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COMPARISON OF SURGICAL AND NON-SURGICAL APPROACHES FOR CLASS III MALOCCLUSION CORRECTION IN ADULTS: A LITERATURE REVIEW

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ABSTRACT

Because malocclusion involves complex facial abnormalities, orthodontic treatment may be rather challenging, especially for Class III malocclusion. In order to treat adult Class III malocclusion, this narrative review assesses and contrasts the effectiveness of surgical and non-surgical methods. With an emphasis on current developments over the last ten years, the study methodically obtained and examined literature from reliable databases. The results show that orthodontic camouflage, protraction facemask, and chin cup therapy are excellent non-surgical therapies for mild to moderate malocclusions, frequently avoiding the need for surgery. Although helpful for young patients, chin cup treatment could not endure if it is stopped before the patient reaches full maturity. With notable improvements in overjet and facial aesthetics, protraction facemask treatment has promise in lessening the need for orthognathic surgery. When a patient cannot afford or is uncomfortable with surgery, orthodontic camouflage is a good alternative. More effective and long-lasting repairs may be achieved for severe malocclusions by surgical procedures such orthognathic surgery, surgically aided rapid palatal expansion (SARPE), and microimplant-assisted rapid palatal expansion (MARPE). These operations, however, come with more risk and need more time to recuperate from. The present study emphasises the significance of customised treatment planning in Class III malocclusion therapy. This planning should consider the patient's age, preferences, and the severity of the malocclusion.

INTRODUCTION

After periodontal and dental caries, malocclusion ranks third in terms of prevalence in oral health issues [1]. The incidence of class III malocclusion in permanent dentition is predicted to range from 0.7% in Israel to 19.9% in China, according to a recent comprehensive study [2]. It is linked to the most severe facial deformities even though it is less common than other malocclusion features [3]. A heterogeneous clustering of dentofacial malformations, characterized primarily by the forward posture of the mandible relative to the maxilla, either as an independent feature or as a component of a syndrome, is what is known as this kind of malocclusion [4].

For doctors, diagnosing, treating, and prognosing it have never been easy [5]. By using orthodontic camouflage, growth modification, or orthognathic surgery, skeletal class III malocclusion patients may attain a normal occlusion and better facial aesthetics [6]. The optimal course of therapy will be determined by the patient's age, the degree of malocclusion, the primary complaint, clinical exams, and cephalometric analysis [7]. Before the pubertal growth spurt, growth modification should start [8]. After that, the only options are orthognathic surgery or orthodontic concealment. In adult circumstances, the degree of class III malocclusion would determine whether the patient is a candidate for orthodontic therapy or surgery [9]. According to Kerr et al, patients with incisor mandibular plane angles of less than 83° and – 4°, respectively, and ANB should have surgery [10]. In order to distinguish class III individuals who may get orthodontic treatment appropriately from those who need orthognathic surgery, Eisenhauer et al, also carried out a research [11]. For the accurate categorisation of class III malocclusion in adult patients, they proposed a prediction model using factors from the Wits assessment, SN, maxillary/mandibular ratio, and lower gonial angle. Differentiating between instances of class III malocclusion that are borderline surgical and orthodontic would provide challenges, however. After evaluating borderline class III individuals who had received orthognathic surgery or camouflage orthodontic treatment, Rabie et al, proposed that the Holdaway angle might be a useful tool for deciding on the best course of therapy for these patients [12]. They went on to say that although individuals with Holdaway angles less than 12° would need surgery, those with angles beyond 12° might be adequately treated with orthodontics alone. Therefore, this review aims to evaluate and compare the efficacy of surgical and non-surgical treatments for correcting Class III malocclusion in adults.

METHODOLOGY

This comprehensive review utilized a structured approach to systematically gather and evaluate relevant literature from reputable academic databases, including PubMed, Scopus, and Google Scholar. The methodology was adapted from established systematic review protocols to address the complexities involved in comparing surgical and non-surgical approaches for Class III malocclusion correction in adults. Search terms such as "Class III malocclusion," "chin cup," "protraction facemask," "orthodontic camouflage," "orthognathic surgery," "SARPE," and "MARPE" were used to identify pertinent studies.

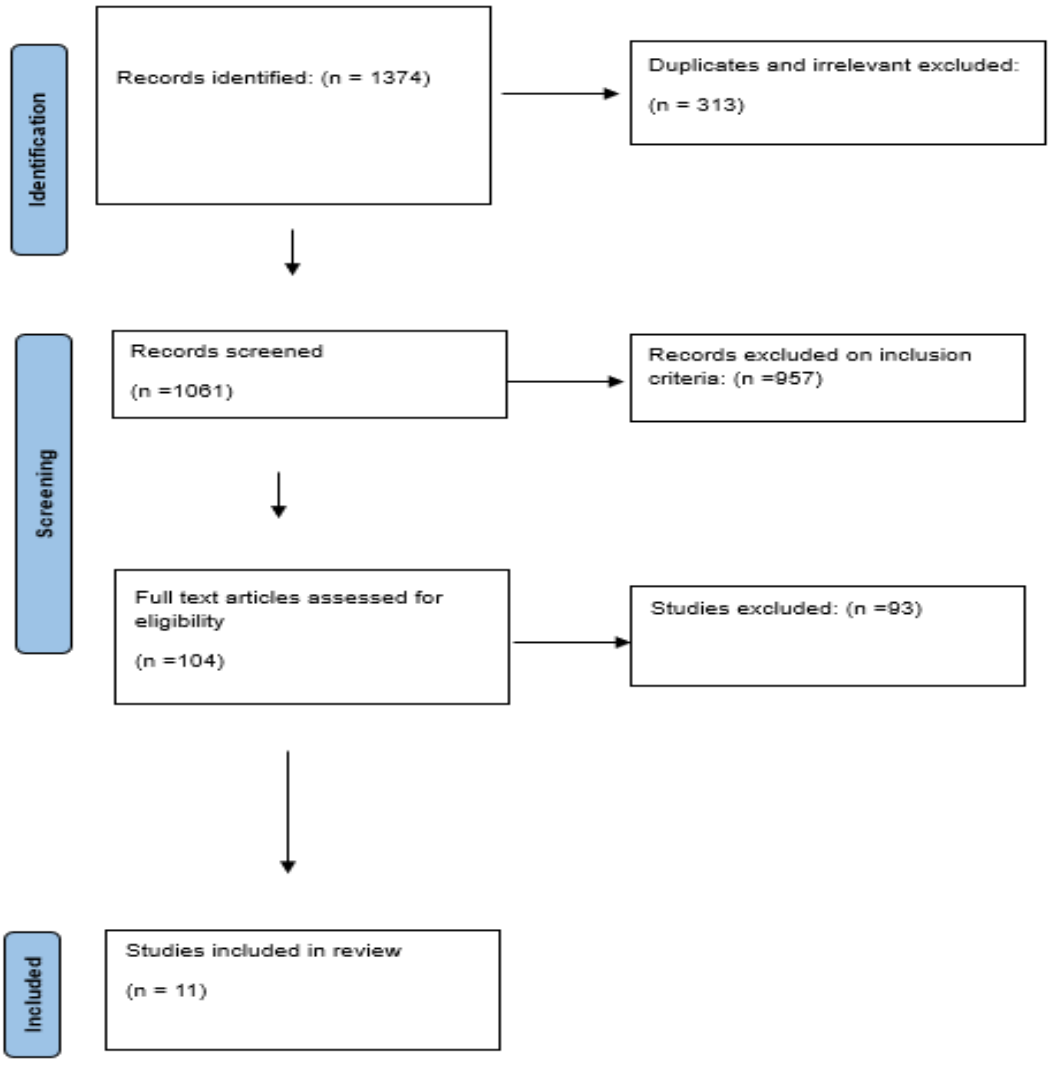
Inclusion and Exclusion Criteria

Articles focusing on the treatment strategies for Class III malocclusion, both surgical and non-surgical, were considered for inclusion. To ensure the review encompassed recent advancements in the field, only studies published in English within the last ten years (2014–2024) were included. Studies involving human subjects that provided substantial insights into the efficacy, mechanisms, and clinical outcomes of these treatment approaches were selected. Conversely, studies that did not directly address the topic or did not adhere to rigorous methodological standards were excluded. Each

identified article was meticulously reviewed by assessing abstracts and titles to determine its relevance and suitability for inclusion.

Categorization and Analysis

The extensive range of literature on Class III malocclusion treatment was organized and analyzed using a systematic categorization approach. The primary objective of this review was to compare the efficacy, benefits, and limitations of surgical and non-surgical treatments. Analytical categories were established to explore various aspects such as the effectiveness of chin cup therapy, protraction facemask, orthodontic camouflage, orthognathic surgery, surgically assisted rapid palatal expansion (SARPE), and microimplant-assisted rapid palatal expansion (MARPE). Each category was examined to elucidate the underlying mechanisms, clinical effectiveness, and potential synergies between different treatment modalities. The review aimed to provide a comprehensive overview of the current state of treatment strategies for Class III malocclusion in adults by synthesizing findings from diverse studies. Through this structured approach, the review sought to offer valuable insights into the comparative efficacy of surgical and non-surgical approaches, helping clinicians make informed decisions in managing Class III malocclusion.



Results

Non- surgical treatments

Chin cup for Class III malocclusion

Chin cup appliances are recommended for juvenile mandibular prognathism patients. Rather than inhibit mandibular development, chin cup treatment redirects it vertically, generating a backward rotation. These mandibular development alterations enhance Class III malocclusion. Based on short-term outcomes, chin cup therapy may be used to interceptively treat increasing Class III malocclusion, according to recent systematic review [13].

If chin cup appliance treatment is stopped before development completion, these modifications will not last and the mandible will grow normally [14]. To preserve chin cup therapy benefits, Class III malocclusion patients with mandibular prognathism should wear the device until growth is complete. In mixed dentition patients with marked mandibular prognathism, especially if associated with increased vertical proportions, chin cup therapy should be considered but surgical orthognathic treatment is usually best when growth is complete. A case study by Gözde GÜR and Dilek Erdem discusses early chin cup treatment of Class III malocclusions [15]. This case report describes a 9-year-old girl with an anterior crossbite and functional Class III malocclusion. She used chin cup for 10 months. A maxillary device lifted the occlusion and liberated the maxilla from mandibular constriction. This allowed the maxilla to expand while chincup inhibited mandible expansion. Positive overjet and anterior cross-bite correction were accomplished. Improved facial profile. With the chincup, posterior mandibular rotation was predicted, but SN-GoGn angle did not alter. A class I relationship and smooth soft tissue profile were established after therapy.

Protraction facemask

Reverse headgear, or protraction facemask, is a typical interceptive technique for skeletal Class III malocclusion [16] The appliance has an intraoral connection to the maxillary dentition and an extraoral framework (facemask) that fits on the forehead and chin. The elastics link to the intraoral attachment to the maxillary dentition via a central bar between the chin and forehead of the extraoral framework. The intraoral attachment might be detachable, banded, or acrylic-bonded. Each has bilateral hooks near the maxillary canines. Class III elastics near maxillary canines at 30° to the occlusal plane reduce palatal plane rotation. Bonded expansion appliance is used because it creates a transient bite plane effect in hyperdivergent instances and helps deep bite patients leap anterior crossbite. Elastic forces of 400–450 g per side (14–16 OZ) must be worn 12–14 hours each day. The average therapy lasts 6–9 months. Growth hormone and other growth-promoting endocrine elements are released more at night than during the day. We suggest wearing the device at night and in the evening.

Rapid maxillary expansion (RME) using the protraction facemask is controversial. Transverse and anteroposterior maxilla constriction is common in Class III skeletal patterns; therefore, this expansion helps. Expansion may relax circummaxillary sutures and pull the maxilla forward. A recent randomised controlled trial (RCT) and meta-analysis suggest that facemask with and without RME therapy are similarly effective early treatments for skeletal Class III malocclusion. If there is no transverse disparity, facemask without RME may be used. If transverse maxillary constriction exists, early permanent dentition is treated by expansion and protraction [17] [18]. A 0.25-mm-per-turn expansion appliance is

operated twice daily for 7–10 days. To treat severely restricted maxilla, the screw is activated for ≥2 weeks.

In a study effect of facemask intervention on the need of orgatnthic surgery was assessed and and it indicated that 36% of protraction facemask patients needed orthognathic surgery, compared to 66% of control group patients. An encouraging 68% of protraction facemask patients had a favorable overjet after 6 years [19].

Camouflage

The limited therapy choices for adults make treatment more complicated in malocclusion [20]. Orthodontic and orthognathic surgery are usually best. Many individuals avoid surgery owing to expense or invasiveness [21] [20].

Camouflage orthodontic therapy may displace teeth relative to their supporting bone to correct for a jaw disparity in nongrowing individuals with mild to moderate skeletal Class III malocclusion and acceptable facial aesthetics. It is advised when growth modification cannot solve the fundamental issue. The goals of camouflage therapy are to provide adequate occlusion, function, and aesthetics by dentoalveolar skeletal discrepancy correction [22].

In a case study, Lorenzo Rustico et al. discuss the challenges of treating Angle's Class III malocclusions in nongrowing individuals, who must choose between orthognathic surgery and camouflage [23]. A borderline nongrowing patient with skeletal class III malocclusion, upper incisor proclination and spacing, lower crowding, and arch width discrepancy has had orthodontic treatment. After mandibular first premolar extraction, class I canine connection with excellent overjet, overbite, and arch coordination was achieved. The orthodontic camouflage normalised upper incisor inclination without retroclination of lower incisors and somewhat enhanced the patient's skeletal face pattern. Osteoclass III has hardly changed. Posttreatment results were steady after 1 year.

Surgical treatments

Orthognathic surgery

Orthognathic surgery for the treatment of Class III malocclusion involves repositioning the jaws to correct a significant misalignment where the lower jaw (mandible) is protruded beyond the upper jaw (maxilla), resulting in an underbite [24]. This corrective surgery typically includes procedures such as a Le Fort I osteotomy to move the maxilla forward and a bilateral sagittal split osteotomy (BSSO) to reposition the mandible backward or reshape it for optimal alignment. These surgical interventions, performed under general anesthesia, aim to improve occlusion, enhance facial aesthetics, and restore proper jaw function.

Maged S. Alhammadi et al. undertook a comprehensive analysis of the skeletal, dentoalveolar, and soft tissue effects of orthodontic camouflage (OC) vs orthodontic-orthognathic surgical (OOS) in borderline Class III malocclusion patients [25]. The results showed that OC caused maxillary and mandibular bases to retrude, whereas OOS caused protrusion and an increased ANB angle. In one research, mandibular plane inclination decreased significantly in the OC group but increased significantly in the OOS group. Both treatments proclinated maxillary and mandibular incisors, although OOS also proclinated them. OC retroclinated them. The review found that OOS protruded the maxillary base and retruded the mandibular base, enhancing the sagittal relationship with clockwise rotation on the mandibular plane.

OC showed a greater maxillary incisor proclination and mandibular incisor retroclination than OOS. The authors observed that the included papers were too different to undertake a meta-analysis and called for further study using standardised methods.

Surgically assisted rapid palatal expander

Treatment options for maxillary transverse deficit (MTD) include rapid maxillary expansion (RME) in orthodontics and surgically assisted rapid palatal expansion (SARPE). Conventional orthodontic RME has shown effectiveness in children and adolescents when used before sutural closure [26]. The likelihood of effective maxillary expansion diminishes in skeletally mature individuals as sutures close and resistance to mechanical forces rises. For patients above 15, the significant maxillary transverse disparity may be effectively treated by SARPE. When palatal growth occurs in young adults and adults in their 20s and 30s, the maxillary arch does not expand as much and the molar tips may become tipped. Additionally, it has been proposed that some relapse may occur because the intermaxillary suture anterior to the incisive canal never ossifies until very late in life [27]

Retrospective research by A. Barrabé et al. examined the effectiveness and safety of surgically aided rapid palatal expansion (SARPE) in treating Class III malocclusion patients with maxillary transverse deficit (MTD) [28]. SARPE required a full Le Fort I osteotomy and medial sagittal submucosal hard palate separation with teeth- and bone-supported distracters. Activation of the distracter began on day 2 at a rate of 2x0.25mm per day for 4 days and 2x0.5mm per day thereafter. About 4 months were spent with distractions. MTD was isolated in 6 instances, accompanied with maxillary retrognathism in 5, mandibular prognathism in 6, and both in 6. The average distraction was 7.2mm (range: 4-12), parallel in 20 instances and angular in 3. Three patients had bone-supported distracters and 20 had custom-made tooth-supported distracters. Average distracter cylinder distraction was 7.7mm (range: 5-13). We found 2 palatal fibromucosa perforations, 1 posterior excess of distraction, 1 nasal septum deviation, 1 iatrogenic necrosis of tooth #11, 1 naso-genial sulcus haematoma, 1 intraoperative mobility of tooth #21, and 5 asymmetric distractions. Seventeen individuals required a second orthognathic operation and 22 had stable Class I occlusion at 18 months on average following appliance removal.

Microimplant-assisted rapid palatal expansion for adults

Maxillary expansion in late adolescence and adulthood has proven effective using microimplant-assisted rapid palatal expansion (MARPE). Maxillary advancement and expansion are expected, which helps cure class III malocclusion [29]. Some cone beams computerised tomography (CBCT) measurements following expansion show airway volume gain.

According to Sin-Ni Shih, a 15-year-old girl had class III skeletal pattern. Maxillary transverse deficit, mild crowding, and posterior/anterior crossbites plagued her [30]. Maxillary Skeletal Expander type-2 was utilized for MARPE. Maxillary growth was considerable at four weeks, and the anterior crossbite spontaneously repaired. 0.022-slot preadjusted brackets (MBT prescription) were used for fixed appliance therapy four weeks following MARPE. TADs were inserted over mandibular buccal shelves to distalize posterior teeth and relieve crowding. Maxillary advancement (SNA: 83° to 83.5°) and mandibular backward rotation (SNB: 83° to 82°; SN-MP: 34.5° to 35°) enhanced the facial profile at 25 months. In this situation, MARPE causes considerable transverse correction and anteroposterior alteration. In skeletal class III situations, maxillary advancement and mandibular backward rotation may improve appearance.

Comparison

Effectiveness

For significant skeletal discrepancies, surgical procedures such orthognathic surgery and surgically aided rapid palatal expansion (SARPE) provide more conclusive and durable improvements (Furquim et al., 2014; Barrabé et al., 2018). The chincup, protraction facemask, and camouflage therapy are examples of non-surgical therapies that are useful for mild to moderate cases and, in some situations, may eliminate the need for surgery (Mousoulea et al., 2016; Watkinson et al., 2013; J Lin, 2003).

Patient Profile

Adults or individuals with severe malocclusions are often the only candidates for surgical therapies (Alhammadi et al., 2022). Adults with less severe differences as well as developing children and adolescents are better candidates for non-surgical therapies (Wendl et al., 2017; Rustico et al., 2022).

Duration of Treatment

Surgery takes a long time to heal, but it may resolve serious problems more quickly (Anttila et al., 2004). To attain and sustain benefits, non-surgical therapies need a sustained commitment and regular appliance usage (Mandall et al., 2016; Shih et al., 2022).

Risks and Considerations

Anesthesia and surgical complications are greater hazards connected with surgical therapies (Rachmiel et al., 2020). Although there are less risks associated with non-surgical therapies, they may not be able to adequately repair severe malocclusions (Park et al., 2019; Araujo & Squeff, 2021).

DISCUSSION

For class III malocclusion, orthodontic diagnosis and treatment planning are crucial and dependent on a number of variables. The most important aspect to consider is the severity, which may vary from minor dentoalveolar issues to serious skeletal issues [25]. Numerous surgical and non-surgical methods are used in the therapy, each having advantages and disadvantages of its own. While non-surgical alternatives like protraction facemasks, chin cups, and orthodontic concealment provide less intrusive choices that may work in some cases, they are often insufficient to resolve significant skeletal abnormalities.

Severe skeletal disparities are well-known to be corrected medically, with orthognathic surgery and surgically aided rapid palatal expansion (SARPE) being two popular surgical therapies. According to Furquim et al. (2014) and Barrabé et al. (2018), these operations provide significant and long-lasting benefits in occlusion, face aesthetics, and jaw function. But because of their invasive nature and longer recovery times, they carry more dangers and demand a big commitment from their patients. On the other hand, albeit less intrusive and with less dangers, non-surgical therapies like the chincup, protraction facemask, and camouflage therapy work best for mild to moderate instances. In some cases, these therapies may lessen the need for surgery (Mousoulea et al., 2016; Watkinson et al., 2013; J Lin, 2003).

The patient's age and the degree of their malocclusion are typically determining factors when choosing between non-surgical and surgical therapies. Adults or patients with severe malocclusions that cannot

be sufficiently treated non-surgically are usually the only candidates for surgical therapies (Alhammadi et al., 2022). However, non-surgical treatments are better suited for adults with less severe discrepancies who may choose not to have surgery because it is more invasive or expensive, as well as growing children and adolescents who can benefit from growth modification techniques (Wendl et al., 2017; Rustico et al., 2022).

The time and effort needed for therapy differ greatly between non-surgical and surgical methods. Despite a lengthy recovery time, surgical therapies provide a more rapid resolution of serious problems as compared to non-surgical approaches. For example, considerable adjustments may be made rather fast with orthognathic surgery with SARPE (Anttila et al., 2004). However, non-surgical therapies need regular appliance usage over an extended period of time, which might be difficult for some individuals. These therapies are less appealing to those looking for faster results since they need constant effort to produce and sustain results (Mandall et al., 2016; Shih et al., 2022).

Anesthesia-related risks and surgical consequences, such as nerve injury, infection, and unfavourable outcomes, are increased with surgical therapies (Rachmiel et al., 2020). In spite of these hazards, the outcomes are often more consistent and long-lasting. Even though they carry reduced risk, non-surgical therapies may not be able to adequately cure severe malocclusions and may eventually need further surgical operations (Park et al., 2019; Araujo & Squeff, 2021). Furthermore, people with significant skeletal discrepancies may find it more difficult to achieve the appropriate skeletal and dental alignment using non-surgical methods.

CONCLUSION

In conclusion, the severity of the problem, the patient's preferences, and the possible risks and advantages of each therapy should all be taken into consideration when deciding between surgery and non-surgical therapies for adult Class III malocclusion. Although surgical therapies have greater risks and require a longer recovery time, they provide more permanent and definitive repairs. Although non-surgical therapies are less intrusive and risky, they need to be committed to over time and may not be enough in extreme situations. To suggest the best course of action, clinicians must thoroughly assess the unique circumstances of each patient.

REFERENCES

1. Y.F.H.G.B.L.Y.Z.L Guo, “Consequences of orthodontic treatment in malocclusion patients: clinical and microbial effects in adults and children,” *BMC Oral Health*, vol. 112, pp. 1–7, 2016.
2. M. S. Alhammadi, E. Halboub, M. S. Fayed, A. Labib, and C. El-Saaidi, “Global distribution of malocclusion traits: a systematic review,” *Dent. Press J Orthod*, vol. 23, no. 6, pp. 40.e41-40.e10, 2018, doi: 10.1590/2177-6709.23.6.40.e1-10.onl.
3. P. M. Berto, C. S. Lima, M. A. Lenza, and J. Faber, “Esthetic effect of orthodontic appliances on a smiling face with and without a missing maxillary first premolar,” *Am J Orthod Dentofac. Orthop*, vol. 135, no. 4 SUPPL., pp. S55-60, Apr. 2009, doi: 10.1016/j.ajodo.2007.08.018.
4. L. de Frutos-Valle, C. Martin, J. A. Alarcon, J. C. Palma-Fernandez, and A. Iglesias-Linares, “Subclustering in skeletal class III phenotypes of different ethnic origins: a systematic review,”

J Evid Based Dent Pr., vol. 19, no. 1, pp. 34–52, Mar. 2019, doi: 10.1016/j.jebdp.2018.09.002.

5. A. Jamilian, R. Cannavale, M. G. Piancino, S. Eslami, and L. Perillo, "Methodological quality and outcome of systematic reviews reporting on orthopaedic treatment for class III malocclusion: Overview of systematic reviews," *J. Orthod.*, vol. 43, no. 2, pp. 102–120, Jul. 2016, doi: 10.1080/14653125.2016.1155334.
6. P. Ngan, B. Wilmes, D. Drescher, C. Martin, B. Weaver, and E. Gunel, "Comparison of two maxillary protraction protocols: tooth-borne versus bone-anchored protraction facemask treatment," *Prog. Orthod.*, vol. 16, no. 1, Dec. 2015, doi: 10.1186/S40510-015-0096-7.
7. L. Perillo, B. Femminella, D. Farronato, T. Baccetti, L. Contardo, and G. Perinetti, "Do malocclusion and Helkimo Index ≥5 correlate with body posture?," *J. Oral Rehabil.*, vol. 38, no. 4, pp. 242–252, Apr. 2011, doi: 10.1111/J.1365-2842.2010.02156.X.
8. L. Perillo, M. Vitale, C. Masucci, F. D'Apuzzo, P. Cozza, and L. Franchi, "Comparisons of two protocols for the early treatment of Class III dentoskeletal disharmony," *Eur. J. Orthod.*, vol. 38, no. 1, pp. 51–56, Feb. 2016, doi: 10.1093/EJO/CJV010.
9. L. Perillo, A. Monsurrò, E. Bonci, A. Torella, M. Mutarelli, and V. Nigro, "Genetic association of ARHGAP21 gene variant with mandibular prognathism," *J. Dent. Res.*, vol. 94, no. 4, pp. 569–576, Apr. 2015, doi: 10.1177/0022034515572190.
10. W. J. Kerr, S. Miller, and J. E. Dawber, "Class III malocclusion: surgery or orthodontics?," *Br. J. Orthod.*, vol. 19, no. 1, pp. 21–24, 1992, doi: 10.1179/BJO.19.1.21.
11. A. Stellzig-Eisenhauer, C. J. Lux, and G. Schuster, "Treatment decision in adult patients with Class III malocclusion: Orthodontic therapy or orthognathic surgery?," *Am. J. Orthod. Dentofac. Orthop.*, vol. 122, no. 1, pp. 27–37, 2002, doi: 10.1067/MOD.2002.123632.
12. A.-B. M. Rabie, R. W. K. Wong, and G. U. Min, "Treatment in Borderline Class III Malocclusion: Orthodontic Camouflage (Extraction) Versus Orthognathic Surgery," *Open Dent. J.*, vol. 2, no. 1, pp. 38–48, Mar. 2008, doi: 10.2174/1874210600802010038.
13. S. Mousoulea, I. Tsolakis, E. Ferdianakis, and A. I. Tsolakis, "The Effect of Chin-cup Therapy in Class III Malocclusion: A Systematic Review," *Open Dent. J.*, vol. 10, no. 1, p. 664, Dec. 2016, doi: 10.2174/1874210601610010664.
14. B. Wendl *et al.*, "Long-term skeletal and dental effects of facemask versus chincup treatment in Class III patients: A retrospective study," *J. Orofac. Orthop.*, vol. 78, no. 4, p. 293, Jul. 2017, doi: 10.1007/S00056-017-0083-3.
15. G. Gür and D. Erdem, "Early Treatment of a Class III Patient with Chincup: A Case Report,"

Cumhur. Dent. J., vol. 26, no. 1, pp. 104–110, 2023, doi: 10.7126/CUMUDJ.1213205.

16. S. Watkinson, J. E. Harrison, S. Furness, and H. V. Worthington, "Orthodontic treatment for prominent lower front teeth (Class III malocclusion) in children," *Cochrane database Syst. Rev.*, vol. 2013, no. 9, Sep. 2013, doi: 10.1002/14651858.CD003451.PUB2.
17. W. Liu, Y. Zhou, X. Wang, D. Liu, and S. Zhou, "Effect of maxillary protraction with alternating rapid palatal expansion and constriction vs expansion alone in maxillary retrusive patients: A single-center, randomized controlled trial," *Am. J. Orthod. Dentofac. Orthop.*, vol. 148, no. 4, pp. 641–651, Oct. 2015, doi: 10.1016/J.AJODO.2015.04.038.
18. W. Zhang, H. C. Qu, M. Yu, and Y. Zhang, "The effects of maxillary protraction with or without rapid maxillary expansion and age factors in treating Class III malocclusion: A meta-Analysis," *PLoS One*, vol. 10, no. 6, Jun. 2015, doi: 10.1371/JOURNAL.PONE.0130096.
19. N. Mandall *et al.*, "Early class III protraction facemask treatment reduces the need for orthognathic surgery: a multi-centre, two-arm parallel randomized, controlled trial," *J. Orthod.*, vol. 43, no. 3, pp. 164–175, Jul. 2016, doi: 10.1080/14653125.2016.1201302.
20. M. T. de S. Araujo and L. R. Squeff, "Orthodontic camouflage as a treatment alternative for skeletal Class III," *Dental Press J. Orthod.*, vol. 26, no. 4, 2021, doi: 10.1590/2177-6709.26.4.E21BBO4.
21. J. H. Park, M. Emamy, and S. H. Lee, "Adult skeletal Class III correction with camouflage orthodontic treatment," *Am. J. Orthod. Dentofac. Orthop.*, vol. 156, no. 6, pp. 858–869, Dec. 2019, doi: 10.1016/J.AJODO.2018.07.029.
22. Y. G. J Lin, "Preliminary investigation of nonsurgical treatment of severe skeletal class III malocclusion in the permanent dentition," *Angle Orthod*, vol. 73, pp. 401–410, 2003.
23. L. Rustico, V. Ronsivalle, F. Iaculli, G. Spagnuolo, G. Isola, and A. Lo Giudice, "Class III Orthodontic Camouflage: Is the 'Ideal' Treatment Always the Best Option? A Documented Case Report," *Case Rep. Dent.*, vol. 2022, no. 1, p. 9200469, Jan. 2022, doi: 10.1155/2022/9200469.
24. B. A. Furquim, K. M. S. De Freitas, G. Janson, L. F. Simoneti, M. R. De Freitas, and D. S. De Freitas, "Class III Malocclusion Surgical-Orthodontic Treatment," *Case Rep. Dent.*, vol. 2014, 2014, doi: 10.1155/2014/868390.
25. M. S. Alhammadi *et al.*, "Orthodontic camouflage versus orthodontic-orthognathic surgical treatment in borderline class III malocclusion: a systematic review," *Clin. Oral Investig.*, vol. 26, no. 11, pp. 6443–6455, Nov. 2022, doi: 10.1007/S00784-022-04685-6/TABLES/5.
26. A. Rachmiel, S. Turgeman, D. Shilo, O. Emodi, and D. Aizenbud, "Surgically Assisted Rapid

Palatal Expansion to Correct Maxillary Transverse Deficiency," *Ann. Maxillofac. Surg.*, vol. 10, no. 1, p. 136, Jan. 2020, doi: 10.4103/AMS.AMS_163_19.

27. A. Anttila, K. Finne, K. Keski-Nisula, M. Somppi, K. Panula, and T. Peltomäki, "Feasibility and long-term stability of surgically assisted rapid maxillary expansion with lateral osteotomy," *Eur. J. Orthod.*, vol. 26, no. 4, pp. 391–395, 2004, doi: 10.1093/ejo/26.4.391.
28. A. Barrabé, C. Meyer, H. Bonomi, E. Weber, N. Sigaux, and A. Louvrier, "Surgically assisted rapid palatal expansion in class III malocclusion: Our experience," *J. Stomatol. oral Maxillofac. Surg.*, vol. 119, no. 5, pp. 384–388, Nov. 2018, doi: 10.1016/J.JORMAS.2018.05.001.
29. A. Wilson Machado, "An interview with Won Moon. By André Wilson Machado, Barry Briss, Greg J Huang, Richard Kulbersh and Sergei Godeiro Fernandes Rabelo Caldas," *Dental Press J. Orthod.*, vol. 18, no. 3, pp. 12–28, May 2013, doi: 10.1590/S2176-94512013000300005.
30. S. N. Shih, K. H. Ho, C. W. Wang, K. L. Wang, S. C. Hsieh, and H. M. Chang, "Management of Class III Malocclusion and Maxillary Transverse Deficiency with Microimplant-Assisted Rapid Palatal Expansion (MARPE): A Case Report," *Med. 2022, Vol. 58, Page 1052*, vol. 58, no. 8, p. 1052, Aug. 2022, doi: 10.3390/MEDICINA58081052.