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2734 17 Avenue SW,  
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# USE OF ORTHODONTIC MINISCREWS AS TEMPORARY SKELETAL ANCHORAGE IN THE TREATMENT OF SKELETAL CLASS III MALOCCLUSION: A NARRATIVE REVIEW

**Julia Grzegorzczuk** (Corresponding Author, Email: [gjulia02@gmail.com](mailto:gjulia02@gmail.com))

EM-DENT, Lublin, Poland

ORCID ID: 0009-0005-2157-9132

**Krzysztof Opala**

EM-DENT, Lublin, Poland

ORCID ID: 0009-0002-5378-9001

**Jakub Krowiński**

The Wrocław Medical University, Wrocław, Poland

ORCID ID: 0009-0000-1328-5154

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## ABSTRACT

Skeletal Class III malocclusion presents substantial therapeutic challenges because of its heterogeneous skeletal and dentoalveolar components and the limitations of conventional orthodontic and orthopedic approaches. This narrative review aimed to critically summarize the available evidence on the use of orthodontic microimplants as temporary skeletal anchorage in the treatment of skeletal Class III malocclusion. A literature search was conducted in PubMed, Scopus, and Google Scholar for English-language publications from 2015 to 2026 using terms related to skeletal Class III malocclusion, microimplants, skeletal anchorage, MARPE, and maxillary protraction; additional studies were identified through reference screening. The reviewed evidence indicates that microimplant-assisted protocols can improve anchorage control, reduce unwanted dentoalveolar compensation, and facilitate maxillary protraction, hybrid expansion, intermaxillary elastic therapy, and mandibular distalization. The greatest clinical benefit appears to occur in growing patients with maxillary deficiency, whereas in nongrowing patients microimplants mainly support orthodontic camouflage. Outcomes depend on skeletal maturity, appliance design, implant location and stability, force direction, anatomical conditions, and patient cooperation. Although short-term skeletal, dental, and soft-tissue effects are generally favorable, microimplants do not predictably restrict mandibular growth and cannot replace orthognathic surgery in severe skeletal discrepancies. Current evidence remains limited by heterogeneous protocols, small samples, and insufficient long-term follow-up. Microimplants should therefore be regarded as an adjunctive anchorage method within individualized biomechanical treatment planning.

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## KEYWORDS

Skeletal Class III Malocclusion, Orthodontic Miniscrews, Temporary Anchorage Devices, Skeletal Anchorage, Maxillary Protraction, MARPE

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## Introduction

Skeletal Class III malocclusion is characterized by abnormal intermaxillary relationships due to unbalanced growth of the maxilla and mandible, accompanied by significant dental compensation (Sarangal et al., 2020). In the permanent dentition, the global average distribution of this malocclusion was found to be 5.93% (1-20%) (Alhammadi et al., 2018). The condition is commonly associated with a prognathic mandible, a retrognathic maxilla or a combination of both (Sarangal et al., 2020).

The etiology of Class III malocclusion is multifactorial, and results from a complex combination of genetic, environmental and developmental factors (Srinidhee et al., 2024). As a polygenic inherited condition, both genetics and the environment contribute to its etiology. Evaluation of family history for skeletal deformities may provide valuable diagnostic insight. Some chromosomal disorders and single-gene genetic syndromes can affect jaw and tooth development (Zhou et al., 2025). These include Apert syndrome, Down syndrome, Klinefelter syndrome and ectodermal dysplasia (Faria-Teixeira et al., 2024). Various environmental factors also play a significant etiological role, including abnormal growth stimuli, prolonged sucking or resting tongue habits, atypical swallowing, nasal airway obstruction, mouth breathing, functional mandibular shifts due to respiratory needs, hormonal imbalances (gigantism, pituitary adenomas), trauma, premature loss of primary teeth, congenital anatomic defects (cleft lip/palate) and muscle dysfunction (Fleseriu et al., 2022; Sugawara et al., 2016; Zere et al., 2018).

Diagnosis of Class III malocclusion is based on evaluation of centric relation, family history, interincisal relationships and cephalometric findings. Most patients present with an anterior crossbite, mostly involving six maxillary anterior teeth. The molar relationship is typically mesial, with a mesially positioned mandibular dental arch. The length and width of the mandibular dental arch are larger than those of the maxillary arch (Zhou et al., 2025). Cephalometric analysis can reveal an increased Sella-Nasion-point B (SNB) angle and decreased Sella-Nasion-point A (SNA) angle, retroclination of lower incisors and a reduced incisor mandibular plane (MP) angle (Azamian & Shirban, 2016).

Early intervention in severe Class III malocclusion is crucial for normal oral and maxillofacial development, facial aesthetics and healthy psychological development (Zhou et al., 2025). Interception of this malocclusion can prevent irreversible soft- and hard-tissue changes, which includes labial plate thinning in the anterior region, gingival recession, interincisal compensation, labial wearing of mandibular incisors and overclosure of the mandible (Sarangal et al., 2020). Various treatment options are available. Common orthodontic appliances used for Class III malocclusion include simple removable appliances, functional appliances, reverse-pull headgear, fixed appliances and clear aligners (Zhou et al., 2025).

Current evidence suggests that microimplant-assisted treatment may improve skeletal correction and reduce dentoalveolar compensation compared with traditional protocols. However, considerable heterogeneity exists among published studies regarding appliance design, patient age, treatment duration, force magnitude, outcome measures, and follow up periods. Additionally, the long-term stability and predictability of these treatment approaches remain insufficiently established.

The aim of this narrative review is to critically summarise the available evidence on microimplant-assisted treatment of skeletal Class III malocclusion.

## Methodology

A narrative literature review was conducted using the databases: PubMed, Scopus, and Google Scholar. The search included publications from 2015 to 2026 and was carried out using the following keywords: “skeletal Class III”, “microimplant”, “skeletal anchorage”, “MARPE”, “maxillary protraction”. Articles published in English were selected for analysis. Additional relevant studies were identified by screening the reference lists of included articles.

## Results

### Conventional treatment approaches

Conventional treatment of skeletal Class III malocclusion includes orthopedic growth modification, orthodontic camouflage, and combined orthodontic–orthognathic surgical therapy. Selection between these approaches depends primarily on the origin and severity of the skeletal discrepancy, skeletal maturity, facial aesthetics, growth potential, and the extent of dentoalveolar compensation.

In growing patients with maxillary deficiency, treatment commonly involves maxillary protraction with a facemask, frequently combined with rapid maxillary expansion. Other conventional approaches include functional appliances and chin-cup therapy. Facemask treatment may improve maxillary position and overjet; however, its effects are influenced by treatment timing and patient compliance. Long-term outcomes remain variable because subsequent mandibular growth may reduce the initial correction. Although early facemask therapy may decrease the probability of future orthognathic surgery, the stability of skeletal changes is not fully predictable (Mandall et al., 2016; Otel et al., 2025; Raghupathy et al., 2023).

Orthodontic camouflage is generally considered in nongrowing patients with mild or moderate skeletal discrepancies and an acceptable facial profile. It relies on dentoalveolar compensation, including proclination of the maxillary incisors, retroclination of the mandibular incisors, extractions, and Class III elastics. Although camouflage may achieve an acceptable occlusion, it does not correct the underlying skeletal deformity and may be limited by periodontal boundaries, pre-existing dental compensation, and unfavourable facial aesthetics (Alhammadi et al., 2022).

Severe skeletal discrepancies in adults generally require combined orthodontic and orthognathic surgical treatment. Depending on the anatomical component, treatment may involve maxillary advancement, mandibular setback, or bimaxillary surgery. Surgical treatment provides a more direct correction of skeletal and facial abnormalities than orthodontic camouflage, but it is associated with greater invasiveness, cost, treatment burden, and potential complications. Therefore, the choice between camouflage and surgery should incorporate both objective morphological criteria and the patient's expectations (Alhammadi et al., 2022).

Overall, conventional methods can produce clinically satisfactory outcomes in appropriately selected patients, but they are limited by compliance requirements, dentoalveolar adverse effects, growth unpredictability, and the inability of camouflage to correct the skeletal discrepancy. These limitations provide the rationale for microimplant-assisted protocols, which aim to improve anchorage control and increase the skeletal component of treatment.

### Characteristics of orthodontic microimplants

Orthodontic microimplants, also referred to as miniscrews or temporary anchorage devices, provide temporary skeletal anchorage during orthodontic and orthopedic treatment. Their main clinical function is to create a stable point of force application that is independent of dental anchorage. This improves control of tooth movement and reduces unwanted displacement of the anchoring teeth. Microimplants are generally small, mechanically retained devices that can be loaded shortly after placement and removed after completing the planned treatment stage (Jaramillo-Bedoya et al., 2022; Ritchie et al., 2023).

The clinical effectiveness of microimplants depends on their design, insertion site, surrounding bone quality, soft-tissue conditions, and the direction and magnitude of the applied force. Potential insertion sites include interradicular spaces, the palate, the infrazygomatic crest, and the mandibular buccal shelf. Palatal and other extraradicular sites may provide greater cortical bone thickness and reduce interference with dental roots. However, anatomical variability requires individualized assessment before placement (Mohammed et al., 2018; Nucera et al., 2022).

In the treatment of skeletal Class III malocclusion, microimplants may support maxillary protraction, hybrid expansion appliances, intermaxillary elastics, and distalization of the mandibular dentition. Their use may limit dentoalveolar side effects associated with conventional tooth-borne anchorage, including incisor inclination, molar migration, and extrusion. Nevertheless, microimplants do not independently correct the skeletal discrepancy. Their therapeutic effect depends on the biomechanics of the complete appliance system and on whether the applied forces address the maxillary, mandibular, or dentoalveolar component of the malocclusion.

Microimplants are generally less invasive than miniplates and can usually be inserted and removed without extensive surgical intervention. However, their stability is not equivalent to osseointegrated dental

implants. Failure may occur as a result of insufficient cortical bone, root proximity, excessive force, peri-implant inflammation, poor oral hygiene, or placement in mobile soft tissues. Reported complications include loosening, soft-tissue irritation, infection, root contact, and, less frequently, fracture of the device (Casaña-Ruiz et al., 2020; Lo Giudice et al., 2021).

In summary, orthodontic microimplants provide versatile and clinically effective anchorage. Their use may improve biomechanical control and reduce unwanted dental effects in selected patients with skeletal Class III malocclusion. However, successful treatment requires appropriate case selection, careful anatomical planning, adequate primary stability, and a force system adapted to the individual skeletal pattern.

### **Hybrid expanders and anchorage configuration**

Hybrid maxillary expanders combine dental support with palatal miniscrews and may increase the skeletal component of transverse expansion while reducing the load transferred to the anchoring teeth. Comparative evidence suggests that hybrid Hyrax appliances may produce greater increases in maxillary and nasal cavity width than conventional expanders. However, the differences in dental arch dimensions and alveolar bone response are generally limited, and both appliance types appear acceptable in appropriately selected growing patients (Garib et al., 2021; Silva et al., 2024).

The type of anchorage may also influence the balance between skeletal and dentoalveolar effects during maxillary protraction. Miniscrew-anchored appliances aim to reduce dental compensation, although treatment outcomes remain dependent on patient age, initial skeletal morphology, appliance construction, and force direction. Consequently, current evidence does not establish one anchorage configuration as universally superior (Baik et al., 2023).

The biomechanical effects of microimplant-assisted treatment depend on the location of skeletal anchorage, the point of force application, elastic angulation, and the presence of maxillary expansion. Finite element analyses indicate that alteration of the force vector can modify the magnitude of forward maxillary displacement and the rotational response of both jaws. Lower angulations of Class III elastics may increase anterior maxillary displacement, whereas changes in MARPE construction may influence stress distribution within the circummaxillary sutures (Rai et al., 2021; Suresh et al., 2024).

Finite element models are valuable for explaining biomechanical principles and comparing appliance designs under standardized conditions. Nevertheless, they are based on simplified assumptions concerning bone properties, sutural maturation, and biological response. Their findings should therefore support, rather than replace, evidence from controlled clinical studies.

### **Outcomes**

Evaluation of microimplant-assisted treatment should include patient-reported outcomes in addition to skeletal and dental measurements. Pain and discomfort are generally greatest immediately after appliance and miniscrew placement but decrease substantially during the first month. Similar levels of discomfort have been reported for miniscrew-anchored maxillary protraction using hybrid and conventional Hyrax expanders (Miranda et al., 2023). Patients may also experience temporary difficulties with speech, mastication, swallowing, and adaptation to appliance appearance. The available evidence suggests that these effects usually diminish with time, although the findings are based on relatively small study groups. Patient expectations, cooperation with intermaxillary elastics, and acceptance of invasive procedures should therefore be considered during treatment planning.

Forward displacement of the maxilla may be accompanied by changes in the dimensions of the nasopharyngeal and oropharyngeal airway. Comparative studies have reported greater increases in selected airway measurements after skeletal anchored protraction than after conventional tooth-borne facemask treatment (Seo & Han, 2017). However, a systematic review found that the available studies were few, methodologically heterogeneous, and frequently characterized by a high or unclear risk of bias. Therefore, although improvement in airway dimensions may represent an additional effect of treatment, current evidence is insufficient to regard airway enlargement as a primary indication for microimplant-assisted maxillary protraction (Adel et al., 2023).

### Limitations

Microimplant-assisted treatment is generally considered minimally invasive; however, it is not free from biological and mechanical complications. The most frequently reported problems include miniscrew loosening, peri-implant inflammation, pain, softtissue irritation, mucosal overgrowth, and accidental root contact. Less common complications include damage to adjacent anatomical structures and fracture of the miniscrew. Their occurrence is influenced by insertion site, cortical bone quality, root proximity, soft-tissue conditions, oral hygiene, and placement technique (Casaña-Ruiz et al., 2020; Lo Giudice et al., 2021).

Loss of anchorage stability may interrupt force application and require repositioning or replacement of the miniscrew. Careful anatomical assessment and appropriate implant positioning are therefore essential, particularly in interradicular regions, where root injury represents an important clinical risk. Skeletal anchorage also does not entirely eliminate dependence on patient cooperation when treatment requires intermaxillary elastics or facemask wear.

An important biological limitation is the inability of microimplant-assisted therapy to predictably inhibit mandibular growth. Although maxillary protraction may improve the sagittal relationship and reduce unwanted dental compensation, continued mandibular development can partially reverse the correction. Consequently, long-term stability depends not only on the treatment protocol but also on the initial skeletal pattern, treatment timing, residual growth, and severity of mandibular prognathism (Wang et al., 2022).

Long-term studies indicate that favourable skeletal effects may persist after treatment, although partial deterioration of ANB and Wits values may occur as facial growth continues. In one extended follow-up, maxillary advancement remained clinically relevant despite limited relapse, while a randomized trial found comparable long-term skeletal effects between two different protraction protocols. These findings suggest that skeletal anchorage may improve treatment control but cannot guarantee permanent correction in every patient (Maino et al., 2022; Meyns et al., 2025).

Interpretation of treatment stability is additionally limited by considerable heterogeneity among studies. Differences in patient age, skeletal maturity, appliance design, implant location, force magnitude, treatment duration, retention, and follow-up prevent definitive identification of a superior protocol. Many studies involve small samples or short observation periods, and high-quality long-term randomized evidence remains limited. Overall, microimplant-assisted treatment may provide favourable and relatively stable outcomes in appropriately selected patients, but relapse associated with residual mandibular growth remains possible. Patients and clinicians should therefore regard skeletal anchorage as a method of improving biomechanical control rather than as a guarantee of permanent skeletal correction.

### Discussion

Microimplant-assisted treatment is primarily indicated in growing patients with skeletal Class III malocclusion caused predominantly by maxillary deficiency. The most favourable candidates present with maxillary retrusion, an anterior crossbite, sufficient residual growth, and a mild-to-moderate mandibular component. In these patients, miniscrew-anchored maxillary protraction may increase skeletal effects and reduce unwanted dental compensation compared with conventional tooth-borne anchorage (Kamel et al., 2023; Wang et al., 2022).

In nongrowing patients, microimplants may be used to support orthodontic camouflage, particularly through distalization of the mandibular dentition. This approach is appropriate mainly for mild or borderline skeletal discrepancies with acceptable facial aesthetics and sufficient alveolar and periodontal support. It does not correct severe mandibular prognathism and should not be considered a substitute for orthognathic surgery when the skeletal deformity is pronounced.

Patient selection should be based on skeletal maturity rather than chronological age alone. Treatment planning must also consider the origin and severity of the discrepancy, vertical growth pattern, existing dental compensation, periodontal condition, available bone volume, root position, and the feasibility of safe miniscrew placement. Although skeletal anchorage reduces dependence on dental anchorage, cooperation may still be required when intermaxillary elastics or facemasks are used.

Microimplant-assisted treatment of skeletal Class III malocclusion includes several protocols, and no single approach can be considered universally applicable. Protocol selection depends on the anatomical origin of the discrepancy, skeletal maturity, vertical growth pattern, available bone, and the degree of required skeletal or dentoalveolar correction.

In growing patients with maxillary deficiency, miniscrew-anchored maxillary protraction is the most commonly described protocol. A hybrid Hyrax appliance supported by palatal miniscrews may be combined with mandibular miniscrews or a miniscrew supported anchorage bar. Class III elastics are applied between the maxillary and mandibular anchorage units, allowing predominantly intraoral and prolonged force application. Some protocols additionally use alternate rapid maxillary expansion and constriction to increase the response of the circummaxillary sutures. Initial forces of approximately 100 g per side may be progressively increased to approximately 200 g (Kamel et al., 2023).

An alternative method involves conventional miniscrews placed in both jaws and connected with intermaxillary elastics. This approach avoids complete dependence on dental anchorage and may reduce the need for extraoral appliances. However, treatment success remains influenced by elastic wear, miniscrew stability, and the direction of force application. The force vector should promote forward maxillary displacement while limiting excessive vertical movement and undesirable jaw rotation (de Souza et al., 2019; Moon et al., 2015).

Microimplant-supported protraction may also be combined with a facemask. In such protocols, skeletal anchorage reduces loading of the maxillary teeth, whereas the facemask provides a stronger extraoral protraction force. Nevertheless, this approach continues to require patient cooperation and may be less acceptable than full-time intraoral elastics. Current protocols therefore attempt to combine skeletal anchorage with reduced or nighttime facemask wear.

In nongrowing patients with mild or moderate Class III discrepancies, microimplants may support distalization of the mandibular molars or the entire mandibular dentition. Miniscrews may be inserted in interradicular, retromolar, or buccal-shelf regions, depending on anatomical conditions and the amount of planned movement. This protocol represents orthodontic camouflage and cannot correct severe mandibular prognathism or a pronounced facial deformity (Aslan et al., 2019).

Fixed functional appliances, such as an inverted Forsus device anchored to mandibular miniscrews, constitute another possible protocol for selected growing patients. Such appliances provide continuous force and reduce reliance on removable appliance wear, although their effects include both skeletal and dentoalveolar changes (Eissa et al., 2018). Overall, treatment protocols differ considerably in miniscrew location, appliance design, force magnitude, treatment duration, and patient cooperation requirements.

Consequently, the available evidence does not support a standardized universal protocol. Treatment mechanics should be individualized to direct forces toward the dominant component of the malocclusion while minimizing dental compensation and unfavourable vertical effects

## Conclusions

Microimplant-assisted treatment has expanded the therapeutic possibilities for patients with skeletal Class III malocclusion. Its main advantages include improved anchorage control, reduced unwanted dental compensation, and the possibility of directing forces more effectively toward the maxillary or mandibular dentition. The greatest clinical benefit appears to occur in growing patients with maxillary deficiency, whereas in nongrowing patients microimplants primarily support orthodontic camouflage.

Current evidence suggests favourable short-term skeletal, dental, and soft-tissue outcomes. However, microimplants do not predictably restrict mandibular growth and cannot replace orthognathic surgery in severe skeletal discrepancies. Treatment success depends on appropriate patient selection, skeletal maturity, implant stability, force direction, anatomical conditions, and patient cooperation.

The available literature remains limited by heterogeneous treatment protocols, small study groups, inconsistent outcome measures, and relatively short follow-up periods. Direct comparison between studies is additionally complicated by differences in appliance design, miniscrew location, force magnitude, patient age, and severity of the malocclusion. Future research should therefore focus on well-designed randomized clinical trials with standardized diagnostic criteria, treatment protocols, and outcome measures. Longterm follow-up extending beyond completion of craniofacial growth is particularly necessary to determine treatment stability and the risk of relapse. Further studies should also compare miniscrew-supported protocols with miniplates, conventional orthopedic treatment, orthodontic camouflage, and orthognathic surgery.

Overall, microimplants should be regarded as an effective anchorage method rather than an independent treatment modality. Their clinical value is greatest when they are incorporated into an individualized biomechanical strategy based on the dominant skeletal component, growth potential, and treatment objectives.

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