ORIGINAL ARTICLE

Evaluation of treatment and posttreatment changes of protraction facemask treatment using the PAR index

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The purpose of this study was to use the Peer Assesment Rating (PAR) index score to evaluate the treatment and posttreatment changes of Class III patients treated by protraction facemask. The sample consisted of 20 Chinese children, 6 to 11 years old, with Class III skeletal malocclusion who had been treated with maxillary expansion and a protraction facemask. The average treatment time was 8.2 months, followed by 1 year of retention with a Class III functional appliance. Study casts were taken pretreatment (T1), posttreatment (T2), 1 year follow-up (T3), and 2 years follow-up (T4). After treatment, PAR scores were calculated for each time period. Differences among the 4 time periods were analyzed with the Wilcoxin matched-pairs test. Significant reductions in PAR scores were found at T2 (56%), T3 (70%), and T4 (63%) compared with T1. Immediately posttreatment (T2), 17 (85%) of 20 patients had improved PAR scores by a reduction of at least 30%. Reductions were caused primarily by correction of the anterior crossbite. One year after treatment (T3), further reductions in PAR score were noted ($P < .01$) as a result of better alignment of the anterior segment, improvement of the buccal occlusion, and overbite and midline corrections. Two years after treatment (T4), PAR scores were higher than at the previous time period. The increases were due to relapses in overjet (4 of 20 patients), overbite, and centerline corrections. These results indicate that significant reductions in the severity of Class III malocclusion can be achieved with early orthopedic facemask treatment. In most cases, further improvement in the PAR score can be expected 1 and 2 years after treatment. In a few patients, the benefits of early treatment are negated by relapses in overjet, overbite, and centerline corrections during the follow-up period. (Am J Orthod Dentofacial Orthop 2000;118:414-20)

A major objective of early treatment for a developing Class III malocclusion is to provide a more favorable environment for normal growth and an improved occlusal relationship.[1-3] With the reintroduction of the facemask treatment by Delaire in 1976, it has become possible to move the maxilla forward with extraoral traction. Facemask treatment initiated at an early age facilitates movement of the maxillary bones while the circummaxillary sutures are still patent.[4] Recent clinical studies have demonstrated significant short-term skeletal and occlusal changes with the use of maxillary protraction in combination with fixed palatal expansion appliances.[5-10] However, the permanency of these orthopedic corrections remains unproven, and documentation of long-term growth adaptation after early orthopedic treatment is lacking in the literature. Several indices of occlusion have been developed to assess treatment success.[11,12] The occlusal index,[13] which was designed initially for other tasks, has been used to assess treatment outcome.[14-17] The peer assessment rating (PAR) index was developed to quantify how much orthodontic treatment reduces the severity of

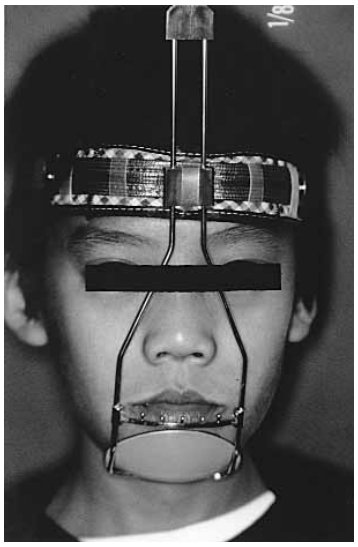

Fig 1. Protraction facemask with adjustable anterior wire and hooks to accommodate downward and forward pull of maxilla with elastics. (Reprinted with permission from *Seminars in Orthodontics* 1997;3:256-7.)

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Table I. Scoring of the various components of PAR index[16]

1. Upper and lower segments
   The scores were recorded for both upper and lower anterior segments. The recording zone was from the mesial of the canine on one side, to the mesial of the canine on the opposite side. The occlusal features recorded were crowding, displacement, and impacted teeth. Displacements were recorded as the shortest distance between contact points of adjacent teeth in relation to the occlusal plane. Greater displacement indicated a greater score.
2. Right and left buccal segments
   The buccal segment was recorded for both left and right in all 3 planes of space: anteroposterior, vertical, and transverse. The recording zone was from the canine to the last molar, either first, second, or third.
3. Overjet
   The recording zone was from left to right lateral incisors. The most prominent aspect of any incisor was recorded. The score for overjet was the sum of the overjet and anterior crossbite score.
4. Overbite
   The overbite was recorded in relation to the coverage of the lower incisors or the degree of openbite. The recording zone included the lateral incisors.
5. Centerline discrepancy
   The centerline discrepancy was recorded in relation to lower central incisors. No measurement was recorded if one central incisor was extracted.

Table II. Weightings period for the 5 components of the PAR index[18]

Components	*Weightings*
Upper and lower anterior segments	×1
Left and right buccal occlusions	×2
Overjet	×5
Overbite	×3
Centerline	×3

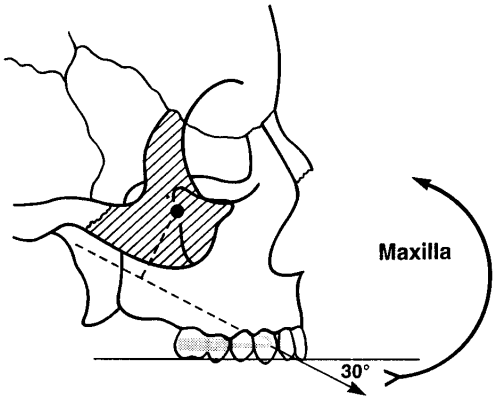

Fig 2. Maxillary protraction below center of resistance generates an anticlockwise movement. Protraction elastics attached near maxillary canines with downward pull of 30° to occlusal plane minimizes anticlockwise movement. (Reprinted with permission from *Seminars in Orthodontics* 1997;3:256-7.)

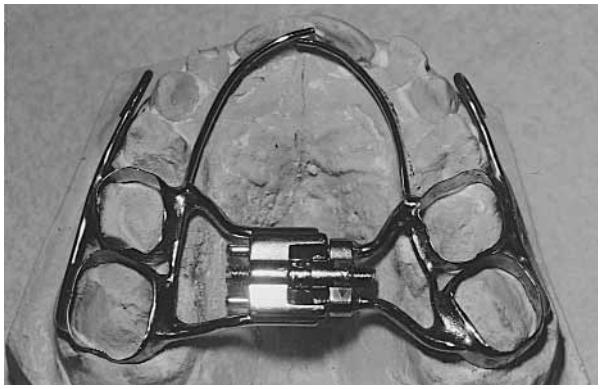

Fig 3. Design of banded palatal expansion appliance for maxillary anchorage. (Reprinted with permission from *Seminars in Orthodontics* 1997;3:256-7.)

malocclusion.[16] Its reliability and validity have been established in England and the United States.[18] Scores are assigned to various occlusal traits that make up a malocclusion (Table I). The individual scores are summed, and the total represents the degree to which a case deviates from normal alignment and occlusion. Improvement in the PAR index can be assessed with either the point reduction in the weighted PAR score or a percentage reduction.

The objective of this study was to use the PAR index to evaluate the treatment and posttreatment changes in Class III patients treated with a protraction facemask. Data from this study may help elucidate the benefits of early Class III orthopedic treatment.

MATERIAL AND METHODS

The sample consisted of 20 Chinese children with Class III malocclusion who were treated consecutively with maxillary expansion and protraction headgear appliances in the Department of Children's Dentistry and Orthodontics, University of Hong Kong. The sample included 8 boys and 12 girls (mean age, 8.4 ± 1.7 years; range, 6 to 11 years). These patients were found clinically and cephalometrically to have skeletal Class III malocclusion with maxillary deficiency. All patients presented with a negative overjet. None had a history of orthodontic treatment. Patients were treated with a protraction facemask for an average of 8.2 months, followed by 1 year of retention with nighttime wear of a Class III functional appliance. Patients were then followed on a yearly basis with no further orthodontic or orthopedic treatment.

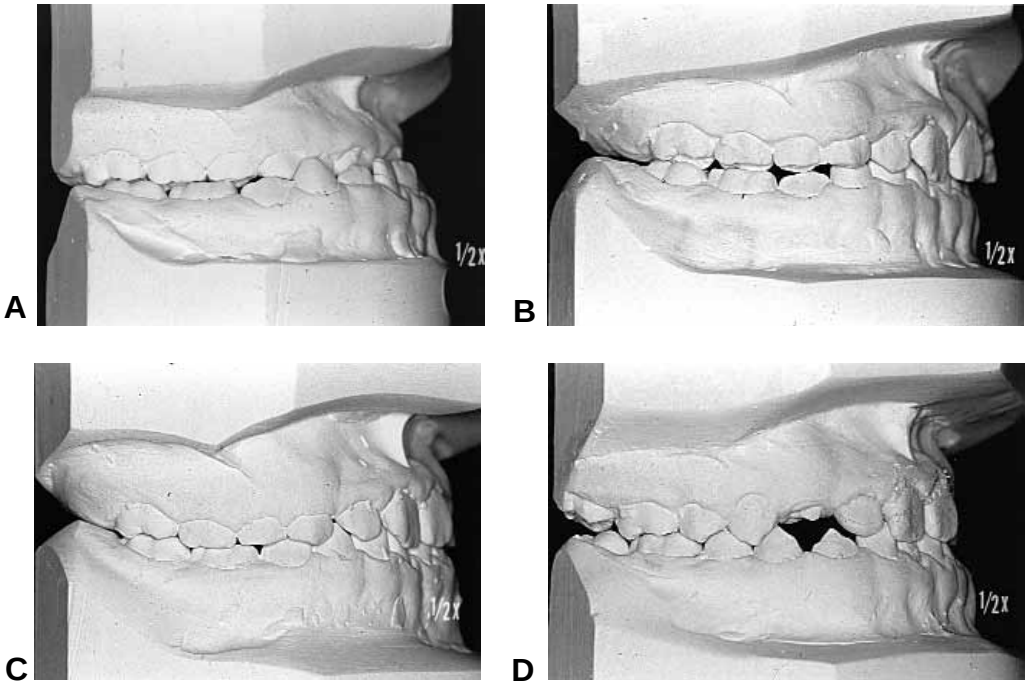

Fig 4. Example of patient showing great improvement after treatment with protraction facemask. **A**, Pretreatment, PAR score 38; **B**, posttreatment, PAR score 14; **C**, 1 year after treatment, PAR score 12; **D**, 2 years after treatment, PAR score 2.

Orthodontic study casts were taken before treatment (T1), posttreatment (T2), 1 year after treatment (T3), and 2 years after treatment (T4).

Protraction Facemask

The protraction facemask is a 1-piece construction with adjustable anterior wire and hooks to accommodate a downward and forward pull of the maxilla with elastics (Fig 1). To avoid an opening of the bite as the maxilla is repositioned, protraction elastics are attached near the maxillary canines with a downward and forward pull of 30° to the occlusal plane (Fig 2).

Maxillary protraction generally requires 300 to 600 g of force per side, depending on the age of the patient. In the present study, elastics that delivered 380 g of force per side (as measured by a gauge) were used. Patients were instructed to wear the headgear 12 hours a day until a positive overjet of 3 to 4 mm was obtained.

Design and Construction of the Anchorage System

The banded palatal expansion appliance (Fig 3) was constructed using bands on the posterior teeth. Bands were fitted on the maxillary primary second molars and permanent first molars. In patients with primary dentition, bands were fitted on the primary first and second molars. The bands were joined by a heavy wire (0.043 inch) to the palatal plate, which had a Hyrax-type screw (Palex expansion screw, Great Lakes Orthodontic Products, Tonawanda, NY) in the midline. A 0.045-inch wire was soldered bilaterally to the buccal aspects of the molar bands and extended anteriorly to the canine area for protraction with elastics. The appliance was activated twice daily (0.25 mm per turn) by the patient for 1 week (2 weeks in patients with a constricted maxilla). Protraction facemask treatment was initiated immediately after active expansion.

PAR Index

The PAR index includes the scores of 5 individual traits: upper and lower segments, right and left buccal segments, overjet, overbite, and centerline. The scoring of each component is shown in Table I. The raw PAR score is calculated by adding the individual components of the PAR score. Weighting is attached to the various components, in this case according to DeGuzman et al[18] to reflect orthodontic opinion on malocclusion and severity in the United States (Table II). The result is the weighted PAR score. Feghali et al[19] found a reduction in PAR score of 22 points or more indicates "great improvement," while a reduction of 30% indicates an "improved" condition, and a reduction of less than 30% indicates "no improve-

Table III. Error study of 10 cases analyzed twice

	TI		*T2*		*T3*		*T4*	
PAR index component	*Mean (mm)*	*SD (mm)*	*Mean (mm)*	*SD (mm)*	*Mean (mm)*	*SD (mm)*	*Mean*	*SD (mm)*
Anterior segments	0.4	0.6	0.5	0.7	0.1	0.3	0.3	0.5
Buccal segments	1.3	1.1	1.4	1.9	0.6	0.8	0.8	0.9
Overjet	0.8	2.1	0.1	0.2	0.0	0	0.2	0.1
Overbite	0.3	0.4	0.4	0.5	0.2	0.4	0.3	0.3
Centerline	0.0	0.0	0.1	0.3	0.1	0.3	0.3	0.3
Raw PAR score	1.7	3.0	1.6	2.3	1.2	1.9	1.9	2.1

ment." In this article, differences between the pretreatment and posttreatment scores were categorized into these groups: (1) great improvement, patients showing a reduction of 22 weighted PAR points; (2) improved, patients showing at least a 30% reduction in weighted PAR score; and (3) worse or no difference, patients showing less than 30% reduction in weighted PAR score.

Fig 4 shows the study casts of a patient with great improvement after treatment with protraction facemask. The PAR score improved from 38 at T1 to 14 at T2. Further improvement in PAR score was observed from T3 (12) to T4 (2) with improvement of the buccal segments.

Error Studies

The model recordings were performed by one examiner. Study casts of 10 cases were selected at random and analyzed twice with 3 weeks between analyses to determine the intrarater reliability of the measurements. Error measurements for the various time periods (T1, T2, T3, T4) expressed in mean and standard deviations are shown in Table III. No significant differences were found between the first and second measurements for any of the variables or time periods tested.

Statistics

Data were analyzed with the Wilcoxin matched-pairs test.

RESULTS

The changes in PAR scores for the various time periods (T1, T2, T3, T4) are shown in Table IV. The mean weighted PAR score at the start of the treatment (T1) was 38.7 ± 7.9 for the Class III sample. All patients exhibited an anterior crossbite of more than 2 mm, giving a perfect overjet PAR score of 4.0. Treatment with protraction facemask (T2) reduced the weighted PAR score to a mean of 17.2 ± 9.6, a 21.5-point or 56% reduction. Correction of anterior crossbite provided an 80% reduction in the overjet score, reduction in overbite provided a 54% reduction in the overbite score, improvement in midline provided a 50% reduction in the centerline score, and improvement in molar relationship provided an 11% reduction in the buccal segment score. Changes in alignment and crowding caused the PAR score for the anterior segment to increase by 38%. Table V shows the PAR score changes for each time period. At T2, 13 patients (65%) were categorized as greatly improved, 4 (20%) as improved, and 3 (15%) as worse or no difference.

One year after treatment (T3), further reduction in the weighted PAR score was observed, from an average of 17.2 ± 9.6 to 11.6 ± 8.4, an additional 48% reduction. This included 13% improvement in the PAR score of the anterior segment, 32% improvement in the PAR score of the buccal segment, 50% improvement in the PAR score for overjet, and 33% improvement in the PAR score for centerline. Changes in the first follow-up period brought about some shift of improvement categories compared with the situation at the end of treatment. The greatly improved category increased from 13 patients to 15 as 2 moved up from the improved category. The 3 patients in the worse or no difference category did not show improvement during the follow-up period.

Two years after treatment (T4), the weighted PAR score increased from an average of 11.6 ± 8.4 to 14.5 ± 13.5, a 25% increase. This included a 20% increase in the overjet PAR score, 33% increase in the overbite PAR score, and 50% increase in the centerline PAR score. One patient in the greatly improved category and one in the improved category shifted to the worse or no difference category.

DISCUSSION

The mean PAR score of the Class III sample was 38.7 ± 7.9 at the start of treatment (T1). This score represented a sample of individuals with moderate to severe malocclusion.[20] Treatment with maxillary expansion and protraction (T2) reduced the PAR score by 21.5 points or 56%. In general, a reduction in PAR score of 22 points or more indicates great improvement.[19] Fox[21] reported a greater reduction

Table IV. Changes in PAR score for the time registrations T1 (pretreatment), T2 (posttreatment), T3 (1 year posttreatment), T4 (2 years posttreatment)

	T1		*T2*		*T2-T1*		*T3*	
PAR index components	*Mean*	*SD*	*Mean*	*SD*	*Difference*	*% Change*	*Mean*	*SD*
Anterior segments	3.4	4.0	4.7	4.5	1.3	38	4.1	3.9
Buccal segments	6.3	2.8	5.6	1.8	–0.7	–11	3.8	1.7
Overjet	4.0	0.0	0.8	1.1	–3.2***	–80	0.4	0.8
Overbite	1.3	1.1	0.6	0.8	–0.7**	–54	0.3	0.6
Centerline	0.6	0.8	0.3	0.6	–0.3	–50	0.2	0.4
Raw PAR score	14.9	5.5	11.4	5.0	–3.5**	–23	8.0	4.7
Weighted PAR score	38.7	7.9	17.2	9.6	–21.5**	–56	11.6	8.4

*$P < .05$; **$P < .01$; ***$P < .001$

Table V. PAR score changes and improvement categories posttreatment (T2), 1 year follow-up (T3), and 2 years follow-up (T4) (Category criteria as used by Richmond et al,[17] 1992)

	(T1-T2)		*(T1-T3)*		*(T1-T4)*	
	n	*Mean PAR score*	*n*	*Mean PAR score*	*n*	*Mean PAR score*
Greatly improved	13	12.2	15	7.9	14	6.6
Improved	4	14.8	2	14.5	1	22.0
Worse-no difference	3	29.7	3	26.3	5	34.8

in PAR score (66.6%) with a mixed sample of children treated with fixed or removable functional appliances. On the other hand, Pangrazio-Kulbersh et al[22] evaluated 103 patients with different types of malocclusions who received early treatment and found that 68% of the patients had reductions in the weighted PAR score of 30% or more. The difference is probably due to the starting PAR scores. Higher starting PAR scores tend to have greater percentage reductions.

At T2, reduction in the overall PAR score was caused mainly by correction of anterior crossbite (80% reduction). Overbite was reduced as a result of the downward and backward rotation of the mandible after correction of the anterior crossbite.[23] Centerline was improved with the elimination of mandibular shift after expansion, but alignment or crowding of the anterior segments was worse because of the mesial movement of the maxillary molars and reduction in arch length. The buccal segments were not improved because of the overcorrection of the molar relationship from Class III to Class II.

One year after treatment (T3), a further reduction in PAR score, from an average of 17.2 ± 9.6 to 11.6 ± 8.4 or 48%, was observed, giving a total reduction in PAR score of 70% (T3-T1). Previous studies[23] with cephalometric radiographs to assess growth changes after maxillary protraction show continuous forward and downward movement of the maxilla after appliance removal. In the present study, reduction in PAR score after appliance removal was caused by maintenance of a positive overjet in 18 of 20 patients, better alignment of the anterior segment after expansion, improvement of the buccal occlusion, and overbite and midline corrections.

When patients were followed for another year after active treatment (T4-T3), a 25% increase in the weighted PAR score was observed. In 4 patients, overjet relapsed to an anterior crossbite. PAR scores for overbite and centerline correction also increased. The anterior and buccal segments, however, continued to improve. The overall reduction in PAR score from pretreatment was 63% (T4-T1). These data agree with those reported using cephalometric measurements and show that continued improvement can be expected in the majority of the patients 2 years after treatment with protraction facemask.[23]

This article attempts to explain some of the follow-up growth changes that can be evaluated on dental casts, especially some of the unfavorable changes that occur after treatment. Further studies are needed to document the benefits of early orthopedic treatment of Class III patients. The PAR index is not the optimal tool for evaluation of treatment benefits.

T3-T1		*T3-T2*		*T4*		*T4-T1*		*T4-T2*		*T4-T3*	
Difference	*% Change*	*Difference*	*% Change*	*Mean*	*SD*	*Difference*	*% Change*	*Difference*	*% Change*	*Difference*	*% Change*
0.7	–21	–0.6	–13	2.6	3.1	1.2	–24	2.1*	–45	1.5**	–37
–2.5***	–40	–1.8***	–32	3.2	1.8	–3.1***	–49	–2.4**	–43	–0.6	–16
–3.6***	–99	–0.4	–50	1.2	1.6	–2.8***	–70	0.4	50	0.8*	20
–1.0***	–77	–0.3	–50	0.4	0.7	–0.9**	–69	–0.2	–50	0.1	33
0.4*	–67	–0.1	–33	0.3	0.6	–0.3	–50	0.1	20	0.1	50
–6.9***	–46	–3.4**	–30	7.5	5.3	–4.4***	–30	–3.9*	–34	0.5	–6
–27.1***	–70	–5.6**	–48	14.5	13.5	–24.2***	–63	–2.7	–16	2.9	25

Cephalometric changes can be used to explain the skeletal changes observed in this study. However, there are no established ideals of published analysis accepted by orthodontists. Furthermore, evaluation of facial esthetics, treatment duration, and patients' accounts of treatment satisfaction are necessary to fully evaluate the benefits of such treatment.

CONCLUSIONS

1. A significant reduction of the mean PAR index occurred from pretreatment to posttreatment (T1 to T2, $P < .01$).
2. Seventeen (85%) of 20 cases had improved PAR scores with reductions of at least 30%.
3. Reductions in PAR score at T2 were caused primarily by correction of anterior crossbite.
4. One year after treatment (T3), further reductions in PAR scores were noted from posttreatment ($P < .01$).
5. Two cases shifted from the improved category to the greatly improved category at T3.
6. Reductions in PAR score at T3 were caused by better alignment of the anterior segment, improvement of the buccal occlusion, and overbite and midline corrections.
7. Two years after treatment (T4), PAR scores were higher than at the previous period (T3).
8. One patient from the improved and greatly improved categories shifted to the worse-no difference category at T4.
9. The increase in PAR score at T4 was caused by relapses in overjet, overbite, and centerline correction.

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