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Major considerations of minimally invasive orthognathic surgery in Class III malocclusions: a systematic review

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Abstract

Introduction: In Brazil, malocclusion is found in the ages between 7 and 15 years old with a prevalence of 6%. In this scenario, Class III malocclusion affects between 5% and 15% of the entire Brazilian population. Orthodontics stands out due to the strong aesthetic impairment and unfavorable treatment prognosis, especially when there is a hereditary component. It is suggested that most cases of Class III malocclusion have retrusion or maxillary hypoplasia, which may or may not be associated with mandibular prognathism. Thus, several treatment modalities are proposed to correct Class III malocclusion. **Objective:** It explored the literary findings on the importance of knowing the advances in orthodontics for the treatment of class III malocclusion. **Methods:** Clinical studies (case reports, retrospective, prospective and randomized) with qualitative and / or quantitative analysis were included, following the rules of the systematic review-PRISMA. 134 articles were found initially and, after selection, 37 articles were used to compose the present study. **Results and conclusion:** According to the literary findings, the treatment of Class III must be fundamentally based on the diagnosis so that the treatment is installed in order to correct the compromised structures instead of being compensated in places not affected by this malocclusion. In other words, the degree of involvement of the maxilla and mandible should be evaluated so that the treatment is directed to that bone base and really reaches its objectives and impacts of facial improvement. Growth redirection in Class III cases is indicated as soon as the anomaly is diagnosed, since the displacement processes that occur on the middle face can only be affected with treatment as long as the growth zones are able to respond to the biomechanical stimulus. Therefore, the younger the Class III patient is treated, the better the effects of facial correction.

Keywords: Malocclusion. Class III malocclusion. Treatments. Minimally invasive surgery. Orthognathic surgery.

Introduction

In Brazil, malocclusion is found between the ages of 7 and 15 years, with a prevalence of 6% [1]. The highest number of traumatic injuries to deciduous teeth occurs between the ages of one and a half and three years, and to permanent teeth between the ages of 7 and 10 years. Boys are more prone to dental trauma than girls. In this scenario, Class III malocclusion affects between 5% and 15% of the entire Brazilian population [1]. Orthodontics stands out due to the strong aesthetic impairment and unfavorable treatment prognosis, especially when there is a hereditary component. It is suggested that most cases of Class III malocclusion have maxillary retrusion or hypoplasia, which may or may not be associated with mandibular prognathism [2]. Treatment of Class III malocclusion before late mixed dentition appears to induce more favorable craniofacial changes, with a significant increase in maxillary sagittal growth. However, a mandibular restriction effect can be achieved in a later treatment [2]. Some studies report that the disarticulation of the circumaxillary sutures accentuates the orthopedic

effects [3,4], but the use of a face mask at a young age, even without palatal expansion, is effective for the correction of skeletal Class III.

Therefore, expansion should be indicated based on the clinical characteristics of the case. The harmonious functional aspect of the patient is important for the stability of the results. The dental and skeletal modifications of the Class III correction produce an improvement in the relationship between the teeth, the bone bases, and the soft tissues [5].

Therefore, several treatment modalities are proposed for the correction of Class III malocclusion [6]. The approaches include the use of a protraction face mask with rapid maxillary expansion, a face mask without maxillary expansion, a face mask with alternating expansion and maxillary constriction, a face mask associated with mini-implants in the zygomatic pillar, the use of orthodontic mini-implants in the lower arch as anchorage for maxillary traction using a removable upper appliance, the use of mini-implants in the retromolar region, the use of miniimplants in the vestibular area of the lower arch, the posterior region, the use of a chin cup, a reverse chin cup, a Fränkel functional regulating appliance using an acrylic grid and stop, the use of a removable mandibular retractor, the use of a reverse twin block, and the use of a tandem traction bow appliance [7-11].

In this scenario, the diagnosis must be made as early as possible since skeletal discrepancies are very difficult to correct due to the complexity of the treatment and the lack of predictability in the growth pattern of patients [12,13]. It is well documented in the literature that, in patients with Class III malocclusion who still have growth potential, the most commonly used treatment protocol is the protraction face mask associated with rapid maxillary expansion. Several studies that seek to demonstrate other types of treatment use this therapeutic modality as a control group [14-17].

Therefore, the present study aimed to explore the literary findings on the importance of knowing the advances in orthodontics for the treatment of Class III malocclusion.

Methods

Study Design

This study followed the international systematic review model, following the PRISMA (preferred reporting items for systematic reviews and meta-analysis) rules. Available at: http://www.prisma-statement.org/?AspxAutoDetectCookieSupport=1. It was accessed on: 07/21/2024. The AMSTAR-2 (Assessing the methodological quality of systematic reviews) methodological quality standards were also followed. Available at: https://amstar.ca/. It was accessed on: 07/21/2024.

Data Sources and Search Strategy

The literature search process was carried out from June to July 2024 and developed based on Web of Science, Scopus, PubMed, Lilacs, Ebsco, Scielo, and Google Scholar, covering scientific articles from various periods to the present day. The descriptors (DeCS / MeSH Terms. Available on: https://decs.bvsalud.org/) were used: *"Malocclusion. Class III malocclusion. Treatments. Minimally invasive surgery. Orthognathic surgery",* and using the Boolean "and" between MeSH terms and "or" between historical findings.

Study Quality and Risk of Bias

The quality was classified as high, moderate, low, or very low regarding the risk of bias, clarity of comparisons, precision, and consistency of analyses. The most evident emphasis was on systematic review articles or meta-analysis of randomized clinical trials, followed by randomized clinical trials. Low quality of evidence was attributed to case reports, editorials, and brief communications, according to the GRADE instrument. The risk of bias was analyzed according to the Cochrane instrument by analyzing the Funnel Plot graph (Sample size versus Effect size), using Cohen's d test.

Results and Discussion

Summary of Findings

A total of 134 articles were found. Initially, duplicate articles were excluded. After this process, the abstracts were evaluated and a new exclusion was performed, removing the articles that did not include the theme of this article, resulting in 61 articles. A total of 45 articles were evaluated in full and included in this study, but only 37 were developed in the systematic review item (Figure 1). Considering the Cochrane tool for risk of bias, the overall evaluation resulted in 16 studies with a high risk of bias and 20 studies that did not meet GRADE and AMSTAR-2. According to the GRADE instrument, the 37 studies that composed the systematic review presented homogeneity in their results, with X^2= 91.2% >50%, with $p<0.05$. Due to the limited literature, an open search strategy was performed to include a larger number of studies.

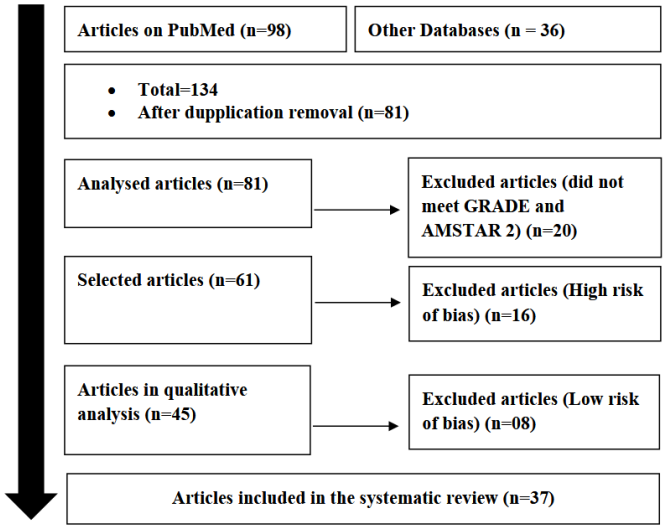

Figure 1. Flowchart showing the article selection process. Source: Own Authorship.

Figure 2 presents the results of the risk of bias of the studies using the Funnel Plot, showing the calculation of the Effect Size (Magnitude of the difference) using Cohen's Test (d). Precision (sample size) was determined indirectly by the inverse of the standard error (1/Standard Error). This graph had a symmetrical behavior, not suggesting a significant risk of bias, both among studies with small sample sizes (lower precision) at the base of the graph and in studies with large sample sizes at the top.

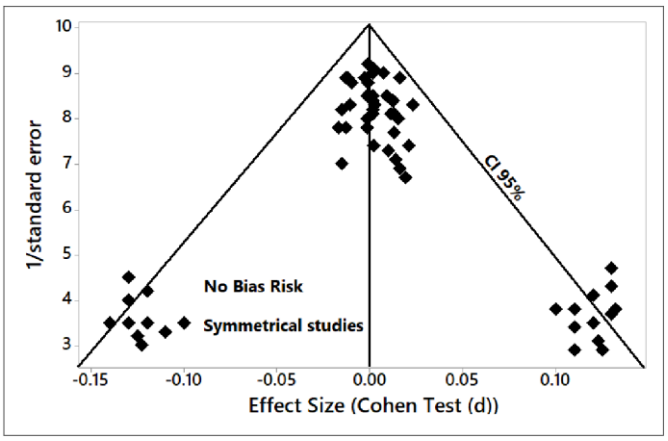

Figure 2. The symmetrical funnel plot does not suggest a risk of bias among the studies with small sample sizes, which are shown at the bottom of the graph. High confidence and high recommendation studies are shown above the graph (n=37 studies). Source: Own Authorship.

Major Findings

The two most common dilemmas surrounding Class III treatment are the timing of treatment and the type of appliance [18]. Various appliances have been used to correct a Class III skeletal discrepancy, but there is little evidence available on their long-term effectiveness. Similarly, early treatment of Class III malocclusion has been pursued with increasing interest. However, there is no solid evidence of the long-term benefits [18,19].

A meta-analysis study therefore evaluated the short- and long-term effectiveness of orthodontic/orthopedic methods used in the early treatment of Class III malocclusion. Selection criteria included randomized controlled trials (RCTs) and prospective controlled clinical trials (CCTs) of children between the ages of 7 and 12 years who received early treatment with any type of orthodontic/orthopedic appliance compared with another appliance to correct Class III malocclusion or with an untreated control group. The primary outcome was correction of reverse overjet, and secondary outcomes included skeletal changes, soft tissue changes, quality of life, patient compliance, adverse effects, peer review score, and treatment time. Fifteen studies, 9 RCTs and 6 CCTs, were included in this review. In the RCT group, only 3 of the 9 studies were assessed as having a low risk of bias, and the others were at high or unclear risk of bias. All 6 CCT studies were classified as having a high risk of bias. Three randomized controlled trials involving 141 participants analyzed the comparison between protraction mask and untreated control. The results for reverse overjet (mean difference, 2.5 mm; 95% CI, 1.21–3.79; P = .0001) and ANB angle (mean difference, 3.90°; 95% CI, 3.54–4.25; p< .0001) were statistically significant in favor of the facemask group. All CCTs demonstrated a statistically significant benefit in favor of the use of each appliance. However, the studies were at high risk of bias. Therefore, there is a moderate amount of evidence to show that early treatment with a facemask result in improvement in skeletal and dental outcomes in the short term. However, there was a lack of evidence regarding long-term benefits. There is some evidence regarding the chin cup, tandem traction arch appliance, and removable mandibular retractor, but the studies were at high risk of bias. Further high-quality, long-term studies are needed to evaluate the effects of early treatment for patients with Class III malocclusion [20].

In addition, Mandall et al. [17] tested Class III treatment with a face mask associated with rapid maxillary expansion and concluded that it was effective both skeletally and dentally. The only difference in the respective studies was the follow-up time after obtaining a Class I molar relationship, which ranged from 15 months14 to 36 months. Maxillary expansion before treatment with a face mask is used in most cases because it has the benefits of correcting posterior crossbite when present, increasing arch length, causing bite opening, generating loosening/activation of the circumaxillary sutures, and generating initiation of

movement of the maxillary complex downward and forward [21-25].

Also, Vaughn et al. [26], in a randomized clinical trial, testing maxillary protraction in a group with expansion and another without prior maxillary expansion, concluded that the changes produced in the dentofacial complex were equivalent to an improvement in Class III malocclusion, in addition to there being no change in the total treatment time. Maxillary expansion is only necessary in cases of posterior crossbite or space deficiency [27-38]. These data are also in agreement with the systematic review conducted by Kim et al. [39]. In contrast to the use or not of maxillary expansion prior to maxillary protraction treatment, Liu et al. [36] tested the expansion plus constriction protocol and observed that there were some statistically significant differences, such as better anterior movement of the maxilla and rotation of the mandibular and palatal planes in the expansion/constriction group, however, these changes did not demonstrate any clinical relevance, since they were less than 1 mm and 1º, respectively.

Besides, chin cups have been used to control mandibular protrusion in growing patients for almost a century [40]. However, a more in-depth investigation of the literature revealed controversies and contradictions regarding the methodology of use, such as the appropriate age to start treatment and the magnitude of force used. The clinical effectiveness is widely debated by authors who use different protocols, obtaining different results [41-44]. Abdelnaby and Nassar [30] conducted a study on patients aged between nine and ten years using a chin cup with occipital pull using two magnitudes of force. The authors obtained as a result a significant decrease in the SNB angle both by clockwise rotation of the mandible and by an increase in anterior facial height in the two treated groups when compared to the untreated group, data that are also in agreement with the systematic review prepared by Chatzoudi et al. [45]. The results achieved with the use of this device significantly improved the maxillomandibular relationship, but with few skeletal effects, and the difference in force magnitude generated the same effects.

Given the many devices already used and tested for the treatment of Class III malocclusion, due to their lack of aesthetics, several authors have sought to develop new devices that can facilitate their use and, consequently, patient acceptance. Showkatbakhsh et al. [29] developed a new device called the reverse chin cup, to perform maxillary protraction. In this randomized clinical trial, the age range of the patients varied from seven to ten years and the aim was to compare its effectiveness with the facial mask. In both treatments, an anterior movement of the maxilla was achieved, as well as vestibularization of the upper anterior teeth and lingualization of the lower incisors. The authors mention that, because the face mask is bulky, children feel discouraged from using it, especially at school, due to embarrassment and the discomfort it causes. Thus, they suggest that the use of the reverse chin cup, because it is an aesthetically more acceptable method, maybe a better option for maxillary protraction.

The use of the lingual grid or the removable upper acrylic stop generates pressure from the tongue on the screen, causing this force to be transmitted to the maxilla, causing it to move forward [46,47]. When comparing its effects with those of the face mask, the results are similar in moving the maxilla forward. One advantage is that the lingual grid does not cause some unfavorable effects on the mandible (rotation backward and downward) for patients with a vertical growth pattern [47,48].

Orthopedic treatments with skeletal anchorage have become a new paradigm for the early treatment of Class III malocclusion [49-51]. Several studies mention the use of extraoral appliances associated with this type of anchorage [52,53]. The use of mini-implants installed bilaterally in the zygomatic abutment associated with a face mask or installed between the roots of the canines and first lower premolars on the vestibular side associated with a removable upper appliance 28 with Class III hooks and elastics can be used to pull the maxilla forward. These treatment modalities, when compared with the use of a face mask, present similar results in the correction of maxillary deficiency. The fact that smaller appliances are used, causing less aesthetic imbalance, can generate better patient acceptance, allowing treatment to be started earlier [54].

Conclusion

According to the findings in the literature, Class III treatment should be fundamentally based on the diagnosis so that treatment is implemented to correct the compromised structures rather than compensating for areas not affected by this malocclusion. In other words, the degree of involvement of the maxilla and mandible should be assessed so that treatment is directed to that bone base and truly achieves its goals and impacts of facial improvement. Growth redirection in Class III cases is indicated as soon as the anomaly is diagnosed since the displacement processes that occur in the midface can only be affected with treatment while the growth zones are capable of responding to the biomechanical stimulus. Therefore, the younger the Class III patient is treated, the better the effects of facial correction will be.

CRediT

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Conflict of Interest

The authors declare no conflict of interest.

Similarity Check

It was applied by Ithenticate®.

Application of Artificial Intelligence (AI)

Not applicable.

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It was performed.

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