Original Article

Posttreatment and physiologic occlusal changes comparison

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ABSTRACT

Objective: To compare posttreatment and postretention occlusal changes with the physiologic occlusal changes caused by natural development of untreated subjects.

Materials and Methods: The sample was divided into three groups. Group 1 comprised 97 subjects treated with four premolar extractions at a mean pretreatment (T0) age of 13.03 years, a mean posttreatment (T1, first observation) age of 15.12 years, and a mean postretention (T2, second observation) age of 20.52 years. The mean observation period (T2-T1) was 5.39 years. Group 2 comprised 58 subjects treated nonextraction at a mean pretreatment age of 12.83 years, a mean posttreatment age of 14.99 years, a mean postretention age of 20.22 years, and a mean observation period of 5.22 years. Group 3 comprised 114 untreated subjects at a mean age at T1 of 14.91 years and at T2 of 20.48 years. The mean observation period was 5.56 years. Dental casts were evaluated using the Peer Assessment Rating (PAR) index and the Little irregularity index in maxillary and mandibular arches. Changes in PAR and Little indexes were compared among the three groups by analysis of variance and Tukey tests.

Results: Intergroup comparison showed that at T1 and T2 the treated groups presented smaller PAR and Little indexes than the untreated group. In the observation period, the treated groups showed greater increase in PAR and Little maxillary indexes than the untreated group. The extraction group showed a greater increase of the Little mandibular index than the untreated group.

Conclusions: The treated groups showed more changes according to PAR and Little maxillary indexes than the untreated group. The posttreatment change of the mandibular anterior crowding of the treated extraction group was greater than the mandibular crowding caused by physiologic changes in the untreated group. (*Angle Orthod.* 2013;83:239–245.)

KEY WORDS: Stability; Relapse; Crowding

INTRODUCTION

Orthodontists and researchers are aware that changes occur after orthodontic treatment, and the most studied is the relapse of mandibular anterior crowding. However, late mandibular incisor crowding can occur regardless of whether a person receives orthodontic treatment. The natural aging process causes some changes that are similar to those that occur after orthodontic treatment and removal of retainers.[1–3]

Some studies have demonstrated the changes over time with natural development.[3–5] Sinclair and Little[1] compared the natural development in an untreated normal group with four premolar extraction groups and found that mandibular crowding relapse was greater than the late mandibular crowding presented in the untreated group. However, the authors studied only normal occlusion cases, and the treated and untreated samples were not compatible regarding ages and observation period.

Driscoll-Gilliland et al.[6] compared skeletal and dental changes in treated patients with an untreated group to evaluate the relationship between skeletal changes and mandibular incisor crowding. Changes were annualized because the observation periods did not

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Accepted: June 2012. Submitted: March 2012.
Published Online: July 16, 2012

match between groups. There were no differences in the changes in irregularity between the groups.

The above mentioned studies showed controversial results. Sinclair and Little[1] found that relapse in the treated group was greater than late mandibular crowding in the untreated group. Driscoll-Gilliland et al.[6] found no difference in mandibular irregularity changes between the treated and untreated group. Therefore, we still do not know if the amount of posttreatment and natural development change is comparable or not.

In order to clarify this issue, the present study aimed to compare posttreatment and postretention occlusal changes with the physiologic occlusal changes of untreated subjects, using the Peer Assessment Rating (PAR) index and the Little irregularity index in the maxillary and mandibular arches.

MATERIALS AND METHODS

This research was approved by the Ethics Committee of the University of São Paulo. The sample comprised the retrospective records of 269 subjects obtained from the files of two institutions.

The sample was divided into three groups. Groups 1 and 2 were obtained from the Department of Orthodontics at Bauru Dental School, Bauru, São Paulo, Brazil. Subjects were treated with fixed appliances and chosen according to the following criteria:

- Class I or II malocclusion present at the beginning of orthodontic treatment;
- Treatment protocol with extraction of the four first premolars (Group1) or nonextraction (Group 2);
- Age at the end of orthodontic treatment between 13 and 16 years;
- All permanent teeth erupted up to the first molars, at pretreatment stage;
- Absence of tooth agenesis and anomalies;
- Maxillary removable (Hawley), worn for 1 year, and mandibular fixed canine to canine retainers worn for 1 to 2 years posttreatment, and no retention at the time of followup record;
- Dental casts from pretreatment, posttreatment, and postretention available at the time of the study; and
- At the end of treatment, all patients presented a Class I molar relationship.

Group 1 comprised 97 subjects (44 male, 53 female) treated with extraction of four first premolars; 60 subjects presented Class I and 37 presented Class II malocclusion (seven 1/4-cusp Class II, nine half-cusp Class II, five 3/4-cusp Class II, and 16 full-cusp Class II).[7,8] The mean age at pretreatment (T0) was 13.03 years (SD = 1.09), at posttreatment (T1) 15.12 years (SD = 1.22), and at postretention (T2, second observation stage) 20.52 years (SD = 1.50). The mean treatment time was 2.09 years (SD = 0.58), and the mean observation period was 5.39 years (SD = 1.14).

Group 2 comprised 58 subjects (24 male, 34 female) treated nonextraction; 29 subjects presented Class I and 29 presented Class II malocclusion (five 1/4-cusp Class II, seven half-cusp Class II, four 3/4-cusp Class II, and 13 full-cusp Class II).[7,8] The mean age at pretreatment (T0) was 12.83 years (SD = 1.11), at posttreatment (T1) 14.99 years (SD = 1.17), and at postretention (T2) 20.22 years (SD = 1.48). The mean treatment time was 2.16 years (SD = 0.71), and the mean observation period was 5.22 years (SD = 0.96).

Group 3 was obtained from the Burlington Growth Centre, University of Toronto, Ontario, Canada. Subjects of this group were chosen according to the following criteria:

- Class I or II malocclusion. Normal occlusions were excluded;
- No orthodontic treatment;
- All permanent teeth erupted up to the first molars, at the first observation stage;
- Absence of tooth agenesis and anomalies; and
- At least two dental casts at ages 14 to 16 and 19 to 21, available at the time of the study.

This group comprised 114 subjects (59 male, 55 female), 76 presenting Class I and 38 presenting Class II malocclusions (ten 1/4-cusp Class II, eight half-cusp Class II, eight 3/4-cusp Class II, and 12 full-cusp Class II).[7,8]

The mean age at the first observation stage was 14.91 years (SD = 0.92), and the mean age at the second observation stage was 20.48 years (SD = 0.29). The mean observation period was 5.5 years (SD = 0.94).

Stages were defined as follows: T1, end of treatment (posttreatment) in Groups 1 and 2 and first observation in Group 3; T2, postretention stage in Groups 1 and 2 and second observation in Group 3. Intergroup comparisons of PAR and Little indexes were performed at T1 and T2, and intergroup change comparisons from T1 to T2 (T2-T1) were also conducted.

To check whether the severity of the mandibular irregularity influenced its amount of increase in the untreated group, it was divided into two subgroups according to the severity of mandibular crowding at T1. Subgroup A included subjects with a Little mandibular index less than 4 mm, and subgroup B included subjects with an index of 4 mm or more.

Pretreatment (T0), posttreatment (T1), and postretention (T2) dental casts were used for Groups 1 and 2, and observation stages 1 (T1) and 2 (T2) for Group 3. All dental cast measurements were performed with

Table 1. Casual and Systematic Errors Between the First and Second Measurements[a]

	First Measurement		Second Measurement				
Variables	Mean	SD	Mean	SD	N	Dahlberg	*P*
PAR	9.74	2.23	10.12	1.97	100	0.74	.102
Little Mx	4.21	1.13	3.99	1.22	100	0.45	.093
Little Md	3.76	1.62	3.89	1.55	100	0.52	.281

[a] SD indicates standard deviation; PAR, Peer Assessment Rating; Mx, maxillary; Md, mandibular.

a 0.01-mm precision digital caliper (Mitutoyo America, Aurora, Ill) by one calibrated examiner. The assessed variables were: PAR index, described by Richmond et al.[9] and scored with the American weight,[10] and Little irregularity index[11] for maxillary and mandibular teeth.

The PAR index is an occlusal index designed and validated as an instrument to measure how much a patient deviates from normal occlusion.[9] This index was designed to measure the outcome of treatment by comparing the severity of the initial malocclusion with the result, as seen on pretreatment and posttreatment dental casts.[9] A posttreatment PAR score of 5 or less is considered an excellent outcome,[12] and a posttreatment PAR score above 10 indicates residual malocclusion.[13] The PAR index has been widely used for evaluating the effects of treatment in a variety of circumstances,[14–16] even in untreated cases.[4,5]

The Little irregularity index[11] is the summed displacement of the five anatomic contact points of mandibular anterior teeth. The caliper should be parallel to the occlusal plane.

The degree of change from the first to the second observation (T2-T1) was assessed by the index changes (PAR and Little Mx and Md).

Error Study

One month after the original exam, 100 pairs of dental casts were randomly selected and remeasured by the same examiner. The casual error was calculated according to Dahlberg's[17] formula ($S^2 = \Sigma d^2/2n$) and the systematic error with dependent *t*-tests[18] for $P < .05$.

Statistical Analysis

To check the compatibility of groups 1 and 2 for the age at pretreatment (T0), treatment time (T1-T0), and the PAR and Little indexes at T0, *t*-tests were used.

To check group compatibility, chi-square tests were used to compare sex distribution, type of malocclusion, and severity of the Class II molar relationship; one-way analysis of variance and Tukey tests were used to compare the ages and the observation period.

Intergroup comparison of the PAR and Little indexes was performed by one-way analysis of variance and Tukey tests. Comparison of subgroups A and B was performed by *t*-tests.

Intragroup comparisons of the unweighted components of the PAR index between the first and second observations for treated and untreated groups were performed by Wilcoxon tests.

Results were considered statistically significant for $P < .05$. All statistical analyses were performed on Statistica software (Statistica for Windows 6.0; Statsoft, Tulsa, Okla).

RESULTS

No systematic errors were detected, and the casual errors were within acceptable levels (between 0.45 for the Little Mx and 0.74 for the PAR; Table 1).

Groups 1 and 2 were compatible regarding pretreatment age, treatment time, and PAR at T0. Little maxillary and mandibular indexes were significantly greater in the extraction group (Table 2).

Groups were compatible regarding sex distribution (Table 3), type of malocclusion (Table 4), severity of the Class II molar relationship (Table 5), and age at

Table 2. Comparison of Age and PAR and Little Indexes at T0 for Groups 1 and 2[a]

	Group 1, Treated Extraction (N = 97)		Group 2, Treated Nonextraction (N = 58)		
Variables	Mean	SD	Mean	SD	*P*
Age, y	13.03	1.09	12.83	1.11	.267
Treatment time (T1-T0), y	2.09	0.58	2.16	0.71	.509
PAR	26.41	7.61	25.87	1.10	.679
Little Mx, mm	10.96	3.97	9.54	4.58	.044*
Little Md, mm	7.78	3.49	5.62	2.81	.000*

[a] PAR indicated Peer Assessment Rating; T0, pretreatment stage; T1, first observation; SD, standard deviation; Mx, maxillary; Md, mandibular.

* *t*-test, statistically significant for $P < .05$.

Table 3. Comparison of Sex Distribution Among the Groups*

	Sex		
Groups	Male	Female	Total
1. Treated extraction	44	53	97
2. Treated nonextraction	24	34	58
3. Untreated	59	55	114
Total	127	142	269

* $\chi^2_2 = 1.86$, $P < .392$.

Table 4. Comparison of Type of Malocclusion Among the Groups*

Groups	Class		
	Class I	Class II	Total
1. Treated extraction	60	37	97
2. Treated nonextraction	29	29	58
3. Untreated	76	38	114
Total	165	104	269

* $\chi^2_2 = 4.52$, $P = .104$.

first and second observation stages and observation period (Table 6).

Intergroup comparison results showed that, at T1 and T2, both treated groups presented smaller PAR and Little indexes than the untreated group (Table 7). In the observation period, the treated groups showed a greater increase in PAR and Little maxillary indexes than the untreated group. The treated extraction group showed a greater increase of the Little mandibular index than the untreated group (Table 7).

There was no difference in ages, observation period, and PAR and Little index changes (T2-1) when subgroups A and B were compared (Table 8).

For the treated groups, the overjet, overbite, midline deviation, and maxillary anterior alignment components significantly increased from posttreatment to postretention stage (Table 9). For the untreated group, only the midline deviation and the maxillary anterior component significantly increased (Table 10).

DISCUSSION

Sample and Groups Compatibility

The sample includes a great number of subjects divided into three groups, two treated and one untreated. This way, it is certainly not a totally homogeneous sample, because patients of the treated groups presented, as expected, a better occlusal condition (PAR and Little indexes) at posttreatment (T1) than the untreated group presented at the first observation stage (T1; Table 7). This difference was already reported in other studies comparing treated and untreated groups,[1,6] because the treated group is expected to have a better occlusal condition than untreated patients.

Table 5. Comparison of the Severity of the Class II Molar Relationship Among the Groups*

Groups	Molar Relationship				
	1/4-Cusp Class II	1/2-Cusp Class II	3/4-Cusp Class II	Full-Cusp Class II	Total
1. Treated extraction	7	9	5	16	37
2. Treated nonextraction	5	7	4	13	29
3. Untreated	10	8	8	12	38
Total	22	24	17	41	104

* $\chi^2_6 = 2.63$, $P = .852$.

Table 6. Intergroup Comparison of Ages at T1 and T2 and Observation Period[a]

Variables, y	Group 1, Treated Extraction (N = 97) Mean (SD)	Group 2, Treated Nonextraction (N = 58) Mean (SD)	Group 3, Untreated (N = 114) Mean (SD)	P[b]
Age at T1	15.12 (1.22)	14.99 (1.17)	14.91 (0.91)	.368
Age at T2	20.52 (1.50)	20.22 (1.48)	20.48 (0.29)	.249
Observation period (T2-T1)	5.39 (1.14)	5.22 (0.96)	5.56 (0.94)	.110

[a] T1 indicates first observation; T2, second observation; SD, standard deviation.
[b] *t*-test.

However, the groups presented similar sex distribution (Table 3), type of malocclusion (Table 4), severity of the Class II molar relationship (Table 5), and ages and length of observation period (Table 6).

The sample selection criteria and compatibility of the groups seemed to be appropriately used for the comparison of posttreatment and postretention changes with those of the natural development.

Regarding the treated groups, all cases had similar retention protocol to ensure the stability of the results.[19–21] Extraction and nonextraction protocols seem to have no influence on postretention stability[2]; however, we evaluated these cases in groups separately. Extraction- and nonextraction-treated groups were compatible regarding age at pretreatment, treatment time, and PAR at T0. As expected, the extraction group showed greater Little maxillary and mandibular indexes than the nonextraction group (Table 2).

Methodology

The best evaluation of occlusion changes is performed on dental casts. Despite not allowing clinic and radiographic evaluation, the dental cast gathers the largest amount of information related to orthodontic diagnosis and treatment.[23]

Currently the occlusal indexes constitute an important research method.[5] Therefore, the PAR index was used for occlusal evaluation and the Little index was used for the detailed evaluation of maxillary and mandibular irregularity.

Intergroup and Intragroup Comparison

As expected, at T1, the treated groups presented a better occlusal condition, showing smaller PAR and Little indexes than the untreated group (Table 7). At T2, the treated groups also presented smaller PAR and

Table 7. Results of Intergroup Comparison of the PAR and Little Indexes at T1 and T2 and Observation Period (T2-T1)[ab]

Variables	Group 1, Treated Extraction (N = 97), Mean (SD)	Group 2, Treated Nonextraction (N = 58), Mean (SD)	Group 3, Untreated (N = 114), Mean (SD)	*P*
PAR T1	4.11 (3.07)[A]	4.05 (3.91)[A]	14.41 (7.05)[B]	.000*
Little Mx T1, mm	1.54 (1.21)[A]	1.41 (1.18)[A]	6.76 (2.78)[B]	.000*
Little Md T1, mm	1.36 (0.94)[A]	1.06 (0.87)[A]	4.48 (2.08)[B]	.000*
PAR T2	7.04 (5.45)[A]	6.27 (5.79)[A]	14.82 (7.20)[B]	.000*
Little Mx T2, mm	2.84 (1.80)[A]	3.08 (1.89)[A]	7.65 (2.78)[B]	.000*
Little Md T2, mm	3.30 (2.02)[A]	2.46 (1.41)[A]	5.86 (2.36)[B]	.000*
PAR T2-T1	2.92 (5.62)[A]	2.22 (5.22)[A]	0.41 (2.05)[B]	.000*
Little Mx T2-T1, mm	1.30 (1.75)[A]	1.66 (1.42)[A]	0.89 (0.96)[B]	.002*
Little Md T2-T1, mm	1.93 (2.06)[A]	1.40 (1.18)[AB]	1.38 (1.11)[B]	.022*

[a] PAR indicates Peer Assessment Rating; T1, first observation; T2, second observation; SD, standard deviation; Mx, maxillary; Md, mandibular.

[b] For each line horizontally, the same letters indicate there is no statistically significant difference; different letters indicate there is a statistically significant difference.

* One-way analysis of variance and Tukey test, statistically significant for $P < .05$.

Little indexes when compared to the untreated group (Table 7). This was expected because the treated groups received orthodontic treatment to correct the malocclusion and the untreated group did not.

In the observation period, the treated groups showed greater increases in PAR and Little maxillary indexes than the untreated group (Table 7).

Our result corroborates the findings of Al Yami et al.,[5] in which the evaluation of an untreated sample found that the PAR score was not affected by physiological growth between 12 and 22 years of age, irrespective of the Angle classification or the treatment need. Sixty three percent of the cases showed no improvement of the PAR index or became worse. The present study found an increase of only 0.41 in the PAR index between the first and second observation stages in the untreated group.

The treated extraction and nonextraction groups showed a similar change (relapse) of 2.92 and 2.22 for the PAR index, respectively, which is in agreement with the relapse found by Freitas et al.[24] (2.87 measured by the PAR index) and is less than the 4.00 points in the PAR relapse found by Woods et al.[25]

Based on the present study results, the postretention relapse of the treated groups according to the PAR index was significantly greater than the physiological changes due to normal development in the untreated group. This is also true for maxillary anterior crowding.

In the observation period, the change in the Little mandibular index was greater in the treated extraction group than in the untreated group (Table 7).

Our results corroborate the findings of Sinclair and Little[1] that compared the natural development in an untreated normal occlusion group with a treated extraction group and found that mandibular crowding relapse was greater than the late mandibular crowding presented in the untreated group.

Richardson[26] found that 50 untreated subjects who were longitudinally followed from 13 to 18 years showed an average increase in mandibular crowding of 2.36 mm, which is greater than the 1.38 mm of the present study. Maybe the difference in the ages can explain this difference.

Eslambolchi et al.[3] found that from 13 to 19 years, the mandibular crowding of untreated subjects increased 1.57 mm, similar to the present study that demonstrated that from 15 to 20 years the mandibular irregularity increased 1.38 mm.

Driscoll-Gilliland et al.[6] found that there were no difference in the changes in irregularity of mandibular

Table 8. Results of Comparison of Subgroups A and B, Divided by the Severity of Mandibular Crowding at the First Observation Stage[a]

	Subgroup A—Little Md from 0 to 4 mm (N = 54)		Subgroup B—Little Md > 4 mm (N = 60)		
Variables	Mean	SD	Mean	SD	*P*[b]
Age at T1, y	14.94	0.92	14.88	0.91	.723
Age at T2, y	20.48	0.23	20.48	0.34	.951
Observation time (T2-T1), y	5.53	1.01	5.59	0.88	.745
PAR T2-T1	0.50	1.80	0.33	2.23	.667
Little Mx T2-T1, mm	0.94	0.92	0.84	1.00	.585
Little Md T2-T1, mm	1.43	1.19	1.33	1.04	.629

[a] Md indicates mandibular; Mx, maxillary; SD, standard deviation; T1, first observation; T2, second observation; PAR, Peer Assessment Rating.

[b] *t*-test.

Table 9. Intragroup Comparison of the Components of the PAR Index Between First and Second Observations for Groups 1 and 2 (Treated, N = 155)[a]

Components of the PAR Index	First Observation (Posttreatment) (T1)			Second Observation (Postretention) (T2)			*P*
	Median (Mean)	First Quartile (25%)	Third Quartile (75%)	Median (Mean)	First Quartile (25%)	Third Quartile (75%)	
Overjet	0.00 (0.27)	0.00	1.00	0.00 (0.51)	0.00	1.00	.000*
Overbite	0.00 (0.29)	0.00	1.00	0.00 (0.52)	0.00	1.00	.000*
Midline deviation	0.00 (0.05)	0.00	0.00	0.00 (0.13)	0.00	0.00	.001*
Posterior occlusion	0.00 (0.70)	0.00	1.00	0.00 (0.84)	0.00	1.00	.294
Maxillary anterior alignment	0.00 (0.23)	0.00	0.00	0.00 (0.54)	0.00	1.00	.000*

[a] PAR indicates Peer Assessment Rating.
* Wilcoxon test, statistically significant for $P < .05$.

teeth between a treated extraction and an untreated group. Our results showed similar changes in the mandibular index between the nonextraction and untreated groups, but significantly different changes among the extraction and the untreated groups. Maybe the greater pretreatment mandibular irregularity of the extraction group can explain these findings, since the severity of initial mandibular crowding can influence the amount of relapse.[27,28]

One concern was whether the severity of the mandibular irregularity would influence the amount of crowding increase in the untreated group. To address this concern, the untreated group was divided into two subgroups according to the severity of the mandibular crowding at T1.

The results showed that the changes of PAR and Little maxillary and mandibular indexes were similar in both groups (Table 7). It indicates that the amount of mandibular anterior crowding does not influence the changes due to natural development of untreated subjects. Untreated subjects with less or more mandibular crowding showed similar increase in crowding from 15 to 20 years.

For the whole treated group, overjet, overbite, midline deviation, and maxillary anterior alignment components increased significantly from the posttreatment to postretention stages, ie, showed a significant postretention relapse (Table 8). Only the posterior occlusion did not show significant relapse (Table 8). The posterior occlusion was previously shown to be stable in the long term.[19]

For the untreated group, only midline deviation and maxillary anterior alignment increased significantly (Table 9). Overjet, overbite, and posterior occlusion did not significantly change from T1 to T2. Maxillary anterior crowding is known to increase with age,[5] and therefore midline deviation should increase consequent to displacement of the maxillary incisors.

The present study proved that the mandibular incisor crowding occurs as a relapse of orthodontic treatment and also as part of the normal developmental process, despite the fact that it is greater in treated extraction cases, but it is similar to treated nonextraction cases. This corroborates somewhat the statement of Thilander[2] that late changes occurring during the postretention period generally cannot be distinguished from normal aging processes.

The present results underline the importance of studies showing that untreated dentitions change with time. Education of orthodontic patients about retention protocols and late developmental crowding is imperative.[3] The development of mandibular incisor crowding appears to be a continuous process throughout life, but more evidence is needed to understand why these changes occur.[3]

Table 10. Intragroup Comparison of the Components of the PAR Index Between First and Second Observations for Group 2 (Untreated, N = 114)[a]

Components of the PAR Index	First Observation (T1)			Second Observation (T2)			*P*
	Median (Mean)	First Quartile (25%)	Third Quartile (75%)	Median (Mean)	First Quartile (25%)	Third Quartile (75%)	
Overjet	1.00 (1.05)	0.00	2.00	1.00 (1.10)	0.00	2.00	.109
Overbite	1.00 (1.10)	0.00	2.00	1.00 (1.10)	0.00	2.00	.932
Midline deviation	1.00 (0.59)	0.00	1.00	1.00 (0.64)	0.00	1.00	.027*
Posterior occlusion	1.00 (1.06)	0.00	2.00	0.00 (1.03)	0.00	2.00	.573
Maxillary anterior alignment	2.00 (1.92)	1.00	3.00	2.00 (1.96)	1.00	3.00	.043*

[a] PAR indicates Peer Assessment Rating.
* Wilcoxon test, statistically significant for $P < .05$.

CONCLUSIONS

- The treated groups showed more changes according to PAR and Little maxillary indexes than the untreated group in the observation period.
- The posttreatment change of the mandibular anterior crowding of the treated extraction group was greater than the mandibular crowding caused by physiologic changes in the untreated group.

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