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Longitudinal changes of the insertion of the maxillary labial frenum in children and adolescents undergoing orthodontic treatment

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Introduction: This study aimed to evaluate potential vertical changes in the position of the maxillary labial frenum (MLF) insertion in growing children and to compare these changes to the vertical growth of the dentoalveolar process and lower facial third. **Methods:** This retrospective longitudinal study investigated records of 33 healthy children. Dental casts, lateral cephalograms, and photographs were evaluated at pretreatment (T0), posttreatment (T1), and 3-5 years into retention (T2). To evaluate the vertical changes of MLF insertion in relation to the vertical growth of the dentoalveolar process, the palatal plane (PP) was used as a reference. These changes were also compared between different MLF typologies (ascribed as thin or fibrous). **Results:** The distance from MLF to PP only slightly increased from T0 to T2 by 0.6 ± 0.5 mm ($P < 0.001$), whereas the distance between the incisal edge and PP increased significantly from T0 to T2 by 2.6 ± 0.8 mm ($P < 0.001$). A positive correlation was found ($r = 0.94$; $P < 0.001$) between the changes from the incisal edge to the PP and the MLF to the incisal edge between T0 and T2. No correlation was found between the change from the incisal edge to the PP and MLF to PP between T0 and T2. Thin MLF types showed a larger increase in distance from their insertion to the incisal edge (2.6 ± 0.8 mm) than thick MLF types (1.8 ± 0.7; $P < 0.03$). **Conclusions:** The MLF remains stable compared with the PP, whereas the maxillary incisal edge moves away from the PP, indicating increased vertical growth of the alveolar process. Dentists should be aware of those changes before performing interventions such as unnecessary frenectomies. (Am J Orthod Dentofacial Orthop 2023;■:■-■)

The maxillary labial frenum (MLF) is a mucosal structure on the median part of the maxilla, extending from the labial gingiva to the middle of the upper lip. It connects the upper lip to the alveolar process, creating a bond between these 2 anatomic structures.[1,2] The MLF is considered to be a posteruptive remnant of the tectolabial bands.[3] These bands appear at 3 months in utero and connect the tubercle of the upper lip to the palatal papilla.

According to Henry et al,[4] the MLF contains 3 of the 4 general types of tissue found in human beings, namely epithelial tissue, connective tissue, and nerve fibers. However, the MLF does not seem to contain muscle tissue, even though some studies support the presence of striated muscle fibers within this structure.[5]

The interest in the position of the MLF from a clinical perspective lies in the fact that it has often been blamed for being responsible for problems such as a midline diastema between the maxillary central incisors,[6] recessions of the maxillary labial gingiva[7] or relapse after orthodontic treatment.[8] However, the MLF can show changes in its form and dimensions over time, and its insertion can show variations relative to the adjacent structures, such as the lip and vestibule, primarily during growth.

It has been suggested that the growth of the alveolar process can cause a displacement of the insertion of the MLF to a more apical position.[9] The prevalence of the position of insertion of the MLF, generally based on a

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classification proposed by Mirko et al,[10] was previously investigated using cross-sectional study designs.[11,12] These studies aimed to investigate in which periodontal site the MLF insertion was found and to classify this site into 4 categories: mucosal, gingival, papillary, or papillary penetrating. Several studies[10,11] have suggested that age could be the predominant factor defining the position of the MLF insertion. Dewel et al[9] showed that the passage of time results in a more apical insertion of the MLF on average, which can be attributed to the growth of the adjacent structures (ie, the dentoalveolar process). Despite this finding based on cross-sectional data, longitudinal studies investigating the change in the position of insertion of the MLF during growth are lacking.

Furthermore, no longitudinal studies have looked into identifying factors that may be linked to the variation between subjects with different characteristics, such as the growth of the lower third of the face. Our primary hypothesis was that if the MLF remains stable in reference to the palatal plane (PP), the increasing vertical distance of the PP to the MLF and the incisal edge over time would be highly correlated. Therefore, this study aimed to evaluate the potential vertical changes in the insertion of the MLF in growing children aged >8 years and to associate these changes with the vertical growth of the dentoalveolar process and the lower third of the face.

MATERIAL AND METHODS

After a written request, this retrospective longitudinal study was given clearance by the ethics commission for research on human beings, University Hospitals of Geneva (CCER_Req2019-01103).

The records of 33 healthy children treated in the Division of Orthodontics at the University of Geneva, Switzerland, were investigated. This sample was selected consecutively from 837 patients in the archives of the Division of Orthodontics at the University of Geneva. The sample size estimation was carried out to find a correlation between the distance from the MLF to the PP and the distance from the incisal edge to the PP of at least $r = 0.55$ (with an $\alpha = 0.05$ and a power of 90%). Based on this calculation, using G*Power software (Franz Faul, Universitat Kiel, Kiel, Germany),[13] 30 patients were found to be necessary to obtain sufficient power. It was decided to add 10% more patients than required in case of potential problems during measurements. All records used for this study were anonymized before starting the measurements. The patients were chosen without regard to their orthodontic history or final treatment results. The selection was based on the following criteria: (1) available pretreatment (T0) and posttreatment (T1) records, including dental study casts with the MLF readily visible, high-quality lateral cephalometric radiographs and intraoral photographs; (2) initial records taken before 15 years of age; (3) the presence of a low labial frenum (category 2 and 3 based on the classification of Mirko et al[10]), with no history of frenectomy or maxillofacial surgery, congenital/developmental defects, trauma/injuries to the premaxillary region, dental extractions, or patients on medications that may affect the gingiva. Thirty-three consecutive patients that met the inclusion criteria were selected, 17 of which were girls and 16 of which were boys. Intraoral photographs, dental study casts, and lateral cephalometric radiographs were evaluated at T0, T1, and 3-5 years into retention (T2). All of the included patients had fixed appliance treatment. Intraoral photographs were used to evaluate if the frenum had a normal form and shape (referred to as thin in this article) or if it was fibrous in type (with a hypertrophic and/or fibrous texture).

The measurements on dental study casts were performed using digital calipers with a resolution of 0.01 mm (Tesa Technology, Renens, Switzerland) and included the distance from the insertion of the frenum to the incisal edge of the maxillary central incisor.

The measurements of the distance from the MLF insertion to the maxillary central incisor edge carried out on the dental study casts were transferred to the lateral cephalometric radiographs (Fig 1), all of which were taken on the same x-ray machine (Carestream CS 900C; Carestream Dental LLC, Atlanta, Ga, USA), calibrated for enlargement with the use of a metal reference scale of known dimensions. The lateral cephalometric radiographs were manually traced by 1 investigator (I.S.) using a protractor with a resolution of 0.01 mm. The measurements were calibrated between the first (I.S.) and second (C.V.) author at the beginning of the investigation.

The landmarks and measurements made for the present study were the following: (1) PP: spina nasalis anterior (Spa) − spina nasalis posterior (Spp); (2) incisal edge of the maxillary central incisors; (3) position of insertion of the MLF (on the dental study casts and subsequently transferred to the lateral cephalometric radiograph); (4) U1: the line connecting the incisal edge and root apex of the most prominent maxillary central incisor; (5) the perpendicular distance between the PP to the MLF (Fig 2); (6) the perpendicular distance from the PP to the maxillary central incisal edge; and (7) lower facial third height: the distance from Spa-Spp to menton, on a vertical line passing through nasion-menton (N-Me) (Fig 3).

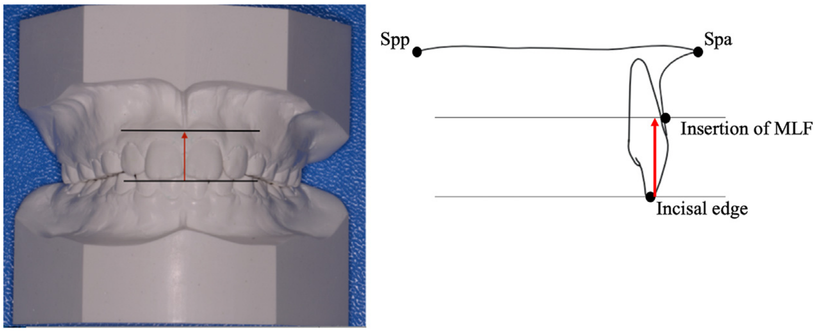

Fig 1. Illustration of the measurement of the vertical position of the maxillary labial frenum (MLF) on the dental study casts. The *arrow* is the distance between the incisal edge and MLF insertion.

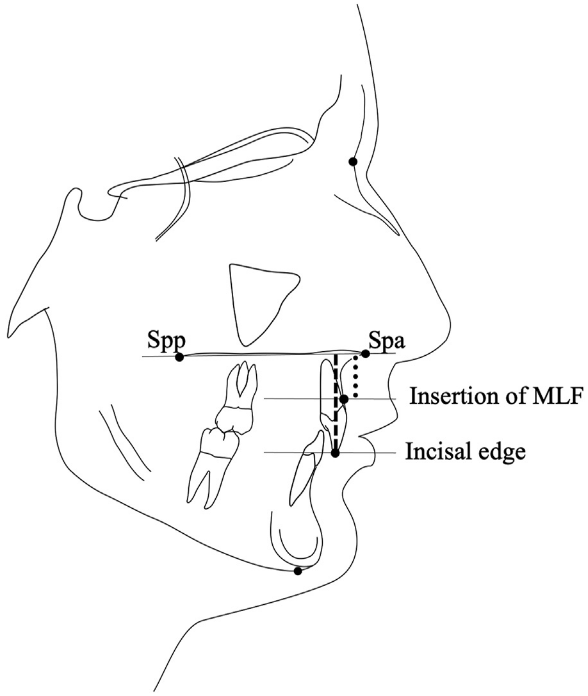

Fig 2. Lateral cephalometric tracing showing the measurements made from the PP (Spa-Spp), to the incisal edge or the insertion of the MLF (maxillary labial frenum), namely the perpendicular distance.

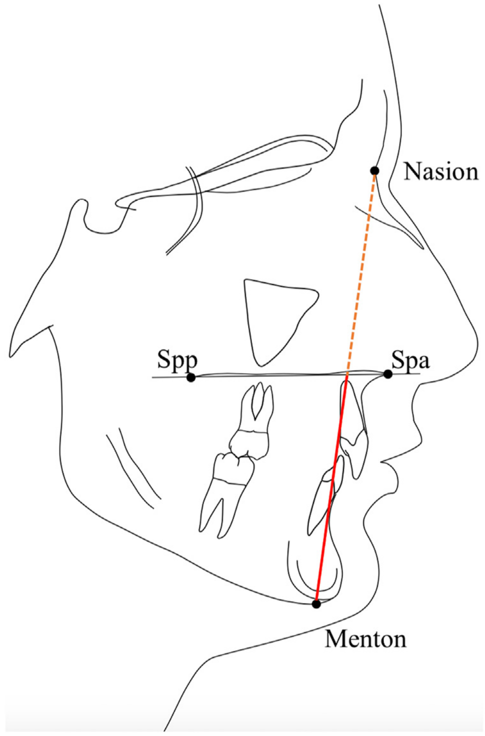

Fig 3. Lateral cephalometric tracing showing the measurement of the lower facial third, namely the distance from the PP (Spa-Spp).

An assessment of reproducibility was performed for the measurements on the dental study casts, and the lateral cephalometric radiographs, evaluating random and systematic errors as proposed by Houston.[14] Landmark tracing and measurements were performed a second time in 10 of the 33 included patients after a 3-week interval. All of the lateral cephalometric radiographs were measured in random order to try to minimize systematic errors.

To ensure that the evaluation of the dental study casts was representative of the actual clinical situation, the distance between the maxillary central incisal edge and the insertion of the MLF on 10 patients was measured by the first (I.S.) and second (C.V.) authors on 10 patients clinically, and subsequently 1 week later on the dental study casts of these patients, in random order. The reliability of the measurements on the study casts could thus be evaluated to ensure that they reflected the insertion position of the MLF intraorally.

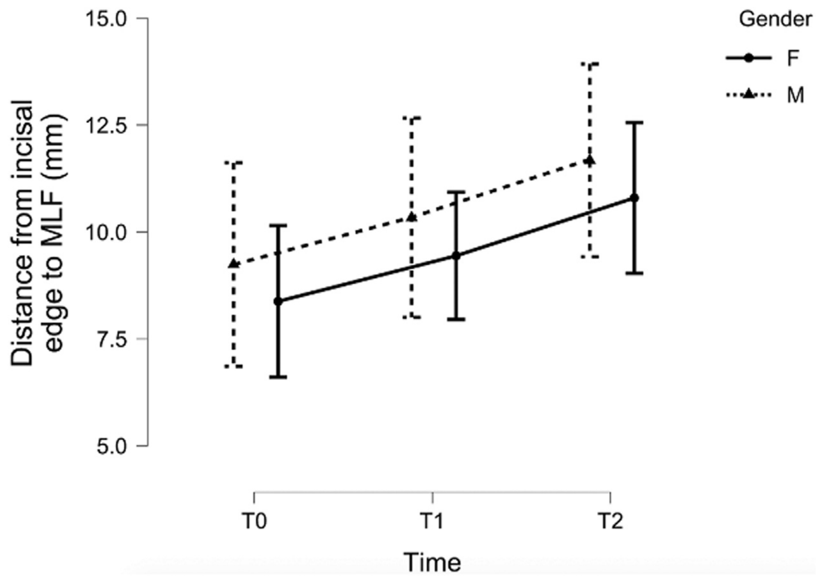

Fig 4. Line plot showing the increasing distance for both genders respectively from the incisal edge to the maxillary labial frenum (MLF) over time. *F*, female; *M*, male.

Statistical analysis

Descriptive statistics were initially performed to calculate means, standard deviations, and minimum and maximum values for each continuous variable at T0, T1, and T2. The association of the position of the insertion of the MLF with the maxillary central incisal edge, gender, age, lower facial third changes, maxillary incisor axis, and gingival hyperplasia was investigated using analysis of variance, and linear regression models were used to look at the relationships between these variables. Finally, a Bland-Altman plot was used to analyze the agreement between the 2 investigators (I.S. and C.V.). SPSS software (version 17.0; IBM, Armonk, NY, USA) was used for all statistical analyses.

RESULTS

Among 837 consecutively-treated patients in our archive and evaluated, the records of 33 consecutively-selected patients, complying with the inclusion criteria, were selected, 17 of which were girls (51.5%) and 16 boys (48.5%). The mean age at T0 was 11.2 years for girls and 12.4 years for boys. The mean age at records 3-5 years into retention was 19.8 years for girls and 20.6 years for boys. As per the inclusion criteria, there were no missing data on all the investigated patients.

The measurements on the dental study casts showed that the distance from the MLF to the incisal edge increased from T0 to T2 with an average (± standard deviation) increase of 2.4 ± 0.8 mm (95% confidence interval [CI], 2.1-2.7; $P < 0.001$) (Fig 4). The distance from the MLF to the PP only slightly increased from 21.2 ± 2.7 mm (95% CI, 21.1-22.3) at T0 to 21.8 ± 2.7 mm (95% CI, 20.8-22.8) at T2 ($P < 0.001$) (Table I).

Concerning the distance between the incisal edge and the PP, a statistically significant increase was found with a change in mean distance from T0 to T2 of 2.6 ± 0.8 mm (95% CI, 2.3-2.9; $P < 0.001$). A Pearson correlation coefficient of 0.94 ($P < 0.001$) was found between the change in distance from the incisal edge to the PP and the change in distance from the MLF to the incisal edge from T0 to T2 (Table II). In contrast, no correlation was found between the change in distance from the incisal edge to the PP and the change in distance from the MLF to the PP from T0 to T2.

Although the distance on the line N-Me from the intersection of Spa-Spp to Menton increased from T0 to T2, with a mean change of 4.9 ± 3.5 mm (95% CI, 8.4-1.4; $P < 0.001$), the statistical analysis showed no correlation with the changes in the insertion of the MLF and correlation with the changes in the position of the incisal edge (Table II).

Twenty-six patients were considered to have a thin (normal) frenum, whereas 7 were considered to have a fibrous (hypertrophic and/or fibrous texture) frenum. When looking at the type of frenum (fibrous or thin), those with thin frenums showed a bigger increase from their insertion to the incisal edge, with a mean of 2.6 ± 0.8 mm (95% CI, 2.3-2.9), than those with thick frenums with a mean of 1.8 ± 0.7 mm (95% CI, 1.3-2.3;

Table I. Means, standard deviations, and 95% CI of the different measurements taken T0, T1, and T2

	T0		*T1*		*T2*	
Variables	*Mean ± SD (mm)*	*95% CI*	*Mean ± SD (mm)*	*95% CI*	*Mean ± SD (mm)*	*95% CI*
MLF-incisal edge	8.8 ± 2.1	8.1-9.5	9.9 ± 2.0	9.2-10.6	11.2 ± 2.0	10.5-11.9
MLF-Spa-Spp plane	21.2 ± 2.7	20.2-22.2	21.4 ± 2.7	20.4-22.4	21.8 ± 2.7	20.8-22.8
Incisal edge-Spa-Spp plane	29.8 ± 3.1	28.7-30.9	31.0 ± 2.9	30.0-32.0	32.5 ± 3.0	31.4-33.6
Spa-Spp plane-Me (from the line N-Me)	57.6 ± 3.4	56.4-58.8	60.7 ± 4.2	59.2-62.2	62.5 ± 3.8	61.1-63.9

CI, confidence interval; *MLF,* maxillary labial frenum; *SD,* standard deviation.

Table II. Pearson correlation coefficients with *P* values for the different associations investigated

Variable	*MLF-Spa-Spp*	*MLF-incisal edge*	*Incisal edge-Spa-Spp*	*Me-Spa-Spp (from the line S-Me)*
MLF-Spa-Spp T2-T0				
Pearson's *r*	–			
P value	–			
MLF-Incisal edge T2-T0				
Pearson's *r*	0.038	–		
P value	0.835	–		
Incisal edge-Spa-Spp T2-T0				
Pearson's *r*	0.107	0.944	–	
P value	0.554	<0.001	–	
Me-Spa-Spp (from the line S-Me) T2-T0				
Pearson's *r*	−0.248	0.254	0.194	–
P value	0.165	0.153	0.055	–

MLF, maxillary labial frenum.

$P = 0.03$) (Table III). Gender did not show any statistically significant difference for the measurements recorded.

For the evaluation of the error of measurement using Dahlberg's formula,[15] it varied between 0.1 mm for the PP and incisal edge to 0.3 mm for the MLF insertion.

Concerning the reliability of the measurements taken on the study casts, the results recorded by the 2 examiners on the 10 patients clinically and on the dental study casts show excellent reliability with a good limit of agreement of (−0.6, 0.5) calculated with a Bland-Altman plot.

DISCUSSION

Based on this study, it seems that the maxillary labial frenum remains stable with time in reference to the PP, whereas the maxillary central incisal edge moves away from this reference. The remoteness of the maxillary incisal edge from the insertion of the MLF is directly linked to the eruption of the incisors. Indeed, if we look at the changes between these 2 structures, the maxillary incisal edge moves away from the MLF in the same manner as the maxillary incisal edge moves away from the PP. These findings may be explained by the fact that the dentoalveolar process undergoes vertical growth without affecting the insertion position of the frenum. This is in accordance with the study of Vera et al,[16] who ascribed this characteristic to the vertical growth of the alveolar process, permitting the MLF to move away from the alveolar ridge. In the same manner, other studies[17,18] looking at frenectomies proposed that changes in the position of the MLF during childhood are due to a static position of the frenum, whereas the rest of the surrounding structures grow in a sagittal and vertical direction. No differences were found when looking at the possible differences between males and females in this study. Similarly, Boutsi et al,[11] looking at the prevalence of the different types of insertion of the MLF in children, did not show any differences between males and females.

When looking at the changes based on age, the results of this study are in line with cross-sectional epidemiologic studies.[10,19,20] Diaz et al[21] found in a population of 1355 children aged 0-6 years that the gingival insertion level increased with age, showing that these changes take place even during the beginning of the growth of the child. They also found that orthodontic considerations, such as midline diastemas, also decreased with time because of the upward movement in the insertion of the MLF. Boutsi et al[11] showed in a population of 226 children aged 1-18 years that the papillary penetrating frenum type was mostly seen in younger patients (aged 7.2 ± 2.9 years), whereas the mucosal frenum type was mostly seen in older patients (aged 9.4 ± 2.7 years).

In this study, although age was correlated with the increasing distance on the line N-Me from the intersection of Spa-Spp to Menton (which reflects the growth of the

Table III. Mean, standard deviation, and 95% CI of the changes from T0 to T2 of the different measurements comparing those with a thin to thick (fibrous) frenum and comparing gender

	Thin frenulum (n = 26)		*Thick frenulum (n = 7)*		
Variables	*Mean ± SD (mm)*	*95% CI*	*Mean ± SD (mm)*	*95% CI*	P *value*
MLF-incisal edge	2.6 ± 0.8	2.3-2.9	1.8 ± 0.7	1.3-2.3	0.03
MLF-Spa-Spp plane	0.6 ± 0.5	0.5-0.8	0.6 ± 0.6	0.2-1.0	0.95
Incisal edge-Spa-Spp plane	2.8 ± 0.8	2.6-3.0	2.0 ± 0.8	1.4-2.6	0.02
	Male		*Female*		
Variables	*Mean ± SD (mm)*	*95% CI*	*Mean ± SD (mm)*	*95% CI*	P *value*
MLF-incisal edge	2.4 ± 0.8	2.1-2.8	2.4 ± 0.9	2.0-2.9	0.95
MLF-Spa-Spp plane	0.5 ± 0.5	0.3-0.8	0.7 ± 0.4	0.5-0.9	0.30
Incisal edge-Spa-Spp plane	2.7 ± 0.8	2.3-3.0	2.6 ± 0.9	2.2-3.0	0.75

CI, confidence interval; *MLF,* maxillary labial frenum; *SD,* standard deviation.

lower third of the face, with the reference being the PP), no correlation was found with changes of insertion of the frenum. Concerning the changes in the position of the incisal edge and the increasing distance of Me-Spa-Spp (from the line N-Me), no correlation was also found, but this time the *P* value was borderline significant ($P = 0.055$). These findings tend to show that the modification in the insertion of the frenum with respect to the PP compared with the growth of the dentoalveolar process is independent of the vertical growth of the lower third of the face. Nevertheless, it must be kept in mind that the *P* value was borderline significant for a possible correlation, meaning that a bigger sample could have passed this threshold. Therefore, this possible association cannot be completely excluded.

Our findings tend to show that regardless of the amount of vertical movement of the dentoalveolar process, it does not change the insertion of the MLF accordingly. This points to the direction that the MLF seems to be rather independent of the growth modeling of the dentoalveolar process. It may be expected that the distance from the incisal edge to the MLF will increase with age with the continuous eruption of maxillary teeth even in adult life, as shown by Huanca Ghislanzoni et al.[22]

The frenum tends to show some similarities with the third rugae on the palate concerning its stability over time. As shown by Christou and Kiliaridis,[23] whereas the position of the first rugae is associated with growth changes in the vertical position of the maxillary incisors, the third rugae showed much less change. Thereby, the third rugae can be used as a reliable reference to look at longitudinal dental changes. This study suggests that the insertion of the MLF for the group selected in this study could be an additional point on the buccal aspect of the dentoalveolar process that could be used as a stable structure for the superimposition of dental study casts.

Furthermore, as dentists may be influenced by the position of the MLF when proposing frenectomies, the results of this study suggest that this position should not be an alarm to dentists performing frenectomies with MLFs close to the gingival borders because the MLF insertion will present perceived relative apical displacement with age. This is particularly true when the growth of the dentoalveolar process is at its peak, and the frenum presents a thin phenotype. Dentists should be aware of the increasing distance of the MLF insertion from the maxillary central incisal edge with growth, as this may prevent them from performing unnecessary frenectomies at a young age. The same goes for gummy smiles in young patients concerned about their unesthetic MLF on smiling. It is advised before undergoing frenectomies to wait for the relative physiological changes in the position of the MLF during growth that will improve their esthetic concern and to reevaluate the situation after puberty.

The limitations of this study include that it was a retrospective study and that the sample of patients evaluated did not have papillary penetrating insertions of the MLF or severely thick frenums. Therefore, it is not known if the results would differ if one had looked at MLFs passing through the maxillary central incisors. In addition, all of the children investigated underwent orthodontic treatment, and therefore one should interpret the present results with some caution when considering orthodontically-untreated children. A possible limitation is that the PP is physiologically displaced downwards during growth, which could have influenced the changes in the lower third of the face. Nevertheless, this remodeling would influence both the MLF and the dentoalveolar process equally. Finally, the age of the population studied was somewhat limited, and including younger patients with a bigger spectrum of growth potential could be interesting for future studies. We believe that this study provides important knowledge, thanks to its longitudinal design, allowing for future prospective studies to be carried out in a clinical setting to compare the 4 different types of insertion of the MLF, including the papillary penetrating type as well as the different phenotypes of MLF (such as frenums with or without nodules).

CONCLUSIONS

This study shows that the MLF remains stable in reference to the PP, whereas the maxillary incisal edge moves away from the PP. The distance from the MLF to the incisal edge increases with an average of 2.4 mm over 8 years. These results show that the dentoalveolar process undergoes vertical growth without affecting the insertion of the frenum.

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AUTHOR CREDIT STATEMENT

Ian Schuepbach contributed to investigation, methodology, resources, visualization, and original draft preparation; Cristina Vento contributed to investigation, validation, and manuscript review and editing; Balazs J. Denes contributed to formal analysis, visualization, and manuscript review and editing; Gregory S. Antonarakis contributed to supervision, project administration, and manuscript review and editing; Stavros Kiliaridis contributed to conceptualization, supervision, project administration, and manuscript review and editing.

REFERENCES

1. Dewel BF. The normal and the abnormal labial frenum; clinical differentiation. J Am Dent Assoc 1946;33:318-29.
2. Sadeghi EM, Van Swol RL, Eslami A. Histologic analysis of the hyperplastic maxillary anterior frenum. J Oral Maxillofac Surg 1984; 42:765-70.
3. Gartner LP, Schein D. The superior labial frenum: a histologic observation. Quintessence Int 1991;22:443-5.
4. Henry SW, Levin MP, Tsaknis PJ. Histologic features of the superior labial frenum. J Periodontol 1976;47:25-8.
5. Ross RO, Brown FH, Houston GD. Histologic survey of the frena of the oral cavity. Quintessence Int 1990;21:233-7.
6. Popovich F, Thompson GW, Main PA. The maxillary interincisal diastema and its relationship to the superior labial frenum and intermaxillary suture. Angle Orthod 1977;47:265-71.
7. Rose GJ. Receding mandibular labial gingiva on children. Angle Orthod 1967;37:147-50.
8. Edwards JG. The diastema, the frenum, the frenectomy: a clinical study. Am J Orthod 1977;71:489-508.
9. Dewel BF. The labial frenum, midline diastema, and palatine papilla: a clinical analysis. Dent Clin North Am 1966;35:175-84.
10. Mirko P, Miroslav S, Lubor M. Significance of the labial frenum attachment in periodontal disease in man. Part I. Classification and epidemiology of the labial frenum attachment. J Periodontol 1974;45:891-4.
11. Boutsi EA, Tatakis DN. Maxillary labial frenum attachment in children. Int J Paediatr Dent 2011;21:284-8.
12. Addy M, Dummer PM, Hunter ML, Kingdon A, Shaw WC. A study of the association of fraenal attachment, lip coverage, and vestibular depth with plaque and gingivitis. J Periodontol 1987;58: 752-7.
13. Faul F, Erdfelder E, Buchner A, Lang AG. Statistical power analyses using G*Power 3.1: tests for correlation and regression analyses. Behav Res Methods 2009;41:1149-60.
14. Houston WJ. The analysis of errors in orthodontic measurements. Am J Orthod 1983;83:382-90.
15. Dahlberg G. Statistical methods for medical and biological students. New York: Interscience; 1940.
16. Vera VR. Malocclusions, gingivitis, upper labial frenum and diastemas in students of Itá (Paraguay). Rev Odont Circ Odont Parag 1974;20:79-87: Spanish.
17. Curran M. Superior labial frenotomy. J Am Dent Assoc 1950;41: 419-22.
18. Bedell WR. Nonsurgical reduction of the labial frenum with and without orthodontic treatment. J Am Dent Assoc 1951;42:510-5.
19. Jańczuk Z, Banach J. Prevalence of narrow zone of attached gingiva and improper attachment of labial frena in youths. Community Dent Oral Epidemiol 1980;8:385-6.
20. Lindsey D. The upper mid-line space and its relation to the labial fraenum in children and in adults. A statistical evaluation. Br Dent J 1977;143:327-32.
21. Díaz-Pizán ME, Lagravère MO, Villena R. Midline diastema and frenum morphology in the primary dentition. J Dent Child (Chic) 2006;73:11-4.
22. Huanca Ghislanzoni L, Jonasson G, Kiliaridis S. Continuous eruption of maxillary teeth and changes in clinical crown length: a 10-year longitudinal study in adult women. Clin Implant Dent Relat Res 2017;19:1082-9.
23. Christou P, Kiliaridis S. Vertical growth-related changes in the positions of palatal rugae and maxillary incisors. Am J Orthod Dentofacial Orthop 2008;133:81-6.