Comparative analysis of treatment outcomes between Bi-Maxillary Plates and Facemask for treating class III malocclusion in growing subjects. A retrospective study



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Abstract

Aim To comparatively analyse the skeletal and dento-alveolar changes after treatment with Class III Bi-Maxillary Plates (BMPs) and FM appliances in growing patients with Class III skeletal malocclusion.

Study Design The study sample included 66 subjects 28 males and 38 females, mean age 8,4 ± 1,4) retrospectively recruited who underwent treatment with Bi-Maxillary Plates and Class III elastics (BMP group = 31 subjects, 13 males and 18 females, mean age 8,2 ± 1,6) and with Facemask (FM group = 35 subjects, 15 males and 20 females, mean age 8,6 ± 1,3) to correct mild class III malocclusion. Both groups of patients were instructed to wear the appliance at least 14 hours a day. Pre-treatment (T0) and post-treatment (T1) lateral cephalograms and dental digitised models were analysed and 10 angular measurements and 3 linear measurements were evaluated to perform inter-timing and inter-group comparisons. Changes in measurements from each group were compared by paired t-tests, considering a 5% significance level.

Results In both BMP and FM groups, there was a significant improvement in maxillary growth, while changes in the mandibular projection were recorded only in the changes FM group with a slight tendency to clockwise mandibular rotation and increased facial divergence. Dento-alveolar effects were similar in both groups but were exacerbated in the BMP group with significant greater buccal inclination of the upper incisors and lingual inclination of the lower incisors. A greater counter-clockwise rotation of the occlusal plane was also recorded in the BP group.

Conclusions BMPs with class III elastics provided a similar pattern of skeletal and dento-alveolar changes compared to FMs, however supported by slightly greater dentoalveolar effects that contribute to the correction of the class III malocclusion in growing subjects.

KEYWORDS class III malocclusion, paediatric orthodontics, digital orthodontics, face-mask, facial orthopaedics.

Introduction

Growing patients with Class III malocclusion typically feature a combination of skeletal and dental factors [Reyes et al., 2006; Wolfe et al., 2011; Quinzi et al., 2023]. Early intervention for Class III malocclusion is advocated to reduce or re-direct mandibular growth and protract the maxilla, and restore the anterior guidance, maintaining the mandible constrained by the upper arch during growth [Schneider-Moser et al., 2005; Quinzi et al., 2023, D'Apuzzo et al., 2019]. Chin-cup is the treatment option in case of mandibular protrusion [Woon and Thiruvenkatachari, 2017], instead, FaceMasks (FMs) are used when it is necessary to improve other conditions contributing to the development of the malocclusion such as maxillary retrusion combined with mandibular protrusion and lower facial height [McNamara et al., 1990; Aileni and Rachala, 2011; Piancino et al., 2019]. In this regard, data from systematic review and meta-analysis suggest impressive effects of FMs for most patients with Class III malocclusion in the early mixed dentition [Cordasco et al., 2014; Woon and Thiruvenkatachari, 2017; Grippaudo et al., 2020; Gelb et al., 2021].

Intra-oral appliances were also found to be effective in correcting Class III malocclusion in mixed dentition, including functional appliances (Frankel III, Bionator III and Reverse Twin-block) [Yang et al., 2014; Seehra et al., 2012] or Class III horseshoe appliance [Yang, 1997; Lim et al., 2021]. Using extra-oral or intra-oral devices has its advantages and disadvantages, and the appropriate treatment modality should be selected based on accurate diagnosis and the severity of the malocclusion [Lo Giudice et al., 2022; Lo Giudice et al., 2023]. However, children presenting early or mild class III malocclusion (including pseudo-class III) could benefit from simple and less invasive intra-oral devices that can correct the sagittal inter-maxillary discrepancy with less discomfort compared to extra-oral appliances [Schneider-Moser et al., 2005].

A new variant of intra-oral appliance has been proposed to manage class III malocclusion in children [Ronsivalle et al., 2023], which consists of Hawley-type bi-maxillary plates (BMPs) and Class III elastics attached at the hooks of the upper molar clamps and lower vestibular arch. As for Class III horseshoe appliances, BMPs connect all the dentition regardless of the presence of spaces while the retention is obtained by the presence of clamps underneath dental

	Measurements	Description
Skeletal Sagittal Measurements	SNA^	Angle between S-N line and N-point A line
	SN-Pog^	Angle between S-N line and N-Pog line
	N-A-Pog^	Angle between N-A line and A-Pog line
Skeletal Vertical Measurements	SN-PP^	Angle between S-N line and PP line (anterior-posterior nasal spines)
	SN-GoGn^	Angle between S-N line and GoGn line
	PP-Go-Gn^	Angle between PP line (anterior-posterior nasal spines) and GoGn line
Dento-Skeletal Measurements	PP-U1^	Angle formed by the intersection of tooth axis of upper incisor and PP plane
	GoGn-L1^	Angle formed by the intersection of tooth axis of lower incisor and GoGN plane
	Apo-L1 (mm)	Distance from lower incisor edge to A-Pog line
	SN-OP^	Angle between S-N line and occlusal plane
Dental Measurements	Overjet (mm)	Sagittal distance between incisal edges of upper and lower central incisor
	Overbite (mm)	Vertical distance between incisal edges of upper and lower central incisor
	Inter-incisal angle^	Angle formed by intersection of tooth of upper incisor and lower incisor

TABLE 1 Description of the skeletal and occlusal parameters used for the purpose of the present study.

Sample Characteristics	Total (n= 66)	BMP (n= 31)	FM (n= 35)	Significance
	Mean/n	Mean/n	Mean/n	
Mean age	8.4 (± 1.4)	8.2 (± 1.6)	8.6 (± 1.3)	p = 0.743
Gender				p = 0.547
Male	28	13	15	
Female	38	18	20	
Skeletal Maturity				p = 0.389
CVMS 1	50	24	26	
CVMS 2	16	7	9	
Observation Timing (months)		15 (± 0.7)	14 (± 0.6)	p = 0.622
P-value for comparison of group means by t-test or differences in proportion calculated by chi-square test.				

TABLE 2 Demography and clinical characteristics of the sample of the study.

undercuts and by the elasticity of the acrylic resin.

However, the literature is lacking studies evaluating the treatment effect of BMPs in comparison with FMs which represent the most investigated protocol for the treatment of class III growing subjects featuring maxillary retrusion or a combination of maxillary retrusion and mandibular protrusion. In this regard, the aim of this retrospective study was to comparatively analyse the skeletal and dento-alveolar changes after treatment with BMPs and FM appliances in growing patients with Class III skeletal malocclusion.

Materials and methods

Study setting

The present retrospective study was carried out following the Helsinki Declaration on medical protocols and ethics. The research protocol was accepted by the Local Institutional Review Board (protocol n. 119/2019/po-Q.A.M.D.I). Informed consent for both orthodontic treatment and research purposes was signed by the parents of all the included subjects. The study sample consisted of 66 patients, 28 males and 38 females (mean age 8.4 ± 1.4), with mild Class III malocclusion seeking orthodontic treatment at the Department of Orthodontics of Catania University, between September 2004 and March 2022.

Participants

The inclusion criteria used for recruiting the study sample were: age between 7 and 10 years old, pre-pubertal skeletal maturation stage according to the Cervical Vertebrae Maturation Stage method (CVMS 1 and CVMS 2), class III malocclusion assessed at the first occlusal contact both clinically, including also subjects with edge-to-edge incisors relationship and mandibular anterior shift, and radiographically (N-A-Pog^ <= 0), lateral cephalogram recorded before treatment (T0) and within two years of treatment (T1), lateral cephalogram performed with a specific bite-wax that registered the mandibular position at the first occlusal contact. The exclusion criteria were: mandibular prognathism and hyper-divergent growing pattern, craniofacial anomalies,

	Measurements	BMP group			FM group			Comparison
		Mean	SE		Mean	SE		P Value
Skeletal Sagittal Measurements	SNA^	79.41	1.53		78.83	1.33		0.631
	SN-Pog^	80.5	0.92		79.55	1.14		0.555
	N-A-Pog^	-0.63	0.97		-0.72	0.85		0.721
Skeletal Vertical Measurements	SN-PP^	6.14	0.74		7.24	0.96		0.093
	SN-GoGn^	28.37	1.45		28.89	1.27		0.978
	PP-Go-Gn^	22.25	1.12		21.64	1.14		0.842
Dento-Skeletal Measurements	PP-U1^	101.33	2.27		100.6	3.34		0.454
	GoGn-L1^	95.38	1.95		94.93	1.66		0.692
	Apo-L1 (mm)	3.92	0.49		3.9	0.72		0.981
	SN-OP^	18.66	2.42		18.97	1.98		0.646
Dental Measurements	Overjet (mm)	-1.81	0.57		-1.91	0.68		0.773
	Overbite (mm)	0.12	0.62		0.35	0.4		0.802
	Inter-incisal angle^	136.67	3.9		137.68	2.81		0.365
p value set at p < 0.05 and based on Independent Student t test; SE = standard error								

TABLE 3 Descriptive statistics of baseline skeletal and dental measurements between Bi-Maxillary Plates (BMP) and FaceMask (FM) groups.

	Measurements	BMP group		FM group		Comparison
		Mean	SE	Mean	SE	P Value
Skeletal Sagittal Measurements	SNA^	1.23	0.41	1.54	0.51	0.116
	SN-Pog^	-0.21	0.31	-0.61	0.37	0.004
	N-A-Pog^	1.44	0.38	2.15	0.41	0.003
Skeletal Vertical Measurements	SN-PP^	-0.11	0.56	-0.93	1.44	0.109
	SN-GoGn^	0.17	0.23	0.9	0.37	p < 0.0001
	PP-Go-Gn^	0.28	0.46	1.84	0.51	p < 0.0001
Dento-Skeletal Measurements	PP-U1^	7.76	1.06	5.65	1.19	p < 0.0001
	GoGn-L1^	-2.62	0.75	-1.53	0.81	0.002
	Apo-L1 (mm)	-1.23	0.33	-0.66	0.39	0.003
	SN-OP^	-2.15	0.69	-1.33	0.66	p < 0.0001
Dental Measurements	Overjet (mm)	4	1.03	3.81	0.91	0.472
	Overbite (mm)	0.72	0.29	0.92	0.39	0.581
	Inter-incisal ^	-8.29	2.16	-4.94	1.77	p < 0.0001
** p value set at p < 0.05 and based on paired Student t test; SE = standard error*						
** p value set at p < 0.05 and based on Independent Student t test; SE = standard error*						

TABLE 4 Comparison of treatment changes between Bi-Maxillary Plates (BMP) and FaceMask (FM) groups.

previous orthodontic treatment, temporomandibular joint (TMJ) dysfunction. Figure 1 showed the flow chart with a detailed description of the retrospective sample selection.

Treatment

Thirty-five subjects (mean age 8.6 ± 1.3) were treated using FaceMask appliance and were included in the FMG group. The clinical protocol for these patients consisted of a banded palatal arch (on first molars or second deciduous molars if steady) with bilateral vestibular hook and elastics connected from the hooks to the crossbar of a vertically adjustable protraction Petit facemask (Figure 2), with downwards inclination of 30 degrees. Bilateral 5/16″ 14 oz (400 gr) extraoral elastics were administered and patients were asked to wear the facemask for at least 14 hours per day [Baccetti et al., 1998]. Subjects were visited every 4 weeks to evaluate occlusal changes and the status of the appliance fitting.

Thirty-one subjects (mean age 8.2 ± 1.6) were treated using bi-maxillary plates with class III elastics and were included in the BMP group (Figure 3). The clinical protocol for these patients consisted of upper and lower modified Hawley plates with bilateral hooks soldered on the upper molar clamps and

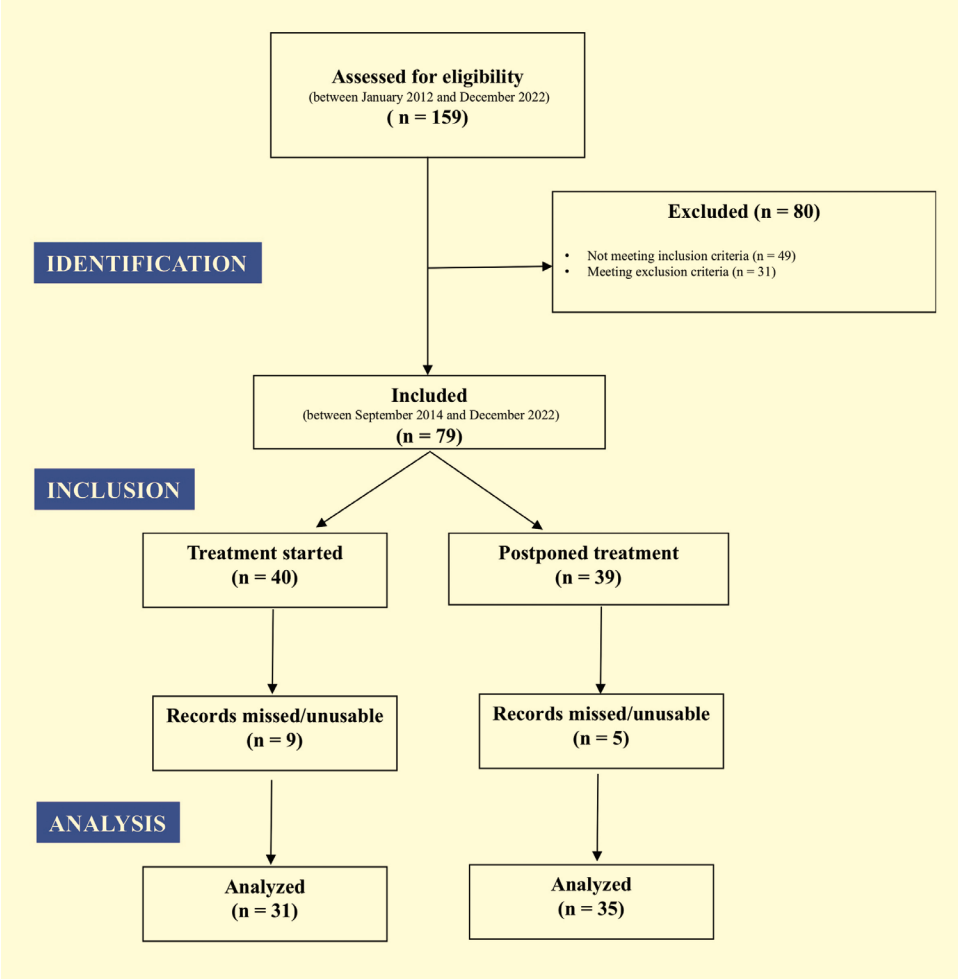


FIG. 1
Flow chart with detailed description of the retrospective sample selection.

on the lower vestibular arch. Bilateral 4/16" 4,5 oz (120 gr) intra-oral elastics were administered and patients were asked to wear the facemask for at least 14 hours per day. Appliance fitting was checked every 4 weeks and adjusted by squeezing clamps or relining the inner surface of the appliance to improve retention.

In both groups, the treatment was interrupted when achieving a class I incisal relationship or a positive overjet with no anterior crossbite and a correction of the class III skeletal pattern into a class I skeletal relationship. None of the patients in both groups receive retention appliances at the end of the treatment.

Measurements

Cephalometric analysis was performed using Dolphin Imaging Software, (Dolphin Imaging, version 11.0, Chatsworth, CA, USA) on T0 and T1 lateral cephalograms (Figure 4) and was customised according to the guidelines of the Italian Board of Orthodontics (IBO, https://www.sido.it/model-display-ibo/ibo/) plus the occlusal plane inclination parameter. Table 1 reports a detailed description of the measurements used along with baseline values in both groups. The overjet and overbite parameters were calculated on T0 and T1 digital models. In this regard, plaster models were scanned using D2000 desktop scanner (3Shape, Copenaghen, Denmark; trueness = 5 µm) and uploaded into 3-Matic software (vr. 13, Materialise NV, Leuven, Belgium) to perform digital measurements (Figure 4). Cephalometric analysis and model analysis were performed by an operator with 15 years of expertise in clinical and digital orthodontic procedures (A.L.G.). To calculate intra-operator reliability, the same operator repeated the measurements four weeks later. Moreover, a second operator (V.R.) performed cephalometric and model analyses to evaluate inter-operator reliability.

Sample size calculation

A preliminary analysis was performed on 20 subjects satisfying the inclusion/exclusion criteria to evaluate sample size power. The analysis showed that 22 subjects for each group were required to detect a mean difference of 0.53° for post-treatment N-A-Pog^ changes between the BMP and FM group, with a power of 80% and a significance level of 0.05. However, we were able to include 66 subjects increasing the robustness of the data findings.

Statistical analysis

Descriptive statistics were employed to analyse the demographic and clinical characteristics of BMP and FM groups. Student t-test and chi-square test were utilised to compare numerical variables (age) and categorical variables (gender and skeletal maturity) between the two groups.

The Shapiro-Wilk test was used to assess data distribution and the Levene's test was used to evaluate the equality of variance. Since the data exhibited a normal distribution,

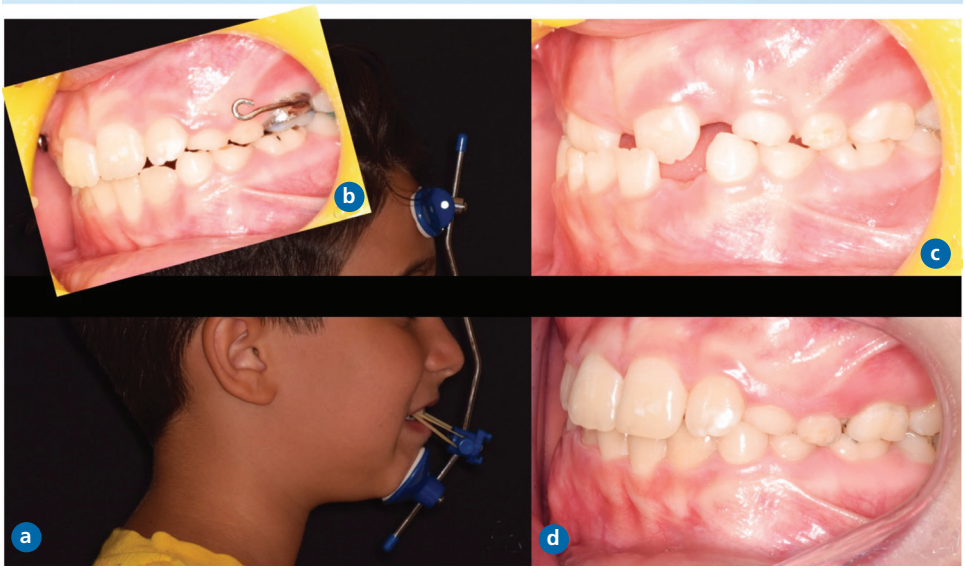


FIG. 2
Petit facemask used in the FMG. A) extra-oral lateral view, B) intra-oral lateral view, C) pre-treatment occlusion, D) post treatment occlusion.



FIG. 3
Bi-maxillary plates with class III elastics used in the BMP group. (A) extra-oral lateral view, B) intra-oral lateral view, C) pre-treatment occlusion, D) post treatment occlusion.

parametric tests were employed. Independent Student's t-test was used to compare the baseline data outcomes and the changes between T0 and T1 for each parameter between the two groups. Paired Student t-test was used for inter-timing comparison of the data outcomes within each group. Intra-examiner and inter-examiner reliability were evaluated using the Intraclass Correlation Coefficient (ICC). The statistical analysis was performed using SPSS® version 24 Statistics software (IBM Corporation, 1 New Orchard Road, Armonk, New York, USA).

Result

Descriptive statistics are reported in Tables 2 and 3. No statistically significant differences were recorded between the two groups according to age, gender, skeletal maturation stage and follow-up timing ($p > 0.05$), suggesting homologous distribution of confounding variables (Table 2). Concerning the latter variable, all post-treatment cephalograms were acquired between 12 to 18 months after treatment/first consultation. No significant differences were found between baseline cephalometric and occlusal parameters recorded in both groups (Table 3).

Table 4 shows the mean values and standard errors for the T0-T1 changes occurred in each group. In both BMP and FM, there was a significant improvement in skeletal sagittal parameters. In particular, SNA^ and N-A-Pog^ statistically increased (BMP group: SNA^ = + 1.23 ± 0.41, N-A-Pog^ = + 1.44 ± 0.38; FM group SNA^ = + 1.54 ± 0.51, N-A-Pog^ = + 2.15 ± 0.41) and SN-Pog^ statistically decreased (BMP group: SN-Pog^ = - 0,21 ± 0.31; FM group: SN-Pog^ = - 0.61 ± 0.37) at T1 in both groups ($p < 0.05$). Changes of SN-Pog^ and N-A-Pog^ were also statistically differed between BMP and FM groups ($p < 0.05$).

Concerning vertical skeletal measurements, statistically significant differences were recorded only for SN-GoGn^ and PP-GoGn^ in the FM group between T0 and T1, with significant differences also in comparison with the changes obtained in the BMP group (BMP group: SN-GoGn^ = + 0,17 ± 0.23, PP-GoGn^ = +0.28 ± 0.46; FM group: SN-GoGn^ = + 0,9 ± 0.37, PP-GoGn^ = +1.84 ± 0.51).

In both BMP and FM groups there was a significant increment of dento-alveolar compensation of class III malocclusion. In particular, the PP-U1^ statistically increased (BMP group: PP-U1^ = + 7.76 ± 1.06; FM group: PP-U1^ = + 5.65 ± 1.19) while the GoGn-L1^ and Apo-L1 statistically

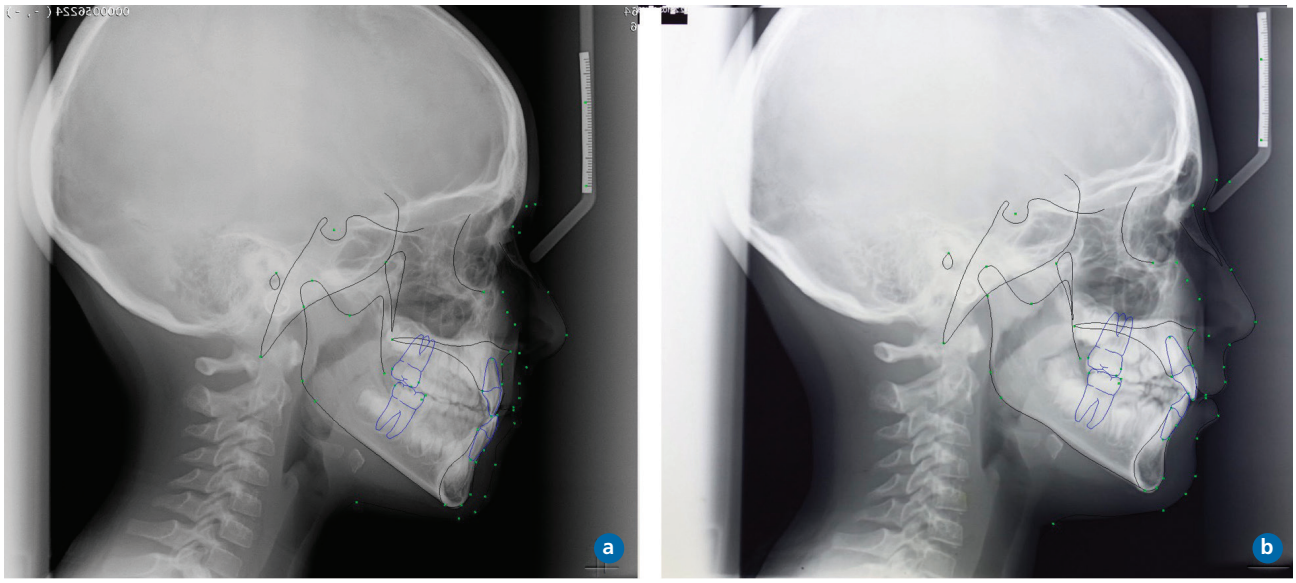


FIG. 4 Cephalometric analysis. A) Pre-treatment, B) Post-treatment.

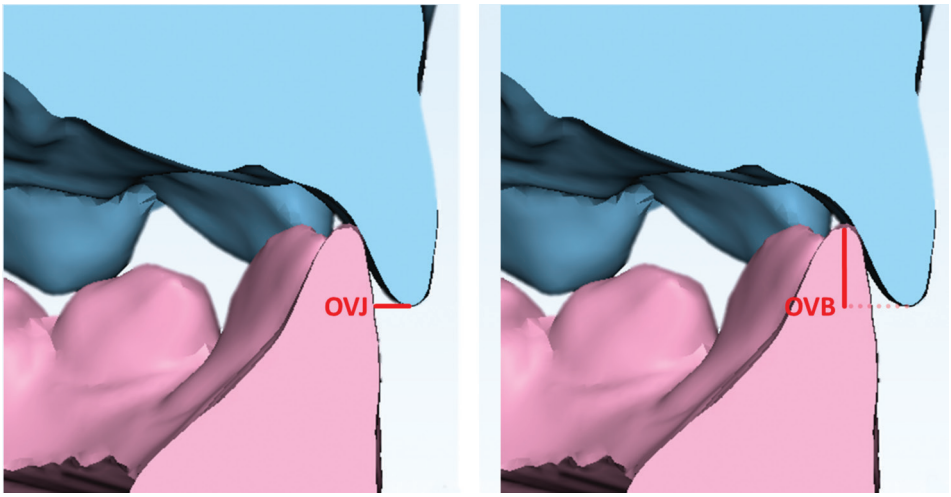


FIG. 5
Measurements performed on digital models. (A) Overjet (OVJ), B) Overbite (OVB).

Discussion

decreased (BMP group: GoGn-L1^ = - 2.62 ± 0.75, Apo-L1 = - 1.23 ± 0.33; FM group: GoGn-L1^ = - 1.53 ± 0.81, Apo-L1= - 0.66 ± 0.39) in both groups ($p < 0.05$). The SN-OP^ also statistically decreased in both groups (BMP group: SN-OP^ = - 2.15 ± 0.69; FM group: SN-OP^ = - 1.33 ± 0.66). Changes in all the dento-skeletal measurements were also statistically differed between BMP and FM groups ($p < 0.05$).

Finally, overjet, overbite parameters significantly increased (BMP group: Overjet = + 4 mm ± 1.03; Overbite = + 0.72 ± 0.29; FM group: Overjet = + 3.81 ± 0.91; Overbite = + 0.92 ± 0.39) while the inter-incisal angle significantly reduced (BMP group: Inter-incisal^ = - 8.29 ± 2.16; FM group: Inter-incisal^ = - 4.94 ± 1.77) in both groups; the changes of inter-incisal^ were also statistically different between the two groups ($p < 0.05$). No significant differences were observed for both intra-operator and inter-operator readings. In particular, excellent correlation coefficients were found for linear measurements (intra-operator reliability = 0.897, inter-operator reliability = 0.868) and for angular measurements (intra-operator reliability = 0.903, inter-operator reliability = 0.872).

To the best of our knowledge, this is the first study in the literature that comparatively investigates the treatment effectiveness of class III Bi-Maxillary Plates and FaceMasks in Class III growing subjects. Both treatment approaches determined the achievement of the established clinical outcome, i.e., the correction of the negative overjet along with the re-establishment of physiological mandibular function, by a combination of skeletal and dento-alveolar effects.

Available data from the highest level of the pyramid of evidence confirm that FMs effectively correct class III malocclusion by promoting maxillary protraction and clockwise rotation of the mandible, resulting in the improvement of the sagittal relationship between the maxilla and mandible and of the overjet, and in the increment of lower facial height [Kim et al., 1999; Cordasco et al., 2014]. The present findings corroborate previous pieces of evidence since in the FM group the maxilla exhibited a significant anterior projection and counterclockwise rotation, while the mandible exhibited a clockwise and backwards rotation, with a significant reduction

of the SNB angle. All these changes contributed to the improvement of the skeletal discrepancy and of the angle of convexity (N-A-Pog^) and to the slight increment of facial divergence.

Concerning the usage of BMPs, the first interesting result was the significant advancement of the maxilla compared to the baseline values. Unexpectedly, the difference in the maxillary advancement between the two groups was not statistically significant, although the increment of SNA angle was smaller than that recorded in the FM group. In light of this finding, it may be assumed that in children who exhibit less sutural resistance light forces may generate orthopaedic effects in the maxilla close to those obtained with heavy forces [Lim et al., 2021; Nguyen et al., 2011].

The position of the mandible related to the cranial base was stable compared to that recorded at the baseline which suggests a restraining effect on the mandibular forward displacement, in the short-term. The re-establishment of the normal overjet and anterior guidance could have contributed to this effect [Schneider-Moser et al., 2005]. Furthermore, it has been postulated that light class III forces may favor the remodeling of the glenoid fossa with bone apposition at the posterior wall, preventing the advancement of the mandible [De Clerck et al., 2010; De Clerck et al., 2012]. Further studies testing the same appliances and involving superimposition of pre-treatment and post-treatment cephalogram and 3D datasets are necessary to elucidate this aspect. At the same time, the stable position of the mandible at T1 in the BMP group can be also ascribed to the absence of significant changes in the mandibular rotation, as instead occurred in the FM group.

The main differences between the two groups were related to the dent-alveolar effects generated by wearing the two different appliances. In particular, the BMP and FM groups showed a significant buccal inclination of the upper incisors and lingual inclination of the lower incisors, however, the amount of dentoalveolar changes was remarkably greater in the BMP group. This finding can represent an important clinical discriminating factors when choosing the appropriate appliance for interceptive treatment of class III malocclusion, since subjects without dental compensations or presenting anterior occlusal interferences (often accompanied by functional shifts of the mandible) could benefit more from BMPs appliance compared to the FM. No differences were recorded in the final overjet recorded at T1 between both groups, although the greater dento-alveolar effects with the usage of BMPs may explain the tendency for increased overjet in this group compared to FM group. The occlusal plane tended to rotate counterclockwise with greater effect compared to that recorded in the FM group, although no statistical differences were found. In both groups, the counterclockwise rotation of the occlusal plane could be ascribed to the vector of force application which is below the centre of resistance of the maxilla (near the apex of second premolars and first molar). However, FMs are more versatile since the vector of force can be easily adjusted by sliding the crossbar along the metal vertical bar, instead in the BMP appliances, the point of application of the elastics is firmly localised in the first molars' clamps and the vector of forces cannot be significantly adjusted.

Comprehensively, the changes recorded in the BMP group are similar to those documented with the usage of class III horseshoe appliance [Lim et al., 2021; Lo Giudice et al., 2021]. In this regard, both appliances feature a similar mechanism which involves two distinct intra-oral plates (maxillary and mandibular) connected by inter-maxillary elastics. However, horseshoe appliance is a splint-type appliance which covers completely the upper and lower dentition, including the occlusal surfaces; instead, in the BMP appliances, the occlusal and vestibular surfaces of upper and lower dentition are uncovered and the appliance retention is primarly based on the clamps connected to the resin framework. Such difference may produce different dentoalveolar effects between the two appliances as suggested by the present study and that of Lim et al. [2021], since the latter found greater compensation of the upper and lower incisors in a shorter observational timing. The present findings would confirm that BMPs are almost equal to the FM in the early treatment of mild class III malocclusion, with slightly less skeletal changes and greater dento-alveolar effects. However, the present observations are related to a short-term evaluation of post-treatment changes in class III subjects. In this regard, although literature suggests that early treatment using simple appliances can lead to a stable occlusion after treatment [Mandall et al., 2016], and that the early maxillary protraction significantly reduces the necessity for orthognathic surgery and favour the maintenance of positive overjet, there is also evidence that sagittal skeletal changes are not maintained after 6 years follow-up from FM therapy [Mandall et al., 2016]. In this regard, future studies involving long-term assessment of post-treatment changes are needed for a comprehensive evaluation of the effectiveness of BMP compared to FM therapy. Also, future studies are encouraged to support the assumption that BMPs may represent the best choice for those subjects affected by mild form of class III malocclusion, considering the patients' discomfort and treatment acceptance with FMs.

Limitations

The absence of a control group is certainly the major limitation of the present study. An untreated control group would have provided comparative information about growth patterns and the amount of mandibular growth in subjects exposed to the malocclusion throughout the observation timing. Previous evidence [De Clerck et al., 2010; De Clerck et al., 2012] confirmed that untreated Class III subjects showed 2.2 mm of anterior displacement of the chin in 1.2 years. The anterior displacement of the mandible detected in the BMP group and in the FM group was respectively 0.59 mm and 0.7 mm and comparing these data with the above-mentioned evidence it can be assumed that both treatments inhibit mandibular growth in the short-term (data calculated as the distance between Pogonion and perpendicular line from N to FH - Nper-Pog parameter – and not shown)

Both treatment groups were retrospectively recruited. Thus, it was impossible to control a priori potential confounding factors or specific variables that may have affected data outcomes. However, according to the inclusion/exclusion criteria, we were able to analyse a homogeneous study sample concerning gender, mean age, dental and skeletal maturation stage and observation timing. Future randomised studies are warmly encouraged to overcome the reported limitation of study design.

Conclusion

Both treatments successfully achieved the correction of the

negative overjet and Class III correction with a combination of skeletal and dento-alveolar effects.

The dento-alveolar effects contributing to the correction of Class III treatment were significantly greater in the BMP group.

Forward growth of the maxilla was improved in the BMP group with no statistically significant differences in comparison with the FM group; instead, greater control on mandibular growth (clock-wise rotation) was found in the FM group which contributed to the greater (slight) skeletal correction of the malocclusion compared with BMP group.

References

- Aileni KR, Rachala MR. Early treatment of class III malocclusion with Petit facemask therapy. Int J Orthod Milwaukee. 2011 Winter;22(4):41-5. PMID: 22360081.
- Baccetti T, McGill JS, Franchi L, McNamara JA Jr, Tollaro I. Skeletal effects of early treatment of Class III malocclusion with maxillary expansion and face-mask therapy. Am J Orthod Dentofacial Orthop. 1998 Mar;113(3):333-43. doi: 10.1016/s0889-5406(98)70306-3. PMID: 9517727.
- Cordasco G, Matarese G, Rustico L, Fastuca S, Caprioglio A, Lindauer SJ, Nucera R. Efficacy of orthopedic treatment with protraction facemask on skeletal Class III malocclusion: a systematic review and meta-analysis. Orthod Craniofac Res. 2014 Aug;17(3):133-43. doi: 10.1111/ocr.12040. Epub 2014 Apr 14. PMID: 24725349.
- D'Apuzzo F, Grassia V, Quinzi V, Vitale M, Marzo G, Perillo L. Paediatric Orthodontics. Part 4: SEC III protocol in Class III malocclusion. Eur J Paediatr Dent. 2019 Dec;20(4):330-334. doi: 10.23804/ejpd.2019.20.04.14. PMID: 31850779.
- De Clerck H, Cevidanes L, Baccetti T. Dentofacial effects of bone-anchored maxillary protraction: a controlled study of consecutively treated Class III patients. Am J Orthod Dentofacial Orthop. 2010 Nov;138(5):577-81. doi: 10.1016/j.ajodo.2009.10.037. PMID: 21055597; PMCID: PMC3033914.
- De Clerck H, Nguyen T, de Paula LK, Cevidanes L. Three-dimensional assessment of mandibular and glenoid fossa changes after bone-anchored Class III intermaxillary traction. Am J Orthod Dentofacial Orthop. 2012 Jul;142(1):25-31. doi: 10.1016/j.ajodo.2012.01.017. PMID: 22748987; PMCID: PMC3553657.
- Gelb M, Montrose J, Paglia L, Saccomanno S, Quinzi V, Marzo G. Myofunctional therapy Part 2: Prevention of dentofacial disorders. Eur J Paediatr Dent. 2021 Jun;22(2):163-167. doi: 10.23804/ejpd.2021.22.02.15. PMID: 34238010.
- Grippaudo MM, Quinzi V, Manai A, Paolantonio EG, Valente F, La Torre G, Marzo G. Orthodontic treatment need and timing: Assessment of evolutive malocclusion conditions and associated risk factors. Eur J Paediatr Dent. 2020 Sep;21(3):203-208. doi: 10.23804/ejpd.2020.21.03.09. PMID: 32893653.
- Kim JH, Viana MA, Graber TM, Omerza FF, BeGole EA. The effectiveness of protraction face mask therapy: a meta-analysis. Am J Orthod Dentofacial Orthop. 1999 Jun;115(6):675-85. doi: 10.1016/s0889-5406(99)70294-5. PMID: 10358251.
- Lim LI, Choi JY, Ahn HW, Kim SH, Chung KR, Nelson G. Treatment outcomes of various force applications in growing patients with skeletal Class III malocclusion. Angle Orthod. 2021 Jul 1;91(4):449-458. doi: 10.2319/090320-768.1. PMID: 33587106; PMCID: PMC8259750.
- Lo Giudice A, Ronsivalle V, Conforte C, Marzo G, Lucchese A, Leonardi R, Isola G. Palatal changes after treatment of functional posterior cross-bite using elastodontic appliances: a 3D imaging study using deviation analysis and surface-to-surface matching technique. BMC Oral Health. 2023 Feb 2;23(1):68. doi: 10.1186/s12903-023-02731-7. PMID: 36732751; PMCID: PMC9894513.
- Lo Giudice A, Ronsivalle V, Pedullà E, Rugeri M, Leonardi R. Digitally programmed (CAD) offset values for prototyped occlusal splints (CAM): assessment of appliance-fitting using surface-based superimposition and deviation analysis. Int J Comput Dent. 2021 Feb 26;24(1):53-63. PMID: 34006063.
- Lo Giudice A, Ronsivalle V, Santonocito S, Lucchese A, Venezia P, Marzo G, Leonardi R, Quinzi V. Digital analysis of the occlusal changes and palatal morphology using elastodontic devices. A prospective clinical study including Class II subjects in mixed dentition. Eur J Paediatr Dent. 2022 Dec;23(4):275-280. doi: 10.23804/ejpd.2022.23.04.04. PMID: 36511914.
- Mandall N, Cousley R, DiBiase A, Dyer F, Littlewood S, Mattick R, Nute SJ, Doherty B, Stivaros N, McDowall R, Shargill I, Worthington HV. Early class III protraction facemask treatment reduces the need for orthognathic surgery: a multi-centre, two-arm parallel randomized, controlled trial. J Orthod. 2016; 43, 164-75.
- McNamara JA Jr, Howe RP, Dischinger TG. A comparison of the Herbst and Fränkel appliances in the treatment of Class II malocclusion. Am J Orthod Dentofacial Orthop. 1990 Aug;98(2):134-44. doi: 10.1016/0889-5406(90)70007-Y. PMID: 2378319.
- Nguyen T, Cevidanes L, Cornelis MA, Heymann G, de Paula LK, De Clerck H. Three-dimensional assessment of maxillary changes associated with bone anchored maxillary protraction. Am J Orthod Dentofacial Orthop. 2011 Dec;140(6):790-8. doi: 10.1016/j.ajodo.2011.04.025. PMID: 22133943; PMCID: PMC3734342.
- Piancino MG, Di Benedetto L, Matacena G, Deregibus A, Marzo G, Quinzi V. Paediatric Orthodontics Part 3: Masticatory function during development. Eur J Paediatr Dent. 2019 Sep;20(3):247-249. doi: 10.23804/ejpd.2019.20.03.15. PMID: 31489827.
- Quinzi V, Salvati SE, Pisaneschi A, Palermiti M, Marzo G. Class III malocclusions in deciduous or early mixed dentition: an early orthopaedic treatment. Eur J Paediatr Dent. 2023 Feb;24(1):42-44. doi: 10.23804/ejpd.2023.24.01.07. PMID: 36853215..
- Reyes BC, Baccetti T, McNamara JA Jr. An estimate of craniofacial growth in Class III malocclusion. Angle Orthod. 2006; 76, 577-84.
- Ronsivalle V, Quinzi V, La Rosa S, Leonardi R, Lo Giudice A. Comparative Analysis of Skeletal Changes, Occlusal Changes, and Palatal Morphology in Children with Mild Class III Malocclusion Treated with Elastodontic Appliances and Bimaxillary Plates. Children (Basel). 2023 Jul 14;10(7):1219. doi: 10.3390/children10071219. PMID: 37508716; PMCID: PMC10377802.
- Schneider-Moser U, Moser L, Bennett J. Atypical treatment of Class II malocclusion with space closure only in the lower arch. Prog Orthod. 2005;6(2):188-205. English, Italian. PMID: 16276428.
- Seehra J, Fleming PS, Mandall N, Dibiase AT. A comparison of two different techniques for early correction of Class III malocclusion. Angle Orthod. 2012 Jan;82(1):96-101. doi: 10.2319/032011-197.1. Epub 2011 Aug 1. PMID: 21806467; PMCID: PMC8881034.
- Wolfe SM, Araujo E, Behrents RG, Buschang PH. Craniofacial growth of Class III subjects six to sixteen years of age. Angle Orthod. 2011 Mar;81(2):211-6. doi: 10.2319/051010-252.1. PMID: 21208071; PMCID: PMC8925254.
- Woon SC, Thiruvenkatachari B. Early orthodontic treatment for Class III malocclusion: A systematic review and meta-analysis. Am J Orthod Dentofacial Orthop. 2017 Jan;151(1):28-52. doi: 10.1016/j.ajodo.2016.07.017. PMID: 28024779.
- Yang KH. Treatment of Class III malocclusion with the horseshoe appliance: case reports in growing patients. J Clin Pediatr Dent. 1997 Fall;22(1):1-8. PMID: 9643195.
- Yang X, Li C, Bai D, Su N, Chen T, Xu Y, Han X. Treatment effectiveness of Fränkel function regulator on the Class III malocclusion: a systematic review and meta-analysis. Am J Orthod Dentofacial Orthop. 2014 Aug;146(2):143-54. doi: 10.1016/j.ajodo.2014.04.017. PMID: 25085296.