

Effectiveness of Phase I Orthodontic Treatment in an Undergraduate Teaching Clinic

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Abstract: In this retrospective study, the Peer Assessment Rating (PAR) index was used to objectively evaluate the effectiveness of Phase I (early) orthodontic treatment provided in an undergraduate teaching clinic. Pre-treatment and post-treatment casts of ninety-three patients were analyzed. All patients selected for Phase I orthodontic treatment had Class I skeletal relationships and did not require complex orthodontic treatment such as growth modification or treatment of occlusions with missing or impacted teeth. The mean age of patients who received Phase I orthodontic treatment was 9.9 years. The mean initial PAR score for the sample was 29.70 ± 9.84 . The mean reduction in PAR score was 14.9 points corresponding to a 50.2 percent decrease in the PAR score following Phase I orthodontic treatment. Seventy-three percent of the patients experienced at least a 30 percent reduction in their PAR score following Phase I (early) orthodontic treatment. The mean cost of \$381.00 for the Phase I orthodontic treatment was found to be influenced by the length of treatment, type of Phase I treatment provided, age at start of treatment, and percentage reduction in PAR score. The greatest success rate for the Phase I orthodontic treatment occurred with either fixed or a combination of fixed and removable appliances. Over half of the patients recommended for Phase I orthodontic treatment in the undergraduate dental clinic were successfully treated and did not require Phase II treatment. For them, there was both a treatment and a financial benefit to the Phase I orthodontic treatment.

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Over the past few decades, the dental community has become increasingly interested in the objective analysis of treatment outcomes in order to assess quality of care.¹ Traditionally, orthodontic diagnosis has been considered resistant to quantitative evaluation because of its subjective nature.²⁻⁴ The development of quantitative systems for assessing malocclusion and evaluating treatment need have been evolving for the last half of the past century.⁵ These indices aim to provide valid systems of measurement that are easily reproducible.⁶⁻⁹

One such index, the Peer Assessment Rating (PAR), was developed in 1990 by Richmond.¹⁰ It quantifies malocclusion based on five criteria of different weightings: upper and lower anterior segment alignment (x1), left and right buccal occlusion (x1), overjet (x6), overbite (x2), and centerline (x4). The analysis is performed on dental casts and involves a comparison between pre-treatment and post-treatment study models permitting the evaluation of treatment effectiveness in aligning teeth within and between the dental arches.^{7,11} A change in the PAR

index is measured both as a reduction in the total score and as a percentage reduction. Richmond et al.¹² found that a change (reduction) greater than 30 percent in the weighted PAR score is required for a case to be considered as improved, and a reduction of at least twenty-two points is deemed to be a great improvement. Other studies have reported that a change in PAR score greater or equal to 70 percent can be categorized as great improvement.^{13,14}

The PAR index has become increasingly used in studies assessing the effectiveness of orthodontic treatment in private practices and graduate clinics.^{4,14-23} A study by Birkeland et al.¹⁷ involving 224 cases treated in a postgraduate clinic achieved a mean reduction in PAR score of 76.7 percent. These results were comparable to a study performed by Willems et al.¹⁶ that involved 292 cases and a study by Buchanan et al.²⁴ that involved eighty-two cases with mean reductions of 79.1 percent and 74 percent, respectively. A study by Fox²⁵ obtained a 66 percent reduction using removable, fixed, and functional appliances.

Results of orthodontic treatment outcomes in undergraduate clinics are also available. Tolidis and Sandy¹⁵ performed a study of the effectiveness of orthodontic treatment over two time periods and published PAR score reductions of 64 percent and 47 percent. In terms of Phase I or early intervention, Pangrazio-Kulbersh et al.¹⁴ reported a 38 percent decrease in PAR scores.

The objective of this study was to measure, by means of the PAR index, the effectiveness of Phase I orthodontic treatment performed in an undergraduate dental school clinic. The study also assessed the ability of Phase I treatment to alleviate or prevent the need for Phase II therapy (i.e., full fixed appliance comprehensive treatment) and the cost-effectiveness of Phase I treatment.

Methods

Cases were selected from the archives of the undergraduate Simulated Practice Environment Clinic (SPEC), Schulich Dentistry, University of Western Ontario. The study models of 342 randomly selected patients who had received Phase I (early) orthodontic treatment were examined. Two hundred and forty-nine patients were excluded from the study based on the following reasons: there were incomplete records, the patient went directly into Phase II orthodontic treatment, or the patient was too old at the start of treatment (over fourteen years for females and sixteen years for males). Based on these exclusion factors, ninety-three cases were analyzed in the study.

Pre-treatment and post-treatment study models were evaluated, using the PAR index, by an undergraduate dental student, a visiting orthodontic

instructor from China, and a full-time orthodontic faculty member. Replicate measurements were performed by all evaluators on twenty randomly selected cases to determine measurement error. The error among the three evaluators was within one point on the PAR index.

Information obtained for each patient included the patient's age at start of treatment, patient's gender, type of malocclusion, type of treatment provided, need for additional orthodontic (Phase II) treatment (due to relapse, incompleteness of treatment, or referral to private practice or graduate orthodontics), treatment fees charged, and number of treatment episodes (some patients had more than one episode of Phase I treatment).

The cost of the Phase I orthodontic treatment was calculated in order to assess the cost-effectiveness of the treatment. Fees were charged for diagnostic casts, cephalometric and panoramic radiographs, extractions (if orthodontically related), appliances, laboratory costs, and appliance adjustments. These fees reflect only the cost of the Phase I orthodontic treatment and not the cost of all treatment provided to the patient in the undergraduate clinic.

Analysis of the data was performed using descriptive statistics and multiple variable regression models in the JMP v. statistical program. Reductions in PAR scores between pre-treatment and post-treatment study models were calculated both as a percentage and as a whole number. P-values less than 0.05 were considered to be statistically significant.

Results

Of the ninety-three cases selected, there were fifty-six (60.2 percent) female patients and thirty-seven (39.8 percent) male patients. The mean age was 121.23 months (10.10 years) for female patients and 114.70 months (9.56 years) for male patients.

The types of orthodontic problems present in the ninety-three patients are shown in Table 1. All of the cases at pre-treatment were Class I in terms of their skeletal relationship, although a few cases were Class II or Class III with respect to their dental relationship.

The majority of patients in this study (68.8 percent) had an arch length to tooth size discrepancy. The most common treatment modality provided was partial fixed appliances (41 percent). The distribution of treatment modalities used during Phase I treatment is presented in Figure 1.

Table 1. Number and percent of orthodontic problems in ninety-three patients undergoing Phase I treatment

Orthodontic Problem	N (%)
Anterior cross bite	29 (31.3%)
Posterior cross bite	29 (31.2%)
Arch length to tooth size discrepancy	64 (68.8%)
• Crowding	44 (47.3%)
• Spacing (including midline diastema)	24 (25.8%)
Vertical discrepancies ^a	17 (18.3%)
Other ^b	18 (19.4%)
Total	157*

^aDeep bite and open bite

^bHabit correction and midline deviations

*Some patients had more than one problem.

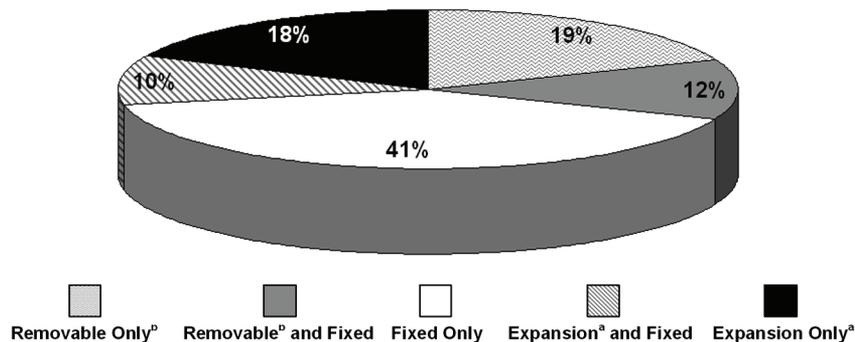


Figure 1. Percent of Phase I orthodontic treatment provided by treatment type

^aExpansion appliances include both slow palatal expansion (removable) and rapid palatal expansion (fixed) appliances.

^bActive removable appliances not involving expansion.

The mean pre-treatment PAR score was 29.71 ± 9.84 , and that score dropped to a mean of 14.80 ± 9.46 following Phase I treatment. This represents an average 50.2 percent reduction in the PAR score. The mean length of treatment was 16.30 ± 11.78 months with a range of three to fifty-nine months, and the mean cost of the Phase I treatment was $\$380.79 \pm \186.66 with a range of \$65.00 to \$1,131.50.

Seventy-five percent of the patients underwent a single episode of Phase I treatment, while the remainder (25 percent) had two or more episodes (three patients had three episodes of Phase I treatment). Based on the nomogram in Figure 2, a reduction (improvement) in PAR score ≥ 30 percent was shown in sixty-eight cases (73.1 percent). Twenty-six patients (28.0 percent) had a reduction in their PAR scores ≥ 70 percent, qualifying them as being greatly improved following Phase I treatment. Twenty-five patients (26.9 percent) either showed no difference or a deterioration in their PAR scores. Additional (Phase II) treatment was recommended for 47.3 percent of the patients (Table 2). Both III Year (junior) and IV Year (senior) students provided the Phase I treatment under supervision.

A positive but low ($r=0.24$, $R^2=0.06$) correlation was found between the percent reduction in the PAR score and the length of the treatment. Longer treatment resulted in slightly greater PAR score reductions; however, very little of the percent PAR

score reduction is accounted for by the length of the Phase I treatment (Figure 3). The mean percent reduction in PAR scores by type of treatment used in the Phase I treatment ranged from 41.6 percent to 51.8 percent. There was no statistically significant difference found among the mean percent reduction in PAR scores attributed to the different types of Phase I treatment provided ($p=0.92$).

A multiple regression model revealed that the post-treatment PAR score was significantly influenced by the pre-treatment PAR score ($p=0.002$) and the length of the treatment ($p=0.02$). But there was also a significant interaction term between the pre-treatment PAR score and the length of the Phase I treatment ($p=0.01$), indicating that the effect of the pre-treatment PAR score and the length of treatment on the post-treatment PAR score must be interpreted with caution. The type of treatment, multiple treatment episodes, and age at start of treatment were not significant predictors of the post-treatment PAR score.

Similarly, a multiple variable regression model showed that the length of treatment ($p=0.003$), the age at start of treatment ($p=0.04$), the treatment type ($p=0.007$), and the percent PAR score change ($p=0.006$) were all statistically significant variables for predicting the cost of treatment. Gender and the pre-treatment PAR score were not statistically significant explanatory variables for predicting cost

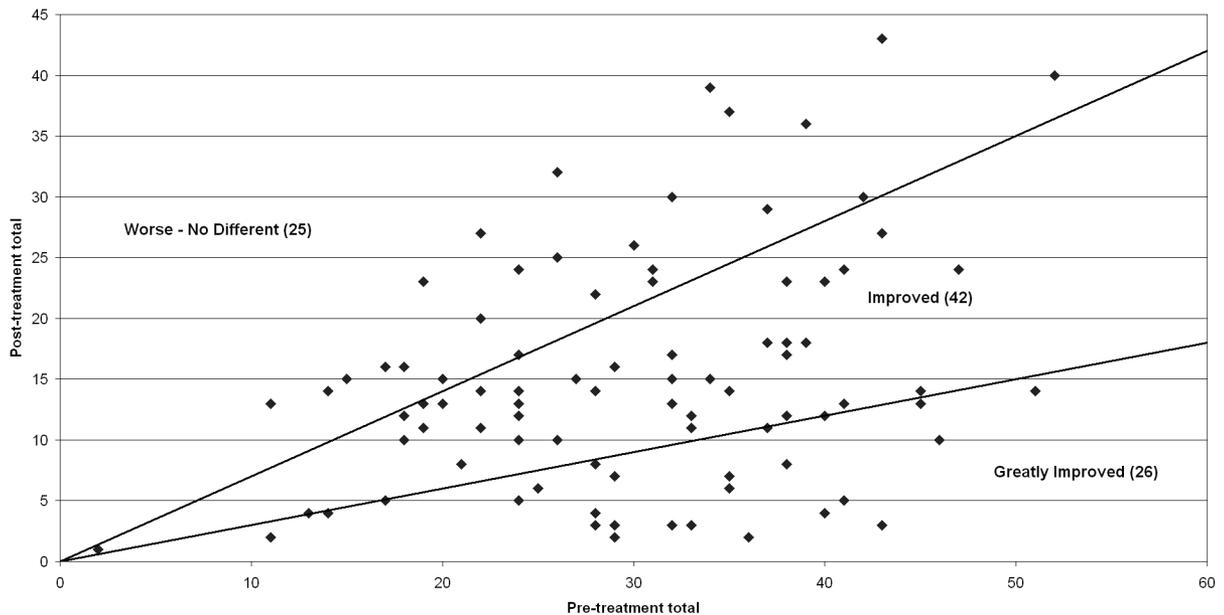


Figure 2. Nomogram illustrating pre-treatment and post-treatment PAR scores in terms of degree of improvement

Table 2. Number and percent of patients recommended for Phase II treatment following Phase I treatment by type of Phase I treatment

Type of Phase I Treatment Provided	Number of Patients Completing Phase I Treatment	Number and Percent of Patients Recommended for Phase II Treatment
Expansion ^a	17	12 (70.6%)
Expansion ^a and fixed	9	6 (66.7%)
Fixed only	38	12 (31.6%)
Removable only	18	10 (55.6%)
Removable ^b and fixed	11	4 (36.4%)
Overall	93	44 (47.3%)

^aExpansion appliances include both slow palatal expansion (removable) and rapid palatal expansion (fixed) appliances.

^bActive removable appliances not involving expansion.

of treatment. No interaction terms were used. This model was able to account for 35.2 percent of the variability in the cost of Phase I treatment.

The mean fees for the various Phase I treatment modalities of treatment are presented in Table 3. Treatment involving partial fixed appliances was the most expensive, especially when combined with other treatment types. The total fee charged for the Phase I treatment was shown to correlate positively ($r=0.36$, $R^2=0.13$) with the percent reduction in PAR score (Figure 4).

Discussion

Phase I (early) orthodontic treatment is advocated for several types of orofacial problems ranging from simple space management to more complicated problems requiring skeletal and dental changes. In this study, only Phase I orthodontic treatment provided in a dental school undergraduate clinic was investigated. This study did not look at Phase I treatment associated with skeletal malocclusions or complicated dental malocclusions.

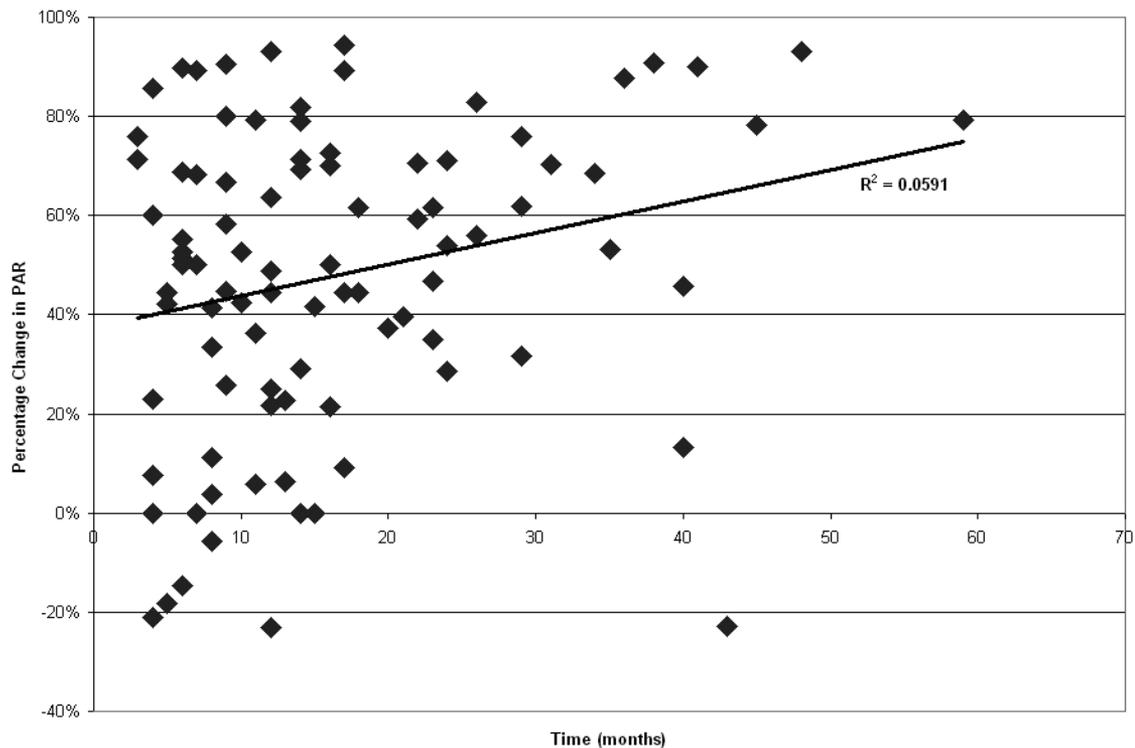


Figure 3. Percent change (reduction) in PAR score by length of treatment ($r=0.24$, $R^2=0.06$)

Over half (53 percent) of the sample did not continue on to Phase II treatment because an adequate outcome was achieved with Phase I treatment. This finding is encouraging as it is rare for a malocclusion to improve without orthodontic intervention.^{14,26,27} It should be remembered that Phase I treatment is considerably less expensive than Phase II treatment.

The mean percentage change (reduction) in PAR score in this study was lower than studies assessing Phase II or comprehensive treatment.^{1,4,17,24,28} However, this study agreed with a study by Pangrazio-Kulbersh et al. that assessed Phase I treatment.¹⁴ This suggests that the degree of improvement in PAR score is reflective of the phase of treatment assessed. Phase I (early or limited treatment) is not necessarily designed to finish the occlusion but to address major concerns of the malocclusion that are noted early, thereby alleviating the need for comprehensive orthodontic treatment. Given

these considerations, complete reduction of PAR is not expected in Phase I. Another explanation for these results is that the cases selected in the undergraduate clinic are uncomplicated. Patients treated are skeletal Class I with only mild to moderate malocclusions. Thus, another explanation for the limited reduction in PAR for this group could be the low initial PAR scores, thereby making it more difficult to achieve a

Table 3. Mean cost of Phase I treatment by type of treatment

Type of Phase I Treatment	Mean Cost	Standard Deviation
Expansion ^a and fixed	\$503.72	204.39
Removable ^b and fixed	\$485.32	195.09
Expansion ^a only	\$307.29	150.02
Fixed only	\$386.49	192.23
Removable ^b only	\$312.83	139.54
Overall	\$380.79	

^aExpansion appliances include both slow palatal expansion (removable) and rapid palatal expansion (fixed) appliances.

^bActive removable appliances not involving expansion.

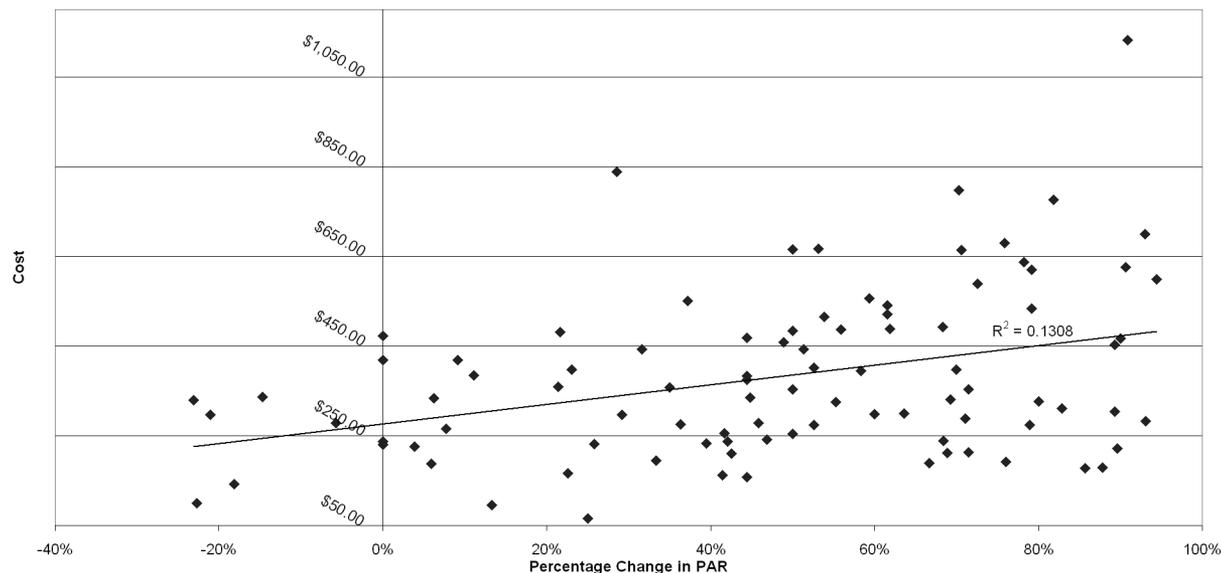


Figure 4. Percent change (reduction) in PAR score by cost of treatment ($r=0.36$, $R^2=0.13$)

more substantial percent reduction in the PAR score as noted by other authors.^{5,14,24}

The sample ($n=93$) was comprised of 60 percent females and 40 percent males. This gender distribution is similar to that reported in other studies.^{15,29,30} The age at the start of treatment (mean 9.9 years) indicates that, generally, skeletal growth is still occurring in these patients.^{14,24,25,31}

Since there was a positive association between the cost of Phase I orthodontic treatment and both the percentage change in PAR scores and the amount of reduction in PAR scores, it would appear that the more money that is spent, the better the result that can be expected. However, the model used to predict the cost of Phase I orthodontic treatment was only able to account for or explain a small proportion of the variability in the fees charged. Thus, there are likely other parameters that were not included in this study that may influence the overall fee to the patient (e.g., diagnostic skills of the clinician).

While removable appliances were shown to be less expensive than the other treatment modalities, nearly 40 percent of patients who received removable appliances had to combine their treatment with partial fixed appliances because the removable appliance alone was unable to complete the Phase I treatment. Furthermore, approximately 56 percent of patients

treated with removable appliances initially were recommended to continue with either further Phase I or Phase II treatment. Therefore, based on the results of this study, removable appliances are not generally able to completely address Phase I orthodontic treatment needs. Apart from mechanical inefficiency, other possible explanations for this finding are poor patient compliance and appliance failure. These features are more common with removable appliances than with fixed appliances. Fixed appliances are generally more efficient because compliance and failure are more easily managed, which appears to translate into less need for additional episodes of treatment. In comparison, only about 30 percent of patients who received partial fixed appliances initially in Phase I treatment required further Phase I or Phase II correction. Our study also showed that when expansion is included in Phase I treatment, the need for further treatment (either Phase I or II) is high (70 percent). This may reflect the increased difficulty of management of lateral deficiencies.

There is a lack of consensus among orthodontists as to different treatment modalities during Phase I treatment.¹⁴ This study did not show any differences between treatment modalities in terms of PAR score reduction. This finding has been demonstrated previously¹⁴ and may reflect the ability of orthodontists

to arrive at a similar result using different methods. Further studies analyzing the way different treatment modalities influence the different components of the PAR score may reveal whether one treatment mode is more efficient at correcting a specific malocclusion, even though the overall change in PAR may be similar. There is also a lack of consensus among orthodontists regarding the need for Phase I treatment at all.^{32,33} If Phase I treatment is sufficient to correct the malocclusion, it can be financially beneficial. This study showed that over half the cases treated in this undergraduate clinic enjoyed this benefit. However, nearly half of the cases in this study required Phase II treatment, raising the possibility that Phase II (comprehensive treatment) alone may have been able to address all treatment needs in a single episode without the additional fees for Phase I treatment.

Despite the fact that the Simulated Practice Environment Clinic is part of a teaching institution and that much of the treatment provided represents valuable teaching material, it is apparent that the expectation for success for early (Phase I) orthodontic treatment may be overly optimistic and that either more exact diagnostic tools or more rigidly applied criteria are needed to ensure a successful outcome. These results underscore the need to emphasize the importance of diagnostic skills and pre-treatment assessment in the undergraduate orthodontic curriculum and treatment clinics.

Conclusions

From the results of this study, it may be concluded that

- a 30 percent or greater improvement (reduction) in PAR scores was achieved in 73.1 percent of the cases recommended for Phase I orthodontic treatment;
- over half (52.7 percent) of the patients undergoing Phase I orthodontic treatment were successfully treated and did not require Phase II orthodontic treatment;
- there was no statistically significant difference in the percent PAR score reduction produced as a result of the type of Phase I orthodontic treatment;
- generally, a greater improvement in PAR score was associated with longer treatment periods and greater treatment costs;
- the greatest success rate for the Phase I orthodontic treatment occurred with either fixed or a combination of fixed and removable appliances; and

- the proper selection of cases for Phase I orthodontic treatment is critical to the success of the treatment.

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