Long-term skeletal and dental effects of facemask versus chincup treatment in Class III patients

A retrospective study

Langfristige skelettale und dentale Auswirkungen der Klasse-III-Behandlung mit Gesichtsmaske vs. Kinnkappe

Eine retrospektive Untersuchung

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Abstract

Objectives To investigate the skeletal and dental changes during chincup versus facemask treatment, to compare the long-term effects of the two appliances, and to document the impact of each on treatment success.

Methods In all, 61 patients with Class III syndrome were retrospectively analyzed at three examination times: 7.8 ± 1.7 years of age (T0, pretreatment), 9.6 ± 2.4 years of age (T1, posttreatment), and around 15–20 years later (T2, long-term follow-up).

Results Significant changes of specific cephalometric parameters for all treatment times: T0–T1 (SNA, interbase and gonial angle, Björk’s sum angle, maxillomandibular differential, and distance of upper lip to esthetic line), T1–T2 (NL-NSL, SNB, mandibular-body length, effective mandibular length, and effective maxillary length), and T0–T2 (mandibular-body length, effective mandibular length, effective maxillary length, maxillomandibular differential, SNB, ANB, gonial angle, Björk’s sum angle, and Wits appraisal). The T1–T2 results illustrate that in both treatment groups the typical Class III growth pattern often reappeared after treatment, including gains in SNB angle, condylion-gnathion length, and gonion-menton distance.

Conclusions Either a facemask or a chincup may be effectively used to treat Class III malocclusion. There were differences in long-term stability. Maxillary development was similarly favorable in both groups of patients with successful outcome. The subgroup in whom chincup treatment had failed were mainly characterized by excessive mandibular growth, or lack of maxillary catch-up growth, with deterioration of the maxillomandibular relationship notably in the initial phase of treatment. Early chincup treatment did not have an adverse impact on the temporomandibular joints.

Keywords Class III syndrome · Facemask · Chincup · Orthopedic appliances · Longterm stability

Zusammenfassung

Ziele Es sollten die skelettalen und dentalen Veränderungen bei Therapie mit Kopf-Kinn-Kappe beziehungsweise Gesichtsmaske untersucht, die Langzeitbehandlungseffekte beider Apparaturen verglichen, und der Einfluss der jeweiligen Therapiegeräte auf den Therapieerfolg dokumentiert werden.

Methoden Insgesamt wurden Daten von 61 Patienten mit Klasse-III-Syndrom zu 3 Untersuchungszeitpunkten retrospektiv analysiert: im Alter von 7.8 ± 1.7 (T0, vor der Behandlung) und 9.6 ± 2.4 Lebensjahren (T1, nach der
Behandlung) sowie etwa 15–20 Jahre später (T2, langfristiges Follow-up).

Results Significant changes of specific cephalometric parameters were found for all treatment intervals: T0–T1 (SNA, Interbasis- and Gonion-Winkel, Winkelsumme nach Björk, maxillomandibuläre Differenz und Distanz Oberlippe-Ästhetiklinke), T1–T2 (NL-NSL, SNB, Länge des Unterkiefers, effektive Mandibula- und effektive Maxillalänge) sowie T0–T2 (Länge des Unterkiefers, effektive Mandibula- und effektive Maxillalänge, maxillomandibuläre Differenz, SNB-, ANB-, Gonionwinkel Winkelsumme nach Björk und Wits-Appraisals). The T1–T2-results of both treatment groups show that the typical Class III Wachstums muster after therapy often reoccur frequently. During treatment, changes in the anterior-posterior position are seen, as well as the interobserver variability of the facial mask treatment. In the group of successful Class III-Kappe-Behandlung, a favorable maxillary development was observed, particularly in the initial therapy phase. An early observation with a maxillary-Kappe had no unfavorable influence on the dental arches.

Schlussfolgerungen Sowohl die Gesichts-Maske, als auch die Kopf-Kinn-Kappe sind effektive Geräte zur Behandlung eines Klasse III Syndroms. Unterschiede bestehen bezüglich der langfristigen Stabilität der Behandlungsergebnisse. Ähnlich der Gesichtsmaskenthерапie zeigte sich interessanterweise, auch bei erfolgreicher Kopf-Kinn-Kappen-Behandlung, ein günstiger Oberkieferentwicklung. Die Subgruppe, bei der die Kopf-Kinn-Kappen-Behandlung ohne Erfolg blieb, zeichnete sich im Wesentlichen durch zu starkes Unterkieferwachstum beziehungsweise einer Verschlechterung der maxillo-mandibulären Differenz bei fehlendem catch-up-Wachstum des Unterkiefers, vor allem in der initialen Therapiephase, aus. Eine frühbehandlung mit der Kopf-Kinn-Kappe hatte keinen ungünstigen Einfluss auf die Kiefergelenke.

Materials and methods

A total of 61 patients, all of whom had been diagnosed with Class III syndrome prior to treatment, were retrospectively evaluated (Table 1). Two examiners independently analyzed data from cephalograms, casts, and orthopantomograms reflecting each patient’s pretreatment situation at a mean age of 7.8 ± 1.7 (range 5–9) years (T0), posttreatment situation after correction of the malocclusion at 9.6 ± 2.4 (range 9–11) years (T1), and long-term follow-up situation 15–20 years later (T2). The cephalometric tracings were based on landmarks from various analysis schemes (Björk, Jarabak, Jacobsen, McNamara) and included 21 (2 dental, 17 skeletal, 2 soft-tissue) parameters.

The chin-up group was compiled from the patient data on file at the Department of Orthodontics at Medical University Graz, where a chin-up is the preferred method of treating Class III cases. The data for the facemask group were made available from an external database in a private practice. For each patient, complete pretreatment (T0), posttreatment (T1), and long-term (T2) records were available, the latter comprising follow-up periods of up to 20 years. Only patients were included who, at T0, exhibited skeletal and dental signs of Class III syndrome (negative overjet, Wits <–1 mm, negative ANB difference, Class III malocclusion). Cleft lip and palate or any other syndromes led to exclusion. Chinups were worn at a force of 600 g per side for 24 h a day whenever possible and, once a positive overjet was achieved, overnight. The

Introduction

Early treatment of Class III malocclusion is provided with different protocols reflecting the specific nature of the syndrome, which may consist in maxillary retragnatism, mandibular prognathism, or a combination of both [34]. Available options range from intraoral removable appliances such as inclined planes or maxillary protrusive plates, through functional orthopedic appliances like Fränkel’s function regulator III or the Class III bionator (also known as “reversed bionator”), to extraoral appliances like a facemask or a chinup [5]. In addition, the older the Class III patients, the more likely their treatment will involve modalities of skeletal anchorage [37].
Results

Significant dental and skeletal changes occurred within the various treatment groups, and the soft-tissue parameters were also found to change considerably. Interestingly, both mandibular and maxillary growth was more pronounced after treatment in the successful chincup group than in the facemask group. Table 2 lists the descriptive statistics of the linear and angular cephalometric parameters measured, subdivided into the three treatment groups (facemasksuccess, chincupsuccess, chincupfailure) and broken down by examination times T0, T1, and T2. Table 3 lists the results of the intergroup comparisons with the differences measured over each of the three intervals between the three examination times (T0–T1, T0–T2, T1–T2).

Cephalometric developments during treatment and through the observation period

The SNA angle changed most significantly (by +1.4°) in the facemask group during T0–T1, then decreasing back by 0.9° while increasing by 1.6° in the chincup group during T1–2. SNB angle decreased by about 0.7° with both appliances during T0–T1 but increased more markedly (by 2.5°) in the chincup than in the facemask group (1°) during T1–T2; in the chincupfailure group, this angle increased by >4°. ANB angle improved by 1.7° in the facemask group during T0–T1, thus, approaching the ideal range; during T1–T2, however, the jaw relationship again deteriorated. Gonial angle decreased by 4.1° in the chincup group during T0–T1, then decreasing further for a total change of 8.3° throughout T0–T2. NSBa decreased slightly in the facemask and in the chincup group during T0–T1, followed by continuation of the downward trend in the chincup group versus an increase back to almost normal in the facemask group during T1–T2. Interbase angle (ML-NL) decreased by 1.3° in the chincup group—thus, counteracting the vertical growth tendency—while increasing by 4.2° in the facemask group during T0–T1. Björk’s sum angle decreased, corresponding to the extreme gonial-angle decrease, in the chincup group but increased in the facemask group during T0–T1; during T1–T2, the values decreased in both groups and more markedly so in the chincup group.

Wits appraisal increased by 3.2 mm, such that an almost neutral jaw relationship was reached, in the facemask group compared to 2.1 mm in the chincup group during T0–T1; both groups showed similar decreases during T1–T2. Effective maxillary length (Cond-A) increased in both groups by the same amounts (3.2 or 3.3 mm) during T0–T1, followed by further gains of 4.4 mm in the facemask and 9.1 mm in the chincup group during T1–T2. Effective mandibular length (Cond-Gn) was found to increase less in the facemask group than in the chincup group throughout T0–T2. Maxillomandibular differential decreased slightly in the facemask group during T0–T1 and increased by about 3 mm more in the chincup than in the facemask group throughout T0–T2. Mandibular-body length (Go-Me) showed larger increase in the chincup group than in
the facemask group throughout T0–T2. Upper-incisor inclination (UCI/SN) was characterized by more pronounced camouflage positions in the chincup group at T2, whereas lower-incisor inclination was almost normal by that time. Distance of upper lip to esthetic line (UL-EL) decreased by 1.6 mm in the facemask group during T0–T1.

Visual examination of the panoramic radiographs did not reveal any remarkable findings at the various examination times (T0, T1, and T2). Three patients showed condylar changes, including, in one case, identification of a flattened condyle at T2, which, however, had been present previously and did not deteriorate during treatment; one
suspicious dorsal formation of a condyle; one flattening of the right condyle. None of the patients revealed any clinical signs or symptoms meeting the criteria of a functional anomaly as defined by the Graz dysfunction index.

**Discussion**

Evidence has repeatedly been provided that a start of treatment as early as possible is essential to the success of Class III treatment [2–4, 16, 18, 19, 25, 29, 38]. Other authors have suggested a low efficiency of Class III appliances [20, 21]. Due to the natural growth direction of the nasomaxillary complex, treatment with a facemask should be expected to yield the most pronounced skeletal effects up to 8 years of age [9, 13]. In older patients, the dentoalveolar effect will progressively increase [14]. Additional use of a maxillary expansion appliance is known to boost the skeletal efficiency of a facemask [6], and this approach was also used in the facemask group of the present study.

While the treatment effects of a facemask are well documented [2–4, 16, 18, 19, 25, 29, 38], long-term data are scarce. Most studies have reported increases in ANB angle, overjet, Cond-A, and SNA angle a decrease in maxillomandibular differential, an improvement of the molar relationship, and clockwise rotation of the mandible [18, 22, 32, 38]. Shanker et al. [30] did not observe a significant difference in A-point changes during Class III therapy of Chinese children with a facemask and an expansion appliance compared to an untreated control group. We found an A-point change of +1.4° in our facemask group during treatment (T0–T1). The ANB angle improved by 1.7° in our facemask group, and Wits appraisal, too, revealed an almost neutral jaw relationship at T1, yet the maxillary
the further course of growth (T1–T2). Ngan et al. [21] studied changes in a Chinese Class III population treated with a facemask and an expansion appliance. They identified slight movement of the maxilla but no significant movement of the mandible in the sagittal or vertical plane. Our study revealed SNB reductions by 0.7° with both appliances (facemask and chincup) from T0 to T1.

Mitani and Fukazawa [20] investigated the effect of chincup treatment on 26 Japanese girls. They found that complete inhibition of mandibular growth was difficult to achieve and the treatment effects to vary greatly between individuals. Regardless of the duration of daily force application and of age categories, they noted an increase in mandibular length. Our study, too, revealed increases in mandibular-body length and effective length of the mandible—in both treatment groups, albeit more so in the chincup than in the facemask group.

Sugawara et al. [31] studied the long-term effects of chincup treatment in three different age groups. They noted profile improvements in the early treatment stage but, since many of these improvements failed to remain stable, did not recommend treatment with a chincup alone for skeletal Class III patients exhibiting an additional maxillary growth deficit in the sagittal plane. Yoshida et al. [39] studied the combined use of a maxillary protractor and a chincup in 28 Japanese girls. They found significant increases in SNA by 2.6° with advancement and counterclockwise rotation of the maxilla, as compared to decreases in SNB by 1.31° with clockwise rotation and delayed growth of the mandible, followed by a relapse of about 35% with the mandible showing excessive growth while its improved position was maintained.

Wendell et al. [33] arrived at clearly successful outcomes of chincup treatment. They analyzed 10 children of an intermediate age (about 8.1 years) treated for a mean of 3.1 years and compared the results to untreated Class I and Class III subjects both after treatment and 6.2 years later. Overall, they found the mandibular growth rate to be 60–68% lower than in untreated control groups. In the literature, the effect and stability of mandibular growth inhibition by chincup treatment has been controversially discussed [28, 29, 33]. Outcomes seem to be more stable in girls than in boys with Class III [23]. It has been suggested that the compression force exerted by a chincup corrects the direction of jaw growth by influencing the mitotic activity of the prechondroblast zone in the temporomandibular joints [35]. Also, Class III treatment might affect growth by modifying condylar morphology and the glenoid fossa [19, 26]. Our study does not support documented findings of a vertical ramus-length reduction [11, 27].

Despite these findings, the efficiency of chincup treatment is not uncontroversial, especially with regard to the risk of causing harm to the condyles. The long-term follow-up and clinical examinations in our study demonstrated no indications of craniomandibular dysfunction in any of the patients. Deguchi and McNamara [8] did not observe any changes of the temporomandibular joints, either. Uçüncü et al. [32], in a retrospective study of cases with combined maxillary retro- and mandibular prognathism, compared the treatment effects of a chincup (12 patients aged 11.03 years) versus a Delaire mask (12 patients aged 10.72 years). They found improvements in ANB angle molar relationship, and overjet in both groups, as well as significantly greater improvements of the sagittal position of the maxilla and of the molar relationship in the group treated by maxillary protraction. Our study revealed changes of the maxilla in both treatment groups, which even were more pronounced in the chincup success than in the facemask group.

Conclusions

Early treatment of Class III syndrome led to successful outcomes both with chincup and with facemask appliance. Successful chincup treatment has similarly favorable effects on maxillary development as treatment with a facemask. The initially successful outcomes do, however, differ with regard to their long-term stability. Failed outcomes of chincup treatment are mainly due to uncontrollable growth of the mandible with deterioration of the maxillomandibular differential. Early chincup treatment was not observed to have an adverse impact on the temporomandibular joints.

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Compliance with ethical guidelines

Conflict of interest

B. Wendl, M. Stampfl, A. P. Muchitsch, H. Droschl, H. Wünsauer, A. Walter, M. Wendl, and T. Wendl state that they have no competing interests. This article does not contain any studies with human participants or animals performed by any of the authors.

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