RETROSPECTIVE ANALYSIS OF ORTHODONTIC TREATMENT OUTCOMES AND ITS RELATION TO POSTRETENTION STABILITY*

ANÁLISE RETROSPECTIVA DOS RESULTADOS DOS TRATAMENTOS ORTODÔNTICOS E SUA RELAÇÃO COM A ESTABILIDADE PÓS-CONTENÇÃO

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ABSTRACT

*O*bjective: The present study was designed to retrospectively evaluate Class I malocclusion cases treated with extraction of the four first premolars, aiming to establish the relationship between the quality of orthodontic treatment outcomes and the long-term occlusal stability. Material and methods: The sample comprised 94 patients of both genders, presenting Class I malocclusion, treated with extractions of the four first premolars and Edgewise mechanics. All the patients selected were whites, being 50 males and 44 females. The mean pretreatment age was 13.46 years (s.d. 1.8). The mean treatment time was 2.09 years (s.d. 0.58), the mean retention time was 1.63 years (s.d. 0.73) and the mean time of postretention evaluation was 5.31 years (s.d. 1.61). The dental casts were measured at pretreatment (T1), posttreatment (T2) and postretention (T3), by the PAR index and by the Little irregularity index, and the correction due to treatment (T1-2) and the change at the postretention period (T3-2) were calculated. The descriptive statistics was performed and the Pearson correlation coefficient was applied for the PAR and the Little indices in the total sample, among the times evaluated. Results: The mean PAR reduction due to treatment was 78.54%, and 66.6%, at the postretention stage related to pretreatment stage. Significant correlations were found for the PAR index at the times evaluated, except between T1 and T2 and between T1-2 and T3. In other words, the higher the treatment correction (T1-2), the lower the posttreatment PAR index (PAR T2) will be, and the higher will be the PAR change at the postretention period (PAR T3-2). Also, the higher the posttreatment PAR score (PAR T2), the higher will be the postretention PAR score (PAR T3).Conclusion: It was concluded that the quality of orthodontic treatment outcomes is not related to the long-term occlusal stability.
Uniterms: Treatment outcomes; Recurrence; Orthodontics.

RESUMO

*O*bjetivo: O presente estudo objetivou analisar retrospectivamente casos com má oclusão de Classe I tratados com extrações dos quatro primeiros pré-molares, visando estabelecer a relação da qualidade dos resultados dos tratamentos ortodônticos e a estabilidade em longo prazo. Material e métodos: A amostra consistiu de 94 pacientes de ambos os gêneros, apresentando má oclusão de Classe I, tratados com extrações dos quatro primeiros pré-molares e mecânica Edgewise. Todos os pacientes selecionados eram leucodermas, sendo 50 do gênero masculino e 44 do feminino. A idade inicial média foi de 13.46 anos (d.p. 1.8). O tempo de tratamento médio foi 2.09 anos (d.p. 0.58), o tempo médio de contenção foi 1.63 anos (d.p. 0.73) e o tempo médio de avaliação pós-contenção, 5.31 anos (d.p.1.61). Foram medidos, nos modelos de estudo, o índice PAR e o índice de irregularidade de Little, nas fases pré (T1), pós-tratamento (T2) e pós-contenção (T3), e calculou-se a quantidade de correção com o tratamento (T1-2) e de alteração no período pós-contenção (T3-2). Realizou-se a estatística descritiva e o coeficiente de correlação de Pearson foi aplicado entre os índices estudados e os tempos avaliados. Resultados: A média de redução do índice PAR da amostra total com o tratamento foi de 78.54%, e na fase pós-contenção, de 66.6%, com relação ao inicial. Houve correlação significante para o índice PAR nos tempos estudados, exceto entre T1 e T2 e entre T1-2 e T3. Ou seja, quanto maior a correção do tratamento (T1-2), menor será o índice PAR final (PAR T2), e maior a alteração no período pós-contenção (PAR T3-2). E quanto maior o índice PAR pós-tratamento (PAR T2), maior o índice PAR pós-contenção (PAR T3).Conclusão: Concluiu-se que a qualidade dos resultados dos tratamentos ortodônticos não está relacionada à estabilidade oclusal em longo prazo.
Unitermos: Resultado de tratamento; Recidiva; Ortodontia.

INTRODUCTION AND STATEMENT OF THE PROBLEM

It is widely considered that some occlusal changes following orthodontic treatment are inevitable[27,29,38,40]. Therefore, the possibility to be able to accurately predict the likelihood of various types of occlusal changes occurring posttreatment would be of great benefit to orthodontists. For that reason, the effects of many diagnostic and treatment factors on short and long-term occlusal stability have been broadly investigated[8,14,15,25,26,28,39].

Despite of all these researches in this matter, there has still been little detailed study of the relationship between the provision of a well-detailed occlusion and long-term posttreatment stability, although such a well-detailed occlusion, with the best esthetic and occlusal results as possible, has been recommended for some time[5,36]. This may be related to the fact that a widely acceptable and reproducible method of occlusal assessment has not been yet available[40]. However, there are many systems of occlusal assessment[9,16,32,33], and recently one of them has been widely promoted and used[32]. It is called Peer Assessment Rating (PAR) Index, and has been frequently subject of studies[3,4,6,7,11,13,19,23,29-31,40], with great acceptance.

The present study was designed to retrospectively evaluate, by means of the use of the PAR index[32] and the Little irregularity index[24], Class I malocclusion cases treated with extraction of the four first premolars, aiming to establish the relationship between the quality of orthodontic treatment outcomes and the long-term occlusal stability.

MATERIAL AND METHODS

Material

The sample comprised the retrospective records of 94 patients treated by postgraduate students at Bauru Dental School, University of São Paulo. Patients were chosen for the sample according to the following criteria:

- Class I malocclusion present at the beginning of orthodontic treatment;
- Treatment protocol with extraction of the four first premolars;
- Complete course of orthodontic treatment with full maxillary and mandibular fixed appliance (slot 0.022" x 0.025"), with Edgewise mechanics;
- All permanent teeth erupted until the first molars, at the pretreatment stage;
- Absence of tooth agenesis and anomalies;
- Maxillary removable (Hawley) and mandibular fixed (3x3) retainers worn for at least one year posttreatment, and no retention at the time of follow-up record;
- Pretreatment, posttreatment and postretention dental casts available at the time of the study.

All patients selected were whites of both genders, being 50 males and 44 females. The mean pretreatment age of the patients was 13.46 years (s.d. 1.8). The mean treatment time was 2.09 years (s.d. 0.58), the mean time that the retainers were used was 1.63 years (s.d. 0.73) and the mean time of postretention evaluation was 5.31 years (s.d. 1.61).

Methods

Pretreatment (T1), posttreatment (T2) and postretention (T3) dental casts were used. All dental cast measurements were performed with a 0.01mm precision digital caliper (Mitutoyo caliper - Mitutoyo South America – model/code 500-143B) by one calibrated examiner (KMSF). The assessed variables were: Little irregularity index[24] and the PAR index, as described by Richmond, et al.[32] (1992), and scored with the American weight[10]. The degree of improvement as a result of orthodontic treatment and the posttreatment changes were assessed by two methods. The first method used the indices (PAR and Little) changes, which is the difference between the pretreatment and posttreatment scores (T1-2) and the difference between the postretention and posttreatment scores (T3-2). The second was the reduction percentage, which reflects the relative change to the pretreatment score. This is determined by the formula: T1-T2/T1 x 100% or T1-T3/T1 x 100%, where T1 is the pretreatment score, T2 is the posttreatment score and T3 is the postretention score.

Error study

After a one-month interval from the first measurement, the dental casts of 25 patients (75 pairs of dental casts) were randomly selected and re-measured by the same examiner (KMSF). The casual error was calculated according to Dahlberg's formula ($Se^2 = \Sigma d^2/2n$) where S^2 is the error variance and d is the difference between the two determinations of the same variable, and the systematic error with dependent t tests, for $p<0.05$.

Statistical analysis

Means and standard deviations for all variables were calculated: the PAR index[32] and the Little irregularity index[24] at the pretreatment, posttreatment and postretention stages, the treatment change (T1-2) and the postretention change (T3-2).

Pearson's coefficient was calculated in order to verify the presence of significant correlation between the PAR scores and the Little irregularity index at all stages and phases evaluated (T1, T2, T3, T1-2 and T3-2). Results were considered significant for $p<0.05$.

RESULTS

The results of the systematic and casual errors are presented in Table 1. No systematic errors were detected, and the casual errors were within acceptable levels.

Descriptive statistics of the PAR index[32] and for the Little irregularity index[24] at the stages and periods evaluated are shown in Table 2.

Table 3 shows the results of Pearson's correlation test, demonstrating the correlation coefficients between the variables studied and the times evaluated.

DISCUSSION

Sample

Even though the sample evaluated in this study might appear to be small, it is still substantial considering that the patients have been evaluated more than 5 years after the end of active orthodontic treatment. It is certainly not a totally homogeneous sample because it includes patients with a wide range of treatment times and different facial patterns. However, all these patients presented the same Angle Class I malocclusion at the beginning of treatment, were treated with fixed appliances, Edgewise mechanics and the same treatment protocol, extraction of the four first premolars. These criteria of sample selection made it possible and appropriate to be used for isolation of the quality of occlusal results as a predictor or not of stability.

The fact that the patients were treated by more than one professional and by postgraduate students could create doubts in relation to the variation of the quality of final occlusion, influencing the results[40]. However, it has already been proven that there is no significant difference in the quality of treatment outcomes between cases treated by students and by specialists[11].

It was intended to select cases with relatively similar retention times (1.63 years was the mean retention time, with a standard deviation of only 0.73), because it was many times mentioned in the literature that the duration of the use of retainers can affect the stability of results[4,25,37]. Besides, all patients had the same retention protocol, a removable Hawley in the maxillary arch and a bonded 3x3 in the mandibular arch.

METHODOLOGY

The methodology should be based on the mean objective of the study. As the purpose of this study was to correlate the quality of treatment results with the postretention stability, dental casts are the best method for evaluation of final occlusion. In spite of not allowing clinical and radiographic evaluation, the dental casts, by themselves, gather the largest amount of information related to diagnosis and to orthodontic treatment[6,17]. Besides, a poor association has been demonstrated between the occlusal characteristics and the morphology obtained in lateral cephalograms and a better prediction of the results by occlusal indices than by cephalometrics[22]. In addition, many important characteristics of the occlusion, such as amount of crowding and transverse relationship of the dental arches, cannot be appraised in cephalometrics[6,20].

Andrews[5] (1972) defined the six keys to normal occlusion based exclusively on data obtained in 120 dental casts, and these keys are valuable parameters for the achievement of a static ideal occlusion. In the same way, actually the occlusal indices constitute an important research method[2,6,7,40]. Therefore, the PAR index was used because it was especially designed to evaluate treatment changes and outcome[2,7,11]. It has been proven valid and reliable in this assessment[10,32]. However, it is not sensitive to fine details of the occlusion[19].

Descriptive statistics

The time of postretention observation (T2 to T3) is acceptable for the evaluation of stability, in spite of being only 5.31 years (s.d. 1.61) on average, since Al Yami, Kuijpers-Jagtman and Van't Hof[4] (1999) reported that about half of the total relapse occurs within the first two years posttreatment with good stability of most features at the period beyond 5 years.

The PAR index is an internationally recognized and

TABLE 2- Descriptive statistics of the variables evaluated

Variables	Mean	s.d.	N
PAR T1	29.46	8.79	94
PAR T2	6.32	3.48	94
PAR T3	9.84	5.02	94
PAR T1-2	23.14	9.51	94
PAR T3-2	3.52	5.33	94
Little T1	6.97	3.55	94
Little T2	1.26	0.91	94
Little T3	2.74	1.82	94
Little T1-2	5.71	3.62	94
Little T3-2	1.48	1.62	94

TABLE 1- Casual and systematic errors between the 1st and 2nd measurements

Variables	1st measurement		2nd measurement		N	Dahlberg	P
	Mean	s.d.	Mean	s.d.			
Little T1	7.03	3.53	6.79	3.54	30	0.406	0.502
Little T2	1.47	0.90	1.49	0.85	30	0.251	0.676
Little T3	2.82	1.61	2.85	1.61	30	0.219	0.536
PAR T1	27.20	6.52	26.93	6.50	30	1.322	0.347
PAR T2	6.16	3.30	6.30	2.97	30	1.095	0.572
PAR T3	10.46	3.76	10.70	3.74	30	1.012	0.281

accepted index for recording occlusal features from dental casts[32] and it was designed to provide objective assessment of the success of orthodontic treatment[11]. However, there are admittedly some limitations. Importantly, changes in facial profile or cephalometric parameters that reflect the skeletal component of malocclusion are not considered in the quantitative evaluation[10]. Unfortunately, measurements of these variables by valid and reliable methods has not been achieved for many reasons, but no universally accepted methods currently exist to assess change in facial profile as an outcome measure[10]. Actually, the optimal feasible method for assessing the attainment of desired occlusal outcomes is by the use of occlusal indices. In this study, the mean PAR score for the total sample at treatment onset (T1) was 29.46 (s.d. 8.79), being reduced to 6.32 (s.d. 3.48) by the end of the active treatment (T2) and increased to 9.84 (s.d. 5.02) when assessed at the postretention stage (T3) (Table 2).

It has been suggested that a good standard of orthodontic treatment should result in a mean PAR reduction of 70% or more[33]. In the present study, the treatment reduced the malocclusions by about 79%, indicating a high standard of treatment[33]. The results correspond well with other reports on orthodontic treatment with fixed appliances[7,11,13,30,31,34,35,40].

The long-term result of 66.6% PAR score reduction implies a loss of about 13% of what was gained by treatment. Unchanged results at the follow-up period would probably be too ambitious. Similar studies reported postretention changes[4,7,29,31,40], and these changes are also found in untreated normals[3,38].

TABLE 3- Results of Pearson's correlation coefficient between the PAR and the Little indices at all times evaluated

Variables	r	P
PAR T1 x PAR T2	-0.090	0.384
PAR T1 x PAR T3	0.256	0.012*
PAR T1 x PAR T1-2	0.918	0.000*
PAR T1 x PAR T3-2	0.302	0.003*
PAR T2 x PAR T3	0.261	0.010*
PAR T2 x PAR T1-2	-0.429	0.000*
PAR T2 x PAR T3-2	-0.404	0.000*
PAR T3 x PAR T1-2	0.150	0.147
PAR T3 x PAR T3-2	0.774	0.000*
PAR T1-2 x PAR T3-2	0.423	0.000*
PAR T1 x Little T3	-0.050	0.626
PAR T2 x Little T3	0.006	0.949
PAR T3 x Little T3	-0.029	0.779
Little T1 x Little T2	0.053	0.606
Little T1 x Little T3	0.380	0.000*
Little T2 x Little T3	0.459	0.000*

* Statistically significant for p<0.05

In relation to Little irregularity index, the pretreatment mean was 6.97mm (s.d. 3.55), it was corrected to 1.26mm (s.d. 0.91) at the end of orthodontic treatment and showed a mean value of 2.74mm (s.d. 1.82) at the postretention stage (Table 2). In other words, the orthodontic treatment provided a mean correction of 81.92% of the amount of mandibular anterior crowding, and during the postretention phase there was a loss of this correction, attaining 60.68% regarding the beginning of treatment. This postretention relapse observed for the irregularity index can be considered a relative stability, compared to other results found in the literature[14,15,25-28,39].

Correlations

The PAR index presented a significant correlation between its initial score and its score at postretention stage, treatment correction and alteration at the postretention period (PAR T1 x PAR T3; PAR T1 x PAR T1-2; PAR T1 x PAR T3-2) (Table 3). Interpreting these results, it can be said that the largest the severity of the malocclusion, the largest will be the treatment correction and the relapse of this correction, implying higher postretention PAR index values.

Regarding the final treatment results (T2), the PAR score was statistically significant and was correlated with changes occurring among phases T1-2 and T3-2 (Table 3), however with negative coefficient values, demonstrating that the largest the correction accomplished during treatment, the smallest will be the posttreatment PAR index, and the largest will be the relapse during the postretention period. However, there was a positive correlation between posttreatment and postretention PAR scores (PAR T2 x PAR T3), indicating that the best finished cases presented best occlusions also at the postretention stage, though presenting more PAR index relapse. These results corroborate the study of Nett and Huang[29] (2005), that evaluated 100 cases randomly chosen by the PAR index and the objective grading system (OGS) and concluded that settling occurs after orthodontic treatment, and the attainment of perfect occlusal results does not ensure stability.

Besides this above cited study, few other studies described the relationship between posttreatment scores and long-term changes[12,21,40]. Kashner[21] (1999) found that a group of patients treated to a higher level of quality also showed a higher quality result in the long-term. However, other studies found no correlation between treatment quality results and long-term stability[12,40]. The results of the present study might support these prior works, because even though well-finished patients tended to worsen and poorly finished tended to improve[29], the well-finished patients still had better absolute occlusal relationships at postretention, showed by the result of correlation coefficient for PAR T2 x PAR T3 (positive correlation) (Table 3). The lack of correlation of the study by Woods, Lee and Crawford[40] (2000) can be explained partly for the wide range of malocclusions appraised, including different treatment plans and protocols[40], while in the present study the malocclusion type and the treatment protocol were the same in all cases evaluated.

The Little irregularity index was not correlated to the PAR index at any of the times of evaluation (Table 3), in other words, the mandibular anterior crowding relapse presents a different behavior from the other occlusal characteristics. This result corroborates the assertion that the characteristic more prone to relapse is certainly the crowding of mandibular incisors[4,14,27,28]. The Little irregularity index was significantly correlated for pretreatment and posttreatment with the postretention phase (Table 3).

One might have expected to find that the higher the standard of occlusal finishing at the end of active treatment, the smaller will be the postretention occlusal change. No such relationship was uncovered in this study, however. It can seem senseless, because high standard of occlusal finish was sometimes previously associated to greatest stability in the long-term[5,36]. Even though, on the other hand, intending that cases treated to a normal occlusion result request larger correction during treatment, and it was demonstrated that the larger the correction, the larger the relapse, the correct interpretation of results becomes easier. The consistent information that untreated cases present a relative stability of occlusion cannot be neglected[1,3,38]. Except for the mandibular anterior crowding, the longitudinal changes of untreated patients are minimum and irrelevant[1,3,38]. These mentioned untreated cases can present normal occlusion[38] or malocclusion[1,3].

FINAL CONSIDERATIONS

In the current climate of high quality, accountable and professional healthcare, the demand for orthodontists to provide treatments that are evidence-based is heightening[18,23]. Critical evaluation of the available evidence is needed in Orthodontics. The exact detail regarding long-term occlusal change is incomplete. It is known that untreated individuals undergo longitudinal occlusal change[1,3,38]. Similarly, patients treated with orthodontic appliances undergo posttreatment change. Most studies report beneficial occlusal change from treatment[13,23], followed by some deterioration in the quality of occlusion at the postretention phase[4,7,28,29,40].

Whilst most papers acknowledge the unpredictability of posttreatment change both in regard to its likelihood in an individual and to its extent[4], it would seem that a high quality of treatment occlusal results relates to a great long-term stability[5,27,28,36], but by these study results, according to the sample and methodology used, it was proved not to be the reality. An ideal occlusal finish is not synonym of stability[12,29,40].

Even though an ideal occlusal treatment result does not assure stability, it does not justify to despise the quality and the full detail of final occlusion, because an excellent finish provides best occlusal, functional and mainly esthetic results, besides of oral and masticatory system health including teeth, bone and periodontium[11].

CONCLUSION

The quality of orthodontic treatment outcomes is not related to the long-term occlusal stability.

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