

Evaluation of the distance between the central teeth after frenectomy: a randomized clinical study

Purpose

The present study aimed to evaluate the periodontal status and the distance between the teeth one year after frenectomy in patients with abnormal frenums in the maxillary and mandibular midline.

Materials and Methods

This study included 50 patients (24 men and 26 women) between the ages of 13 and 53 who have frenum-induced diastemas between the incisors. The abnormal frenums were removed via conventional frenectomy. The distances between the teeth before and one year after the surgery were measured with a caliper. To determine the periodontal status, the pocket depth, plaque index, and bleeding on probing were measured from four surfaces. In addition, the amount of attached gingiva and degree of gingival recession were recorded and were statistically analysed.

Results

A significant decrease in the distance between teeth before and after frenectomy was observed ($p < 0.05$). There was a statistically significant difference in the amount of gingival attachment, pocket depth, degree of gingival recession, plaque index, and bleeding on probing ($p < 0.05$).

Conclusion

The removal of abnormal frenums with frenectomy can contribute to the reduction in the distance between the teeth. In addition, frenectomy increases the amount of gingiva and decreases the depth of the pocket, gingival recession, amount of plaque, and bleeding.

Keywords: Abnormal frenum, Frenectomy, Diastema, Mucogingival surgery, Muscle attachment

Introduction

The frenum is a folded anatomical structure that consist of mucous membrane, connective tissue, and occasionally of myofibers. The labial frenum is triangular in shape, connecting the cheek and lips to the alveolar mucosa/gingiva and the periosteum (1). Frenum-related problems are common in the canine, premolars, and sublingual regions (2). When the frenum attachment point is on the edge of the gingiva, it can cause several problems. Stress caused by this type of high frenum attachment can cause the free gingiva to shift in the apical direction. Frenums decrease the vestibule sulcus depth and increase plaque accumulation due to gingival recession as a result of the stress they create, making it difficult to practice good oral hygiene (3,4).

Frenums have been classified as mucosal, gingival, papillary, or papillary penetrating according to their attachment level and location (5). Based on morphology, frenums are classified as long-thin or short-thick

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Received: 11 September, 2020

Revised: 27 December, 2020

Accepted: 10 January, 2021

DOI: 10.26650/eor.20210030

(6). Abnormal frenums, often seen between the incisors, can cause gingival inflammation, loss of papillae, gingival pocket formation, and diastemas. Thus, they may lead to psychological problems due to aesthetic reasons (4,7). Accordingly, frenums may require surgical removal.

Frenectomy is the surgical removal of an entire frenum with its attachment to the underlying alveolar bone. This procedure separates the structure of the frenum with an incision. There are three techniques to surgically remove a frenum. These periodontal surgical operations are conventionally performed using a scalpel, electrosurgery, or soft tissue lasers (8,9). Each technique has certain advantages and disadvantages. Many surgical techniques, such as classic frenectomy, Miller's technique, V-Y plasty, and Z plasty, are used in conventional frenectomy (8).

The current studies on frenums mostly regard wound healing after the operation (1,2,9). Thus, data in the literature on measuring the distance between teeth after frenectomy are limited. This study aims to measure the distance between the teeth of patients one year after classical frenectomy. The null hypothesis tested is that the frenectomy procedure does not affect the periodontal variables and the distance between the teeth.

Patients and Methods

Participants and study design

This was a cross-sectional randomized clinical study that was approved by the Ethics Committee of the Adiyaman University Faculty of Medicine (protocol no: 2019-3). The study group consisted of patients who were randomly selected between 18 March 2019 and 18 March 2020. 50 participants (26 female, 24 male) scheduled to undergo frenectomy procedure whose age ranged between 13 and 53 years were enrolled in the present study. Before the procedure, the objectives of the study were explained to the patients, and informed consent forms that clearly stated that participation in the study was voluntary were collected. This study was conducted in patients who were admitted to the Periodontology Clinic of the Adiyaman University Faculty of Dentistry. The patients were systemically healthy, did not use any drugs, and had good oral hygiene habits.

The study was conducted by a single periodontist (AT) to standardize oral examinations, measurements, and surgical operations. Patients with abnormal frenums in the gingiva, papilla, and papillary penetration site between the central incisors of the maxilla and mandible and patients with a diastema equal to or greater than 1 mm between the central incisors were included in the study. The frenums were cut and completely removed with a pair of haemostats and a scalpel no. 15. Then, the tissues with fibrous muscle attachments under the periosteum were released, and the wound edges were primarily sutured with silk sutures. Healing was uneventful. Their appearance before and after frenectomy is shown in Figure 1.

Measuring the distance between the teeth

One year after the surgery, the distance between the teeth in the relevant areas were measured on plaster models fab-



Figure 1. a. Clinical view of a patient before frenectomy b. Sutures in place c. Post-operative view.

ricated before and after the operation from three points of patients' teeth with a digital stainless steel caliper (Mitutoyo, Kanagawa, Japan) (measuring range 0-150 mm/6 inches, and sensitivity of 0.01 mm). The first measurement was the distance between the horizontal plane passing through the incisal edges of the teeth and the points where the long axes of the teeth intersect the passing plane. The second measurement was the distance between the horizontal plane passing through the midpoints of the clinical crowns of the teeth and the plane passing through the long axes of the teeth and the points intersecting the plane passing through the midpoint of the teeth. The third measurement was the distance between the horizontal plane passing through the cement-enamel junction in the cervical region of the teeth and the intersections of the plane parallel to the long axes passing through the midpoints of the teeth.

Periodontal examination

In our research, periodontal examinations of the teeth of individuals in the area where frenectomy were performed on the four surfaces of each tooth. The gingival index, plaque index, amount of gingival attachment, and pocket depth of teeth were measured (10). The pocket depth was measured by a calibrated periodontist (AT) using a periodontal probe (Williams probe) (Hu Friedy, Chicago, USA) that provided millimetric measurements. Gingival attachment was measured by the distance between the fold created in the mucosa and gingival edge using dental tweezers according to the Wrinkle method (11).

Statistical analysis

Statistical analysis of the data was performed with SPSS Statistics 15.0 for Windows (SPSS Inc., Chicago, IL, USA). Parametric tests were used to compare normally distributed continuous variables. The measurements were evaluated as the arithmetic mean \pm standard deviation (SD). A dependent t-test was used to compare binary variables obtained from intra-group measurements. An independent t-test for binary variables between groups and a one-way ANOVA test for more than two variables were used. To compare more than two inter-group variables, the Tukey test for post-hoc analysis was employed. The level of significance for was set to $p < 0.05$.

Results

Of the 50 participants, 24 (48.0%) were male and 26 (52.0%) were female. Their age range was 13 to 53 years (average age: 25.80 ± 13.41 years). The distribution of the gender, average age, frenum morphology, frenum location, frenum attachment lo-

cation, and recurrence rate after frenectomy are presented in Table 1. Measurements of the distance between the teeth before and after frenectomy are shown in Table 2. A statistically significant difference was found among the average distance measurements and three other points of the teeth ($p < 0.05$). In particular, the decrease in the distance between the midpoints of the teeth was remarkable ($p = 0.005$). Periodontal measurements of the teeth and gingiva in the relevant region before and after frenectomy are shown in Table 3. There was a statistically significant decrease in periodontal measurements in the area where frenectomy was performed ($p < 0.001$).

Comparisons of the differences in the distance between the teeth of individuals who underwent frenectomy in the lower jaw and upper jaw and the differences between these groups in the periodontal measurements and the locations of

Table 1. Demographic characteristics of the patients.

Variables		Number of Individuals (n)	Percentage (%)
Total number of individuals		50	100.0
Female		26	52.0
Male		24	48.0
Frenum morphology	Short-thick	18	36.0
	Long-thin	32	64.0
Frenum location	Lower jaw	16	32.0
	Upper jaw	34	68.0
Frenum attachment level	Gingival	10	20.0
	Papillary	18	36.0
	Papillary penetrating	22	44.0
Occurrence of relapse	Absent	32	64.0
	Available	6	12.0
	Partially available	12	24.0
Attachment level of frenum after recurrence	Mucosal	28	56.0
	Gingival	18	36.0
	Papillary	4	8.0

Table 2. Measurements of the distance of teeth at baseline and one year after frenectomy. Values are expressed as the arithmetic mean \pm standard deviation. * $P < 0.05$, significance between groups P , dependent t -test.

	Baseline (n=50)	One year after (n=50)	P Value
Total distance between teeth	3.71 \pm 1.81	3.39 \pm 1.50	0.013*
Distance between the cervical margins of the teeth	4.27 \pm 1.85	3.93 \pm 1.58	0.049*
Distance between the midpoints of the teeth	3.66 \pm 1.97	3.20 \pm 1.44	0.005*
Distance between the incisal edges of the teeth	3.33 \pm 1.98	3.04 \pm 1.77	0.021*

Table 3. The periodontal measurements of teeth and gingiva in the relevant region of individuals at baseline and one year after frenectomy. Values are expressed as the arithmetic mean \pm standard deviation. ** $P < 0.001$, significance between groups, P , dependent t -test.

	Baseline (n=50)	After one year (n=50)	P Value
Attached gingiva width	4.38 \pm 2.06	5.29 \pm 1.79	$P < 0.001^{**}$
Pocket depth	2.20 \pm 1.18	1.7 \pm 0.93	$P < 0.001^{**}$
Gingival recession	0.94 \pm 1.46	0.56 \pm 1.06	$P < 0.001^{**}$
Plaque index	1.10 \pm 0.76	0.40 \pm 0.70	$P < 0.001^{**}$
Gingival index	0.56 \pm 0.64	0.18 \pm 0.37	$P < 0.001^{**}$

the frenums are shown in Table 4. The average pocket depth and bleeding around the teeth in the regions where frenectomy was performed significantly decreased in the maxilla ($p = 0.001$ and $p = 0.006$, respectively), and the average degree of gingival recession decreased in the mandible ($p = 0.010$).

The difference in the distance of the teeth in individuals who underwent frenectomy according to frenum type and the difference in the periodontal measurements and the attachment site of frenums according to frenum type are shown in Table 5. A one-way ANOVA showed a statistically significant difference in the mean pocket depth, degree of gingival recession, and bleeding ($p < 0.05$). The post-hoc Tukey test of periodontal measurements in the regions where frenectomy was performed revealed a significant difference in the mean pocket depth between the groups with gingival-papillary penetration ($p = 0.049$). A significant difference was also found in the attachment sites of the frenums between gingival and papillary frenums and between gingival and papillary penetrating frenums ($p = 0.007$ and $p < 0.001$, respectively). There was a statistically significant decrease in the mean bleeding between gingival and papillary penetrating frenums only ($p = 0.017$).

Table 4. Comparison of the change in the distance of teeth, periodontal measurements, and the location of frenums in individuals who underwent frenectomy in the lower and upper jaw * $P < 0.05$, significance between groups ** $P \leq 0.001$, high significance between groups P , independent t -test.

Frenum Location	Lower Jaw	Upper Jaw	P Value
Total distance between teeth	-0.30 \pm 1.07	-0.33 \pm 0.79	0.919
Distance between the cervical margins of the teeth	-0.48 \pm 1.71	-0.26 \pm 0.84	0.537
Distance between the midpoints of the teeth	-0.46 \pm 0.92	-0.45 \pm 1.17	0.977
Distance between the incisal edges of the teeth	-0.35 \pm 0.35	-0.26 \pm 1.01	0.729
Degree of gingival attachment	0.90 \pm 1.57	0.91 \pm 0.89	0.978
Pocket depth	-0.06 \pm 0.48	-0.70 \pm 0.74	0.001*
Degree of gingival recession	-0.68 \pm 0.57	-0.23 \pm 0.43	0.010*
Amount of plaque	-0.81 \pm 0.81	-0.65 \pm 0.69	0.459
Amount of bleeding	-0.24 \pm 0.55	-0.68 \pm 0.44	0.006*

Table 5. Comparison of the changes in the distance of teeth and periodontal measurements according to the attachment areas of frenums in individuals who underwent frenectomy. * $P < 0.05$, significance between groups ** $P < 0.001$, high significance between groups P_1 , one-way ANOVA; P_{1-2} , P_{2-3} , and P_{1-3} , Tukey test.

Frenum Attachment Level	Gingival (1)	Papillary (2)	Papillary Penetrating (3)	P Value	P1-2	P1-3	P2-3
Total distance between teeth	-0.68±0.83	-0.19±0.79	-0.25±0.96	0.353	0.358	0.421	0.979
Distance between the cervical margins of the teeth	-0.92±1.59	-0.12±1.17	-0.25±0.91	0.205	0.200	0.289	0.940
Distance between the midpoints of the teeth	-0.64±0.77	-0.19±0.78	-0.59±1.38	0.432	0.549	0.992	0.481
Distance between the incisal edges of the teeth	-0.50±0.29	-0.28±0.95	-0.20±0.95	0.663	0.793	0.638	0.957
Degree of gingival attachment	1.00±1.89	0.78±1.06	0.97±0.75	0.836	0.878	0.998	0.857
Pocket depth	-0.02±0.47	-0.61±0.80	-0.64±0.69	0.047*	0.078	0.049*	0.993
Degree of gingival recession	-0.90±0.52	-0.33±0.49	-0.18±0.39	0.001*	0.007*	$P < 0.001^{**}$	0.549
Amount of plaque	-1.00±0.67	-0.67±0.49	-0.59±0.89	0.335	0.481	0.311	0.942
Amount of bleeding	-0.80±0.42	-0.33±0.48	-0.23±0.59	0.021*	0.073	0.017*	0.801

Discussion

The size of two adjacent teeth on the same arc, the gap in the arc, and differences between the size of teeth cause diastemas. The prevalence of diastemas ranges from 3.7% to 16.2% in the young population. The aetiology of diastemas is often related to factors such as dental size, labial frenum, shape anomalies, parafunctional habits, tongue position, and periodontal diseases. The most important aetiological factor of diastemas is the maxillary labial frenum type (6,12).

It may be necessary to surgically remove a maxillary midline frenum to prevent a midline diastema and recurrence after orthodontic treatment, to facilitate oral hygiene practices, and to prevent plaque accumulation and gingival recession (13). Clinically, papillary and papillary penetrating frenums are considered pathological and are referred to as abnormal frenums. Abnormal frenums cause the loss of papillae, diastemas, difficulty in brushing teeth, misalignment, and some psychological disorders. Abnormal frenums are visually detected through movement of the papillary tip by applying tension to the lip or detected through pallor due to ischemia in the relevant region (14,15).

Individuals with a distance of 1 mm or greater between the central teeth were included in our study because the diastemas caused by frenums attached to the gingiva were larger than 1 mm and smaller than 2 mm in the frenum attachment classification, and the measurements were made on plaster models in the laboratory to increase objectivity (12).

A study by Boutsis *et al.* (16) included 226 children and demonstrated that frenums had 46.6% gingival attachment, 22.1% papillary attachment rate of and 26.1% papillary penetration. However, the frenums in our study had 20% gingival attachment, 36% papillary attachment, and 44% papillary penetration. The increased values in our study may have been due to the small sample size.

Delli *et al.* (13) reported that the distance between the teeth decreases after frenectomy, and in patients with diastemas of less than 2 mm, closure of the diastema occurred after 6 months. They also stated that the distance between the teeth of patients with diastemas of greater than 2 mm did not usu-

ally close. Suter *et al.* (17) reported that there was a decrease in diastemas 2–12 weeks after frenectomy, but no diastemas closed in any patient. However, they also reported that some patients had diastema closure after 4–19 months. In addition, they stated that after frenectomy, at least six months were required for diastema closure. Bergström *et al.* (18) studied patients with maxillary midline frenums and stated that there was a statistically significant decrease in the distance between central teeth after frenectomy; however, this decrease was no longer statistically significant two years after frenectomy.

In our study, similar to studies in the literature, the decrease in the distance between teeth was statistically significant one year after frenectomy. However, this decrease was smaller between the cervical margins of the teeth and larger between the midpoints. Therefore, the teeth might have moved after frenectomy. Since the average distance between teeth was 2–4 mm, a smaller diastema closure with frenectomy than that in the study by Suter *et al.* (17) higher diastema closure success may be achieved with orthodontic treatment with frenectomy.

When frenums make daily hygiene practices difficult, they may cause plaque formation, bleeding, periodontal pocket formation, and gingival recession (4,6,19). Similar to the findings in the literature, the increase in the degree of gingival attachment and decrease in the pocket depth, degree of gingival recession, amount of plaque, and bleeding significantly differed between the groups.

Frenum problems are more common between the central teeth in the maxilla and the buccal side of the mandible. Abnormal frenums are less visible in the mandible than in the maxilla but manifest more dramatically in the mandible (4,20). Mandibular frenums are responsible for 5% of gingival recession (20). According to the frenum location, the differences in the mean pocket depth and bleeding were significant in the maxilla, and the difference in the mean gingival recession was significant in the mandible. If a frenum clings to free gingiva, it causes displacement in the gingiva as a result of lip movement. Thus, the deepening of periodontal pockets and gingival recession occurs. One of the most important problems encountered in the clinic is that frenums attached to the gingiva through papilla and papillary pene-

tration. As a result of this type of frenum clinging, movement of the lip, cheek, and facial muscles and movement of the free gingiva occur (20,21).

In our study, consistent with previous articles, there was a significant decrease in the mean pocket depth and bleeding between gingival and papillary penetrating frenums. There was a statistically significant decrease in the gingival recession between gingival and papillary frenums and between gingival and papillary penetrating frenums.

When frenums are surgically removed, it is necessary to carefully cut and completely remove muscle attachments and fibres. When muscle attachments and fibres are not completely removed, frenums regenerate after frenectomy. Our study showed that 12% of frenums recurred after frenectomy.

Conclusion

The removal of abnormal frenums with frenectomy can contribute to the reduction of the interdental distance between the incisor teeth. In addition, frenectomy increases the amount of gingiva and decreases the depth of the pocket, gingival recession, amount of plaque, and bleeding.

Türkçe Özet: Frenektomi Operasyonu Sonrasında Santral Dişler Arasındaki Mesafenin Değerlendirilmesi: Bir Randomize Klinik Çalışma. Amaç: Bu çalışmada maksiller ve mandibular orta hatta anormal frenulumu olan hastaların frenektomi operasyonundan 1 yıl sonrasında ilgili bölgedeki periodontal durum ile dişler arasındaki mesafenin değerlendirilmesi amaçlanmıştır. Gereç ve Yöntem: Çalışmaya santral dişler arasında frenulumla bağlı diastema oluşan 13-53 yaş aralığında 50 hasta (24 erkek ve 26 kadın) dahil edildi. Anormal frenulum, klasik frenektomi operasyonu ile uzaklaştırıldı. Başlangıçta ve 1 yıl sonrasında ilgili dişler arasındaki mesafe kumpasla ölçüldü. Periodontal durumun tespiti için çalışmaya katılan bütün hastaların ilgili dişlerin 4 yüzeyinden cep derinliği, plak miktarı, kanama miktarı ölçüldü. Ayrıca yapışık diş eti ve diş eti çekilmesi miktarının da ölçümü yapıldı. Tüm veriler istatistiksel olarak değerlendirildi. Bulgular: Frenektomi operasyonu öncesi ve sonrasında dişler arası mesafe ölçümünde anlamlı bir azalma gözlemlendi ($p < 0.05$). Periodontal bulgular da ise yapışık diş eti miktarında, cep derinliğinde, diş eti çekilmesinde, plak ve kanama miktarında istatistiksel olarak anlamlı bir fark olduğu bulunmuştur ($p < 0.05$). Sonuç: Anormal frenulumları frenektomi operasyonu ile uzaklaştırmak dişler arasındaki mesafenin kapanmasına katkıda bulunabilir. Ayrıca frenektomi işlemi periodontal olarak yapışık diş eti miktarında artma, cep derinliğinde, diş eti çekilmesinde, plak ve kanama miktarının azalmasını sağlamaktadır. Anahtar Kelimeler: Anormal frenulum, Frenektomi, Diastema, Mukogingival cerrahi, Kas tutulumu

Ethics Committee Approval: The study protocol was approved by the Ethics Committee of the Adıyaman University Faculty of Medicine (protocol no: 2019-3).

Informed Consent: Participants provided informed consent.

Peer-review: Externally peer-reviewed.

Author contributions: AT participated in designing the study. AT participated in generating the data for the study. AT participated in gathering the data for the study. AT and YC participated in the analysis of the data. AT wrote the majority of the original draft of the paper. AT participated in writing the paper. AT and YC have had access to all of the raw data of the study. AT and YC have reviewed the pertinent raw data on which the results and conclusions of this study are based. AT and YC have approved the final version of this paper. AT and YC guarantee that all individuals who meet the Journal's authorship criteria are included as authors of this paper.

Conflict of Interest: The authors had no conflict of interest to declare.

Financial Disclosure: The authors declared that they have received no financial support.

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