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Major integrated orthodontic-surgical approaches in Cass III malocclusion: a systematic review

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Abstract

Introduction: Skeletal class III malocclusion in adults is one of the most serious and difficult to correct maxillofacial deformities. The prevalence of Class III malocclusion in Caucasians ranges from 0.8 to 4% and up to 12% in Chinese and Japanese populations. It has been shown that more than 60% of cases of Class III malocclusion are due to skeletal discrepancies, requiring an integrated orthodontic-surgical treatment approach. **Objective:** It was to carry out a systematic review of literary findings on the main approaches and outcomes of clinical studies of orthodontic-surgical treatment in patients with class III malocclusion. **Methods:** The PRISMA Platform systematic review rules were followed. The search was carried out from February to March 2025 in the Scopus, PubMed, Science Direct, Scielo, and Google Scholar databases. The quality of the studies was based on the GRADE instrument and the risk of bias was analyzed according to the Cochrane instrument. **Results and Conclusion:** A total of 125 articles were found, and 58 articles were evaluated in full and 56 were included and developed in the present systematic review study. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 07 studies with a high risk of bias and 15 studies that did not meet GRADE and AMSTAR-2. Most studies showed homogeneity in their results, with X^2=74.7%>50%. It was concluded that orthodontic-surgical treatment in Class III patients must be based on the diagnosis so that the treatment is implemented to correct the compromised structures instead of being compensated in places not affected by the malocclusion. The degree of involvement of the maxilla and mandible must be assessed so that the treatment is directed to that bone base and truly achieves its objectives and impacts of facial improvement. Redirecting growth in Class III cases is indicated as soon as the anomaly is diagnosed, as the displacement processes that occur in the midface can only be affected with treatment as long as the growth zones are capable of responding to the biomechanical stimulus. Therefore, the younger the Class III patient is treated, the better the facial correction effects will be.

Keywords: Malocclusion. Class III malocclusion. Orthodontics. Surgery. Treatments.

Introduction

Skeletal Class III malocclusion in adults is one of the most severe and difficult to correct maxillofacial deformities [1]. This type of malocclusion involves multiple, complex, and interrelated aspects, such as cranial base anomalies, maxillary and mandibular skeletal and dental compensation components, etc., which require precise orthognathic surgical repositioning of the jaws in conjunction with extensive pre- and post-surgical orthodontic treatment to achieve a satisfactory result [2,3].

The goal of treatment is to correct the skeletal deformity and improve masticatory and chewing functions by eliminating the malocclusion and restoring a balanced bone proportion profile [4]. The prevalence of Class III malocclusion in Caucasians ranges from 0.8 to 4% and up to 12% in Chinese and Japanese populations [5-7]. In this context, it has been shown that more than 60% of Class III malocclusion cases are due to skeletal discrepancies [8]. The condition can be characterized by mandibular prognathism, maxillary retrognathism, retrusive mandibular dentition,

protrusive maxillary dentition, and combinations of the above [9].

These complex cases require careful treatment planning, including predictive cephalometric tracings, simulated model surgeries, an integrated orthodontic-surgical approach, and constant and uninterrupted patient compliance, motivation, and cooperation. In Brazil, malocclusion is found in the ages of 7 to 15 years with a prevalence of 6% [1]. The highest number of traumatic injuries to deciduous teeth occurs between one and a half and three years of age and to permanent teeth between seven and ten years of age, with boys being more prone to dental trauma than girls. In this scenario, Class III malocclusion affects between 5% and 15% of the entire Brazilian population [3].

In this global scenario, 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 [4]. 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 with later treatment [4]. Some studies report that the disarticulation of the circumaxillary sutures accentuates the orthopedic effects [5,6], but the use of a face mask at a young age, even without palatal expansion, is effective for the correction of skeletal Class III.

Also, 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 Class III correction produce an improvement in the relationship between the teeth, the bone bases, and the soft tissues [7]. Several treatment modalities are proposed to correct Class III malocclusion [8]. 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 mini-implants 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 [9-13].

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 [14,15]. 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 [16-18].

Therefore, the present study aimed to perform a systematic review of the literature findings on the main approaches and outcomes of clinical studies of orthodontic-surgical treatment in patients with 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. Accessed on: 03/11/2025. The AMSTAR-2 (Assessing the methodological quality of systematic reviews) methodological quality standards were also followed. Available at: https://amstar.ca/. Accessed on: 03/11/2025.

Data Sources and Search Strategy

The literature search process was carried out from February to March 2025 and developed based on Scopus, Embase, PubMed, Lilacs, Ebsco, Scielo, and Google Scholar, covering scientific articles from various periods to the present day. The following descriptors (DeCS /MeSH Terms) were used: *"Malocclusion. Class III malocclusion. Orthodontics. Surgery. Treatments"*, and the Boolean expression "and" was used between the MeSH terms and "or" between the 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-analyses of randomized clinical trials, followed by randomized clinical trials. The 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

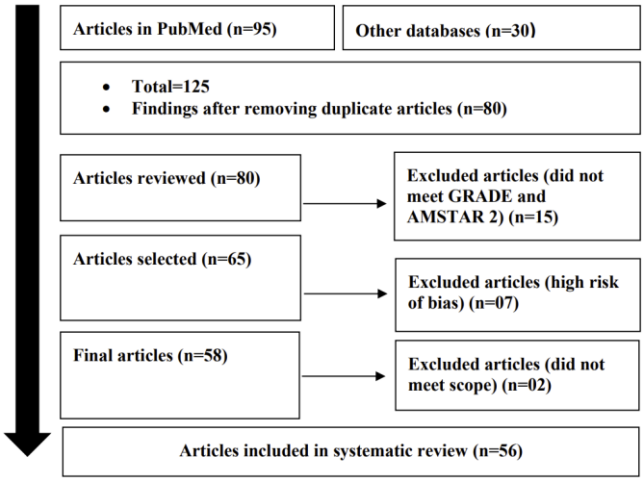
graph (Sample size versus Effect size), using Cohen's d test.

Results and Discussion

Summary of Findings

A total of 125 articles were found and submitted to eligibility analysis, with 56 final studies being selected to compose the results of this systematic review. The studies listed were of medium to high quality (Figure 1), considering the level of scientific evidence of studies such as meta-analysis, consensus, randomized clinical, prospective, and observational. Biases did not compromise the scientific basis of the studies. According to the GRADE instrument, most studies presented homogeneity in their results, with X^2=74.7%>50%. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 07 studies with a high risk of bias and 15 studies that did not meet GRADE and AMSTAR-2.

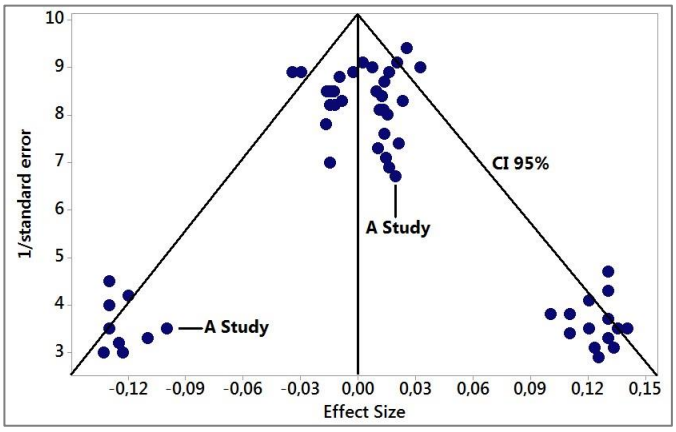
Figure 1. Screening of the article and the selection process.



Source: Own authorship.

Figure 2 presents the results of the risk of bias of the studies through the Funnel Plot, showing the calculation of the Effect Size (Magnitude of the difference) using Cohen's Test (d). The 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, either among studies with small sample sizes (lower precision) that are shown at the base of the graph or in studies with large sample sizes that are presented at the top.

Figure 2. The symmetric funnel plot suggests no risk of bias among the small sample size studies shown at the bottom of the graph. High confidence and high recommendation studies are shown above the graph (n=56 studies).



Source: Own authorship.

Main Aspects of Class III Malocclusion

Class III malocclusion was defined by Angle1 as a condition in which the first permanent lower molar is positioned mesially to the first permanent upper molar. This condition may be due to maxillary retrusion, mandibular protrusion or a combination of both situations, with most patients showing maxillary retrusion [1,2]. It may also be caused by underdevelopment of the maxilla or overdevelopment of the mandible [6].

A pseudo-Class III dental relationship may also occur, which is characterized by a forward displacement of the mandible due to occlusal interferences. Even though Class III malocclusion does not have such a significant prevalence in the most diverse populations around the world, except in Eastern countries such as Japan, China, South Korea, and others, it leads to a search for treatment very early, since it generates a very unpleasant facial disharmony [7]. In this sense, Class III has a multifactorial etiology and may be the result of an interaction of hereditary factors associated with environmental factors [8]. The diagnosis must be made as early as possible since skeletal discrepancies are quite difficult to correct due to the complexity of the treatment and the lack of predictability in the patient's growth pattern [9].

The idea of aligning teeth dates back to 1,000 years B.C. Archaeologists have discovered ancient mummies with rudimentary metal bands tied around individual teeth. To close the spaces, cords were used that did the job of today's orthodontic wires. Roman reports from 25 B.C. said that teeth could be moved by finger pressure [10].

Between 400 and 500 B.C. Hippocrates and Aristotle commented on ways to align and fix the condition of several teeth. There are reports from Ancient Greece of devices to maintain spaces and prevent the collapse of the dentition during life [10]. Although several reports and evidence of the desire to align teeth date back to well before Christ, it was not

until around 1700 that truly significant events occurred for orthodontics. In 1728, the French dentist Pierre Fauchard published a book called "The Dental Surgeon", with an entire chapter on how to align teeth. Fauchard used a device called a "Bandeau", a horseshoe-shaped piece made of precious metal that helped to expand the arch and align the teeth [10].

The term orthodontics only appeared in 1841, with Joachim Lefoulon. The first books on orthodontics were published around 1880. The first of them, "Treatise on Oral Deformities" was written by Norman Kingsley, a dentist, writer, sculptor, and artist [9]. At the beginning of the 20th century, the first simplified system for classifying malocclusions (Class I, Class II, and Class III) emerged and is still used today. This system was created by Edward H. Angle, perhaps the most famous figure in the history of orthodontics and considered by many to be the father of modern orthodontics. Angle contributed greatly to orthodontics through improvements in orthodontic appliances and many other simplifications [9].

In addition, Edward H. Angle founded the first school of orthodontics and organized the American Society of Orthodontics in 1901, which became the famous AAO (American Association of Orthodontics) in 1930. Angle founded the first orthodontics journal in 1907. It was from Angle that orthodontics became a respectable specialty of dentistry. Angle also left behind famous disciples such as Charles H. Tweed, Cecil Steiner, and others [9].

In 1940, in a study of 476 children between two and nine and a half years of age, a 40% incidence of premature extractions of primary molars was found. In many cases there seemed to be a relationship between these extractions and the severity of certain malocclusions, although it was not possible to establish a cause and effect relationship [12].

The idea of artificially maintaining the spaces produced by the early loss of temporary teeth seems to have originally belonged to Angle. Convinced that a high percentage of malocclusions are caused by these early losses, in 1907 he proposed a space maintainer that would remain in place without many variations, even if it remained in the oral cavity for a long time [13].

In the literature, there have been initiatives in favor of the use of space maintainers since 1924. From 1930 onwards, authors recommended and spoke of the need for the use of such devices. Quinteros, Ficher, Goberer, and Hogeboon, among others, are authors who proposed rigid space maintainers. The author mentions that such devices were completely rejected sometime after their advent due to their rigidity in comparison to the normal development of the jaws. With few variations, they consisted of bands adapted to the molars and a wire welded together joining the two ends [14]. Furthermore, Chapin, Strang, Bierman, Lancett, Foster, Morgan, and Willet were the first physiologic maintainers cited in the literature, which allowed normal tooth movements and had variations in shape [15].

Key Highlights

Orthodontists have long debated the relative merits of early treatment in the management of malocclusion, but the evidence base is almost exclusively weak [16]. Should we perform arch development in the mixed dentition to reduce the need for later extractions in the permanent dentition? Or begin our functional appliance therapy at a similar stage to maximize skeletal change? What about the early elimination of a crossbite associated with mandibular displacement?

In recent years, there have been some attempts to adequately synthesize the current data, but this has been challenging [16-19]. A recent discovery has been the potential for early functional appliance treatment to reduce maxillary incisor trauma in adolescence, although the evidence is only marginal at best [20]. The problem associated with many of these questions is, of course, that there are often few studies available to review that are not at high risk of bias. This is exemplified by another fairly recent systematic review investigating orthodontic treatment for posterior crossbites [17]. Out of literally hundreds of studies, only a small handful were considered to be of sufficient quality to evaluate systematically, and all they can tell us is that a quad-helix is marginally more effective than a removable appliance. In the current era of evidence-based medicine, this is all a bit disappointing [17]. It is therefore reassuring to see that a UK-based team has been actively investigating another early intervention with a poor evidence base for over a decade – the effectiveness of early protraction facemask treatment in the management of class III malocclusion [18]. Here, they report their latest findings and provide some of the highest quality evidence to help answer a simple question: in a child with a developing Class III malocclusion associated with midfacial retrusion, does early maxillary expansion and a protraction facemask reduce the need for orthognathic surgery later in life? [19].

This was a multicentre randomized controlled trial involving eight UK hospital orthodontic departments spread across the country. Children aged 7–9 years and diagnosed with midfacial retrusion combined with a majority of permanent incisors in the crossbite were randomized to early treatment involving bonded maxillary expansion and facemask therapy (combined with class III traction) or no treatment. The early effects of this randomization have been reported previously

[18]. In this part of the investigation, the authors report whether these subjects were thought to require orthognathic surgery or not, based on an assessment at age fifteen. The results were conclusive, the early protraction headgear was successful in reducing the perceived need for orthognathic surgery. It was very successful, with the chances of needing surgery being 3.5 times more likely in the control group compared with the early intervention group. Interestingly, this was not associated with maintenance of the improvements that were seen in the cephalometric values in the experimental group, although the majority of these individuals had a positive overjet at fifteen years.

No trial is perfect and in this case there are a few points to consider. Perhaps the most important is the subjective method of assessing whether these children would require surgery or not and the fact that the subjects were still only 15 years old at the time of assessment [16].

A panel consensus method was used and whilst this was done with blinded allocation and appears to have been fairly clear in the majority of cases (only seven generated any discussion), this assessment could have been carried out independently, rather than by members of the research team who provided the treatment. A final point is the fact that one unit treated only one case! This suggests that there were no class III cases in this particular region or that there was potentially some selection bias. Nevertheless, Nicky Mandall and his team should be congratulated for conducting this trial, which had a long follow-up period, and provided orthodontists with important high-quality information to inform their clinical practice [16]. A child with maxillary retrusion and a Class III incisor relationship may be considered for early intervention. Finally, a randomized clinical trial did find a clinically significant difference between interventions [16].

Key Clinical Findings

The two most common dilemmas surrounding Class III treatment are the timing of treatment and the type of appliance [20]. 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 [20,21].

Thus, a meta-analysis study evaluated the effectiveness of orthodontic/orthopedic methods used in the early treatment of Class III malocclusion in the short and long term. The selection criteria included randomized controlled trials (RCTs) and prospective controlled clinical trials (CCTs) of children between the ages of 7 and 12 years undergoing 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 rated as having a high risk of bias. Three randomized controlled trials involving 141 participants analyzed the comparison between a protraction mask and an 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 face mask 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 face mask results in improvement in skeletal and dental outcomes in the short term. However, there was a lack of evidence for long-term benefits. There is some evidence regarding the chin cup, tandem archwire appliance, and removable mandibular retractor, but the studies had a high risk of bias. More high-quality, long-term studies are needed to evaluate the effects of early treatment for patients with Class III malocclusion [22].

Mandall et al. [19] tested Class III treatment with a facemask 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 facemask 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 downward and forward movement of the maxillary complex [23-27].

Vaughn et al. [28], 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 [29-40]. These data are also in agreement with the systematic review conducted by Kim et al.[41].

In contrast to the use or not of maxillary expansion before maxillary protraction treatment, Liu et al. [38] 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 plane in the expansion/constriction group, however, these changes did not demonstrate any clinical relevance, since they were less than 1 mm and 10, respectively. Chin cups have been used to control mandibular protrusion in growing patients for almost a century [42]. 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 [43-46].

Abdelnaby and Nassar [32] conducted a study on patients aged between nine and ten years using a chin cup with occipital pull using two force magnitudes. 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 both treated groups when compared to the untreated group, data that are also in agreement with the systematic review prepared by Chatzoudi et al. [47]. The results achieved with the use of this apparatus significantly improved the maxillomandibular relationship, however, with few skeletal effects, the difference in force magnitude generated the same effects.

Given the many devices already used and tested for the treatment of Class III malocclusion, because they are not very aesthetic, several authors seek to develop new devices that can facilitate use and, consequently, patient acceptance. Showkatbakhsh et al. [31] developed a new device called a reverse chin cup, to perform maxillary protraction. In this randomized clinical trial, the patients' ages ranged from seven to ten years and the aim was to compare its effectiveness with the face mask. In both treatments, an anterior movement of the maxilla was achieved, as well as a vestibularization of the upper anterior teeth and a 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, as 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 its anterior movement [48,49].

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 cage does not cause any unfavorable effects on the mandible (backward and downward rotation) for patients with a vertical growth pattern [49,50]. Currently, orthopedic treatments with skeletal anchorage have become a new paradigm for the early treatment of Class III malocclusion [51-53]. Several studies mention the use of extraoral appliances associated with this type of anchorage [54,55].

Finally, 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 using smaller devices causes less aesthetic imbalance can generate better patient acceptance, meaning that treatment can be started earlier [56].

Conclusion

It was concluded that orthodontic-surgical treatment in Class III patients should be based on the diagnosis so that treatment is implemented to correct the compromised structures rather than compensating for areas not affected by the malocclusion. 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

Author contributions **Conceptualization-** Amanda Fernandes Albano, Ana Paula Bernardes da Rosa; **Formal Analysis-** Amanda Fernandes Albano, Ana Paula Bernardes da Rosa; **Investigation-** Amanda Fernandes Albano; **Methodology-** Amanda Fernandes Albano; **Project administration-** Amanda Fernandes Albano, Ana Paula Bernardes da Rosa; **Supervision-** Ana Paula Bernardes da Rosa; **Writing - original draft-** Amanda Fernandes Albano, Ana Paula Bernardes da Rosa; **Writing-review & editing-** Amanda Fernandes Albano, Ana Paula Bernardes da Rosa.

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