). Suture types 3 and 4 were not found in the presence of crowding, while out of 145 cases of suture type 1, 25 had crowding and 26 had spacing (Table IV). Four children with crowding had suture type 2. Only five of the 230 children had suture type 3, and of those, four had a low frenum attachment (types 5 and 6); the diastema in all five had not closed by age 16, and all exhibited generalized spacing (Table V).

Discussion

Of the 471 cases studied at 9 years, the diastemas in 392 (83.2%) had completely closed by age 16. A further 35 (7.4%) had a space of less than 0.5 mm, while only 44 (9.4%) had a diastema > 0.5 mm at age 16. This dis-

TABLE IV

Association Between Suture Type and Spacing and Crowding at Age 16 Years in the 230 Children With ≥ 0.5 mm Diastema at Age 9 Years

Suture Type	Spacing/Crowding: Spacing (+2 mm or more) n	(%)	No Spacing or Crowding n	(%)	Crowding (—2 mm or more) n	(%)	Total
1	26	(17.9)	94	(64.8)	25	(17.2)	145
2	20	(27.0)	50	(67.6)	4	(5.4)	74
3	4	(80.0)	1	(20.0)	0	(0.0)	5
4	2	(33.3)	4	(66.7)	0	(0.0)	6
Total	52	(22.6)	149	(64.8)	29	(12.6)	230

TABLE V

Association of Suture Type to Frenum Type at Age 16 in the 230 Children with ≥ 0.5 mm Diastema at Age 9 Years

Suture Type	Frenum Type: 1 + 2 n	(%)	3 + 4 n	(%)	5 + 6 n	(%)	Total
type 1	28	(19.3)	93	(64.1)	24	(16.6)	145
type 2	6	(8.1)	46	(62.2)	22	(29.7)	74
type 3	0	(0.0)	1	(20.0)	4	(80.0)	5
type 4	1	(16.7)	3	(50.0)	2	(33.3)	6
Total	35	(15.2)	143	(62.2)	52	(22.6)	230

tribution suggests that most diastemas will close spontaneously by age 16 in the course of normal development.

The low thick frenum attachment (type 6) occurs more frequently in cases with a persisting diastema; 28 (66.6%) of these had low frenum attachments compared with 12 (7.5%) among those in whom the diastema closed. This association suggests that the frenum may actively maintain the space. However, we believe that the frenum persists as a low fleshy attachment because the existing spacing exerts insufficient or no mesial pressure upon it.

Of the 230 children examined, eight (2 males, 6 females) were known to have had frenectomies. The diastema in three of these eight cases closed completely by age 16 years; one had a space of less than 0.5 mm and four had persisting diastemas greater than 0.5 mm at 16 years. All those that did not close had factors other than the frenum which prevented natural closure, chiefly generalized spacing and overjet.[14]

In the random control group (131 cases), suture type 1 and suture type 2 were distributed in a ratio of 3:1, while in the diastema group the ratio was 2:1. This finding suggests that suture type 2 is associated with diastema and that the assessment of any child with a diastema should include suture typing.

These data, which correlate sutures, frenum and degree of spacing and crowding, show that suture types 3 and 4 are not associated with crowding (all 29 youngsters with crowding had suture type 1 or 2). They also show that persisting diastema is associated with a low frenum (types 5 and 6) in more than one half of the children with space ≥ 0.5 mm (Table II). However, some of those cases with frenum types 5 and 6 also had sutures of types 3 and 4. All those with frenum types 5 and 6 which closed by 16 years had suture type 1 or 2.

Persistence of diastema appears to be associated with the combination of spacing, low frenum attachment types 5 and 6, and suture types 3 and 4. Suture type 3 appears to be suture type 1, with lack of mesial pressure, which allows a table of bone to remain in the

midline. Suture type 4 appears as a deeper extension of suture type 2, and the structure of these suture types (2 and 4) appears to be considerably different than that of types 1 and 3. Spacing seems to be the major determining factor in diastema.[14]

Low frenum (types 5 and 6) and spacing seem to occur together, the spacing encouraging the low, wide frenum and also the appearance of suture types 2 and 4. Heredity probably plays the major role in determining tooth size and jaw size and the presence or absence of teeth, while environment contributes to severe overjet which is another form of spacing.

During the period from age 9 to 16 years the frenum type may change and, when it does, it is from low to medium or high, or from medium to high. This study did not detect a single instance in which a high or medium attachment changed to a lower level. This constancy may represent the apical migration of the frenum attachment during alveolar growth, that is, the frenum remains attached at the same level while the alveolar growth proceeds downward.

An examination of the suture data shows that suture type changed in 39 out of 230 children who had a space > 0.5 mm at age 9 years. In the 159 cases that closed completely by age 16, the suture type changed in only ten cases. In nine of these with thick frenum attachments the suture widened and in seven, it became narrower, but in all 16 the teeth were crowded in varying degrees (range 0 to 7 mm); therefore, all spaces were closed. In the 29 children who had a space of less than 0.5 mm at age 16, the suture type changed in eight. All these cases exhibited spacing (range 0 to 4 mm); in five, the suture narrowed, and in three, it widened. In the 42 children with a diastema greater than 0.5 mm at 16 years, suture type changed in 15; all widened and all had increased spacing (range + 1 to 9 mm). Nine had low thick frenum attachments and six had low thin attachments.

Both the serial and cross-sectional data show that, with maturation of the permanent dentition, most diastemas close spontaneously. When it persists, it does so chiefly in those children with spacing. It can be concluded that the larger the diastema at age 9 years, the less likely it will close by age 16, especially when it is associated with generalized spacing, a low attached frenum, and a suture of types 2, 3 and 4.

The primary cause of persistence of a maxillary diastema appears to be generalized spacing[14] with the suture and related low, thick frenum acting as secondary factors. The association of spacing with 50% or more of the persistent diastemas suggests that the clinician should perform thorough space analysis and that this, coupled with an appraisal of heredity factors, should permit him to select those cases that can be expected to close spontaneously. The clinician may then concentrate on those diastemas most likely to persist. Frenectomy occasionally removes an obstacle to closing, but this is necessary in only a few cases; generally, it is done after approximating the central incisors and holding them together, otherwise scar tissue may develop and prevent the central incisors from coming together.

Summary and Conclusions

From the analysis of histories, dental casts, and cephalograms of 471 children of the Burlington Growth Centre sample, interrelationships between the degree of spacing, crowding, diastema and frenum and suture type were derived and the following conclusions were drawn:

1. Suture type remains more constant through development than frenum type.

2. Frenum type is reasonably constant but may change from low to medium or high attachments, but only to a higher level of attachment.

3. Frenum and suture type are related; frenum types 5 and 6 (low attachment) are associated with spacing and with suture types 3 and 4.

4. The primary factors contributing to maxillary diastema appear to be degree of spacing or crowding in most cases, the specific types of sutures and frenum making a minor contribution.

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