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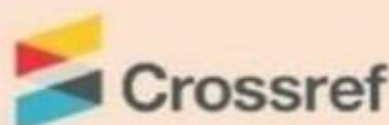
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Myofunctional Appliance for Class III

Malocclusion: A review

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Abstract:

Early management of Class III malocclusion poses many challenges for orthodontic specialists, as the cause of this malocclusion can be multifactorial, being either skeletal, dental, or both skeletal and dental. The aim of this comprehensive review was to shed light on up-to-date orthopedic appliances that can be used in the growth modification of Class III malocclusion along with other treatment modalities that can be used in growing patients for early correction of skeletal/dental components of class III malocclusion. Furthermore, a review of bone-anchored appliances and their combined use with the orthopedic appliances is also discussed in this study.

Keywords: Myofunctional appliance. Angle class III malocclusion. Interceptive treatment. Skeletal anchorage. Mixed dentition.

Introduction

The treatment of skeletal class III malocclusion is considered one of the most pretentious challenges in orthodontics (Fabozzi et al., 2021) (Kadhom et al., 2024). The etiological factors for Class III malocclusions comprise many issues of skeletal and dental constituents. In such cases, the condition might be recognized by many features, such as (Azamian & Shirban, 2016) (Ganesh et al., 2020), (Rédua, 2020):

- Mandibular prognathism, in which there is a protrusion of the lower jaw.
- Maxillary retrognathism, in which there is a retrusion of the upper jaw.
- Retrusive maxillary dentition.
- Protrusive mandibular dentition.
- A combination of the above.

Practically, class III conditions can be found as pseudo Class III in which a premature interference effects the muscular reflex during mandibular closure or as factual Class III cases (Paoloni et al., 2021). With ageing, class III malocclusion becomes more complicated (Valgadde & Chougule, 2016). Therefore, timely orthodontic involvement could help in

preventing serious irreparable soft and hard tissue deviations that may appear in advanced stages (Sarangal et al., 2020).

The concept of myofunctional appliances utilizes forces generated by the orofacial muscles to alter the way of maturation in those patients who are still in the phase of growth (Kumar et al., 2021). Although they're best known for treatment of class II malocclusions, this does not prohibit their use for class III malocclusions in developing dentition (Fleming & Lee, 2016).

This article presents an up-to-date review concerning myofunctional and orthopedic appliances, demonstrating their diverse types, modes of action, and times of intervention, in addition to the other new concepts of treatment that have been proposed in the early management of the dental and skeletal constituents of class III malocclusion.

Type of Appliances

According to the site of anchorage, appliances are classified into two categories: intra-oral appliances and extra-oral appliances (Azamian & Shirban, 2016). These categories may overlap during the course of treatment and will be discussed at the end of this section.

1. Intra-Oral Appliances

The intra-oral appliances include the following:

1.1 Reverse Twin Block (RTB)

This appliance is a modification of the traditional twin-block used for class II malocclusion (Yavan et al., 2022). In this appliance, the blocks are essentially reversed so that the lower block (coating the lower molars) closes off distal to the upper block (coating the upper premolars), as shown in Figure 1 (Albajalan et al., 2020). The upper device can integrate a midline screw, which is turned twice a week for arch harmonization if needed (Fleming & Lee, 2016). The mode of action is primarily dentoalveolar, causing the upper anterior teeth to procline and the lower anteriors to retrocline, and skeletal changes are minimal (Yavan et al., 2022). The best time for treatment with this device is the initial mixed dentition period (6–9 years). It can be fixed to the teeth and be worn all day (24 hours), which hastens the treatment time. This means it can be worn during normal functions of the day (speaking and eating) (Novalia, 2018).

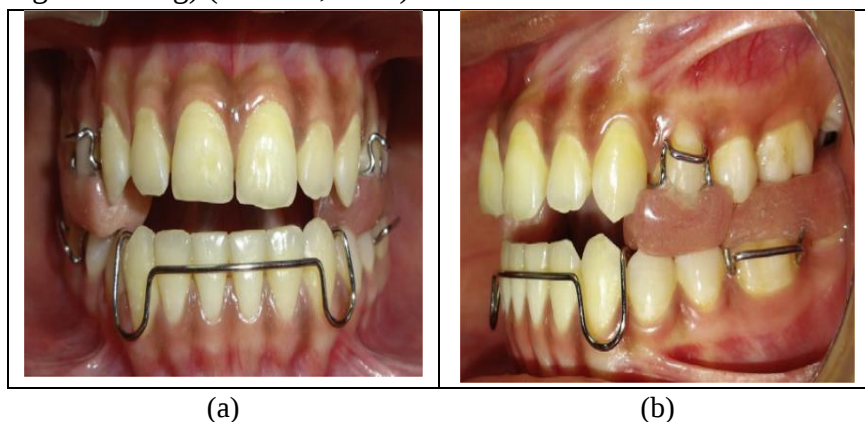


Figure 1: Reverse Twin Block appliance. (a) Frontal view; (b) Lateral view (Singh et al., 2018).

1.2 Fränkel Functional Regulator 3 (FR3)

It's the most frequently used functional appliance for class III correction. It is a soft tissue-borne device planned to dislodge soft tissues and muscles that limit maxillary growth, as shown in Figure 2 (Fleming & Lee, 2016). The effects are skeletal alongside dentoalveolar changes (Di Luzio et al., 2017). The lower portion of the device constrains mandibular development (Ji et al., 2020). The FR-3 can be utilized during the primary, mixed, and early permanent dentition phases. It is worn for around 20 hours per day, being removed only while eating and playing contact sports (Graber et al., 2016).

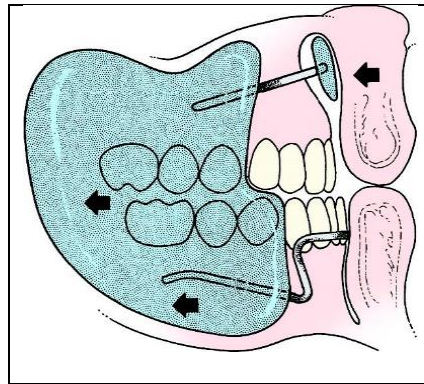


Figure 2: Fränkel Functional Regulator (FR3). The buccal and labial vestibular shields are designed to protect the maxillary alveolus from the forces of the adjacent soft tissues (Graber et al., 2016).

1.3 Reverse Bionator (III)

As Balters suggests in his hypothesis, Class III patients tend to occlude with the tongue positioned more anteriorly than normal (Garattini et al., 1998). The reverse bionator is therefore designed to keep the tongue in a more posterior and higher position (Yang et al., 2022), as shown in Figure 3. The effects are mainly dentoalveolar and, it's mostly used in the mixed dentition period in patients with pseudo-class III malocclusions with the upper anterior teeth tipped palatally, causing forward mandibular movement on closure from postural rest to habitual occlusion (Abeas, 2024). It's recommended to be worn for at least 22 hours a day (Azamian & Shirban, 2016).

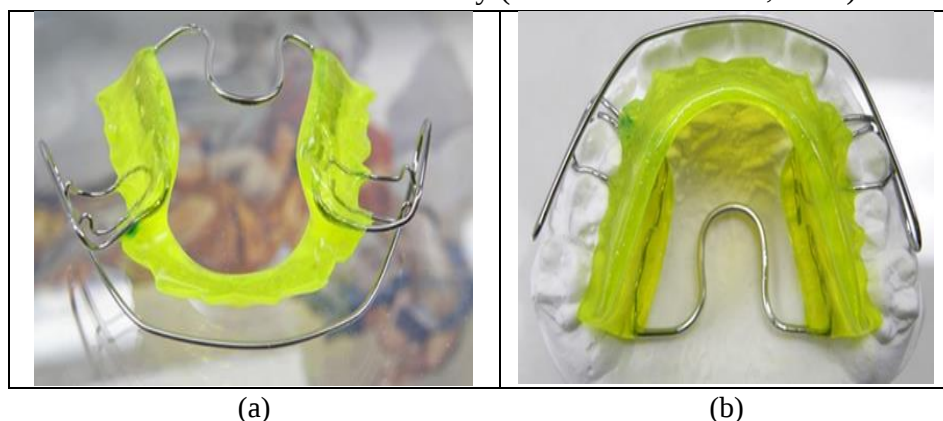


Figure 3: Reverse Bionator III. (a) Frontal view; (b) Lateral view (<https://dvddental.it/ortodonzia.html>).

1.4 Eschler Appliance or Progenic Appliance

This appliance has a reformed labial arc made to touch the labial surface of lower incisors, with an occlusal bite-raising appliance made of acrylic (Novais Machado et al., 2020), as shown in Figure 4. This will help in normal growth of the maxilla, besides the adjustment of the reversed overjet (Almeida et al., 2011). The effect of Eschler appliance is mainly dentoalveolar with slight skeletal effect. The device is applied in cases with pseudo-class III occlusion exhibiting forward displacement of the mandible. It's suggested to be worn for at least 14 hours per day and, the best treatment time is mixed and permanent dentition, from 9 to 12 years of age (Novais Machado et al., 2020) (Sarangal et al., 2020).



Figure 4: Eschler appliance (Majanni & Hajeer, 2016).

1.5 Modified Tandem Appliance (MTA)

This appliance was specifically constructed to get over complaint problems patients had with the traditional facemasks (Valgadde & Chougule, 2016). Chun et al. (Chun et al., 1999) defined MTA as a convenient and more appealing device than traditional appliances due to the fact that it's removable and used intraorally, as shown in Figure 5. The effects are combined skeletal and dental. The mode of action is anterior advancement of the maxilla accompanied by posterior rotation of the lower jaw (Yavan et al., 2022) (Valgadde & Chougule, 2016). The device is recommended to be worn for about 14-16 hours per day (Valgadde & Chougule, 2016).

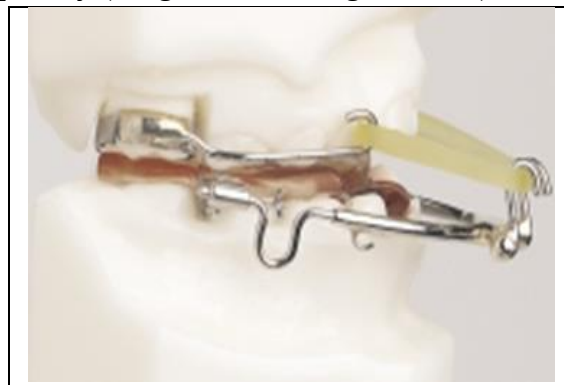


Figure 5: Modified traction bow (Valgadde & Chougule, 2016).

1.6 Double Plate Appliance (DPA)

The appliance is fabricated as angulated acrylic blocks with Class III elastics that are positioned among the upper molars and lower canines, as shown in Figure 6 (Azamian & Shirban, 2016) (Gencer et al., 2015). The double plate device is usually used in conjunction with a facemask. The

effects are mainly dental and it's shown to be effective in patients with maxillary deficiency (Kaygısız et al., 2018). The average age is around 10 years, and patients are expected to wear it daytime and night apart from for meals (Üçem et al., 2004).

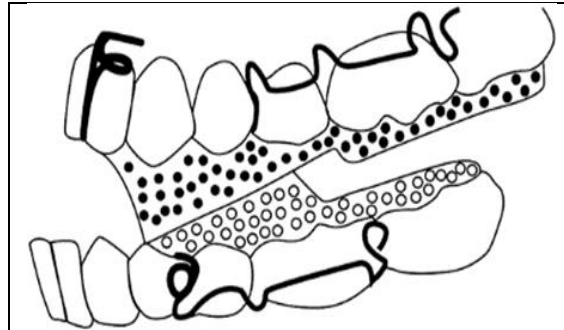


Figure 6: Schematic illustration of the double plate appliance (Azamian & Shirban, 2016).

1.7 Carrier Motion 3D Class III Appliance (CM3)

This is a new appliance with a very simple and uncomplicated design. It has gained wide acceptance among clinical specialists for the past decade (McNamara Jr et al., 2021) (Gentile et al., 2023). It simply consists of bilateral bars joined to the buccal surface of the lower posterior teeth (from the first premolar to the first permanent molar) and a solitary tube-like orthodontic bracket joined to the upper first or second permanent molar by means of intraoral elastics (Kamel & Taha, 2023) (An et al., 2020), as shown in Figure 7. According to a study performed by Shroff (Shroff, 2021), it has been concluded that most of the treatment effects produced by the CM3 were dentoalveolar in origin, with slight skeletal changes. It can be used in the management of class III malocclusion in growing and non-growing patients as a substitute for surgery. Class III elastics are worn full-time, except during meals (Carrière, 2016).



Figure 7: Carrier Motion 3D class III Appliance (Shroff, 2021).

1.8 Pushing Splint 3 (PS3)

The appliance is made up of three parts: two acrylic splints and one Forsus L-pin module for each side, as shown in Figure 8 (Galeotti et al., 2021). The positive features of the PS3 allow the delivery of forces used to improve maxillary jaw relationship in the sagittal plane. In addition to vertical vectors that are capable of restricting the vertical growth of alveolar and skeletal constituents (on the contrary to the facemask, which boosts the vertical growth) (Martina et al., 2020) (Galeotti et al., 2024). Therefore, this appliance is best suited in the treatment of Class III hyper-divergent patients. The effects are combined skeletal and dental, and patients are instructed to wear the appliance for a minimum of 14 hours per day (Martina et al., 2019).

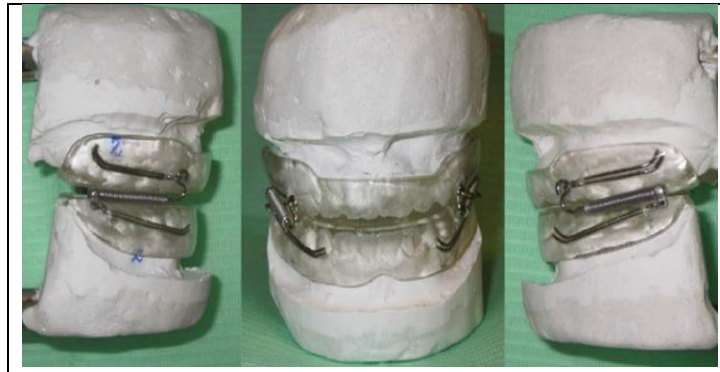


Figure 8: The PS3 appliance (Martina et al., 2019).

2. Extra-oral Appliances

The extra-oral appliances are classified into the following:

2.1 Chin-cup Therapy

Skeletal class III malocclusion having an almost regular maxilla and a reasonably protruded mandible can be managed with chin-cup therapy; with the cup being attached to the chin and an elastic strap covering the head (Ko et al., 2004) (Gür & Erdem, 2023), as shown in Figure 9. The evidence suggests that reducing mandibular prognathism is more effective when treatment is started in the primary or early mixed dentition (varying from one year of age to as far as 4 years) (Ngan & Moon, 2015). The main goal of such an early treatment is to inhibit or redirect mandibular growth posteriorly (Ngan & Moon, 2015) (Martina et al., 2020). Patients are trained to wear the appliance for 14 hours per day (Mousoulela et al., 2016).

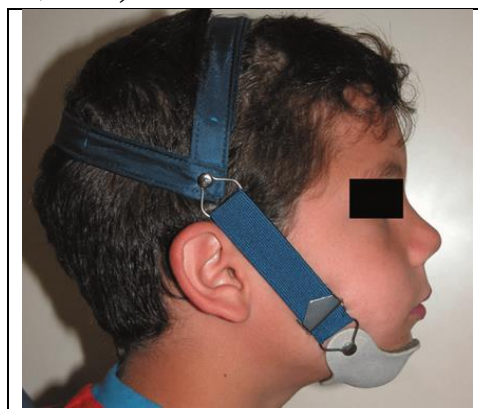


Figure 9: Chin-cup Appliance (Torres et al., 2012).

2.2 Facemask (Reverse-pull headgear, Protraction headgear)

Facemasks are considered one of the main tools used to intervene in emerging skeletal class III malocclusion, as shown in Figure 10. According to Zhou et al. (Zhou et al., 2024) the ideal treatment time is the initial mixed dentition period parallel with the emerging of the upper permanent incisors, that's prior to 9 years of age. Nevertheless, Kapust et al. (Kapust et al., 1998) stated that protraction therapy can also be effective in elder youngsters aged 10–14 years, but to a slighter degree. A facemask being anchored to the forehead and chin is indicated for patients with slight to moderate skeletal class III malocclusion due to maxillary retrognathism (Liu et al., 2021). In addition, it can be

utilized for stabilization after maxillary osteotomy (Zere et al., 2018). A facemask should be used for 12–14 hours per day (Yepes et al., 2014).



Figure 10: Protraction facemask (Littlewood, 2019).

2.3 Protraction Alone Vs Protraction with Rapid Maxillary Expansion

One of the debatable subjects is the use of rapid maxillary expansion (RME) in conjunction with facemask therapy. Usually class III skeletal patients tend to have a restricted maxilla in the horizontal aspect alongside the anteroposterior aspect; therefore, this expansion might be a useful tool for the treatment (Seppala & Cobourne, 2017) (Lee et al., 2021). This attitude has been further developed by formulating a system identified as Alt-RAMEC (Alternating Rapid Maxillary Expansion and Contraction). The Alt-RAMEC system labels the use of alternating weeks of rapid maxillary expansion and constriction to achieve disarticulation of the maxilla. This disarticulation will enhance maxillary forward advancement (Liu et al., 2015) (de Souza et al., 2019) (Lee et al., 2021). “Hyrax expander” is one of the most commonly used expansion apparatuses (Nienkemper et al., 2013). the “Hybrid hyrax” involves two mini-screws planted in the anterior palate, which increases the skeletal anchorage, as shown in Figure 11 (Hourfar et al., 2016). Hybrid hyrax-facemask combined therapy has become a popular treatment strategy for management of class III malocclusion in growing patients (Feldmann & Bazargani, 2017).

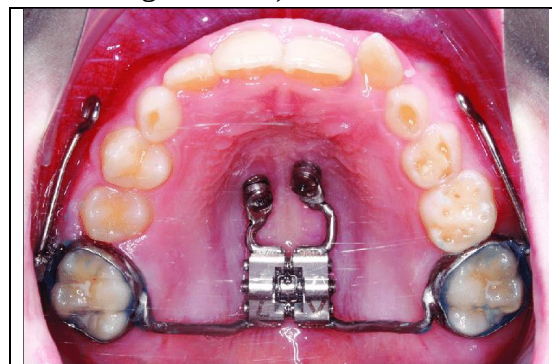


Figure 11: Hybrid hyrax expander involving two mini-screws with buccal hooks for attachment of the facemask (Wilmes, 2022).

Bone Anchored Appliances

Due to the drawbacks reported with tooth-borne appliances (i.e., facemasks, RME), which include mesial tipping and extrusion of maxillary dentition and lingual tipping of lower incisors in addition to posterior rotation of the mandible, bone-anchored maxillary protraction (BAMP) appliances have

been introduced (Zere et al., 2018) (Cha et al., 2021) (Tarraf et al., 2023). The bone-anchored methodology typically involves two approaches: facemask traction to skeletal anchorage and class III elastics to maxillary and mandibular miniplates.

Facemask Traction to Skeletal Anchorage

Obviously, one of the main drawbacks of individual treatment with facemasks is the unfavorable tooth movement that deteriorates from the skeletal change (Seiryu et al., 2020) (Zhou et al., 2024). Temporary implants are now offered as mini titanium screws that provide skeletal anchorage aimed at maxillary advancement, as shown in Figure 12. In order to be effective, it's better that these mini-screws be applied as bilateral mini-implants on the anterior maxilla (Karthi et al., 2013) (Seiryu et al., 2020). It has been confirmed with three adequate arbitrary practical studies that superior skeletal advancement can be obtained when facemasks are anchored to skeletal instead of dental constituents, achieving around 4-5 mm of protraction near the border (Yepes et al., 2014) (Sharifi & Alhuwaizi, 2023). However, this approach poses a negative aspect in such a way that bone maturity in young patients is not sufficient and implant placement surgery is quite invasive, implicating that orthopedic traction with mini-screws should not be started before 10 years of age (De Clerck et al., 2009).



Figure 12: Skeletal anchorage for attachment of a facemask for maxillary protraction (Proffit et al., 2018).

Class III Elastics to Maxillary and Mandibular Miniplates

This method was first presented by De Clerck et al. (De Clerck et al., 2010) in which bilateral miniplates are inserted on the upper jaw at the area of zygomatic buttresses and on the lower jaw at the symphyseal region, as shown in Figure 13. With this methodology, the extraoral facemask is no longer necessary, and intermaxillary traction will be applied 24 hours a day so that the forces directed to the jaws will be light (Esenlik et al., 2015). In optimal treatment by this method, inter-maxillary class III elastics are retained for almost 12 months, which is considered sufficient time to manage jaw discrepancy. Followed then by a second stage of treatment with a fixed orthodontic device (Fakharian et al., 2019) (Yilmaz et al., 2015).



Figure 13: Class III Elastics to Maxillary and Mandibular Miniplates (Proffit et al., 2018).

Discussion

Management of class III malocclusion in developing patients is still considered a puzzling part of the advanced orthodontic field. Numerous treatment strategies have been evolved in the literature using extraoral and intraoral appliances for orthopedic and orthodontic management of class III cases. For example, in cases with maxillary skeletal retrusion frankel functional regulator is the appliance of choice. On the other hand, the orthopedic chin-cup therapy is mainly recommended in cases characterized by mandibular prognathism. The extraoral facemask is widely used in the United States for Class III malocclusion with retruded maxillary arch. (Graber et al., 2016). As for the time of intervention, it is very well acknowledged that skeletal class III malocclusion is initiated early in life and it does not resolve by itself; instead, it may worsen with time if timely intervention is not initiated. Hence, early management has been recommended, such as in the deciduous dentition period or pre-pubertal growth phase (Lee et al., 2021).

However, formulating an appropriate treatment plan and choosing a specific appliance over another is greatly reliant on precise diagnosis and judicious clinical evaluation of the condition, which embraces the following (Proffit et al., 2018) (Fakharian et al., 2019): evaluating the patient's age, phase of growth, assessing the patient's compliance, determining the cause of the malocclusion, and the severity of the skeletal problem. All of the mentioned above should be combined with the radiographical examinations (i.e., cephalometric analysis) in order to formulate the most appropriate treatment plan.

Turpin established a table presenting positive and negative aspects that service judgement making on developing class III malocclusions which are listed in Table 1 (Ngan, 2002) (Zere et al., 2018). Turpin proposed that timely intervention is directed for patients who offered positive features, while those who offered negative features should postpone their treatment until growth is completed. Another suggestion made by the author is concerned with warning the patients of the possibility that a surgery may be required, even after an effective interceptive treatment (Ngan et al., 2014).

Table 1: Turban's positive and negative factors

Positive Factors	Negative Factors
Convex facial form	Concave facial form
Anteroposterior functional shift	No anteroposterior shift
Equal growth of condyle	Unequal growth of condyle
Growing patient	Adult patient
Minor skeletal discrepancy	Severe skeletal discrepancy
Patient compliance anticipated	Poor compliance anticipated
No genetic mandibular prognathism	Genetic pattern recognized
Decent facial esthetics	Reduced facial esthetics

Conclusion

This paper attempts to provide a comprehensive review of the orthopedic treatment approach for class III malocclusion which embraces a variety of appliances and their novel adaptations that have demonstrated their value and efficiency in the timely treatment of developing class III patients. We reported different strategies and the skills of the combined use of dual appliances. Nevertheless, the choice of selecting a particular appliance over another is greatly reliant on the origin of the disharmony and the great analysis of each situation by the orthodontist.

All appliances labelled in this paper would be beneficial when practitioners applied them in judgmental and precise ways.

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