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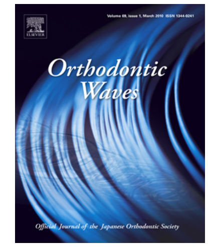

Original article

Effects of facial mask treatment are attributed to accelerated maxillary growth and inhibited counter-clockwise total rotation of the mandibular corpus: A structural superimposition study

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ABSTRACT

Purpose: To test the hypothesis that facial mask treatment influences maxillary sutural growth, condylar growth, and total rotation of mandibular corpus, using a structural superimposition analysis by Björk et al.
Materials and methods: Subjects consisted of 28 girls with Angle Class III malocclusion treated with facial mask (FM group). Eleven girls with pseudo-Class III malocclusion (pseudo-III group) were also examined. Pre- and posttreatment lateral cephalograms were analyzed to evaluate skeletal changes. Cephalometric structural superimposition analysis was also performed.
Results: The FM group exhibited significantly larger forward maxillary growth and negative total rotation of the mandibular corpus as compared to the pseudo-III group. In the FM group, forward maxillary skeletal growth correlated significantly with maxillary counter-clockwise rotation. Negative mandibular total rotation correlated significantly with inhibition of the forward position of the mandible.
Conclusion: Accelerated maxillary sutural growth and inhibited counter-clockwise total rotation of mandibular corpus growth attributed to facial mask treatment may contribute to improvements in Class III malocclusion. The greater the acceleration of maxillary sutural growth due to facial mask treatment, the greater the increase in maxillary counter-clockwise rotation.

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1. Introduction

For a growing patient diagnosed with Angle Class III malocclusion with a retrognathic maxilla, maxillary protraction appliances are used [1–6]. Many cephalometric studies have reported the effects of maxillary protraction appliances, especially facial mask [2–8].

Maxillary growth includes sutural growth, endochondral growth of the nasal septum, and periosteal growth of cortical bone. Mandibular growth includes endochondral growth of the condyle and periosteal growth of the cortical bone. Growth in length of the mandible occurs, essentially at the condyle [9]. Animal studies and a finite element study using dry skulls have suggested sutural modification as the most important determinant of sagittal growth in the naso-maxillary complex [10–12]. However, conventional cephalometric analysis cannot evaluate the effects on maxillary growth by separating sutural growth and changes in maxillary morphology derived from periosteal growth and effects on mandibular growth by separating growth at the condyle and periosteal growth.

To assess maxillofacial growth using cephalogram, external anatomical points of the maxilla and mandible (e.g. point A) may not be stable, because such points depend on local surface remodeling processes [13]. Using a structural (or regional) superimposition method based on that described by Björk and Skieller [14], Haralabakis et al. [15] compared the effects of activator and cervical headgear by dividing treatment changes into maxillary growth, mandibular condylar growth, mandibular molar movement, and mandibular total rotation [14], which represents rotation of the mandibular corpus during growth. Our previous study [16] also assessed the effects of activator on mandibular growth using the structural superimposition method. No report evaluates facial mask effects using the method, even though the method may facilitate a better understanding of how maxillary sutural growth, condylar growth, and mandibular total rotation relate to jaw relationship changes during treatment using facial mask.

The purpose of the present study was to test the hypothesis that facial mask treatment influences maxillary sutural growth, condylar growth, and mandibular total rotation, using the structural superimposition analysis.

2. Materials and methods

2.1. Subjects

Subjects comprised of 28 Japanese girls with Angle Class III malocclusion treated using a facial mask (FM group). Criteria for including a Class III patient in the study were: (1) overjet $\leq$0.0 mm; (2) Class III molar relationships; (3) retrognathic maxilla (point A to nasion perpendicular $<$0.5 mm); and (4) age $\geq$6 years and $\leq$9 years at initial examination. Criteria for excluding a subject from the study were: (1) presence of congenital anomalies; (2) trauma; and (3) previous orthodontic treatment.

The extra-oral facial mask was a one-piece construction with an adjustable anterior wire and hooks to accommodate downward and forward pull of the maxilla with elastics. To avoid bite opening during repositioning of the maxilla, protraction elastics were attached near the maxillary canines with downward and forward pull directed 30° to the occlusal plane. For the intra-oral appliance, bands were fitted on the maxillary permanent first molars. In cases of early mixed dentition, bands were fitted on the primary second molars. Elastics delivering about 300 g of force per side as measured by a gauge were used. All subjects were instructed to wear the facial mask for 10–12 h a day. Although actual wearing time for the facial mask was difficult to assess accurately, subjects who clearly demonstrated lack of compliance were excluded from the study. Mean treatment duration was 14$\pm$7 months. Standardized lateral cephalograms were obtained before (T1; mean age, 8.0$\pm$1.4 years) and after (T2; mean age, 9.2 $\pm$1.4 years) facial mask treatment.

Eleven Japanese girls with pseudo-Class III malocclusion (pseudo-III group) were also examined. Pseudo-Class III malocclusion is characterized by an anterior crossbite caused by a functional forward position of the mandible [5]. All subjects wore a lingual arch with spring [17] for improvement of the anterior crossbite by inclining the maxillary incisors labially. No patients were treated using an orthopedic appliance. All patients obtained positive overjet and overbite within 1–6 months. Standardized lateral cephalograms were obtained before treatment (T1; mean age, 8.1$\pm$0.9 years) and during growth observation (T2; mean age, 9.4$\pm$0.9 years). Mean age of T1 and T2 in the pseudo-III group was almost same as that in the FM group.

The ethics committee at the institution of the author's affiliation approved all protocols in this retrospective study (approval no. 214).

2.2. Cephalometric analysis

The cephalometric measurements employed in this study are shown in Fig. 1.

Cephalometric analysis derived from the original analysis of Björk and Skieller [18] was performed to evaluate facial mask effects by decomposing T1–T2 changes into maxillary skeletal growth and maxillary molar movement. The structural superimposition method for this analysis was applied as described previously [18] and is briefly explained below.

Superimposition of the initial and final (or interim during growth observation in pseudo-III group) tracings on the maxillary internal stable structure, anterior contours of the zygomatic processes, is shown in Fig. 2a. The dental component was represented as the distance between measurement points of the molar on the final tracing and the superimposed initial molar on the final tracing. The skeletal component was represented as the distance between measurement points of the molar on the initial tracing and the superimposed initial molar on the final tracing. The amount and direction of rotation of the maxilla was measured as the angle between SN lines of the superimposed initial tracing and final tracings on superimposition.

A cephalometric analysis derived from the original analysis described by Halazonetis [13] was also performed to evaluate facial mask effects by decomposing T1–T2 changes into condylar growth and total rotation of the mandibular corpus