Original Article

Stability of maxillary interincisor diastema closure after extraction orthodontic treatment

Marcos J. Carruitero[a]; Aron Aliaga-Del Castillo[b]; Daniela Garib[c]; Guilherme Janson[d]

ABSTRACT

Objectives: To evaluate the stability of maxillary interincisor diastema closure and the relationship between space relapse and interincisor diastema width, overjet, overbite, angulations between adjacent maxillary anterior teeth and presence of intermaxillary osseous cleft after orthodontic treatment with extractions.

Materials and Methods: Twenty-four individuals with a maxillary interincisor diastema pretreatment, treated with maxillary first premolar extractions were evaluated. Dental casts and panoramic radiographs taken at pretreatment (T1), posttreatment (T2), and posttreatment follow-up (T3) were assessed. Periapical radiographs at T1 and T2 were also evaluated. Diastema relapse was assumed when T3-T2 interincisor space change was greater than zero. Diastema relapse was considered clinically significant when it was at least 0.50 mm. Data were analyzed using repeated-measures analysis of variance followed by post hoc Tukey tests or Friedman followed by Wilcoxon tests. *T*-test or Mann-Whitney *U*-test, Pearson correlation coefficient, and multiple linear regression analyses were also performed.

Results: No statistically significant relapse of maxillary interincisor diastemas was found. The percentage of clinically significant relapse of the maxillary interincisor diastemas was 27.78%. Specifically, for the interincisor midline diastema, it was 8.33%.

Conclusions: Maxillary interincisor diastema closure showed no statistically significant relapse after orthodontic treatment with premolar extractions. Clinically significant stability for maxillary interincisor diastema closure was 72.22% and, specifically, for interincisor midline diastema closure, it was 91.67%. (*Angle Orthod.* 2020;90:627–633.)

KEY WORDS: Diastema; Stability; Orthodontic space closure

INTRODUCTION

Interincisor diastemas may affect smile attractiveness,[1] compromise dentofacial harmony,[2,3] and can also generate functional[4] and psychological discomfort for patients.[5] They are considered as a malocclusion because they violate Andrew's fifth key to normal occlusion.[6]

The prevalence of maxillary anterior diastema in the permanent dentition is around 38%.[7] It has been suggested that their relapse is associated with initial diastema width,[8] inadequate root parallelism at the end of treatment, sucking habits, imbalanced muscular function,[9] abnormal labial frenum,[10] overjet[11,12] and overbite relapse,[11] and with presence of an intermaxillary osseous cleft.[8,11]

Maxillary diastema closure stability has been frequently studied after orthodontic treatment.[8,10–12] Relapse rates between 60%[12] and 84%[10] have been reported, but only one study specified the inclusion of patients treated with non-extraction protocols.[12] Some authors[8,11] demonstrated that relapse occurred on approximately one-third of the treated patients only. Stability of maxillary interincisor diastema closure and

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its association with initial interincisor diastema width, overjet, overbite, and root parallelism in orthodontic patients with at least 0.5 mm of maxillary interincisor spaces at pretreatment has been studied.[12] The only significant associations found were between midline diastema relapse and the initial diastema width and overjet relapse.

Orthodontic treatment including extractions is still a prevalent treatment option.[13] The choice for extraction largely depends on the initial characteristics of the patient's facial profile, among other factors.[14] However, maxillary interincisor diastema closure relapse after premolar extractions has not been specifically reported. It is important to know whether maxillary interincisor diastema relapse in orthodontic treatment with premolar extractions is similar to when non-extraction treatment is performed.

Therefore, this study evaluated the stability of maxillary interincisor diastema closure and the relationship between diastema relapse and initial interincisor diastema widths, overjet, overbite, angulations between adjacent anterior teeth, and presence of an intermaxillary osseous cleft, after orthodontic treatment with premolar extractions.

MATERIALS AND METHODS

This study was approved by the Ethics in Research Committee of Bauru Dental School, University of São Paulo, Brazil (protocol number: 84329418.6.0000.5417).

Sample size was calculated considering an 80% test power and a level of significance of 0.05 to detect relapse of 0.49 mm in the intercentral incisor diastema with a standard deviation of 0.68 mm, as previously reported.[12] Although a minimum sample of 21 patients was needed, 24 patients (15 females, nine males), including eight Class I and 16 Class II malocclusion patients were included.

The sample was selected retrospectively from the files of the Orthodontic Department at Bauru Dental School, University of São Paulo, Brazil. The selection criteria included: treatment including premolar extractions to correct the initial malocclusion, presence of at least one maxillary interincisor diastema greater than or equal to 0.5 mm at pretreatment, maxillary permanent canines with at least half of the crown erupted, patients who wore a Hawley plate in the maxillary arch as a retainer for a minimum of 6 months, and that had at least two years of posttreatment follow-up. Patients with missing anterior teeth, periodontal disease with bone loss, microdontia, maxillary congenital pathologies, mesiodens, diastema closure by a non-fixed orthodontic method, post-orthodontic mesiodistal restoration of the maxillary anterior teeth, and whose dental casts or radiographs did not allow for evaluation were excluded. None of the patients had supracrestal circumferential fiberotomy before, during, or after orthodontic treatment.

All patients were treated with maxillary first premolar extractions with or without mandibular premolar extractions, according to the specific patient need. Standard edgewise appliances (0.022 $\times$ 0.028-inch) were used for all patients; bands were only used on the first permanent molars. En-masse anterior retraction of the maxillary anterior teeth on 0.018 $\times$ 0.025-inch stainless steel archwires was performed. For retention, all patients used Hawley plates and canine to canine lingual bonded retainers in the maxillary and mandibular arches, respectively. The mean retention time using maxillary retainers was 1.55 $\pm$ 0.79 years, the mean treatment time was 3.29 $\pm$ 1.61 years, and the mean posttreatment follow-up time was 4.01 $\pm$ 1.13 years (range: 2.0 to 5.81 years).

Dental casts and panoramic radiographs taken at pretreatment (T1), posttreatment (T2), and posttreatment follow-up (T3) stages were evaluated. Patients had mean ages of 13.24 $\pm$ 1.68, 16.54 $\pm$ 2.24, and 20.55 $\pm$ 2.41, at T1, T2, and T3, respectively. Periapical radiographs taken at T1 and T2 were also evaluated. Treatment changes were calculated as T2-T1 and posttreatment follow-up changes were calculated as T3-T2. General diastema relapse was considered to have occurred when diastema width change at posttreatment follow-up (T3-T2) was greater than zero. It was considered that there was a clinically significant diastema relapse when there was a diastema width increase at posttreatment follow-up of at least 0.50 mm.

Dental Cast Analysis

Dental casts at T1, T2, and T3 were scanned using the 3Shape R700 3D scanner (3Shape A/S, Copenhagen, Denmark) and analyzed with OrthoAnalyzer 3D software (3Shape). Maxillary interincisor diastema width, overjet, and overbite were measured at the three timepoints.

Each maxillary interincisor diastema width was measured as the smallest distance at the level of the interproximal surfaces of adjacent anterior teeth and parallel to the occlusal plane. Then, right (A), midline (B), and left (C) diastema width measurements were obtained (Figure 1).

Overjet (OJ) was measured as the linear distance from the incisal edge of the maxillary incisor to the labial surface of the mandibular central incisor, parallel to the occlusal plane. Overbite (OB) was measured as the linear distance between the incisal edges of maxillary and mandibular central incisors, perpendicu-

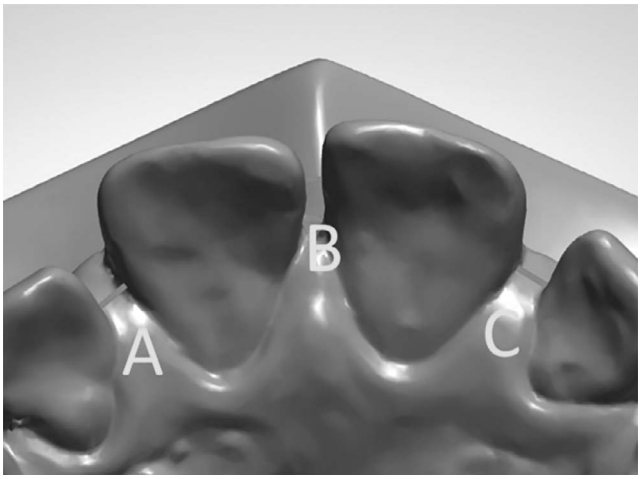

Figure 1. Maxillary interincisor diastemas (A: right diastema; B: midline diastema; C: left diastema).

lar to the occlusal plane. Right and left side OJ and OB values were averaged.

Radiographic Analyses

Panoramic and periapical radiographs were digitized and evaluated using MicroDicom viewer software (version 0.8.1; Simeon Antonov Stoykov, Sofia, Bulgaria).

Panoramic radiographs were used to assess digitally the angulations between the adjacent maxillary incisors. First, the tooth long axis was traced joining the incisor apex and the middle of the incisal edge of each incisor. Then, the angulations between adjacent tooth long axes (a° between right lateral and central incisors, b° between central incisors, and c° between left central and lateral incisors) were measured (Figure 2).

Presence of an intermaxillary osseous cleft was evaluated using T1 and T2 periapical radiographs. It was considered present when a v-shaped radiolucency in crestal bone between the central incisors was observed[8,11] on both T1 and T2 radiographs (Figure 3).

Error Measurement

Thirty dental casts, and panoramic and periapical radiographs were evaluated twice, with a 30-day interval by the same examiner (MC). Random and systematic errors were evaluated with Dahlberg's formula and paired *t*-tests, respectively, at a significance level of 5%. Intraobserver agreement for qualitative variables was evaluated with the Kappa coefficient.

Statistical Analyses

Statistical analyses were performed using SPSS software (version 22; IBM, Armonk, NY, USA). Stata software (version 14; Stata Corp., College Station, Texas, USA) was used to perform the regression analysis. The level of significance was set at $P < .05$.

Normal distribution of the variables was evaluated with Shapiro-Wilk tests. Comparisons between diastemas at the T1, T2, and T3 stages were performed with repeated-measures analysis of variance (ANOVA) followed by post-hoc Tukey tests or with Friedman tests followed by Wilcoxon tests, depending on normality. Individual diastemas (A, right; B, midline; and C, left) and grouped diastemas (A + B + C, A + C)

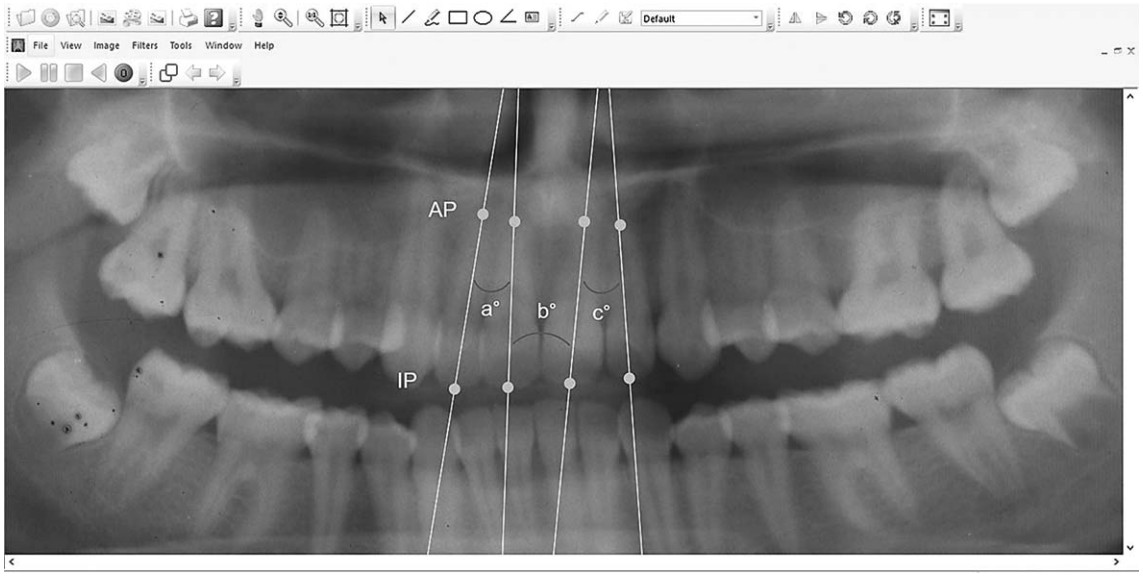

Figure 2. Anterior tooth long axis angulations. AP indicates apical points; IP, incisor points; a°, between right lateral and central incisors; b°, between central incisors; c°, between left central and lateral incisors.

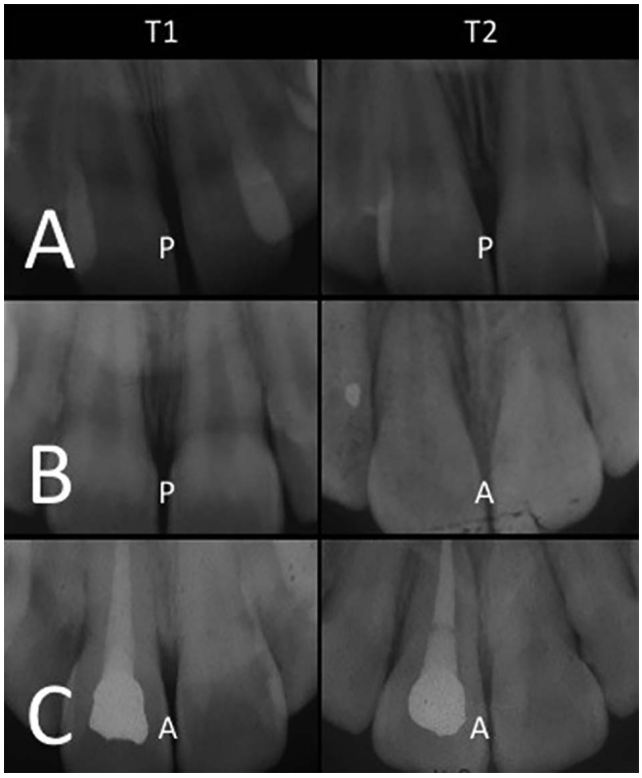

Figure 3. Final presence or absence of an intermaxillary osseous cleft according to the presence (P) or absence (A) of the radiolucent V-shaped crestal bone at pretreatment (T1) or at posttreatment (T2). (A) Final presence: P at T1 and P at T2. (B) Final Absence: P at T1 and A at T2. (C) Final Absence: A at T1 and A at T2.

were considered. To compare the midline diastema (B) relapse between patients with and without intermaxillary osseous clefts, *t*-tests or Mann-Whitney *U*-tests were used, depending on normality.

Relationships between midline diastema relapse with diastema widths, overjet, overbite, and angulations between adjacent anterior teeth were evaluated with Pearson's correlation coefficient. Influence of the variables that exhibited significant correlations ($P < .05$) with midline diastema (B) relapse were further evaluated with a multiple linear regression analysis.

The percentages of clinically significant relapse for maxillary interincisor diastemas (A, B, and C) were calculated.

RESULTS

Random errors ranged from 0.02 mm (A diastema) to 0.40 mm (Overjet) and from 0.63° (c°) to 0.82° (a°). There were no significant systematic errors. Kappa coefficient was 0.93 (95% CI: 0.74–1.00, $P < .001$), indicating almost perfect intraobserver agreement.[15]

All 24 patients had at least one maxillary interincisor diastema (A, B, or C). A, B, and C diastemas were present in 15, 13, and 18 patients, respectively.

Maxillary interincisor diastemas and overjet had statistically significant decreases from T1 to T2. These values remained stable showing no statistically significant relapse at T3 (Table 1). There were no significant differences between groups with and without v-shaped crestal bone (Table 2).

The maxillary interincisor midline diastema relapse was significant and negatively correlated with the total sum of diastemas (A + B + C) and the sum of lateral diastemas (A + C) at the end of treatment (T2), while positively correlated with the total sum of diastemas at T3 (Table 3).

The backward multiple regression analysis confirmed the influence of the total sum of diastemas. For each mm of the total sum of diastemas at T2, the midline diastema relapse was 0.61 mm smaller; and for each mm of the total sum of diastemas at T3, the midline diastema relapse was 0.33 mm larger (Table 4).

Table 1. Comparisons Between Pretreatment (T1), Posttreatment (T2), and Posttreatment Follow-Up (T3) Values in the Whole Sample (n = 24)[a]

	T1		T2		T3		
Variables	Mean	SD	Mean	SD	Mean	SD	*P**
A (mm)	0.46[A]	0.42	0.11[B]	0.17	0.20[B]	0.32	.008[c]
B (mm)	0.48[A]	0.52	0.08[B]	0.22	0.17[B]	0.30	.003[c]
C (mm)	0.53[A]	0.41	0.10[B]	0.17	0.22[B]	0.26	<.001[c]
A + B + C (mm)	1.47[A]	0.90	0.30[B]	0.40	0.60[B]	0.68	<.001[c]
A + C (mm)	0.98[A]	0.74	0.22[B]	0.28	0.42[B]	0.51	<.001[c]
OJ (mm)	7.92[A]	3.72	2.47[B]	1.02	2.96[B]	1.31	<.001[c]
OB (mm)	2.81	1.72	2.58	1.14	2.75	1.41	.847[b]
a (°)	8.88	4.43	7.46	5.34	7.48	3.97	.475[b]
b (°)	5.27	3.88	6.86	5.40	5.03	3.55	.453[c]
c (°)	9.14	4.39	8.76	6.64	7.56	4.87	.573[b]

* Statistically significant at $P < .05$. Different letters indicate statistically significant differences.

[a] SD, standard deviation; A, B, and C, right, middle, and left maxillary interincisor diastemas, respectively; OJ, overjet; OB, overbite; a, b, and c, angles between right, central and left maxillary incisors long axes, respectively.

[b] Repeated-measures analysis of variance.

[c] Friedman test.

Table 2. Comparison of Maxillary Interincisor Midline Diastema Between Groups With and Without Intermaxillary Osseous Cleft (Final V-Shaped Crestal Bone)[a]

	Normal Crestal Bone (n = 10)		V-Shaped Crestal Bone (n = 14)		
Variables	Mean	SD	Mean	SD	*P**
B (T1, mm)	0.27	0.36	0.63	0.58	.084[c]
B (T2, mm)	0.13	0.31	0.05	0.12	.588[c]
B (T3, mm)	0.14	0.26	0.20	0.34	.807[c]
B (T3-T2, mm)	0.01	0.45	0.15	0.33	.393[b]
B (T2-T1, mm)	0.13	0.55	0.58	0.54	.060[b]
b (T1, °)	4.71	2.65	5.66	4.61	.953[c]
b (T2, °)	4.64	3.01	8.44	6.24	.113[c]
b (T3, °)	3.85	2.89	5.88	3.83	.173[b]
b (T3-T2, °)	−0.79	3.76	−2.56	6.76	.464[b]
b (T1-T2, °)	0.07	3.75	−2.77	6.53	.230[b]

* Statistically significant at $P < .05$.

[a] SD indicates standard deviation; B, central diastema; b, angle between maxillary central incisors long axes; T1, pretreatment; T2, posttreatment; T3, posttreatment follow-up; T3-T2, posttreatment follow-up period; T2-T1, treatment period.

[b] *t*-test.

[c] Mann-Whitney *U*-test.

The percentages of clinically significant relapses for the midline diastema and for all the maxillary interincisor diastemas were 8.33% and 27.78%, respectively (Table 5).

DISCUSSION

Maxillary interincisor diastema relapse has been frequently studied in orthodontics.[8,10–12] Most studies did not specify whether the samples were treated with or without extractions.[8,10,11] Only one study disclosed that only non-extraction treated patients were included.[12] Although less frequently, diastemas can be present in patients that need premolar extractions.[16] Then, diastema closure stability also should be studied in this specific treatment protocol.

In this study, the maxillary interincisor diastemas were individually and collectively measured as the sum of the three spaces. Ideally, the maxillary interincisor diastemas should be totally closed at T2. However, not all spaces in every patient were completely closed at the end of treatment, as previously reported.[12,17] This is similar to premolar extraction space closure and shows that clinicians should be more careful at precisely closing the spaces at the end of treatment.[16,18]

Maxillary interincisor diastema dimensions significantly decreased from T1 to T2 and remained stable at T3 (Table 1). Contrary to non-extraction treatment, in which significant midline diastema relapse was reported,[12] in the present study, stability was seen in the three spaces studied. Thus, only minimum partial relapse occurred and diastema closures were stable at the posttreatment follow-up period.

Midline diastema has been the most studied diastema in the literature.[8,10–12] In the present study, it did not show statistically significant relapse, and the percentage of clinical relapse was of only 8.33% (Tables 1 and 5). Other studies showed significant relapse and the percentages of clinical relapse were from 25 to over 50%.[8,10–12] The reasons for the greater relapse in those studies may be the initial size of the diastemas and the treatment protocol. The study of Morais et al.[12] had a larger initial midline diastema and included only patients treated without extractions. The other studies had larger initial midline diastemas but did not disclose whether the patients were treated with or without extractions.[8,10,11] It could be speculated that most of the patients in those studies were treated with non-extraction because, when there is excessive space, it is usually preferable to treat without extractions.[10,19]

A previous study, in non-extraction cases, evaluated right, midline, and left diastema relapse and reported only significant relapse for the midline diastema,

Table 3. Correlations Between Maxillary Interincisor Midline Diastema (B) Relapse (T3-T2) and Variables at Pretreatment (T1), Posttreatment (T2), Posttreatment Follow-Up (T3), and T2-T1 Treatment Period[a]

Variables Correlated With B Relapse	T1		T2		T3		T2-T1	
	r	*P*	r	*P*	r	*P*	r	*P*
A (mm)	−0.01	.931	−0.15	.462	0.09	.649	−0.27	.199
B (mm)	−0.07	.746	0.14	.513	−0.03	.887	−0.08	.679
C (mm)	−0.14	.510	−0.08	.712	−0.28	.184	0.00	.987
A+B+C (mm)	0.08	.692	−0.63	.001*	0.58	.003*	−0.17	.408
A+C (mm)	0.14	.510	−0.42	.038*	0.29	.169	−0.17	.408
OJ (mm)	−0.06	.779	0.02	.915	0.13	.533	−0.36	.077
OB (mm)	0.00	.996	0.16	.435	0.13	.534	0.13	.522
a (°)	0.22	.281	0.40	.051	0.07	.722	−0.16	.432
b (°)	0.19	.359	−0.32	.122	−0.28	.182	−0.16	.432
c (°)	0.17	.419	0.16	.435	−0.10	.633	−0.03	.857

* Statistically significant at $P < .05$.

[a] r indicates Pearson correlation coefficient; A, B, and C, right, middle, and left maxillary interincisor diastemas, respectively; OJ, overjet; OB, overbite; a, b, and c, angles between right, central and left maxillary incisors long axes, respectively.

Table 4. Backward Multiple Linear Regression Analysis Results, Considering the Maxillary Interincisor Midline Diastema (B) Relapse (T3-T2) as Dependent Variable

Variables	β	Standard Error	*t*	*P* Value for Variables	Multiple R2 (%)	*P* Value for R2
A + B + C (T2, mm)	−0.61	0.10	−6.03	<.001*	75.73	<.001*
A + B + C (T3, mm)	0.33	0.06	5.57	<.001*		
Constant	0.07	0.06	1.21	.239		

* Statistically significant at $P < .05$.
[a] A, B, and C indicate right, middle, and left maxillary interincisor diastemas, respectively; R2, coefficient of determination.

suggesting that midline diastema closure was less stable than right or left diastema closure.[12] In contrast, no statistically significant relapse was found for A, B, and C diastemas in the present study (Table 1). It has been reported that the greater the initial diastema, the greater the degree of relapse.[8,10] In the present study, the mean initial values for A, B, and C diastemas were smaller compared to those reported in the previous study in non-extraction cases.[12] These differences could explain the significant midline diastema relapse observed in that previous study.[12]

In contrast to what was reported by other studies,[10,20] midline diastema closure relapse was similar in groups with and without intermaxillary osseous clefts (Table 2). The results of the present study agreed with other studies[8,11,12] in which no influence of the intermaxillary osseous cleft was found. Therefore, it seems that the intermaxillary osseous cleft did not influence relapse in patients treated with or without extractions.[8,11,12] However, due to the contradicting results, this issue should be further investigated.

A negative correlation between midline diastema relapse and the total sum of diastemas (A + B + C) and the sum of lateral diastemas (A + C) at the end of treatment (T2), and a positive correlation with the total sum of diastemas at T3, was observed (Table 3). However, when the backward regression analysis was performed including these variables, the significant influence of only the total sum of diastemas at T2 and T3 on midline diastema relapse was found (Table 4). This could be expected since the correlation with the sum of lateral diastemas at T2 was weak. It was not possible to confirm that the sum of the initial anterior spacing contributed to the relapse of the midline diastema. In contrast, one study reported that anterior spacing at T3 was associated with greater spacing at T1 and at T2. However, they considered only patients with spacing at T3 as their selection criteria. Then, patients with stable diastema closure were not included.[17]

Table 5. Percentage of Clinical Relapse (T3-T2) After Orthodontic Treatment With Premolar Extractions[a]

Interincisor Diastemas	Number of Interincisor Spaces in T1	X = Number of Closed Spaces in T2	Y = Number of Open Spaces in T3	% of Relapse (100 * Y/X)
A	15	13	2	15.38
B	13	12	1	8.33
C	18	17	1	5.88
A, B, or C	24	18	5	27.78

[a] A, B, and C, right, midline, and left maxillary interincisor diastemas, respectively; T1, pretreatment; T2, posttreatment; T3, posttreatment follow-up.

In the current study, regression analysis showed that the greater the total sum of diastemas at T2, the smaller the midline diastema relapse, and that the greater the total sum of diastemas at T3, the greater the midline diastema relapse, which is logical. If the total sum of diastemas was large at T2, it meant that the diastemas were not adequately corrected or even not corrected. If no correction or insufficient correction was performed, the chances of relapse would decrease since the diastemas were not totally closed. On the other hand, if the total sum of diastemas was large at T3, it meant that obviously there was a great amount of relapse.

Among the treatment and post-treatment factors, the initial diastema dimensions, overjet, overbite, angulations between adjacent anterior teeth, or the presence of an intermaxillary osseous cleft were not significantly associated with interincisor diastema relapse (Tables 2 and 3). A previous study[12] assessed these variables in non-extraction orthodontic treatment, and reported association of the overjet with midline diastema relapse, attributing this association to the lingual muscle function typical of Class II malocclusion, and to proclination of the maxillary incisors. However, the current sample had the same number of patients with Class II malocclusion and greater pretreatment overjet (7.92 mm vs 6.13 mm), than the previous study,[12] but the association was not observed.

Overjet behaved similarly to the maxillary interincisor diastemas; it significantly decreased from T1 to T2 and remained stable at T3, as previously reported[12,21] (Table 1).

In premolar extraction treatments, a high prevalence of premolar space reopening at 1 year after the end of treatment has been reported.[22] In addition, it has been demonstrated that premolar space reopening, in the long term, does not depend on the extraction protocol applied.[18] Based on the results of these studies,[18,22] it could be speculated that the chances of relapse could be greater in patients treated with maxillary premolar extractions that presented maxillary interincisor dia-

stemas at pretreatment because more spaces needed to be closed and redistributed. However, this speculation was not confirmed scientifically.

On the other hand, one could conclude that the results were logical. Cases with large anterior diastemas are usually treated non-extraction because they have a positive tooth-bone discrepancy. Due to the excessive space available, there is a greater tendency for significant anterior diastema relapse. However, cases treated with extractions usually have a negative tooth-bone discrepancy, and present with smaller anterior diastemas. Due to the absence of available space, there is a smaller tendency for significant anterior diastema relapse.

Although the sample size was calculated to be adequate for intragroup comparisons, it could be considered to have been too small to perform a regression analysis. This should be taken into consideration when interpreting the results. Further studies should be performed comparing and combining extraction and non-extraction cases to obtain greater samples and complement the current results.

Based on the current results, there is no significant relapse of maxillary interincisor diastema closure in Class I and II malocclusions when appropriate maxillary premolar extraction treatment is performed.

CONCLUSIONS

- There was no statistically significant relapse of maxillary interincisor diastemas.
- There was no relationship between relapse of the maxillary interincisor midline diastema and the initial interincisor diastema width, overjet, overbite, anterior tooth angulations, or presence of an intermaxillary osseous cleft.
- Clinically significant stability for all maxillary interincisor diastemas and interincisor midline diastema closure after orthodontic treatment with premolar extractions were 72.22% and 91.67%, respectively.

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REFERENCES

1. Bernabe E, Flores-Mir C. Influence of anterior occlusal characteristics on self-perceived dental appearance in young adults. *Angle Orthod*. 2007;77:831–836.
2. Furuse AY, Franco EJ, Mondelli J. Esthetic and functional restoration for an anterior open occlusal relationship with multiple diastemata: a multidisciplinary approach. *J Prosthet Dent*. 2008;99:91–94.
3. Witt M, Flores-Mir C. Laypeople's preferences regarding frontal dentofacial esthetics: periodontal factors. *J Am Dent Assoc*. 2011;142:925–937.
4. Farronato G, Giannini L, Riva R, Galbiati G, Maspero C. Correlations between malocclusions and dyslalias. *Eur J Paediatr Dent*. 2012;13:13–18.
5. Gkantidis N, Kolokitha OE, Topouzelis N. Management of maxillary midline diastema with emphasis on etiology. *J Clin Pediatr Dent*. 2008;32:265–272.
6. Andrews LF. The six keys to normal occlusion. *Am J Orthod*. 1972;62:296–309.
7. Steigman S, Gershkovitz E, Harari D. Characteristics and stability of spaced dentition. *Angle Orthod*. 1985;55:321–328.
8. Shashua D, Artun J. Relapse after orthodontic correction of maxillary median diastema: a follow-up evaluation of consecutive cases. *Angle Orthod*. 1999;69:257–263.
9. Mulligan T. Diastema closure and long-term stability. *J Clin Orthod*. 2003;37:560–574.
10. Edwards JG. The diastema, the frenum, the frenectomy: a clinical study. *Am J Orthod*. 1977;71:489–508.
11. Sullivan TC, Turpin DL, Artun J. A postretention study of patients presenting with a maxillary median diastema. *Angle Orthod*. 1996;66:131–138.
12. de Morais JF, de Freitas MR, de Freitas KMS, Janson G, Castello Branco N. Postretention stability after orthodontic closure of maxillary interincisor diastemas. *J Appl Oral Sci*. 2014;22:409–415.
13. Peck S. Extractions, retention and stability: the search for orthodontic truth. *Eur J Orthod*. 2017;39:109–115.
14. Iared W, Koga da Silva EM, Iared W, Rufino Macedo C. Esthetic perception of changes in facial profile resulting from orthodontic treatment with extraction of premolars: a systematic review. *J Am Dent*. Assoc 2017;148:9–16.
15. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics*. 1977;33:159–174.
16. Oftedal B, Wisth J. Residual extraction sites after orthodontic treatment. Part 1. At debanding. *Eur J Orthod*. 1982;4:11–19.
17. Surbeck BT, Årtun J, Hawkins NR, Leroux B. Associations between initial, posttreatment, and postretention alignment of maxillary anterior teeth. *Am J Orthod Dentofacial Orthop*. 1998;113:186–195.
18. Janson G, Valarelli DP, Rizzo M, Valarelli FP. Prevalence of extraction space reopening in different orthodontic treatment protocols. *Am J Orthod Dentofacial Orthop*. 2017;152:320–326.
19. Bishara SE. Management of diastemas in orthodontics. *Am J Orthod*. 1972;61:55–63.
20. Stubley R. The influence of transseptal fibers on incisor position and diastema formation. *Am J Orthod*. 1976;70:645–662.
21. Francisconi MF, Janson G, Freitas KM, Oliveira CB, Oliveira RCB, Freitas MR, et al. Overjet, overbite, and anterior crowding relapses in extraction and nonextraction patients, and their correlations. *Am J Orthod Dentofacial Orthop*. 2014;146:67–72.
22. Garib DG, Bressane LB, Janson G, Gribel BF. Stability of extraction space closure. *Am J Orthod Dentofacial Orthop*. 2016;149:24–30.