Anterior Open Bite Treatment with Skeletal Anchorage

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Anterior open bite (AOB) is still one of the most difficult and demanding clinical problems. This malocclusion relies on a reduction in the vertical relationship between the incisal edges of the upper and lower incisors.

anterior open bite | molar intrusion | skeletal anchorage | orthognathic surgery

1. Introduction

There are many etiological factors of Anterior open bite (AOB). These include genetic, skeletal, dental and functional factors; factors related to the morphology of soft tissues; and habits [1]. Accompanying symptoms of AOB include increased lower face height (LFH), short posterior face height (PFH), increased gonial and mandibular plane angles and higher maxillary molar dentoalveolar height [2]. AOB is very often associated with numerous dental abnormalities, including tooth crowding, followed by problems with chewing food and speech, as well as aesthetic defects. Moreover, AOB is accompanied by muscular and functional problems, such as incompetence of the lips and a convex facial profile [3]. The development of AOB is also associated with the existence of parafunctions, which include thumb sucking or tongue thrust [4].

The development of orthodontics has provided many varieties of treatment for both dental and skeletal forms of AOB. The proposed treatment methods include both functional appliances and fixed appliances. Orthognathic surgical procedures also play an important role in the treatment [3].

In children, it is relatively simple to control facial growth through a variety of functional therapies. In this way, blocking the growth of the lateral parts of the alveolar process and provoking the growth of the dentoalveolar complex in the anterior region provide treatment options for AOB [5]. The treatment of AOB in non-growing patients and adults is much more difficult due to the inability to influence the skeletal development of the facial part of the skull, as well as the high susceptibility to relapse after orthodontic intervention in the dentoalveolar complex.

Traditionally, in patients with accomplished musculoskeletal development, the gold standard of treatment of AOB is orthognathic surgery [6]. The surgical treatment of AOB includes solely LeFort I osteotomy (LIO) or in conjunction with bilateral sagittal split osteotomy (BSSO) procedures performed on the mandible [1][7][8][9]. Orthognathic surgery modalities offer the best possible three-dimensional correction of both the facial skeleton and the dentoalveolar complex. It should be emphasized that the diverse range of procedures on the maxilla and the mandible that are collectively described as orthognathic surgery procedures are recognized to be safe surgical interventions [10][11].

Among the methods of AOB treatment, the intrusion of molars with the use of temporary anchorage devices (TADs) has a unique value. Mini-implants, mini-screws or mini-plates can be used as temporary skeletal anchorage [12]. The objective of this treatment option is to intrude the molar teeth by exerting a force between the temporary anchorage placed on the bone and the orthodontic appliance. This procedure allows a positive overbite to be achieved on the incisors by the intrusion of molar teeth followed by auto-rotation of the mandible [13].

The aim of orthodontic and surgical-orthodontic treatment is to correct malocclusion and achieve stable long-term treatment results. AOB is among the dentoalveolar and skeletal problems characterized by a high relapse rate [14]. Therefore, it is important to critically evaluate the newly introduced methods of treatment in terms of the stability of the achieved treatment effects.

2. Results of AOB Treatment Assessed by Achieving Positive Overbite on the Incisors and Other Parameters of AFH

Regardless of the treatment option chosen, the primary outcome of AOB treatment is a positive overbite on incisors. Changing the value from negative to positive indicated the correct treatment outcome on incisors, regardless of whether the treatment was based on molar intrusion TADs or as a result of maxillary or bimaxillary orthognathic surgery.

In all cases, AOB treatment resulted in a reduction in the measurements of AFH, understood as the linear distance between N and Me, and a decrease in LFH, defined as the linear distance between the anterior nasal spine (ANS) and Me or ANS-Me distance.

The values of overbite measured before and after AOB treatment using molar intrusion with skeletal anchorage alongside the calculated change in the vertical relationship between the incisal edges of U1 and L1 are summarized in **Table 1**, while the values of change in the distance of the mesial buccal cusp from PP are shown in **Figure 1**.

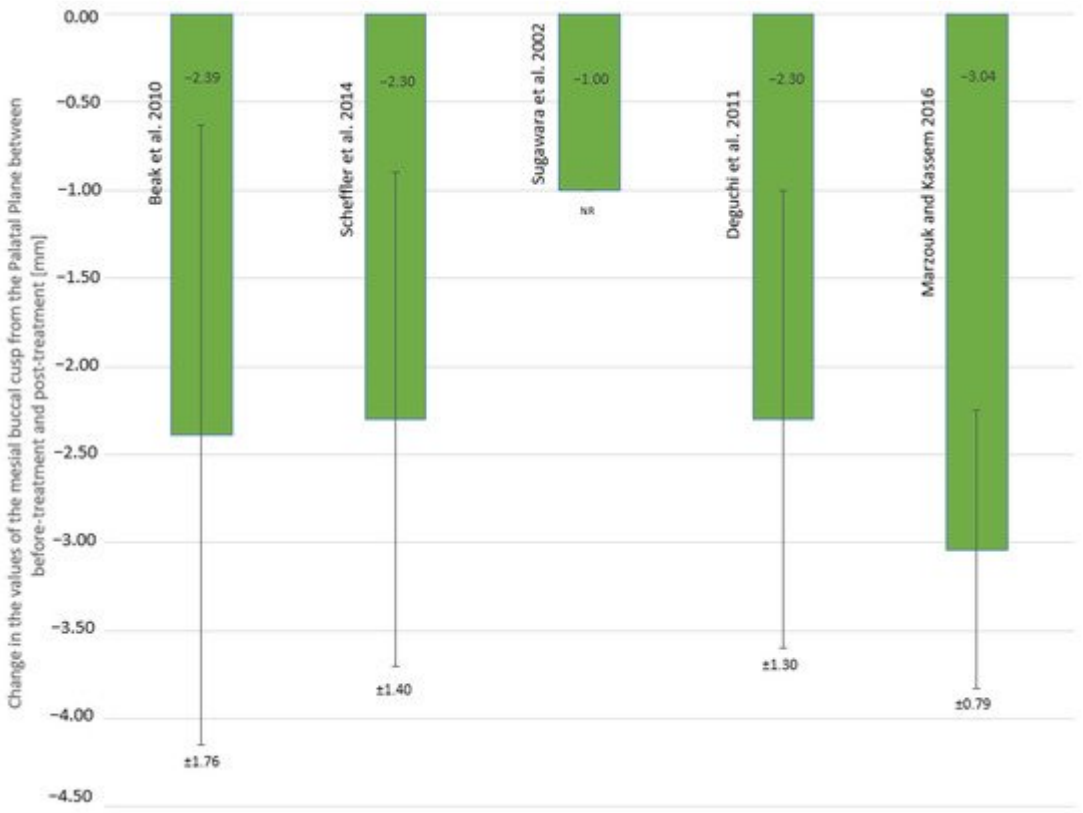

Figure 1. Change in the values of the distance of the mesial buccal cusp of the first upper molar from the palatal plane (mm); NR—not reported.

Table 1. The change in overbite measured on the incisors as a result of anterior open bite treatment by molar intrusion using skeletal anchorage (mm).

Study	Pre-Treatment Mean (SD)	Post-Treatment Mean (SD)	Change in Mean (SD)
Baek et al. 2010	−3.91 (1.65)	1.65 (0.82)	5.56 (1.94) *
Scheffler et al. 2014	−1.2 (1.7)	1.0 (NR)	2.2 (1.6) ^{SNR}
Sugawara et al. 2002	−2.8 (1.8)	2.1 (0.8)	4.9 (NR) ^{SNR}
Deguchi et al. 2011	−4.4 (1.2)	1.8 (1.1)	6.2 (1.7) *
Marzouk and Kassem 2016	−4.7 (2.3)	2.18 (0.48)	6.93 (1.99) **

NR—not reported; SD—standard deviation; * significant difference compared with pre-treatment ($p < 0.05$); ** significant difference compared with pre-treatment ($p < 0.01$); ^{SNR}—significance not reported.

The results of AOB treatment using orthognathic surgery techniques assessed on the basis of overbite are summarized in **Table 2**. The greatest overbite change was found in patients subjected to bimaxillary surgery in the studies by Ding et al. [9] (3.8 mm). It should be noted that in these studies there was also the highest negative

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overbite value occurred before surgery, amounting to −3.2 mm. After bimaxillary surgical treatment, the highest overbite of 1.3 ± 1.1 mm was obtained in the article by Fischer et al. [15]. In studies analyzing the results of AOB treatment with the division into maxillary and bimaxillary surgery, a greater value of overbite change was obtained in the group of patients who underwent maxillary surgery (3.78 mm) than in the group who underwent bimaxillary surgery (3.17 mm) [6]. At the same time, in the same studies, the highest value of overbite after surgery was obtained in the group of patients treated with LIO only (1.23 ± 1.05 mm).

Table 2. The change in overbite measured in the articles as a result of orthognathic surgery (mm).

Study	Pre-Treatment Mean (SD)	Pre-Surgery Mean (SD)	Post-Surgery Mean (SD)	Change in Mean (SD)
Ding et al. 2007	−3.2 (NR)	−3.2 (NR)	0.6 (NR)	3.8 (NR)
Teittinen et al. 2021	NR NR	−2.55 (1.41) M −2.19 (1.44) B	1.23 (1.05) M 0.98 (1.53) B	3.78 (NR) M 3.17 (NR) B
Swinnen et al. 2001	−0.7 MI −2.1 ME	−0.6 MI −1.9 ME	1.3 MI 0.2 ME	1.9 MI 2.1 ME
Fischer et al. 2000	NR	−0.9 (2.6)	1.3 (1.1)	2.2 (2.4)
Proffit et al. 2000	NR	NR	NR	NR

NR—not reported; SD—standard deviation; M—maxillary group; B—bimaxillary group; MI—maxillary intrusion; ME—maxillary extrusion.

3. AOB Treatment with Molar Intrusion

With the advent of skeletal anchorage methods, molar intrusion has become an effective alternative to surgical-orthodontic complex treatment of AOB [7]. Orthodontic molar intrusion is a method that does not require patient cooperation, and the placement of TADs is a much less invasive procedure than orthognathic surgery [16].

It is emphasized that both orthodontic and surgical-orthodontic treatment modalities are associated with a high relapse rate [17]. Historically, many methods of purely orthodontic treatment of AOB have been used. In the case of orthodontic treatments of AOB with extractions, the relapse rate could be as high as 25.8% [14]. An even higher relapse rate of up to 38.1% was found in cases of traditional non-extraction AOB treatment [18].

In all articles on AOB treatment with molar intrusion, a positive overbite was achieved as a result of shortening the distance between the mesial buccal cusp of the first molar and PP. Another consequence of molar intrusion is the shortening of AFH affecting the facial appearance. The consequence of this phenomenon is also the CCW rotation of the mandible. The use of mini-plates fixed with bone screws at a zygomatic buttress significantly accelerated the pace of molar intrusion, made it possible to use greater orthodontic forces and reduced the risk of loosening of the anchoring elements [7][16].

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