

[ORIGINAL]

Long-term follow-up of combined maxillary protraction appliance and chin-cap treatment

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Abstract

In an attempt to distinguish between long-term treatment effects and growth change, the present study evaluates the real post-treatment changes following maxillary protraction treatment after correction for the orthopedic effects which three female patients were investigated

Our proposed treatment plan for skeletal Class III patients consists of 3 stages. In the first stage, a maxillary protraction appliance and a chin-cap are used together to correct the intermaxillary relationship. After removal of the maxillary protraction appliance, the maxilla remains relatively stable during the growth stage. However, the mandible tends to experience overgrowth, which results in a relapse. The occlusal relationship was maintained until the adult stage in all cases. However, they experienced slight relapse, manifested by mandibular forward growth following removal of the maxillary protraction appliance. Therefore, overcorrection of reversed occlusion and control of mandibular growth after the first stage must be performed in order to prevent relapse.

Key words . Skeletal Class III, Maxillary protraction appliance and chin-cap, Long-term follow-up, Post-treatment changes

Introduction

Many cases of skeletal Class III malocclusion exist in Japan, particularly those cases accompanied by maxillary retardation¹⁻⁴⁾. Our previous study demonstrated that a Class III intermaxillary relationship can be corrected in patients in their growth phase using orthopedic appliances, such as a combined maxillary protraction appliance and chin-cap⁵⁻⁷⁾.

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Of our clinic, during the initial stage, severe skeletal Class III malocclusion with or without accompanying maxillary retardation is generally treated using a maxillary protraction appliance with a chin-cap. During the second stage, treatment of chin-cap is maintained until the formation of permanent dentition is complete. During the third stage, malalignment of the teeth is corrected using a fixed appliance.

Many case studies and animal experiments have investigated the effects of orthopedic devices such as the maxillary protraction appliance with a chin-cap for the treatment of Class III patients⁸⁻¹⁵⁾. Clinical studies have demonstrated that maxillary forward movement occurs with forward rotation of the palate, accompanied by growth retardation of the mandible. On the other hand, experimental findings have shown that forward movement and forward rotation of the maxilla are accompanied by remodeling at the circummaxillary sutures and backward rotation of the mandible¹⁶⁻²²⁾.

The ultimate goal of treatment of Class III patients should not only be the correction of the intermaxillary relationship related to reversed occlusion at that stage, but also the stabilization of the intermaxillary relationship resulting from treatment. Thus, close observation and follow-up of mandibular growth during adolescence, particularly during third-stage treatment is essential. However, very little is known about the post-treatment changes following maxillary protraction treatment²³⁻²⁵⁾.

Ishii et al investigated such changes in *Macaca irus* monkeys¹⁵⁾. After removal of the appliances, the maxilla moved slightly backward during the early stages. During the growth stage, mandibular forward and downward overgrowth resulting in the reduction of the overjet was observed.

Similar findings were observed in clinical investigations⁸⁻¹²⁾. Long-term cephalographic evaluation of treatment effects and outcome of Class III patients is difficult because the true treatment effects cannot be distinguished from growth changes during the treatment period. Thus, long-term evaluation of the treatment effects and outcome should account for changes due to normal growth.

The present study evaluates the real post-treatment changes following maxillary protraction treatment after correction for the orthopedic effects.

Template method

In order to accurately evaluate the treatment effects induced by orthopedic forces, the predicted growth change must be subtracted from changes due to treatment. The major difficulty in this type of analysis is how to evaluate growth change during treatment. Examples of the growth prediction methods include the "forecast grid" by Johnston²⁶⁾, the craniofacial templates by Popovich and Tompson²⁷⁾, and the computer method by Ricketts²⁸⁾. A modified template method was used in the present study.

This method can be used to compare changes during the observation period to the estimated

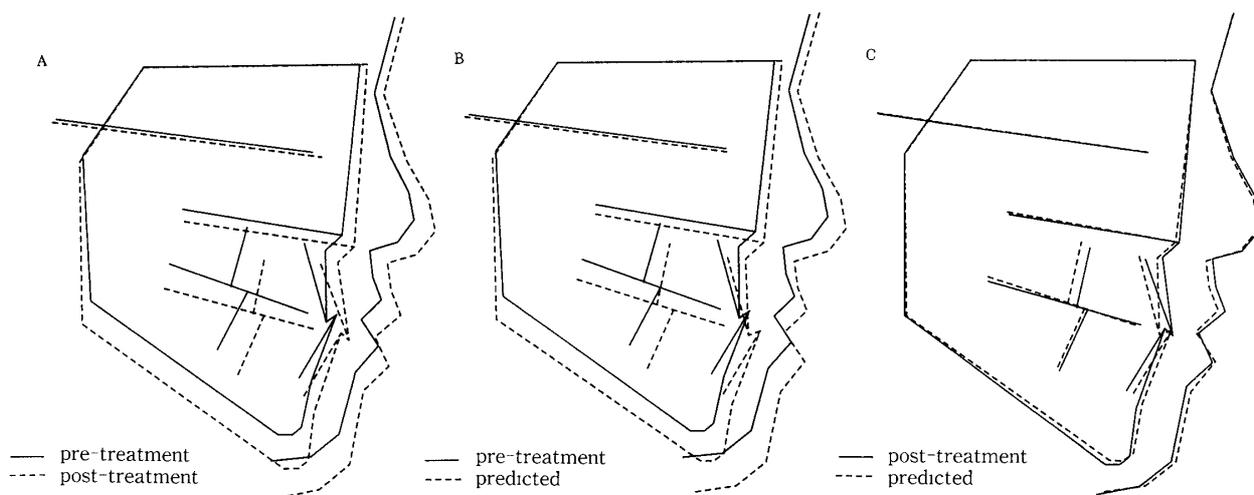


Fig 1 Example of template analysis A Superimposition of pretreatment and post-treatment facial diagrams B Superimposition of pretreatment and predicted facial diagrams Predicted facial diagram made by adding predicted growth change to pretreatment facial diagram C Superimposition of predicted and post-treatment facial diagrams The difference between these clearly displays true treatment effect without growth change

growth changes during the treatment period The treatment effects were evaluated in one patient The estimated growth changes during the treatment period were first added to the landmark coordinates on the cephalogram taken during the initial stage in order to create the estimated facial diagram that incorporates normal growth changes during the treatment period Next, the estimated facial diagram from the first stage was compared to that created during the second stage Fig 1 shows an example of the template analysis

Long-term follow-up of skeletal Class III cases

Three female patients were followed up after three-stage treatment All 3 patients presented with a skeletal Class III intermaxillary relationship The patients were initially treated using a combined maxillary protraction appliance and a chin cap

The mandibular retraction force exerted by the chin cap was approximately 600g, and the maxillary protraction force was approximately 250g on each side A fixed maxillary plate with hooks on the molar bands was used in all three cases The maxilla was protracted from the hooks to the frame wire in front of the face The treatment period using this appliance was approximately 1 year After the over-correction of reversed occlusion, only the chin cap was used until the eruption of the second molars At that point, malalignment of the teeth was corrected Following treatment, the patients were observed until at least the age of 18

Case 1

The first patient was a girl aged 8 years 4 months old The patient exhibited a concave face, a bilateral Class III molar relationship, an overjet of -3 mm and an overbite of 2 mm (Fig 2) Cephalometric analysis showed mandibular prognathism in addition to a flat mandibular plane,

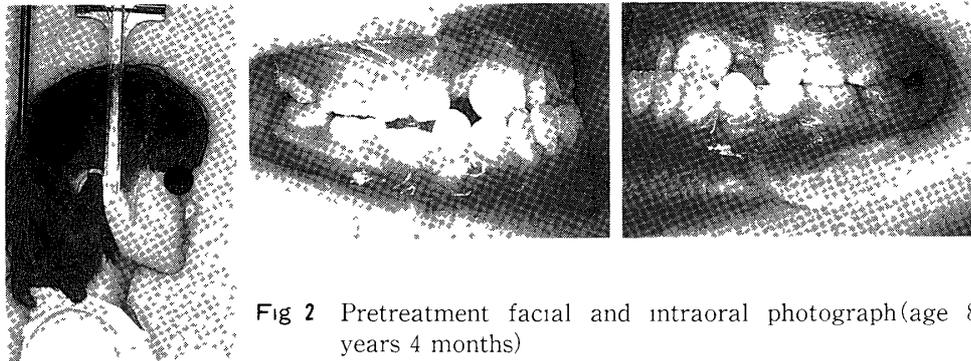


Fig 2 Pretreatment facial and intraoral photograph(age 8 years 4 months)

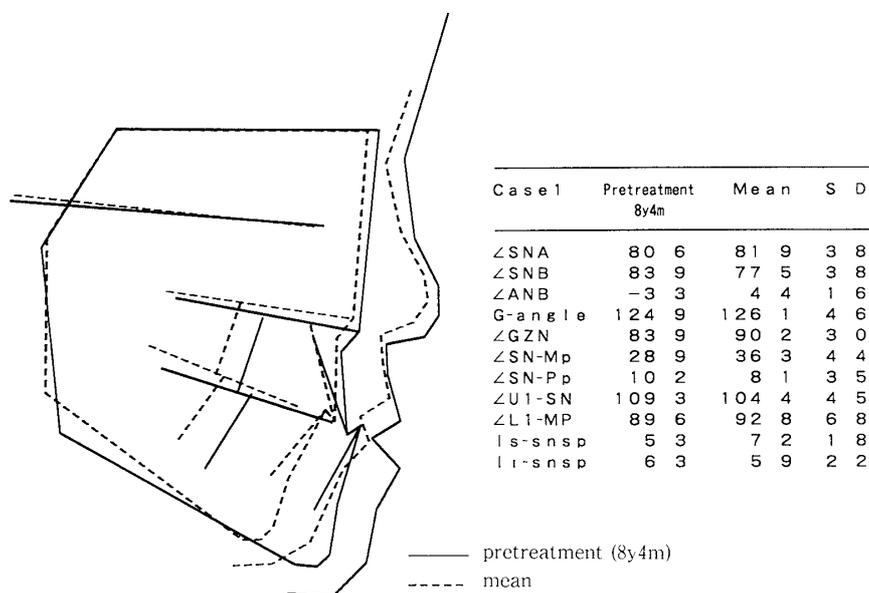


Fig 3 Pretreatment cephalometric analysis

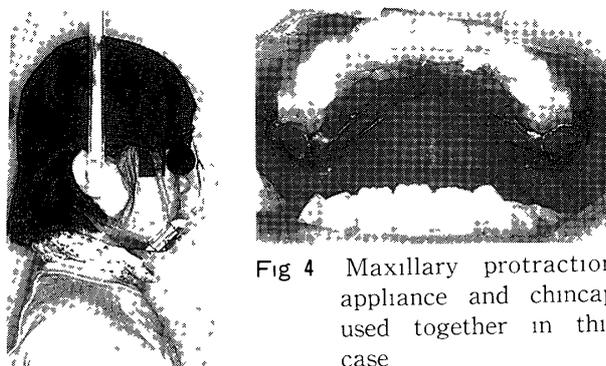


Fig 4 Maxillary protraction appliance and chin cap used together in this case

SNA 80 6°(mean), SNB 83 9°(+2SD), GZN 83 9°(-2SD), SN-MP 28 9°(-2SD) The upper incisors were slightly proclined (Fig 3)

The patient was diagnosed as “Skeletal Class III accompanied by mandibular overgrowth”

⟨Progression of treatment⟩

1) Stage 1 The intermaxillary relationship was corrected using a maxillary protraction appliance and a chin cap (Fig 4) Anterior protraction force was delivered from buccal hooks

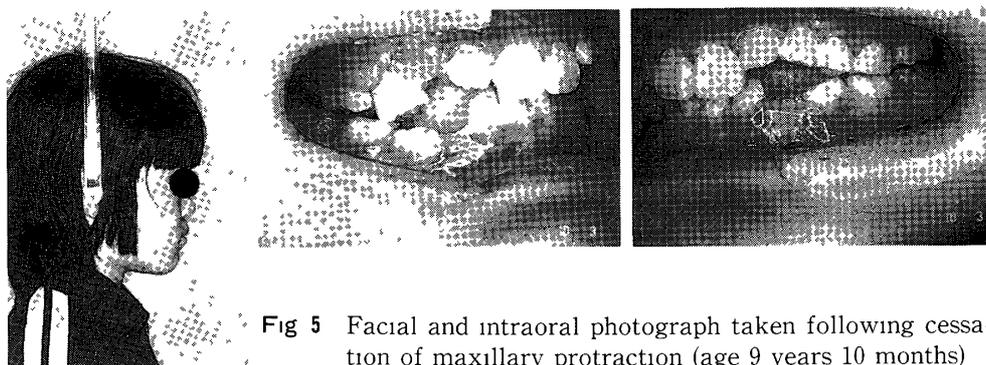
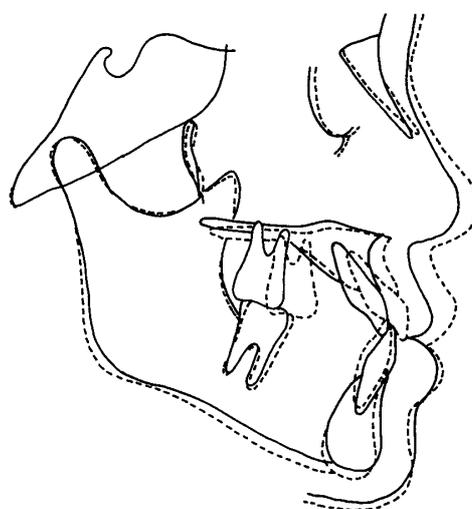


Fig 5 Facial and intraoral photograph taken following cessation of maxillary protraction (age 9 years 10 months)



Case 1	Pretreatment	MPA removal
	8y4m	9y10m
∠SNA	80 6	85 7
∠SNB	83 9	83 1
∠ANB	-3 3	2 6
G-angle	124 9	123 8
∠GZN	83 9	85 3
∠SN-Mp	28 9	29 1
∠SN-Pp	10 2	7 7
∠U1-SN	109 3	116 0
∠L1-MP	89 6	85 6
l s-snsp	5 3	6 4
l s-snsp	6 3	5 8

— pretreatment (8y4m)
 - - - - MPA removal (9y10m)

Fig 6 Analysis of superimposed images taken during maxillary protraction treatment period

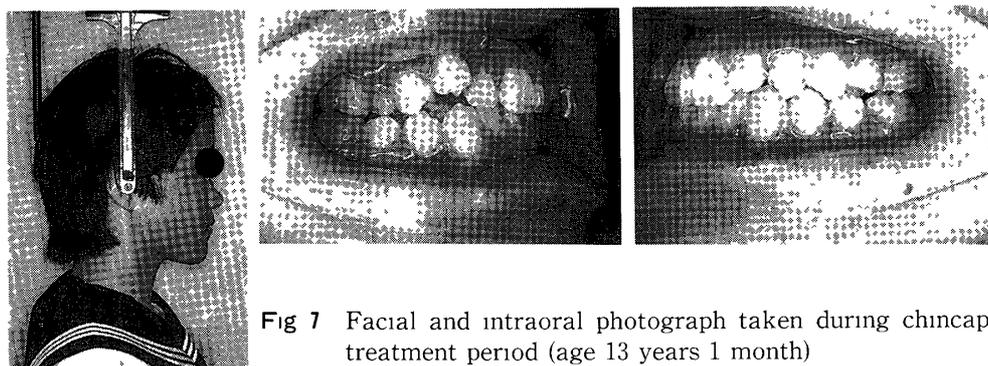


Fig 7 Facial and intraoral photograph taken during chincap treatment period (age 13 years 1 month)

on the bilateral first molars. The duration of treatment was 14 months. At the end of this stage, facial balance had improved significantly. The overjet increased to 4 mm, the overbite also increased to 5 mm, and the first molar relationships changed to unilateral Class II (Fig 5).

Superimposition of the cephalogram revealed that the maxilla had moved forward approximately 4 mm accompanied by counterclockwise rotation of the palatal plane. The mandible on the other hand rotated in a clockwise direction (Fig 6).

2) Stage 2. The intermaxillary relationship was maintained until the age of 14 years 2 months. Only the chincap was used at this stage (Fig 7).

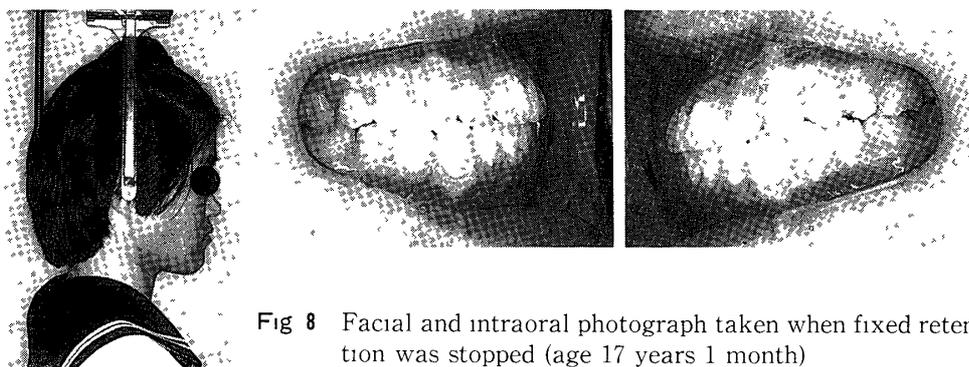


Fig 8 Facial and intraoral photograph taken when fixed retention was stopped (age 17 years 1 month)

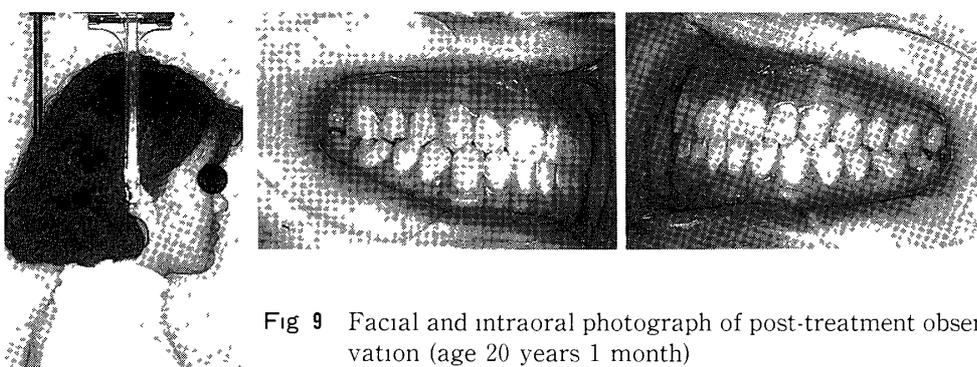


Fig 9 Facial and intraoral photograph of post-treatment observation (age 20 years 1 month)

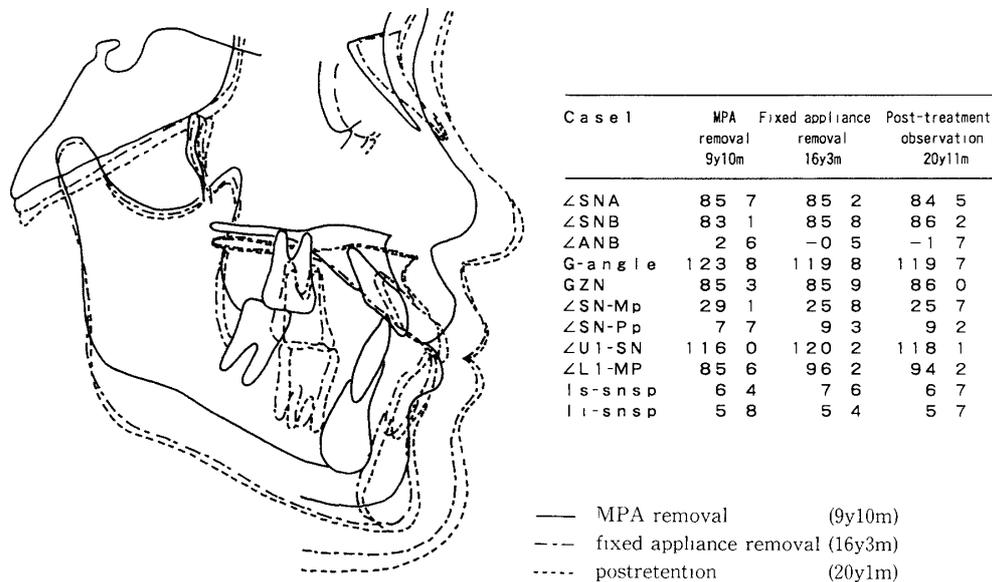
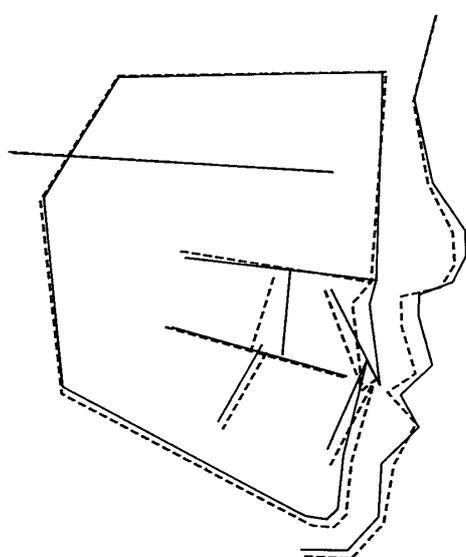


Fig 10 Analysis of superimposed images taken after maxillary protraction appliance was removed

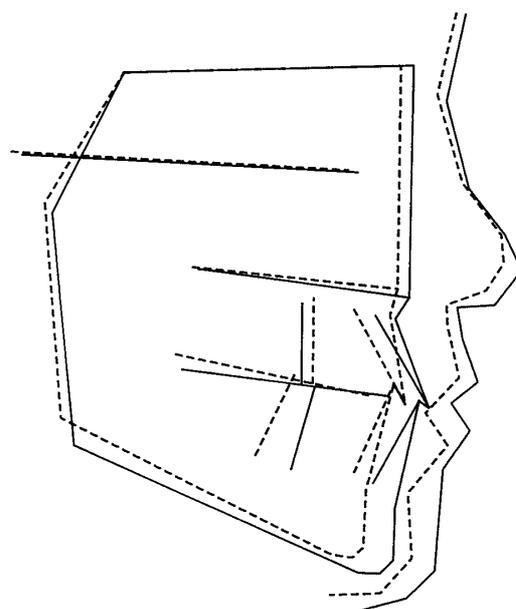
3) Stage 3 Malalignment of the teeth was corrected using edgewise non-extraction treatment. Class III elastics were used to overcome the mandibular forward movement. Following completion of full-arch interdigation, a conventional retainer was introduced until the age of 17 years and 1 month (Fig 8).

The intermaxillary relationship and occlusal interdigation were followed up until the age of 20 years and 1 month (Fig 9). In general, these parameters were maintained. However, some



— MPA removal (9y10m)
 - - - - predicted

Fig 11 Estimated treatment effect of maxillary protraction appliance and chin cap



— post-treatment (20y11m)
 - - - - predicted

Fig 12 Estimated relapse during post-treatment observation period

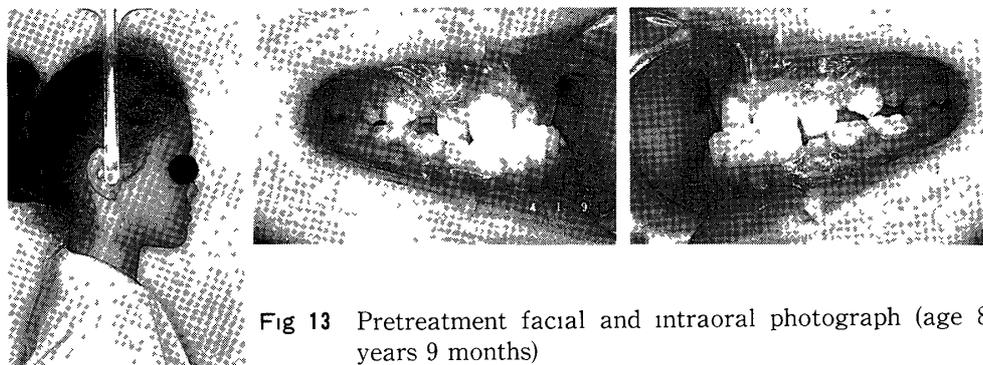


Fig 13 Pretreatment facial and intraoral photograph (age 8 years 9 months)

mandibular overgrowth during the late growth period was evident on the superimposed cephalograms, introducing some potential error into the intermaxillary relationship (Fig 10)

〈Evaluation of treatment effects and outcome〉

The maxilla showed forward movement with some counterclockwise rotation when compared to normal growth. Mandibular forward growth was also less than that seen during normal growth (Fig 11)

Post-treatment evaluation showed that mandibular growth occurred at a faster rate than that of the maxilla (Fig 12)

Case 2

The second patient was a girl aged 8 years 9 months old. She exhibited a concave face, a bilateral Class I molar relationship, an overjet of -3 mm and an overbite of 4 mm (Fig 13)

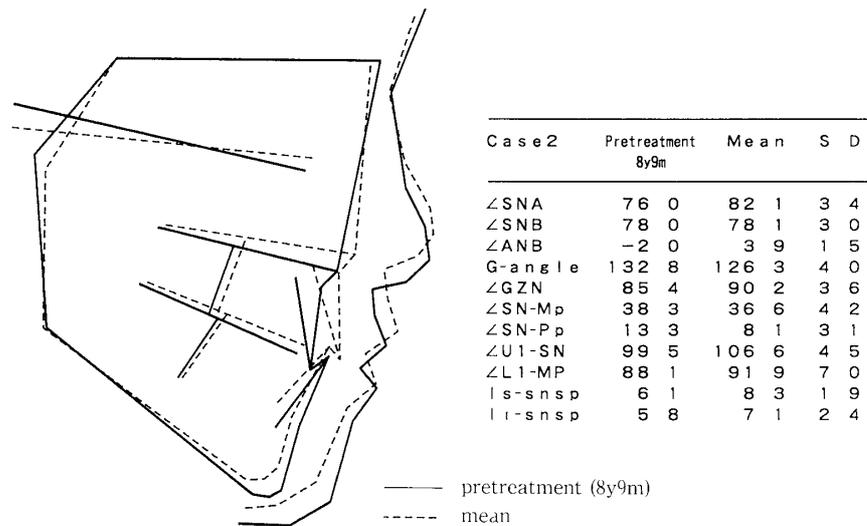


Fig 14 Pretreatment cephalometric analysis

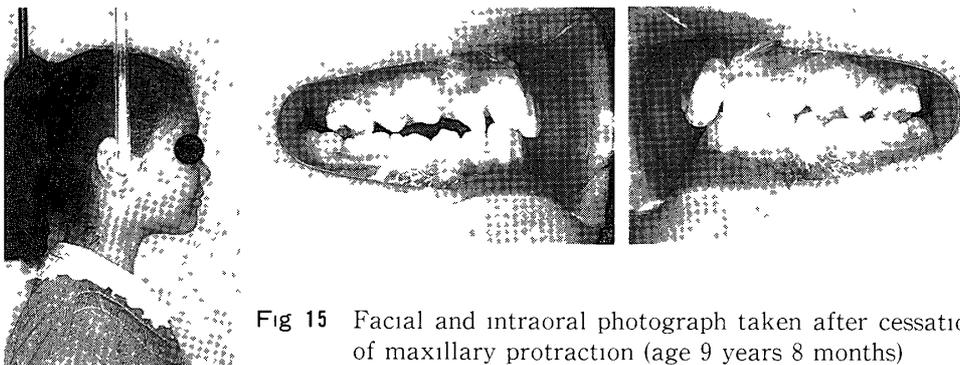


Fig 15 Facial and intraoral photograph taken after cessation of maxillary protraction (age 9 years 8 months)

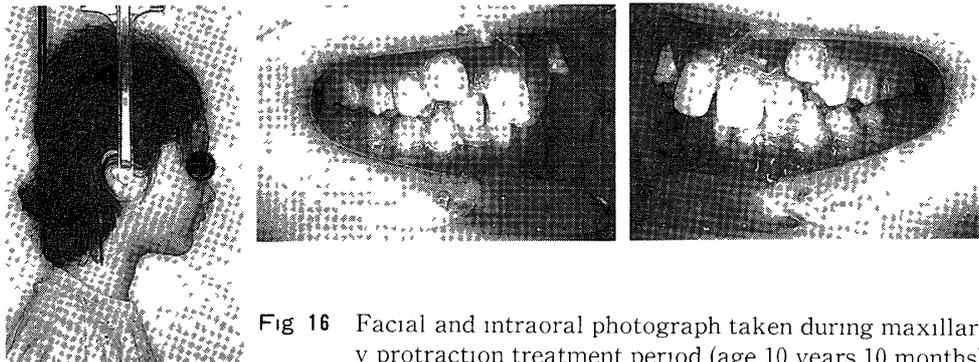


Fig 16 Facial and intraoral photograph taken during maxillary protraction treatment period (age 10 years 10 months)

Cephalometric analysis showed mandibular overgrowth in addition to steep mandibular plane and maxillary retardation, SNA $76^{\circ}0'(-2SD)$, SNB $78^{\circ}0'$ (mean), G-angle $132^{\circ}8'$ (+2SD), SN-MP $38^{\circ}3'$ (+0.5SD) The upper incisors were retroclined (Fig 14)

This patient was diagnosed as "Skeletal Class III with accompanying maxillary retardation and mandibular overgrowth"

<Progression of treatment>

1) Stage 1 The intermaxillary relationship was corrected using a maxillary protraction

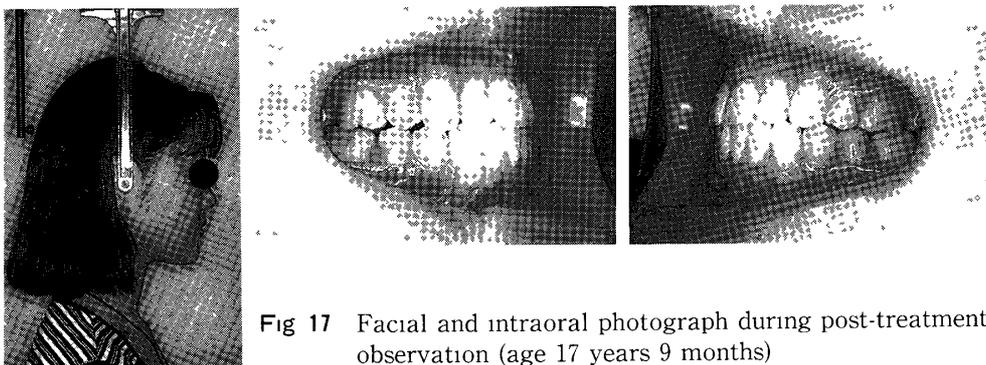


Fig 17 Facial and intraoral photograph during post-treatment observation (age 17 years 9 months)

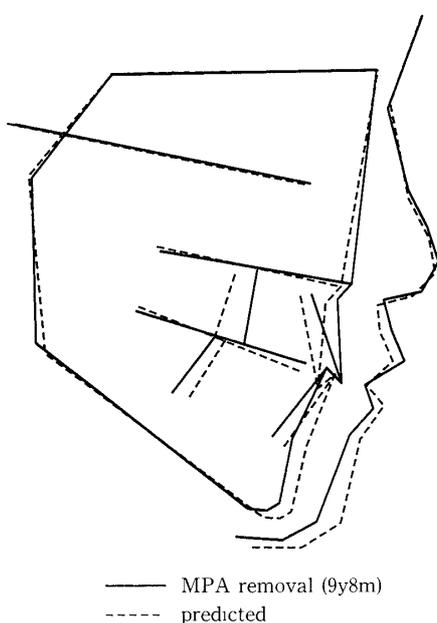


Fig 18 Estimated treatment effect of maxillary protraction appliance and chin cap

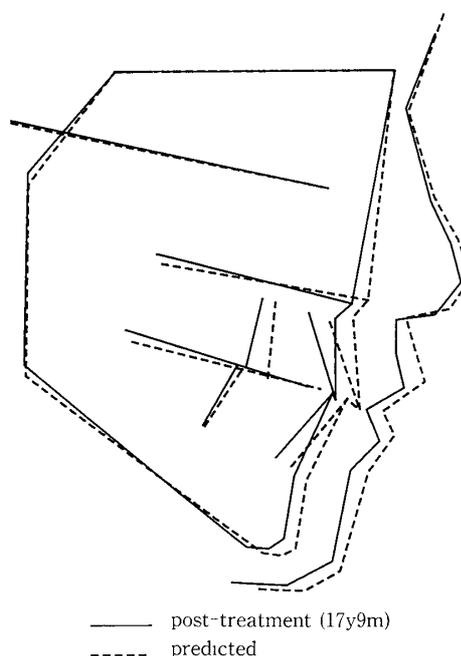


Fig 19 Estimated relapse during post-treatment observation period

appliance and a chin cap. Anterior protraction force was delivered from buccal hooks on the bilateral first molars. At the same time, palatal rapid expansion was performed using an expansion screw. The duration of treatment was 14 months. At the end of this stage, facial balance was improved significantly, the overjet increased to 5 mm, and the overbite decreased to 3 mm. The bilateral first molar relationship also improved to Class II (Fig 15).

2) Stage 2. The intermaxillary relationship was maintained until the age of 14 years 2 months. Only the chin cap was used in this stage (Fig 16).

3) Stage 3. Malalignment of the teeth was corrected by the edgewise appliance in addition to extraction of the upper first premolars.

In this case, the intermaxillary relationship and occlusal relationship were followed up until the age of 17 years 9 months. In general, these parameters were maintained. However, some mandibular overgrowth was apparent during the late growth introducing some potential error into the intermaxillary relationship (Fig 17).

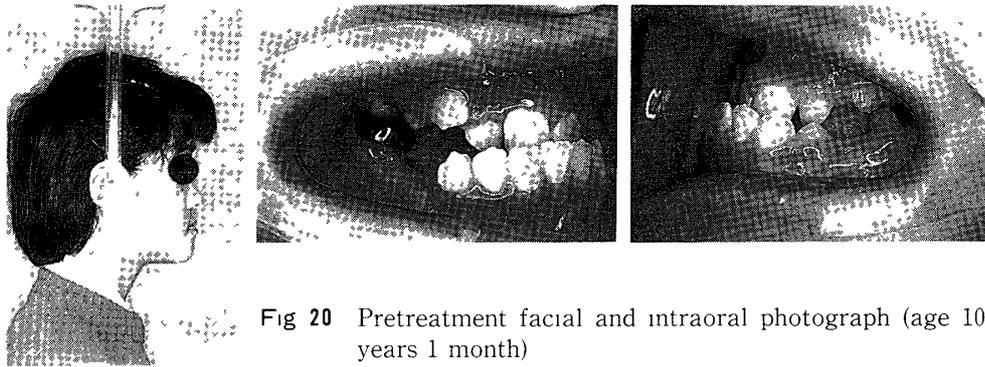


Fig 20 Pretreatment facial and intraoral photograph (age 10 years 1 month)

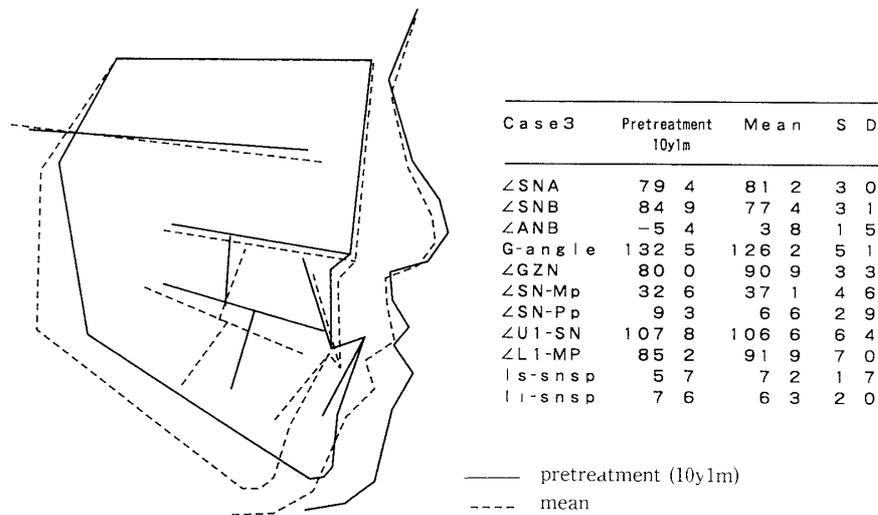


Fig 21 Pretreatment cephalometric analysis

〈Evaluation of treatment effect and outcome〉

The maxilla showed forward movement with some counter-clockwise rotation when compared to normal growth. Mandibular forward growth was also less than that seen during normal growth (Fig 18).

Post-treatment evaluation showed that both maxillary and mandibular growth were more retarded than that seen during normal growth. The intermaxillary relationship was maintained after the maxillary protraction appliance was removed (Fig 19).

Case 3

The third patient was a girl aged 10 years 1 month. She exhibited a concave face, a bilateral Class I molar relationship due to mesial drifting of the first molars, an overjet of -8 mm and an overbite of 5 mm (Fig 20).

Cephalometric analysis showed slight maxillary retardation and mandibular prognathism in addition to a flat mandibular plane that showed overclosure of the mandible, SNA 79°4' (-0.5 SD), SNB 84°9' (+2.5 SD), GZN 80° (-3 SD), SN-MP 32°6' (-1 SD). The upper incisors were slightly proclined (Fig 21).

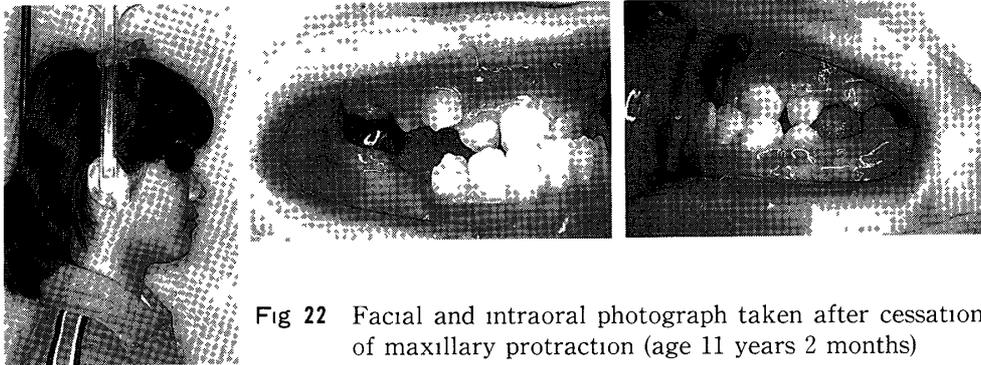


Fig 22 Facial and intraoral photograph taken after cessation of maxillary protraction (age 11 years 2 months)

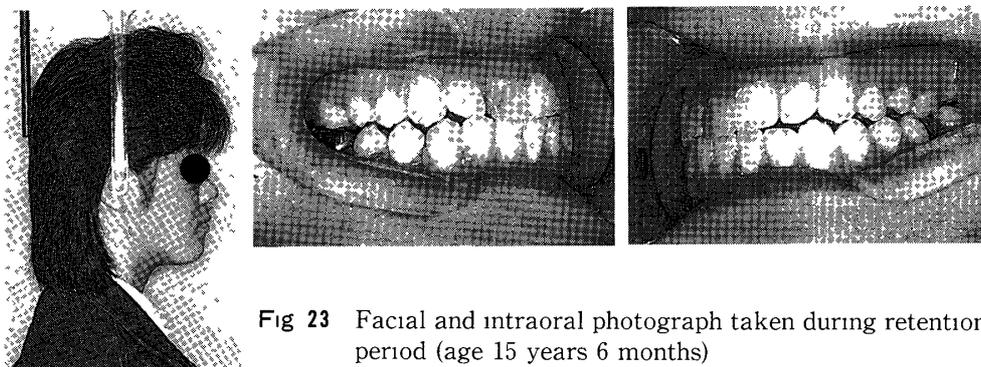


Fig 23 Facial and intraoral photograph taken during retention period (age 15 years 6 months)

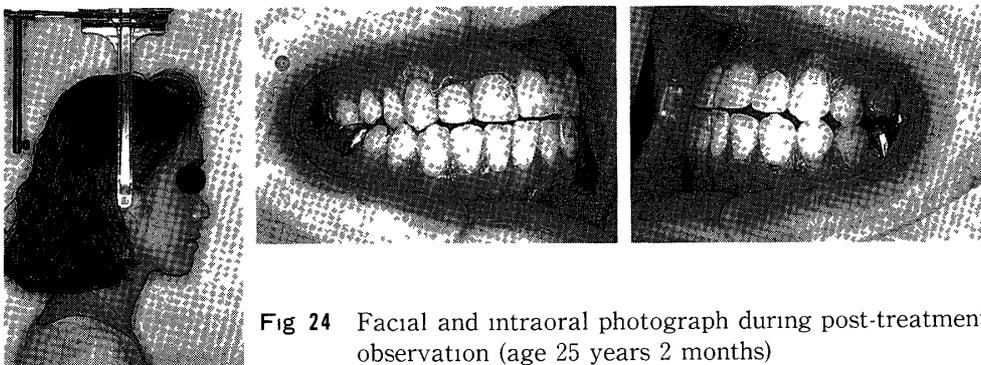


Fig 24 Facial and intraoral photograph during post-treatment observation (age 25 years 2 months)

This patient was diagnosed as “Skeletal Class III with accompanying maxillary retardation and mandibular overgrowth as well as overclosure of the mandible”

<Progression of treatment>

1) Stage 1 The intermaxillary relationship was corrected using a maxillary protraction appliance and a chin cap. The duration of treatment was 12 months. In this patient, Stage 2 was omitted because the formation of permanent dentition was almost complete at the end of Stage 1 (Fig 22)

2) Stage 3 Malalignment of the teeth was corrected by non-extraction edgewise treatment shortly after the maxillary protraction appliance was removed

The upper first molars were moved distally using an open coil spring in order to treat the intermaxillary relationship and occlusal relationship. Retention was complete by the age of 15

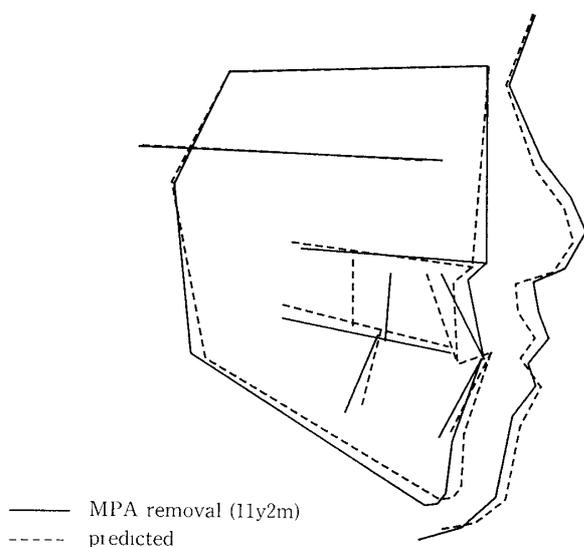


Fig 25 Estimated treatment effect of maxillary protraction appliance and chin cap

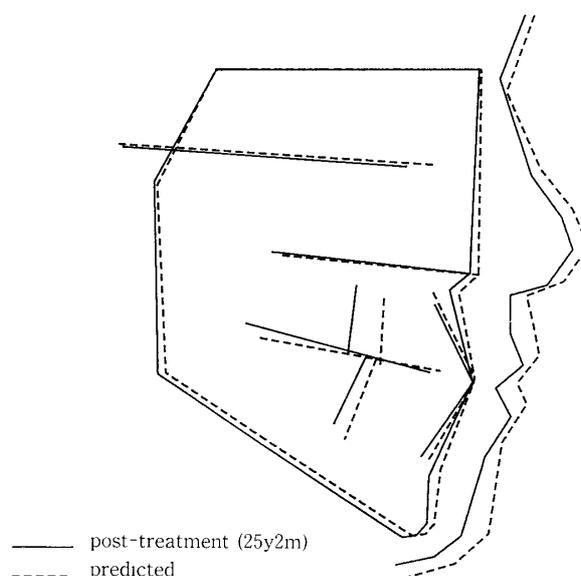


Fig 26 Estimated relapse during post-treatment observation period

years 6 months (Fig 23). The anteroposterior relationship was maintained. However, interdigitation of the posterior teeth was slightly poor. Fig 24 shows the photograph taken at the age of 25 years 2 months.

〈Evaluation of the treatment effect and outcome〉

The maxilla showed significant forward movement with counter-clockwise rotation when compared to normal growth. The mandible moved distally with backward rotation (Fig 25).

Post-treatment evaluation showed that both maxillary and mandibular forward growth were retarded. The intermaxillary relationship was maintained after the maxillary protraction appliance had been removed (Fig 26).

Conclusions

Our proposed treatment plan for skeletal Class III patients consists of 3 stages.

In the first stage, a maxillary protraction appliance and a chin cap are used together to correct the intermaxillary relationship. In most cases, the duration of this stage is generally less than 1 year. After removal of the maxillary protraction appliance, the maxilla remains relatively stable during the growth stage. However, the mandible tends to experience overgrowth, which results in a relapse. In the present case study, three female patients were investigated. The occlusal relationship was maintained until the adult stage in all 3 cases. However, all 3 patients experienced slight relapse, manifested by mandibular forward growth following removal of the maxillary protraction appliance. Therefore, overcorrection of reversed occlusion and control of mandibular growth after the first stage must be performed in order to prevent relapse.

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抄 録

著しい骨格性反対咬合症例の治療において、我々は上顎前方牽引装置とchin capの併用により、顎関係の改善を行うことを含めた長期的管理を行っている。今回我々は骨格性反対咬合と診断され、治療を行った女子3症例の長期的観察を通し検討、考察を行った。これらの症例において、第一段階では上顎前方牽引装置とchin capにより顎関係を改善した。上顎前方牽引装置除去後、上顎は成長期間中位置変化を殆ど示

さなかった。その間、下顎は予測よりも大きな成長を示した。咬合関係はすべての症例において成人期まで維持されていた。しかしこれらの症例は思春期成長の後も、下顎の前方成長により、わずかな後戻り傾向を示した。以上のことから、後戻りを予防するために反対咬合の治療においてはオーバーコレクションと第一段階後の下顎の成長のコントロールが必要であると考えられた。