# **Original Article**

# Comparison of early treatment outcomes rendered in three different types of malocclusions

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#### ABSTRACT

**Objective:** To evaluate the outcome of early treatment in Class I, II, and III malocclusions based on the reduction of weighted Peer Assessment Rating (PAR) scores.

**Materials and Methods:** Two hundred thirty subjects (female = 105; male = 125) selected from 400 cases were divided into three groups based on their malocclusions (Class I, II, and III). The PAR index was evaluated prior to early treatment (T0), at the end of phase I (T1), and after completion of phase II therapy (T2). The reliability of overall PAR scores was assessed by Bland-Altman plot and intraclass correlation coefficient. The starting age, total weighted PAR scores and their changes after phase I and II treatments, treatment time, and the percentage of correction in the three different malocclusions were assessed by repeated-measures analysis of variance with post hoc analysis. The level of significance was set at P < .05.

**Results:** More than 30% reduction of the weighted PAR scores and less than 10 points of the remaining weighted PAR scores were observed in all malocclusion groups at T1. The Class III group had the highest percentage of correction during phase I treatment.

**Conclusions:** Early treatment effectively reduced the complexity of Class I, II, and III malocclusions and accounted for 57%, 64%, and 76% of the total correction, respectively, after phase I treatment, as indicated by an overall reduction in weighted PAR scores. The Class III group responded most favorably to early treatment followed by the Class II group. (*Angle Orthod.* 2018;88:253–258.)

KEY WORDS: Early treatment; PAR index; Occlusal changes

#### INTRODUCTION

Numerous questions have been raised regarding early orthodontic treatment because of controversies and misconceptions. Current systematic reviews reported that the level of evidence was not sufficient to reveal the

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effectiveness of early orthodontic treatment because of a lack of standardization of diagnostic criteria and treatment protocol, adequate methodology, and long-term follow-up studies.<sup>1-3</sup> In addition, none of the Cochrane review articles demonstrated a high level of scientific evidence to support any kind of early intervention in young children.<sup>3,4</sup> Nevertheless, Sunnak et al.<sup>1</sup> emphasized that limited evidence does not necessarily imply the invalidity of early orthodontic treatment.

Many authors have noticed that normal primary occlusion can develop various malocclusions during the transitional stage due to arch length discrepancy, abnormal path/sequence/timing of eruption, imbalance in masticatory musculature, and dentoalveolar/skeletal disharmonies.<sup>5,6</sup> Peres et al.<sup>7</sup> also reported that malocclusions in the deciduous dentition are risk factors for the need of orthodontic treatment in the permanent dentition. Since it is difficult to prevent malocclusions, more effort should be directed toward early preventive or interceptive treatment.<sup>8</sup> Early orthodontic treatment encompasses all the interven-

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 Table 1.
 PAR Scoring Matrix

PAR	Right Left							Weig	Weighted total	
components		1					1			1
Upper anterior segments	3-2		2-1	1-1		1-2		2-3	X1	
Lower anterior segments	3-2		2-1	1-1		1-2		2-3	X1	
Buccal	Ante	Antero-posterior			Right		Left		X1	
occlusion										
	Transverse		Right			Left		X1		
	Vertical			Right			Left		X1	
Overjet	Posit	Positive			Negative			X6		
Overbite	Over	Overbite			Openbite				X2	
Centre line								•	X4	
				Total						

tions and treatments that can be performed during the primary and mixed dentition, with the purpose of eliminating or minimizing dentoalveolar and skeletal disharmonies that can interfere with the normal growth and development of occlusion, function, esthetics, and the psychologic well-being of children.<sup>8,9</sup> Gugino and Dus<sup>10</sup> pointed out that the earlier the treatment was applied, the better the face adapted to it.

For an assessment of treatment needs and treatment outcomes, various occlusal indices have been proposed to assess the complexity of a malocclusion objectively. The Peer Assessment Rating (PAR) index was developed from mixed and permanent dentition casts. Although the PAR index does not include skeletal measurements, Firestone et al.<sup>11</sup> concluded from their study that PAR scores were excellent predictors of orthodontic treatment need as determined by a panel of orthodontists. Its reliability and validity have been corroborated in England and the United States.<sup>12,13</sup> Each dental arch is evaluated by dividing it into three segments with lines crossing the center of canines. The occlusal features of crowding, spacing, impaction, and midline deviation are scored by the scales created accordingly.<sup>12</sup> Eleven dental components of the PAR index (Table 1) provide a single summary score for all occlusal anomalies found in malocclusions. Validation studies have been used to derive weightings for these individual components, which serve as the "gold standard."<sup>14</sup> The overjet, centerline discrepancy, and overbite are weighted by six, four, and two times, respectively, based on individual predictive power.<sup>12</sup> The score provides an estimate of how far a case deviates from normal alignment and occlusion. The difference in scores between pre- and posttreatment casts reflects the degree of improvement and, therefore, success of treatment.<sup>11,15</sup>

Although some studies have attempted to quantify the dental and occlusal changes after early treatment using PAR index, they did not address them in three different types of malocclusions.<sup>16-18</sup> The purpose of this study was to quantify the changes after early treatment in Class I, II, and III malocclusions based on weighted PAR score reduction. The null hypothesis was that there is no significant improvement in total weighted PAR scores after early treatment in different types of malocclusions.

#### MATERIALS AND METHODS

The University of Detroit Mercy Institutional Review Board approval was obtained to conduct this study.

Table 2. Intraclass Correlation Coefficient (ICC) Values for Inter- and Intrarater Reliability

Variable		95% Confide		
	ICC	Lower Bound	Upper Bound	<i>P</i> Valu
Interrater	1.000	.999	1.000	.000
Intrarater 1	.999	.998	1.000	.000
Intrarater 2	1.000	.999	1.000	.000

#### **Sample Collection**

This retrospective cohort study included 230 consecutively treated subjects in a mixed dentition stage (105 females and 125 males) selected from 400 cases, representing various malocclusions. All subjects were treated from 2004 to 2015 in a private practice located in the Detroit metropolitan area. The age of the subjects ranged from 6 to 12 years old. Subjects were diagnosed, treatment planned, and treated in two phases by one practitioner. All subjects who underwent early treatment (phase I) followed by comprehensive treatment (phase II) were divided into Class I, Class II, and Class III malocclusion groups based on Angle's classification.<sup>19</sup> The demographic distribution for the Class I, II, and III groups are presented in Table 2. The Class I group included patients characterized by maxillary constriction, moderate crowding, and normal to deep overbite. The Class II group consisted of Class II division I cases characterized by a disto-occlusion relationship with at least one-half cusp width deviation and overjet greater than 5 mm. The Class III group was characterized by the presence of a mesio-occlusion relationship with more than one-half cusp width deviation and negative overjet larger than 0 mm. Subjects who had congenital abnormalities, any pathologic findings in craniofacial structures, and incomplete records were excluded from data collection. The sample was evaluated at T0, prior to early treatment (phase I); at T1, the end of early treatment (phase I); and at T2, after completion of comprehensive therapy (phase II). The Class I patients were treated with a Hyrax expander and space supervision protocol,<sup>20</sup> the Class II patients were treated with a Twin Block appliance, and the Class III patients were treated with a bonded palatal expander followed by a protraction facemask for phase I treatment.<sup>21,22</sup> Edgewise appliance therapy was instituted during the second phase of treatment. Preliminary orthodontic treatment was not provided prior to functional appliances. Compliance with appliance wear was confirmed by measuring the overjet and questioning patients and parents at each appointment. The patients who had been treated with the functional appliances were informed to continue wearing their functional appliances during sleep for retention.

#### **Measurement of PAR Index**

A total of 690 sets of casts were scored using the PAR index. Two calibrated experienced clinicians (examiner 1: an orthodontist, A.D.; examiner 2: an orthodontist, H.K.) who were not involved in treatment of the cases performed all the measurements. To test interclass and intraclass reliability, 15 sets of casts were scored initially and 1 month later. The reliability of

overall PAR scores was tested by Bland-Altman plot and intraclass correlation coefficient (ICC). The UK PAR weighting (Table 1) was used in this study. Firestone et al.<sup>11</sup> demonstrated higher specificity (89%) and kappa (0.80) for the UK PAR weighting compared with the US PAR weighting method (specificity: 86%, kappa: 0.77).

#### **Statistical Analysis**

The weighted PAR score reading was used to assess the changes at different time periods. The score differences at the two time points were used to identify the change. All statistical calculations were conducted with SPSS software (version 12.0 for Windows, SPSS, Chicago, IL). The starting age, total weighted PAR scores, and their changes after phase I and II treatments, treatment time, and the percentage of correction in the three different malocclusions were assessed by repeated-measures analysis of variance with post hoc analysis. The level of significance was set at P < .05.

#### RESULTS

Bland-Altman plot showed that the differences between the readings at the two time points were within the mean  $\pm$  1.96 SD, which indicated no statistical or clinical significance. In addition, the ICC values for interrater and intrarater reliability were close to 1.0 (Table 2). Therefore, the two measurements were very consistent and reliable.

The mean age at different time points and the mean treatment times for Class I, II, and III groups are shown in Table 3. The Class II subjects were significantly older than the Class I and Class III subjects at T0. The Class II subjects were treated significantly longer than the Class I subjects, but no significant differences were found when comparing with the Class III subjects. No statistical differences in treatment time were noted for phase II treatment in the three malocclusion groups (T2–T1; Table 3).

The Class II and Class III groups started with significantly higher initial weighted PAR scores than the Class I group but finished with similar PAR scores as those of the Class I group at T2 (Table 4). Both Class II and III groups exhibited significant improvement in the total weighted PAR scores between T1 and T0 compared with the Class I group. The Class II group showed significant improvement in the remaining weighted PAR scores from T1 to T2 compared with the Class III group, but no significant differences were seen when comparing with the Class I group (Table 4). The retrospective power of the post hoc analysis was found to be 87%, indicating that negative findings could occur in such a study by chance only 13% of the time.

		Age, Mean ± SD, y				Treatment Time, Mean $\pm$ SD, mo		
Type of Malocclusion	Subjects	Proportion, %	то	T1	T2	T1–T0	T2–T1	Observation Period Between T1 and T2
Class I Class II Class III	$\begin{array}{c} 66 \; (F=33,M=33) \\ 101 \; (F=47,M=54) \\ 63 \; (F=37,M=26) \end{array}$	28.7 43.9 27.4	$\begin{array}{r} 9.32\pm1.12^{\scriptscriptstyle B}\\ 9.86\pm1.23^{\scriptscriptstyle A}\\ 8.72\pm1.12^{\scriptscriptstyle B}\end{array}$	$\begin{array}{c} 10.12  \pm  1.24 \\ 11.28  \pm  1.31 \\ 10.05  \pm  1.09 \end{array}$	$\begin{array}{l} 11.64  \pm  1.28 \\ 12.82  \pm  1.33 \\ 11.56  \pm  1.56 \end{array}$	$\begin{array}{l} 10.56  \pm  1.12^{\scriptscriptstyle B} \\ 15.71  \pm  3.80^{\scriptscriptstyle A} \\ 13.11  \pm  4.88^{\scriptscriptstyle AB} \end{array}$	$\begin{array}{r} 17.24  \pm  6.72^{\text{A}} \\ 19.88  \pm  7.13^{\text{A}} \\ 21.03  \pm  9.75^{\text{A}} \end{array}$	$\begin{array}{r} 4.49 \pm 3.76 \\ 8.45 \pm 6.26 \\ 7.00 \pm 4.80 \end{array}$

 Table 3.
 Demographic Distribution of the Subjects<sup>a</sup>

<sup>a</sup> F indicates female, M, male; T0, prior to phase I treatment; T1, at the end of phase I treatment; T2, after completion of phase II treatment. Different uppercase letters represent statistical difference in columns (P < .05).

The percentage of improvement of phase I and phase II treatments for each malocclusion is represented in Table 4 and Figure 1.

#### DISCUSSION

Crowding, arch constriction, and posterior crossbite were the main features of the Class I malocclusion group. These features showed significant improvement following treatment with space supervision protocol and expansion appliances. Kutin and Hawes<sup>23</sup> and Clifford<sup>24</sup> agreed that maxillary expansion should be initiated as early as possible to avoid any detrimental effects to the facial skeleton. Early correction of Class I malocclusion supports that early treatment of crowded arches and maxillary transverse discrepancy can have a beneficial effect on arch length preservation and craniofacial growth by the elimination of the functional shift.<sup>9,24–26</sup>

The Class II malocclusion group was characterized by skeletal and dental discrepancies and an increased overjet (>5 mm). The Class II malocclusion group comprised 43.9% of the sample (Table 3). This could imply a stronger desire for early correction in the Class II malocclusion. In the present study, 64% of mean reduction of the weighted PAR score was seen from T0 to T1 in the Class II group. von Bremen and Pancherz<sup>27</sup> reported a similar percentage of correction (60%) after early treatment with functional appliances in the Class II division I malocclusion evaluated by the UK PAR weighting system. Functional jaw orthopedics with functional removable appliances is generally an accepted treatment modality in orthodontics. The results of this study addressed the changes in PAR scores using this treatment. Although some disadvantages of the two-phase approach have been critically pointed out (increased numbers of visits, costs, and length of treatment), 15% of the patients who had the early treatment did not need more complex treatment in adolescence.28 Vasilakou et al.29 reported that the Class II subjects had the least improvement during phase I treatment, which is inconsistent with the results of the present study. In their study, the total improvement of the American Board of Orthodontics Discrepancy Index scores was diminished because of the increase in Incisor mandibular plane angle (IMPA), which occurred after early Class II correction.<sup>29</sup> Although the evaluation of the lower incisor position was not part of this study, Siara-Olds et al.<sup>30</sup> found that the flaring of lower incisors caused by Class II toothborne functional appliances can be solved during the second phase of orthodontic treatment.

The most common features of the Class III malocclusion sample were negative overjet/edge-to-edge bite, posterior crossbite, and excessive mesial step of primary molars. The phase I treatment of Class III subjects was initiated about 1 year earlier than the phase I treatment of Class II subjects (Table 3). The greatest reduction of the weighted PAR scores was observed in the Class III group during phase I treatment (Table 4). Vasilakou et al.<sup>29</sup> also agreed that the Class III group benefited the most from early treatment. Ngan and Yiu<sup>31</sup> stated that the reduction in

 Table 4.
 Values of the Total Weighted PAR Scores, Changes, 95% Confidence Intervals, and Percentage of Correction at T0–T1 and T1–T2 in the Class I, II, and III Malocclusions<sup>a</sup>

Types of Mal-		Total Weighted PAR Scores, Mean ± SD		Char Mean	nges, ± SD	Changes 95% Confidence Interval (Lower Bound – Upper Bound)		Percentage of Correction, Mean $\pm$ SD	
occlusion	Т0	T1	T2	T0–T1	T1–T2	T0–T1	T1–T2	T0–T1	T1–T2
Class I	12.62 ± 6.04 <sup>B</sup>	$5.35 \pm 4.02^{\text{AB}}$	$0.05\pm0.27^{\scriptscriptstyle A}$	$7.27 \pm 4.39^{\circ}$	$5.30\pm4.05^{\scriptscriptstyle AB}$	5.72-9.00	4.41–6.14	57.18 ± 20.98 <sup>B</sup>	42.43 ± 21.43 <sup>A</sup>
Class II	$19.86\pm9.00^{\scriptscriptstyle A}$	$6.57\pm3.71^{\scriptscriptstyle A}$	$0.02\pm0.20^{\scriptscriptstyle A}$	13.29 ± 7.51 <sup>B</sup>	$6.55\pm3.73^{\scriptscriptstyle A}$	11.93–14.59	5.73-7.12	$63.96 \pm 19.97^{\scriptscriptstyle B}$	$35.95 \pm 17.89^{\text{A}}$
Class III	$20.60\pm8.40^{\scriptscriptstyle A}$	$4.52\pm3.05^{\scriptscriptstyle B}$	$0.08\pm0.33^{\scriptscriptstyle A}$	$16.08\pm7.99^{\scriptscriptstyle A}$	$4.44~\pm~3.03^{\scriptscriptstyle B}$	14.19–17.56	3.66-5.42	$75.98 \pm 17.73^{\scriptscriptstyle A}$	$23.68 \pm 17.89^{\scriptscriptstyle B}$

<sup>a</sup> T0 indicates prior to phase I treatment; T1, at the end of phase I treatment; T2, after completion of phase II treatment. Different uppercase letters represent statistical difference in columns (P < .05).



Figure 1. Percentage of correction during phase I and phase II treatment in the Class I, II, and III malocclusions.

PAR scores after phase I treatment was primarily from the correction of anterior crossbite in Class III subjects. McNamara and Brudow<sup>21</sup> justified that the results from early intervention with orthopedic masks in young patients are subsequently incorporated in future growth. It has been also stated that early orthopedic treatment to advance the maxilla might reduce the need for surgical intervention later.<sup>32</sup>

It has been very difficult to find a proper scoring system to evaluate both mixed and permanent dentitions. So far, the PAR index is a suitable method for evaluating the severity of dental malocclusion in the mixed and permanent dentitions. To create a new index including dental and skeletal components for any stage of dental development is crucial for systematic evaluation of early treatment effects in the future. Although it was very challenging to collect 230 cases with full records during an 11-year period of clinical practice, further prospective cohort studies are necessary to provide a higher level of evidence.<sup>33</sup>

In conclusion, a 30% reduction in weighted PAR scores is required for a case to be considered as improved.<sup>34</sup> Richmond et al.<sup>12</sup> also found that a PAR score of 10 or less indicated an acceptable alignment and occlusion. In the present study, more than 30% of reduction of the weighted PAR scores and less than 10 points of the remaining weighted PAR scores were observed in three groups at T1 (Figure 1; Table 4). This implies that early treatment significantly reduced the treatment complexity of all malocclusions. Therefore, the null hypothesis was rejected.

### CONCLUSIONS

• Early treatment reduced the severity of Class I, II, and III malocclusions and accounted for 57%, 64%, and 76% of the total overall improvement, respectively, as indicated by an overall reduction in the weighted PAR scores during phase I treatment (T0– T1). • The Class III group had statistically significantly greater improvement in the weighted PAR scores compared with the Class I and II malocclusion samples during phase I treatment (T0–T1).

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