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Does the maxillary midline diastema close after frenectomy?

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Objective: To analyze the closure, persistence or reopening of the maxillary midline diastema after frenectomy in patients with and without subsequent orthodontic treatment. **Method and Materials:** All patients undergoing frenectomy with a CO_2 laser were included in this retrospective study during the period of September 2002 to June 2011. Age and sex, the dimension of the diastema, eruption status of the maxillary canines, and the presence of an orthodontic treatment were recorded at the day of frenectomy and during follow-up. **Results:** Of the 59 patients fulfilling the inclusion criteria, 31 (52.5%) had an active orthodontic therapy, while 27 (45.8%) had a frenectomy without orthodontic treatment. For one patient, information concerning orthodontic treatment was not available. In the first follow-up (2 to 12 weeks), only four diastemas closed after frenectomy and orthodontic treatment, and none after frenectomy alone. In the second follow-up (4 to 19 months), statistically significantly ($P = .002$) more diastemas (n = 20) closed with frenectomy and orthodontic treatment than with frenectomy alone (n = 3). At the long-term (21 to 121 months) follow-up, only four patients had a persisting diastema, and in three patients orthodontic treatment was ongoing. **Conclusion:** Closure of the maxillary midline diastema with a prominent frenum is more predictable with frenectomy and concomitant orthodontic treatment than with frenectomy alone. This study demonstrates the importance of an interdisciplinary approach to treat maxillary midline diastemas, ideally including general practitioners, oral surgeons, periodontists, and orthodontists. *(Quintessence Int 2014;45:57–66; doi: 10.3290/j.qi.a30772)*

Key words: CO_2, frenectomy, frenum, laser, midline diastema, maxillary diastema

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The maxillary midline diastema is a common finding in the primary and in the mixed dentition and generally decreases in size and prevalence after eruption of the permanent dentition. Possible etiologic factors for a midline diastema are genetics, missing teeth, supernumerary teeth (mesiodens), odontogenic tumors like odontomas, cysts like the nasopalatine duct cysts, discrepancies between tooth and jaw size, anomalies of tooth position, habits like suction of lips or fingers, patent intermaxillary suture, and abnormal frenum attachment.[1-3] The maxillary midline frenum is an embryologic remnant of the tectolabial band, which connected

the tubercle of the upper lip to the palatine papilla. Before birth, the two lateral halves of the alveolar ridges unite and the frenum is divided in a palatine and labial portion.[1,4] After eruption, the central incisors are flared by the lateral incisors, which clinically manifests as the so-called "ugly duckling stage".

After eruption of the permanent lateral incisors and canines, the medially extended pressure closes the diastema of the mixed dentition.[2,5] In some cases this does not occur, suggesting that an "abnormal" frenum may be the cause. However, there is still controversy over whether an abnormal frenum attachment is the cause or effect of a maxillary midline diastema.[1,3,6] The classification of Mirko et al[7] gained wide acceptance and it categorizes the frenum according to its site of attachment: mucosal, gingival, papillary, or papillary penetrating. Pulling the upper lip and inspecting if the tissue of the palatine papilla is blanching is an accepted clinical test to evaluate if the frenum is attaching or penetrating the papilla ("blanching test").[2]

Different treatment approaches to close a midline diastema have been described, but there remains some controversy if and how the treatment should be performed. Especially for the general practitioner, who is frequently confronted with persisting maxillary midline diastemas, it is of importance to know when, how and with which dental specialty treatment should be initiated. Closure of the maxillary midline diastema has been reported with orthodontic treatment alone, and some authors perform frenectomy only, if closure is not possible after active orthodontic therapy.[2,3,8,9] The speed of tooth movement and closure of the diastema has been shown to be faster when frenectomy was performed prior to orthodontic treatment.[10] A persistent frenum was also described as an etiologic factor for reopening of a diastema following orthodontic treatment,[5] but the causative role of the frenum for this recurrence remains controversial.[6] Spontaneous closure of the diastema after frenectomy without orthodontic treatment has also been described.[11]

Frenectomy implies total removal of the maxillary midline frenum and can be performed using various surgical techniques such as the V-shaped incision and its modifications, the Z-plasty incision, and the use of lasers.[9] When using a laser, the CO_2 laser is the most widely accepted laser. With the CO_2 laser, many advantages have been described, such as minimal bleeding, no need for sutures, minimal swelling and discomfort following intervention, and less scarring.[9,12-14] The aim of the present retrospective study was to analyze the closure, persistence, or reopening of the maxillary midline diastema after frenectomy in patients with and without subsequent orthodontic treatment using an interdisciplinary treatment approach encompassing general practitioners, orthodontists, and oral surgeons.

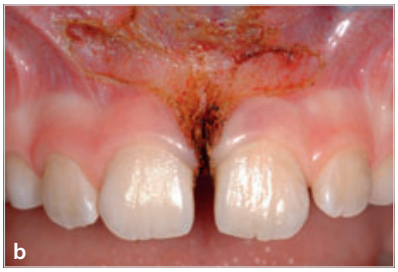
METHOD AND MATERIALS

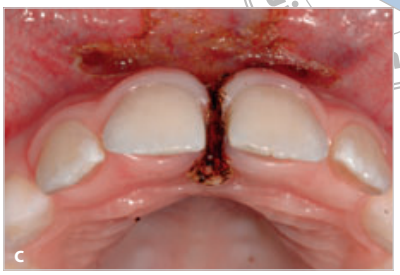
Patient selection

All patients that were referred from general practitioners or orthodontists for frenectomy during the period of September 2002 to June 2011 to the Department of Oral Surgery and Stomatology were initially eligible for this study. Inclusion criteria were that a maxillary midline diastema was present at the initial examination and that frenectomy was performed with a CO_2 laser using the same technique by one single oral surgeon (MB). All cases treated by other oral surgeons or performed with a surgical blade were excluded. Patients with implants, missing teeth, or pathologies at the maxillary central incisor region were also excluded. The study was reviewed by the ethical committee of the State of Bern, but due to its retrospective nature is exempt from formal approval.

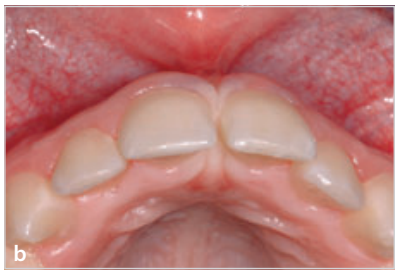
Method

All frenectomies were performed with a CO_2 laser and under local anesthesia. The frenum was always excised in total, performing a triangular excision buccally and removing all soft tissue to the alveolar bone between the central incisors (Fig 1). The wounds were left to open granulation and secondary epithelization. An adhesive wound paste (Solcoseryl Dental Adhesive Paste, Meda Pharmaceuticals) was applied postoperatively. Cases included prior to March 2007 were treated with the Sharplan 15F (Sharplan lasers), and cases after

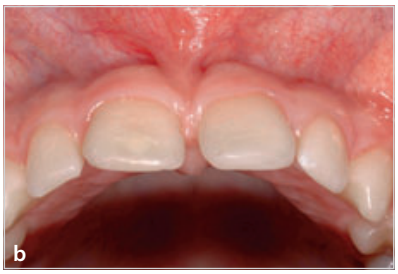




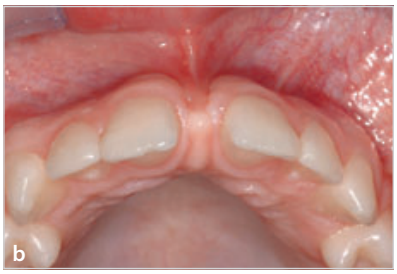
Figs 1a to 1c Frenectomy using a CO_2 laser with a triangular excision buccally, and elimination of all the soft tissue to the alveolar bone between the central incisors until the palatal papilla. *(a)* Initial clinical presentation with a diastema classed in group B; *(b)* anterior view after excision using a CO_2 laser; *(c)* occlusal view after excision using a CO_2 laser.



Figs 2a and 2b Diastema classed in group A (< 2 mm): *(a)* anterior view; *(b)* occlusal view.



Figs 3a and 3b Diastema classed in group B (2 to 4 mm): *(a)* anterior view; *(b)* occlusal view.



Figs 4a and 4b Diastema classed in group C (> 4 mm): *(a)* anterior view; *(b)* occlusal view.

March 2007 with the Spectra Denta CO_2 Laser (MAX Engineering Ltd). Both lasers have a wavelength of 10.6 µm, and power settings between 4W and 5W in a continuous or pulsed mode were applied. An initial follow-up was usually performed between 2 and 12 weeks (follow-up I), and a later examination between 4 and 19 months (follow-up II) after frenectomy.

The medical charts, including written documentation and intraoral photographs of all patients fulfilling the inclusion criteria, were reviewed retrospectively by one person not involved in the actual treatment of the patients (AH). Age at the day of surgery and sex of the included patients were registered. The dimension of the diastema and the state of the eruption of the maxillary canines were recorded. During the follow-up visits, the dimension of the diastema (with or without closure) and whether or not the patient had received active orthodontic therapy was recorded. According to the dimension of the diastema, an allocation into three groups was performed: < 2 mm (group A), 2 to 4 mm (group B), > 4 mm (group C) (Figs 2 to 4). A diastema was considered as closed when the central incisors were aligned in parallel and in direct contact (see Figs 5h, 5i, 6h, and 6i).

All included patients were contacted for a long-term follow-up examination. These patients were asked

if a maxillary midline diastema and if an orthodontic retainer in the anterior maxilla were present. Patients were also asked if the diastema had been disturbing them, and if other family members had a midline diastema. If the patients could not come to the examination, all questions were asked via telephone interview.

Statistical analysis

First, all data were analyzed with descriptive methods. To analyze the influence of sex, age, preoperative type of diastema (groups A to C), active orthodontic therapy, and preoperative status of the canines (erupted yes/no), a logistic regression model was applied. Due to limited sample size, no correction for multiple testing was done. The level of significance for all tests was $P < .05$. All statistical tests were performed using R 2.15.1 (R 2.15.1 for Windows, Institute for Statistics and Mathematics of the WU Wien, Vienna, Austria; http://www.R-project.org).

RESULTS

Of the initial 68 patients treated, 59 patients fulfilled the inclusion criteria. Of these 59 cases, 42 (71.2%) were female and 17 male (28.8%). The mean age was 13.2 years (median 12.8; range 7.8 to 39 years), with 12.5 years for female and 15 years for male patients. The initial dimension of the diastema was between 1 mm and 6 mm. Most of the included cases presented with a group B diastema (2 to 4 mm) at the first examination (41 out of 59) (Fig 3), 11 patients were classed as group A (< 2 mm) (Fig 2), and 7 patients were allocated into group C (> 4 mm) (Fig 4). All maxillary incisors and maxillary canines were partially visible or erupted in 40 patients (67.8%). In 19 patients (32.2 %), the canines were not erupted.

Of the 59 patients, 31 (52.5%) had an active orthodontic therapy, while 27 (45.8%) had a frenectomy without orthodontic treatment during follow-up I and II. In one case, information concerning orthodontic treatment was not available. Therefore, this patient was excluded from further analysis. The results of the persistence or closure of the diastema at the follow-up visits (I and II) are shown in Table 1. The number of cases classed in group A (< 2 mm), group B (2 to 4 mm), and group C (> 4 mm) during each follow-up visit are shown in Table 2.

In the first follow-up, only four cases with an active orthodontic therapy exhibited closure of the diastema. This was not statistically significantly different compared to the group with frenectomy alone, where no case closed during this period ($P = .99$). Furthermore, sex ($P = .85$), age ($P = 0.99$), the preoperative type of diastema ($P = .54$), and the preoperative status of the canines ($P = .75$) did not influence the closure of the diastema for patients examined at follow-up I.

During the second follow-up, frenectomy alone (Fig 5) was found to be less effective ($P = .002$) for closure of a diastema, than when combined with orthodontic treatment (Fig 6). Of the 23 patients with a closure of the diastema at second follow-up, only three did not have the canines erupted when frenectomy was performed. Of the eight patients with a persistent diastema at the second follow-up visit, three had erupted canines initially, while five had not. There was a statistically significant association ($P = .01$) between the closure of the diastema and the status of the canines at the day of treatment. The probability of having a persistent midline diastema was higher in patients with non-erupted maxillary canines upon initial examination. There was also a significant association ($P = .03$) between the closure of the diastema and the age of the patient at the beginning of the treatment. More diastemas closed when the patient was older at the day of treatment. Both sex ($P = .97$) and preoperative type of diastema ($P = .54$) did not influence the closure of the diastema for patients examined at follow-up II.

The long-term follow-up appointment or telephone interview took place 21 to 121 months after frenectomy (median 54 months). Of the 58 patients included, 23 were examined clinically, while in 31 cases a telephone interview was conducted (Table 3). Four patients could not be reached at all. The mean age of the patients at the long-term follow-up was 17.4 years (median 17.3 years). Only five patients had remained without any

Table 1 Number of cases with persistence or closure of the diastema during the two follow-up periods in the two different treatment groups (frenectomy with orthodontic treatment or frenectomy only)

Group/Exam		Day of frenectomy (n = 58)	Follow-up I (2–12 weeks) (n = 48)	Follow-up II (4–19 months) (n = 31)
Frenectomy and orthodontics	Persistent diastema	31	24 (77.4%)	1 (3.2%)
	Closure of diastema		4 (12.9%)	20 (64.5%)
	Missing data*		3 (9.7%)	10 (32.3%)
Frenectomy only	Persistent diastema	27	20 (74.1%)	7 (25.9%)
	Closure of diastema		0	3 (11.1%)
	Missing data*		7 (25.9%)	17 (63%)

*Patient did not attend follow-up examination

Table 2 Number of cases with different dimensions of the midline diastema initially and in the follow-ups in two different treatment groups (frenectomy with orthodontic treatment or frenectomy only)

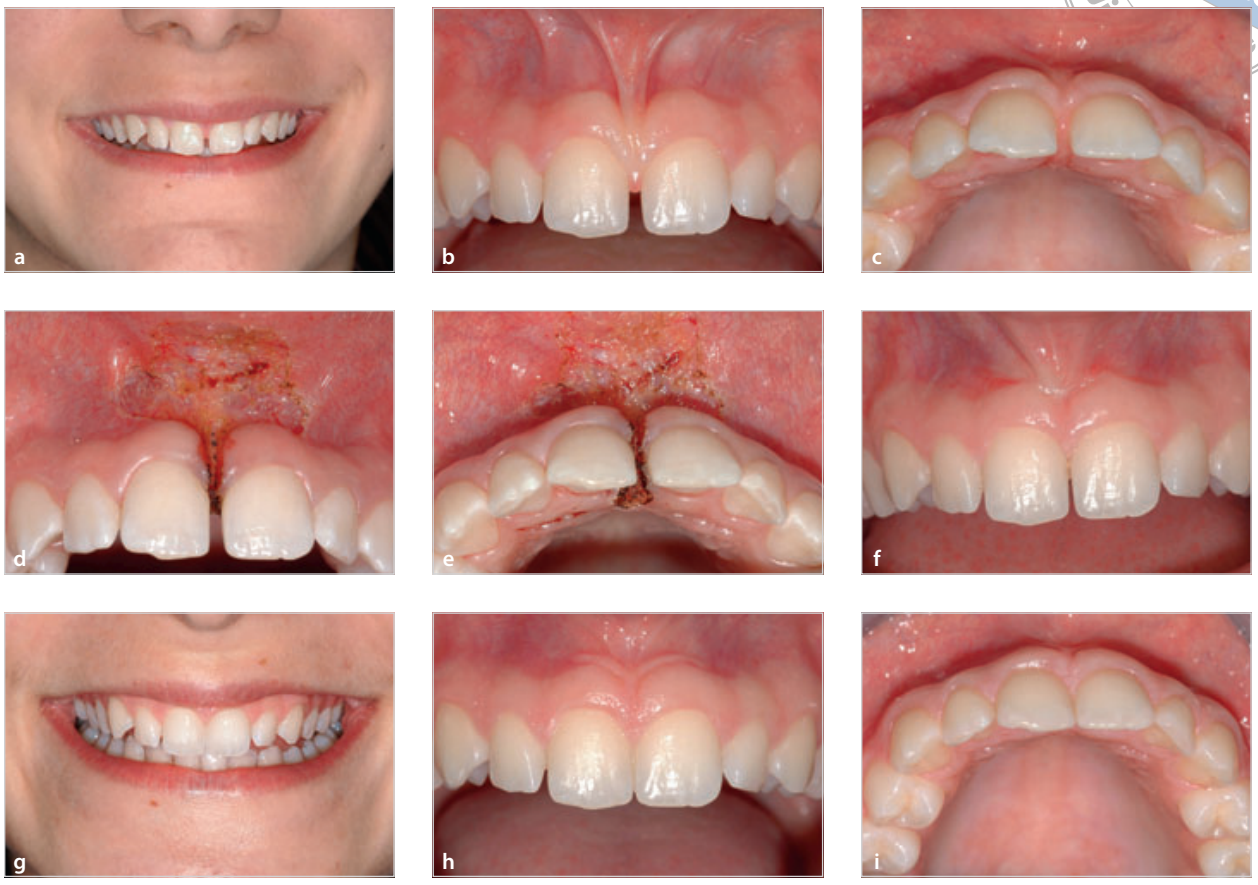
Group/Exam		Day of frenectomy (n = 58)	Follow-up I (2–12 weeks) (n = 48)	Follow-up II (4–19 months) (n = 31)
Frenectomy and orthodontics	Closed	0	4	20
	< 2 mm	8	13	1
	2–4 mm	22	11	0
	> 4 mm	1	0	0
	Missing data*	0	3	10
Frenectomy only	Closed	0	0	3
	< 2 mm	3	6	5
	2–4 mm	18	12	2
	> 4 mm	6	2	0
	Missing data*	0	7	17

*Patient did not attend follow-up examination

Table 3 Number of cases (clinical examination or telephone interview) with persistence or closure of the diastema in the long-term follow-up examination in the two different treatment groups (frenectomy with orthodontic treatment or frenectomy only)

Group/Exam		All cases long-term (21–121 months) (n = 54)*	Clinical examination (n = 23)	Interview (n = 31)
Frenectomy and orthodontics (n = 49)	Persistent diastema	4 (8.2 %)	4	0
	Closure of diastema	45 (91.8%)	19	26
	Retainer	30 (61.2%)	13	17
Frenectomy only (n = 5)	Persistent diastema	0	0	0
	Closure of diastema	5 (100%)	0	5

*4 missing results: patient did not attend follow-up examination or could not be contacted



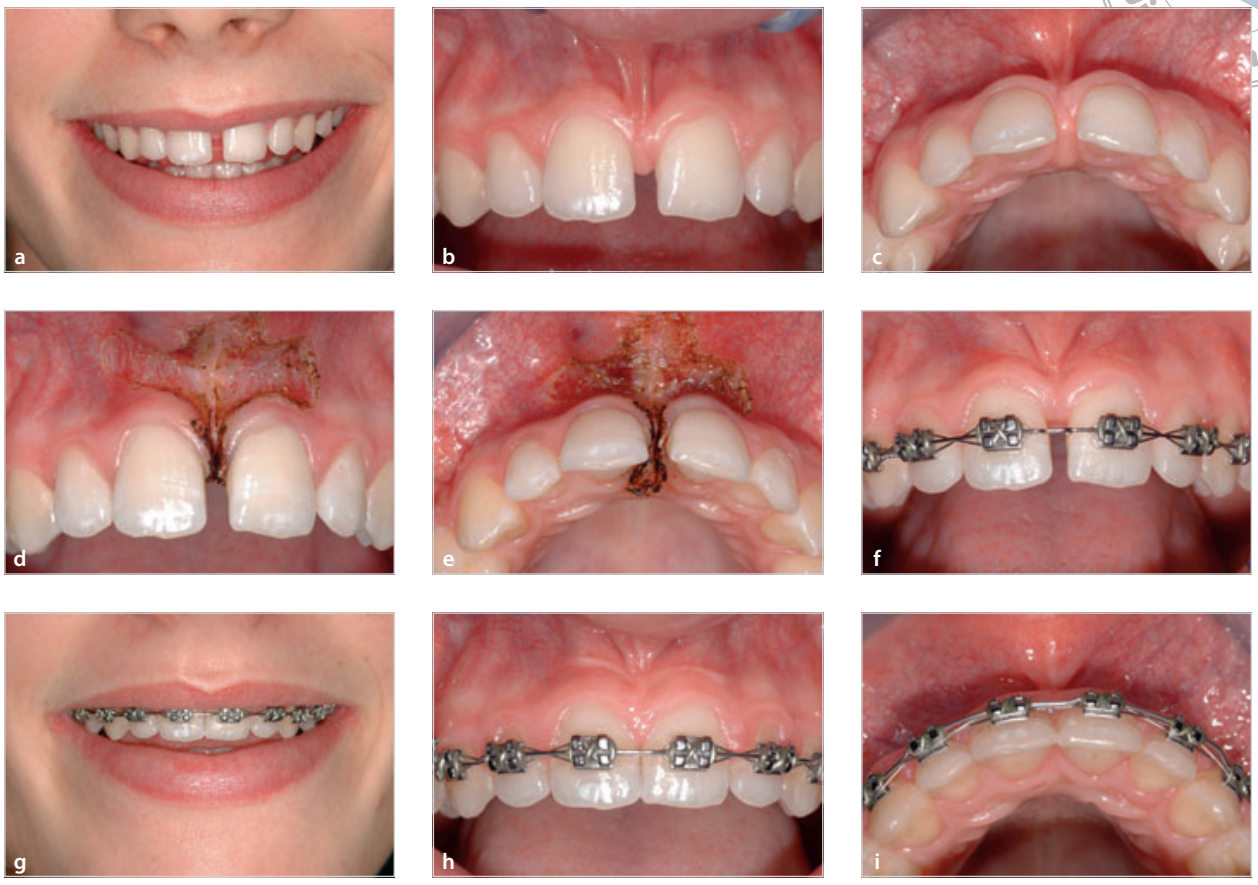
Figs 5a to 5i Case documenting the therapy of a maxillary midline diastema classed in group B with frenectomy without orthodontic treatment. Initial situation of a 12.9-year-old girl: *(a)* extraoral smile; *(b)* anterior view; *(c)* occlusal view. Frenectomy with the CO_2 laser was performed by a triangular excision buccally and elimination of all the soft tissue between the central incisors: *(d)* anterior view; *(e)* occlusal view. In the follow-up visit after 7 weeks, a diastema classed in group A is present: *(f)* anterior view. Second follow-up after 13 months exhibits closure of the midline diastema: *(g)* extraoral smile; *(h)* anterior view; *(i)* occlusal view.

orthodontic treatment during the entire study period and reported that their diastema had closed (Table 3). Four patients, all women, had a persisting diastema, and three of these still were in active orthodontic treatment. The persisting diastema of each of the four cases was less than 2 mm (group A). Two of them had initially a diastema measuring 5 mm (group C), and the other two cases were initially classified in group B. No case was recorded with a recurrence of the diastema after treatment, but 30 patients had an orthodontic retainer in place (Fig 7).

Of the 54 interviewed patients, 37 (68.5%) mentioned the diastema had bothered them, while for 17 (31.5%) patients it did not. For most of them (31 cases), esthetics was the only reason for disturbance, while for the other patients esthetics, impaired speech, and plaque accumulation were mentioned as reasons. Presence of a diastema in other members of the family was mentioned by 29 patients. In most cases, brothers, sisters, and the mother were mentioned.

DISCUSSION

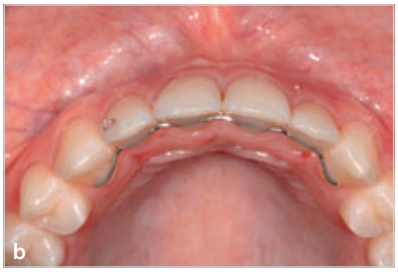
The results of the present study showed that there was no statistically significant difference between closure of the diastema after CO_2 laser frenectomy without or with concomitant orthodontic treatment in the initial time period of 2 to 12 weeks following surgery. After a



Figs 6a to 6i Case documenting the therapy of a maxillary midline diastema classed in group B with frenectomy and orthodontic treatment. Initial situation of the 13.3-year-old girl with erupted canines: *(a)* extraoral smile; *(b)* anterior view; *(c)* occlusal view. Frenectomy with the CO_2 laser was performed by a triangular excision buccally and elimination of all the soft tissue between the central incisors: *(d)* anterior view; *(e)* occlusal view. In the follow-up visit after 8 weeks, orthodontic treatment had been initiated: *(f)* anterior view. Second follow-up after 11 months exhibits closure of the midline diastema and ongoing orthodontic treatment: *(g)* extraoral smile; *(h)* anterior view; *(i)* occlusal view.

period of 4 to 19 months, statistically significantly more diastemas closed after frenectomy and active orthodontic treatment than after frenectomy alone. The long-term data of 54 patients with a follow-up 21 to 121 months showed a closure in all but four cases. During this period, 49 patients had undergone orthodontic treatment. Therefore, a distinction between frenectomy with or without orthodontic treatment could not be performed.

During growth, natural forces including tooth eruption will exert mesial pressure towards the midline. A recently published review gave evidence that a diastema > 2 mm will not close spontaneously during normal development of the dentition.[9] The presence of an abnormal frenum may be one cause for such a diastema. However, it has been reported that during development the form, size, and position of the frenum can vary in the same person at different time points.[1] An "abnormal" frenum is clinically defined as a prominent tissue band with an attachment in the palatine papilla showing some blanching when tension or pull is exerted on it. Nevertheless, diagnosing a frenum as "abnormal" is subjective, and varies between different studies. Mirko et al[7] defined four types of frenum attachment, but there is no literature available distinguishing these variable phenotypes, their consequences, and subsequent therapeutic recommendations.[9]



Figs 7a and 7b Long-term follow-up after frenectomy in a 14-year-old patient. The diastema has remained closed and an orthodontic retainer is in place: *(a)* anterior view; *(b)* occlusal view.

During natural tooth development, the unerupted canines constrain the roots of the lateral and central incisors resulting in a fan-shaped spacing of the respective crowns and a median diastema during the mixed dentition, known as the "ugly duckling stage". After eruption of the canines, a diastema may close. This is the reason for recommending frenectomy and subsequent closure of the diastema after the eruption of the canines. If a diastema is wider than 3 mm, there is evidence that the treatment should be initiated before eruption of the canines.[3] In the present study sample, significantly more diastemas were closed in the follow-up II examination, when the canines were already erupted the day of frenectomy. The cases with non-erupted canines and a persistent diastema were of category C and B, supporting the hypothesis that frenectomy could be performed earlier in cases with a wider diastema, as the eruption of the canines alone did not suffice to close the diastema.

To our best knowledge, studies considering cases of frenectomy without orthodontic treatment are rare in the literature, and no study has compared treatments of frenectomy alone to frenectomy with concomitant orthodontic treatment. Bergström et al[11] studied 40 children randomly allocated in a group of frenectomy and in a group without any treatment. With an initial mean age of 8 years and 8 months, the subjects included were significantly younger than in our sample. Furthermore, narrower diastemas were considered in that study. Closure of diastemas was significantly more frequent in the group with frenectomy after 6 months, 2 years, and 5 years compared to the group without treatment. In the 10-year follow-up, the difference was no longer statistically significant.

Some authors suggest to complete orthodontic treatment in cases with a midline diastema and to perform a frenectomy only after closure or if the diastema persists or has recurred following treatment.[1-3,8,9] This rationale is based on the hypothesis that granulation and scar tissue following frenectomy can interfere with the orthodontic treatment. In the present study sample, 50 of 54 diastemas had closed in the long-term follow-up after frenectomy and orthodontic treatment, suggesting that scar tissue formation was not a major problem. Performing frenectomy with the CO_2 laser instead of a surgical blade has reported advantages such as avoiding suturing, minimal postoperative bleeding and pain, as well as minimal scarring.[13,15] To the best of our knowledge, no case series has ever studied the influence of the surgical technique for frenectomy on short- and long-term results of maxillary midline diastemas. One disadvantage of the present study was that only frenectomies using a CO_2 laser were analyzed. Thus, it remains speculative if similar results would have been obtained using other techniques for frenectomy.

The narrower the available space when excising a maxillary midline diastema using the laser, the more difficult it is to perform proper frenectomy, because damage to neighboring teeth has to be avoided. Campbell et al[10] showed that the closure of the diastema during orthodontic treatment was faster when a frenectomy was performed, but the examination only involved 10 subjects. In the present study sample, 64.5% of the diastemas closed after a period of 4 to 19 months following frenectomy and orthodontic treatment. Regarding the retrospective nature and also the time ranges of the follow-up visits of the present study,

there is a need for future prospective investigations to analyze the impact of different surgical treatment approaches for maxillary midline diastemas ideally using a randomized study design.

Shashua and Årtun[6] examined the relapse of the midline diastema in 96 patients after orthodontic treatment. Initially, the frenum was subjectively judged as abnormal in 27 subjects (28%), and frenectomy was performed in only three of them. In the follow-up examination, they found a reopening in 49% of cases and also graded the need for orthodontic retreatment and/or the presence of a retainer as a relapse. The amount of cases with an open diastema (25%) at a long-term follow-up (mean follow-up time 6.3 years) was considerably higher compared to our sample (mean follow-up time 4.8 years). This difference can be explained, at least in part, by the differences in the two patient populations and treatment approaches. In the study of Shashua and Årtun,[6] the most predictive variable of relapse was the initial width of the diastema. In the present study, we did not have any case of reopening in any of the 54 cases at the long-term follow-up. However, it has to be taken into account that there were 30 cases with a retainer, rendering proper judgment of a possible reopening impossible.

More than two-thirds of the patients reported that they had performed frenectomy because the diastema bothered them, mostly for esthetic reasons. The other patients underwent frenectomy following the advice of their general practitioner and/or orthodontist and/or oral surgeon. In a study evaluating the subjective perception of a maxillary midline diastema by orthodontists, general dentists, and laypersons, the width of the diastema was altered by a software program applied to the images. Dentists and laypersons did not rate a midline diastema as unattractive when it was < 2 mm, while orthodontists were already critical when the diastema was 0.5 to 1 mm.[16]

CONCLUSIONS

On the basis of the data of the present study, the following can be concluded:

- The treatment of a maxillary midline diastema involves general practitioners and specialists such orthodontists, oral surgeons, or periodontists.
- Closure of a maxillary midline diastema with a prominent frenum is more predictable with frenectomy and concomitant orthodontic treatment than with frenectomy alone.
- Performing frenectomy and concomitant orthodontic treatment after canine eruption is a predictable treatment option for closure of maxillary midline diastemas. However, performing frenectomy before canine eruption may be indicated for larger diastemas, when spontaneous closure is questionable. General practitioners should try to initiate treatment at the ideal state of development of the dentition.
- The CO_2 laser has proved to be a valuable and effective treatment method to perform frenectomy in a young patient population with manifest maxillary midline diastemas. Nevertheless, as a control group is missing, it is not possible to evaluate advantages of laser treatment over surgical excision using a scalpel.
- Prospective and controlled clinical studies are needed to analyze the influence of the initial width of the maxillary midline diastema, the type of frenum, and the ideal time point for frenectomy and for initiating the orthodontic therapy on the closure of a diastema and its potential relapse.

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REFERENCES

1. Dewel BF. The labial frenum, midline diastema, and palatine papilla: a clinical analysis. Dent Clin North Am 1966;Mar:175–184.
2. Bishara SE. Management of diastemas in orthodontics. Am J Orthod 1972;61:55–63.
3. Huang WJ, Creath CJ. The midline diastema: a review of its etiology and treatment. Pediatr Dent 1995;17:171–179.
4. Kitamura H. Embryology of the mouth and related structures. Tokyo: Maruzen, 1989:160–162.
5. Edwards JG. The diastema, the frenum, the frenectomy: a clinical study. Am J Orthod 1977;71:489–508.
6. Shashua D, Årtun J. Relapse after orthodontic correction of maxillary median diastema: a follow-up evaluation of consecutive cases. Angle Orthod 1999;69:257–63.
7. 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;45:891–894.
8. Proffit WR, Fields HW, Sarver DM, Ackermannn JL. Contemporary Orthodontics. St. Louis: Elsevier Mosby, 2013:451–452.
9. Delli K, Livas C, Sculean A, Katsaros C, Bornstein MM. Facts and myths regarding the maxillary midline frenum and its treatment: a systematic review of the literature. Quintessence Int 2013;44:177–187.
10. Campbell PM, Moore JW, Matthews JL. Orthodontically corrected midline diastemas. A histologic study and surgical procedure. Am J Orthod 1975;67:139–158.
11. Bergström K, Jensen R, Mårtensson B. The effect of superior labial frenectomy in cases with midline diastema. Am J Orthod 1973;63:633–638.
12. Bornstein MM, Suter VG, Stauffer E, Buser D. The CO_2 laser in stomatology. Part 1 [in German]. Schweiz Monatsschr Zahnmed 2003;113:559–570.
13. Haytac MC, Ozcelik O. Evaluation of patient perceptions after frenectomy operations: a comparison of carbon dioxide laser and scalpel techniques. J Periodontol 2006;77:1815–1819.
14. Pié-Sánchez J, España-Tost AJ, Arnabat-Domínguez J, Gay-Escoda C. Comparative study of upper lip frenectomy with the CO_2 laser versus the Er, Cr:YSGG laser. Med Oral Patol Oral Cir Bucal 2012;17:e228–e232.
15. Suter VG, Altermatt HJ, Dietrich T, Reichart PA, Bornstein MM. Does a pulsed mode offer advantages over a continuous wave mode for excisional biopsies performed using a carbon dioxide laser? J Oral Maxillofac Surg 2012;70:1781–1788.
16. Kokich VO, Kokich VG, Kiyak HA. Perceptions of dental professionals and laypersons to altered dental esthetics: asymmetric and symmetric situations. Am J Orthod Dentofacial Orthop 2006;130:141–151.