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Comparison of the outcomes of the lower incisor extraction, premolar extraction and non-extraction treatments

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SUMMARY The aim of this retrospective study was to evaluate the treatment outcome of lower incisor extraction and to compare it with premolar extraction and non-extraction treatment. The sample consisted of 60 subjects with Class I malocclusion and moderate crowding. The sample was separated into three groups: extraction of a lower incisor group, extraction of a four first premolar group and a non-extraction group. All groups involved 13 girls and 7 boys with a total of 20 patients. The Peer assessment rating (PAR) index was applied to a patient's pre-treatment (T1) and post-treatment (T2) dental casts. T1 dental casts were also used for determining Bolton discrepancy. One-way analysis of variance and *post hoc* Tukey HSD tests were used for statistical analysis. For the mean percentage PAR score reduction for each group, there was one significant difference seen between the lower incisor extraction group and the non-extraction group ($P = 0.047$). For the mean anterior ratios, there were significant differences among premolar extraction group versus non-extraction group ($P = 0.042$) and non-extraction group versus lower incisor extraction group ($P = 0.000$). For the mean overall ratios, there were significant differences among the premolar extraction group versus lower incisor extraction group ($P = 0.048$) and the non-extraction group versus lower incisor extraction group ($P = 0.001$). Orthodontic treatment without extraction has a better treatment outcome than the four-first premolar extraction and single lower incisor extraction protocols in Class I cases with moderate to severe mandibular anterior crowding.

Introduction

Anterior dental crowding is perhaps the most frequently occurring characteristic of malocclusion (Little *et al.*, 1981). The decision to extract permanent teeth as an aid in resolving arch length deficiencies presents a challenge to the orthodontist. While the clinician often debates the merits of an extraction versus a non-extraction approach, clearly some patients are not ideal candidates for either of the treatment options. A deficiency in the mesiodistal width of the maxillary anterior teeth (or conversely, an excess in the mandibular anterior teeth) may provide an additional extraction option: the removal of a mandibular incisor (Klein, 1997). There are references to it, often as case reports (Kokich and Shapiro, 1984; Hinkle, 1987; Doppel, 1991; Klein, 1997; Kokich, 2000; Bayram and Ozer, 2007), and as one of many possible approaches for crowding (Kokich and Shapiro, 1984; Dacre, 1985; Owen, 1993). Others advise it for cases of anterior tooth size discrepancies (Klein, 1997; Bayram and Ozer, 2007), or to harmonize with an absent or peg-shaped maxillary lateral incisor (Owen, 1993; Klein, 1997). Previous articles (Kokich and Shapiro, 1984; Riedel *et al.*, 1992; Valinoti, 1994) have described the indications, advantages, and limitations of the mandibular incisor extraction. Uribe and Nanda (2009) clearly described the case selection and mechanics of treatment with the lower incisor extraction.

It was demonstrated that in Class I cases treatment protocol included extraction of the four first premolars may provide a high-standard orthodontic finishing (Freitas *et al.*, 2008). Complete Class II malocclusion treatment with the two-maxillary premolar extraction protocol has greater treatment efficiency than the non-extraction protocol of complete Class II malocclusion (Janson *et al.*, 2007). However, treatment changes and quality of finishing occlusion in Class I cases treated with lower incisor extraction protocol have not been studied.

The aim of this retrospective study was to quantitatively evaluate the treatment outcome after extraction of one lower incisor and to compare it with the results of the extraction and non-extraction treatments using the Peer assessment rating (PAR) index.

Subjects and methods

The sample consisted of 60 (39 girls and 21 boys) subjects who were selected by means of a retrospective record review of patients treated at the Department of Orthodontics of Selcuk University. Seven PhD students treated the

patients. The sample included three different groups divided depending on an extraction decision as follows: the agenesis or extraction of one lower incisor group (IE), the extraction of four first premolar group (PE) and the non-extraction group (NE). All groups involved 20 patients. Table 1 shows the distribution, mean ages, and the average treatment time of each group.

The patients who fulfilled the following inclusion criteria were selected in treatment groups, so they were not selected randomly. For the subjects of PE and NE group, extraction decision was made depending on the amount of crowding and profile. All subjects of PE had Class I malocclusion with severe crowding (more than 8 mm) in both arches and their profiles allowed to extract four premolars. The patients in NE group whose profiles did not allow to extract teeth had Class I malocclusion with moderate crowding (3–4 mm or less). All samples of IE had Class I malocclusion with a mandibular anterior excess according to the Bolton analysis (Bolton, 1958) (two of them have an absent lower incisor and two of them have Class I malocclusion with Class III tendency), severely crowded lower incisors and mild or no crowding in the upper arch. At the beginning of treatment, the ages and sex distributions of groups were similar (Table 1). The same appliance and mechanics (fixed Edgewise mechanics) were used for all groups.

The PAR index applied to a patient's pre- and post-treatment dental casts. The components of the PAR index consisted of alignment of the maxillary anterior segment, alignment of the mandibular anterior segment, left buccal occlusion, right buccal occlusion, overjet, overbite, and the centre line (Ertas, 1996; Stalpers *et al.*, 2007).

After the measurements were completed, the scores were multiplied by a specific coefficient for each category. The individual traits were weighted according to Richmond *et al.* (1992a). The result was the weighted PAR index, which was used in this presentation. The coefficients were 1 for anterior irregularity and buccal occlusion, 6 for overjet, 2 for overbite, and finally 4 for midline (Richmond *et al.*, 1992a; Ertas, 1996; Stalpers *et al.*, 2007). A score of 0 reflected good alignment and occlusion, and higher scores indicated increased levels of irregularity or malocclusion. There were basically two methods of assessing improvement using the PAR index: 1. reduction in PAR score and 2. percentage reduction in PAR score. The difference in scores between the pre- and post-treatments reflected the degree of the improvement as a result of orthodontic intervention (Richmond *et al.*, 1992a). This percentage also indicated the relative change to the pre-treatment score and the percentage of PAR score reduction expressed the amount of correction with treatment (Birkeland *et al.*, 1997; Stalpers *et al.*, 2007) and calculated using the following formula (Ertas, 1996; Freitas *et al.*, 2008):

$$\text{PAR\%} = \text{PAR T2} - \text{T1} \times 100/\text{PAR T1}.$$

The degree of improvement was organized into three categories according to the results of this formula. These categories were 'worse–no different' (less than 30% reduction), 'improved' (≥30% reduction and less than 22 PAR score reduction), and 'greatly improved' (at least 22 PAR score reduction) (Richmond *et al.*, 1992b; Birkeland *et al.*, 1997; Dyken *et al.*, 2001).

T1 dental casts were also used for determining Bolton discrepancy. Anterior and overall ratios were obtained. All dental cast measurements were performed with a 0.01-mm precision digital caliper (Mitotogo, Tokyo, Japan) by one examiner (ZI).

Statistical analysis

Pre- and post-treatment PAR scores differences and percentage (PAR reduction), Bolton anterior and overall ratio were analysed using one-way analysis of variance (ANOVA), and post hoc Tukey HSD tests with a level of statistical significance set at $P < 0.05$. Whether the groups were comparable before treatment in terms of PAR score was analysed by using Mann–Whitney *U*-test. All statistical analyses were performed using SPSS (13.0, Chicago, Illinois, USA) package program.

Method error

In this study, method error was determined by repeating the measurements for seven pairs of the dental casts for one group (totally 21 casts) with 1-month intervals by same examiner. The reliability of a single measurement was computed by using the formula described by Winner (1971). The reliability of measurements was in the range of 0.94–0.98.

Results

The mean pre-treatment PAR scores of each group are shown in Table 1 and the descriptive statistics and results of ANOVA for the PAR scores and pre-treatment Bolton ratios are summarized in Table 2. Seven of 20 patients in the lower extraction group, 15 of 20 patients in the four-premolar extraction group, and 5 of 20 patients in the without extraction group had an initial scores of greater than or equal to 22 points. Five patients at the incisor extraction group and treatment without extraction and three patients at the treatment with premolar extraction had a PAR score of zero.

There were no patients in the 'no difference–worse' group for all treatment procedure. For treatment with removal of one lower incisor, 6 of 20 patients were in the 'greatly improved' group and 14 were in the 'improved' group. For four-premolar extraction group, 8 of 20 patients were in the 'improved' group whereas 12 were in the 'greatly improved' group. For non-extraction group, 4 of 20 patients were in the 'greatly improved' group and 16 were in the 'improved' group.

According to the Mann–Whitney analysis, IE and NE were similar ($P > 0.05$) whereas PE was different from IE ($P < 0.05$) and NE ($P < 0.001$) in terms of initial PAR scores.

Table 1 Distribution of patients and the mean pre- and post-treatment PAR scores of each group.

	Patient		Age	Treatment time	PAR score before treatment	PAR score after treatment
	Girls	Boys	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
IE	13	7	14.3 ± 2.9	1.6 ± 0.9	21.5 ± 11.5	3.8 ± 3.52
PE	13	7	14.2 ± 2.4	2 ± 0.4	27 ± 6.2	3.5 ± 3.19
NE	13	7	13.6 ± 2.4	1.3 ± 0.4	17.1 ± 5.7	1.4 ± 1.14

SD, standard deviation; IE, lower incisor extraction group; PE, four first premolar extraction group; and NE, non-extraction group.

According to the ANOVA, the per cent reduction of the PAR score was significantly different among the groups ($P = 0.049$). It was found by Tukey HSD test that there was only one significant difference seen between the lower incisor extraction group and the non-extraction group ($P = 0.047$), while there were no significant differences among the premolar extraction versus non-extraction and premolar extraction versus lower incisor extraction groups (Table 2).

According to ANOVA, pre- and post-treatment Bolton ratios were significantly different among the groups ($P = 0.000$ for anterior ratio and $P = 0.001$ for overall ratio). The Bolton analysis and Tukey HSD showed significant differences among the premolar extraction and non-extraction groups ($P = 0.042$) and among the non-extraction and lower incisor extraction ($P = 0.000$) groups for anterior ratio, in addition significant differences among the premolar extraction/lower incisor extraction ($P = 0.048$) groups and the non-extraction/lower incisor extraction groups for overall ratio ($P = 0.001$) (Table 2).

Table 2 The percentage of PAR reduction and Bolton ratios of each group.

	IE	PE	NE	
	Mean ± SD	Mean ± SD	Mean ± SD	ANOVA†
PAR percentage	80.3 ± 18 a	87.7 ± 10.2 ab	91.2 ± 9.2 b	*
Anterior ratio	81.7 ± 4.5 a	79.3 ± 2.3 a	76.9 ± 2.3 b	***
Overall ratio	94.2 ± 2.9 a	92.2 ± 2.2 b	91.2 ± 2 b	**

SD, standard deviation; IE, lower incisor extraction group; PE, four first premolar extraction group; and NE, non-extraction group; ANOVA, analysis of variance.
†Means same letter are not significantly different at α:0.05 the level.
*$P < 0.05$,**$P < 0.01$,***$P < 0.001$.

Discussion

Most previous comments on treatment results after one mandibular incisor extraction have been supported by clinical case reports of one or a few patients (Kokich and Shapiro, 1984; Doppel, 1991; Owen, 1993; Valinoti, 1994; Klein, 1997). However, some studies have analysed patient samples (Dacre, 1985; Riedel *et al.*, 1992). Many of these studies have suggested the treatment with lower incisor extraction as an alternative method especially for the therapy of certain malocclusions but treatment outcome has not exposed quantitatively.

In previous studies, it was also stated that with a careful case selection, single incisor extraction can enable the clinician to produce enhanced functional occlusal and cosmetic results with minimal orthodontic manipulation (Kokich and Shapiro, 1984; Færøvig and Zachrisson, 1999) and a better alignment stability of the treatment with mandibular incisor extraction seemed to be better than the treatment with premolar extraction (Riedel *et al.*, 1992; Canut, 1996). So, our goal was to reveal the results of the treatment with a lower incisor extraction objectively and to compare with premolar extraction and non-extraction treatment.

Mandibular incisor extraction has some advantages (Uribe and Nanda, 2009) such as permitting maintenance of a harmonious profile by keeping antero-posterior position of lower incisor (Uribe and Nanda, 2009) and reducing treatment time (Kokich and Shapiro, 1984). Some warnings are also voiced regarding overjet and overbite increases (Riedel, 1969) and space reopening (Basciftci *et al.*, 2000; Uribe and Nanda, 2009).

Power analysis was performed to determine the minimum number of patients of each group. To increase the percentage of PAR reduction from 80 to 90 per cent with a significance value of 0.05, an expected standard deviation of 10 per cent and power of 0.8 the necessary sample size of patients to be included in each group is 16. We decided that 20 patients in each group would be suitable for the purpose of this study.

This study was a retrospective study. Crowding, facial profile, and the patient's needs were considered primarily while choosing the samples to the groups. The patients with severe crowding for PE and the patients with moderate crowding for NE were selected whereas IE was consisted of the patients with a mandibular anterior excess according to the Bolton analysis. Because a lower incisor extraction was rarely indicated, all patients who were treated with a lower incisor extraction treatment in our clinic between 1998 and 2006 were included in the IE group. The number of these patients was 20 and this number was higher than the number was determined by power analysis. So we decided to collect 20 samples for each group. Thus, although selection bias is a

significant disadvantage of a retrospective study (Hess, 2004), we did not think this study was induced selection bias. Despite some disadvantages such as problems of identifying a suitable cohort, potential exposure misclassification, and possible outcome misclassification (Hess, 2004), a well done retrospective study can serve a useful purpose, help to focus the study question, and determine an appropriate sample size.

In this study, the PAR index was used to evaluate the results of treatments. The PAR index was developed to quantify the extent to which a dentition deviates from an ideally formed dental arch and occlusion (Stalpers *et al.*, 2007). It is not the optimal tool for evaluation of treatment benefits (Birkeland *et al.*, 1997). It does not consider all factors that are important for the total quality of treatment, such as changes in facial profile, psychosocial attitudes, and cephalometric measures that reflect skeletal aspects. The PAR index also does not evaluate functional occlusion, periodontal health, root resorption, tooth angulations, patient satisfaction, patient compliance, white spots, and treatment duration (Birkeland *et al.*, 1997; Dyken *et al.*, 2001). The PAR score gives a general impression of the dental arches and the occlusion but does not take all dental variables into account.

Mesiodistal crown–size relationships are decisive variables in the search for factors associated with the development of occlusal irregularities, the possible effects of discrepancies upon interdigitation, and the isolation of discrepant teeth of minor malocclusion that may be treated in part by selective mesiodistal grindings and minor teeth movements (Sanin and Savara, 1971).

The excess of mandibular anterior Bolton ratio is one of the important criteria for mandibular incisor extraction decision. And also it is one of the parameter that would be effected by mandibular incisor extraction. Both Bolton ratios in IE group were the highest ratios between groups.

Identifying tooth-size discrepancy before final tooth alignment should prove beneficial in defining the final expectations of both the clinician and the patient. Although such an analysis may be time consuming, the benefits of interproximal stripping to correct any discrepancies would seem to outweigh the minor inconvenience of performing the analysis, which should allow more efficient diagnosis of problems, more specificity in treatment planning, and a higher success rate in achieving optimal functional, stable, and esthetically pleasing occlusions (Rossouw and Tortorella, 2003).

The mean percentage of PAR reduction from higher to lower was NE (91.2%), PE (87.7%), and IE (80.3%) groups. The percentage PAR reduction in IE was smaller than the other groups probably because of the increasing overjet and overbite by the treatment with a lower incisor extraction. However, all treatment protocols showed a high standard of orthodontic finishing according to Richmond *et al.* (1992b). Because they proposed the mean PAR reduction with treatment should be greater than 70 per cent as criteria for a high-standard orthodontic treatment.

Conclusions

Using the PAR as an index to assess treatment outcome, orthodontic treatment without extraction has a better treatment result than the four first premolar extraction and single lower incisor extraction protocol in Class I cases with moderate to severe mandibular anterior crowding. Tooth size discrepancy should be considered in the treatment planning to achieve a satisfactory interdigitation of upper and lower teeth.

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