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Incremental effects of facemask therapy associated with intermaxillary mechanics

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Objectives: To determine the dentofacial changes in children with skeletal Class III malocclusions treated with maxillary expansion, external maxillary protraction and intermaxillary traction.
Methods: Fifteen Class III patients in either the deciduous or the mixed dentition (Mean age: 7.6 years; SD: 1.9 years) were used. The children were treated with a modified Haas expander, a modified lingual arch, intermaxillary elastics and facemask for nine months. Lateral cephalometric radiographs were taken at the beginning of treatment (T1) and at 3-month intervals (T2, T3, T4).
Results: Most significant sagittal skeletal modifications occurred in the first three months of treatment. During the first three months of treatment the upper and lower incisors tipped lingually and the face height increased. Towards the end of treatment the upper incisors proclined and the upper lip became more protrusive.
Conclusion: The therapy corrected the horizontal skeletal and arch discrepancies and improved the positions of the lips.
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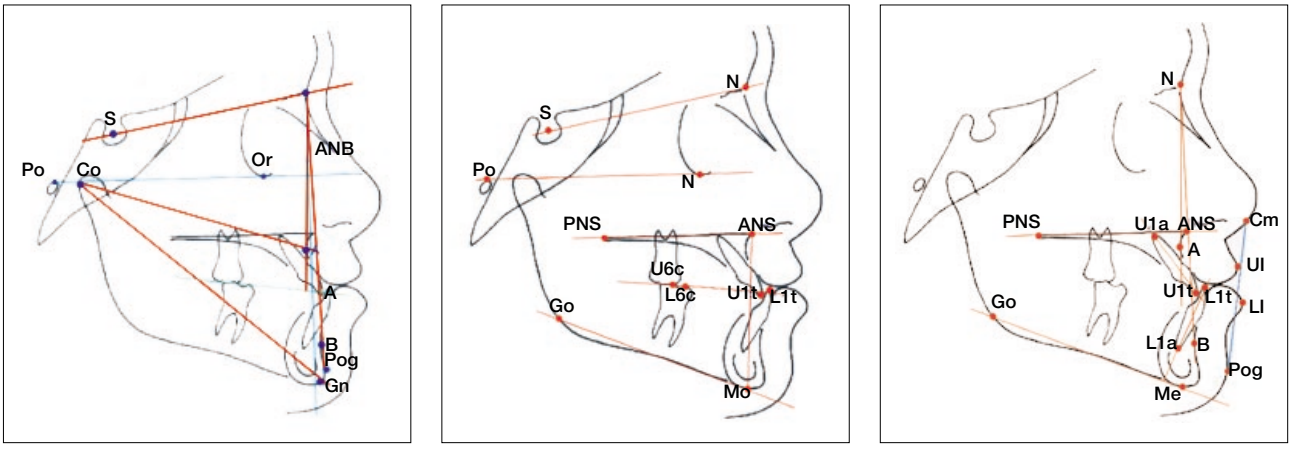
Introduction

Skeletal Class III malocclusion is considered one of the most complex and difficult orthodontic problems to treat. Much controversy and uncertainty surrounds the efficacy and stability of early treatment of this condition.[1–3] Since 45 to 65 per cent of skeletal Class III malocclusions have maxillary retrusion and a normal or prognathic mandible, many Class III patients can be managed with maxillary expansion and facemask therapy.[4,5] Although this approach has been described as maxillary protraction, the anteroposterior discrepancy is corrected by a combination of skeletal and dental movements in the maxilla and mandible.[2,6–13]

Recent publications have reported that favourable outcomes can be maintained long-term in approximately 65 to 75 per cent of cases treated with this type of early orthopaedic Class III treatment.[14–18] However, a recent finite element study by Holberg, Mahaini and Rudzki[19] has cast doubt on the notion of remodelling changes in the facial skeleton. They reported that the strains applied by a facemask were not high enough to stimulate bone growth in the circum-maxillary sutures. Their findings lead us to formulate a study to investigate the skeletal, dentoalveolar and soft tissue effects of combined facemask, intermaxillary traction and rapid maxillary expansion therapy in young subjects with skeletal Class III malocclusion. We postulated that it would be possible to maximise the skeletal changes and minimise the dentoalveolar changes by starting treatment in the late deciduous to mixed dentition. We also aimed to determine the changes at short intervals throughout treatment.

Materials and methods

The sample comprised 15 children (8 girls, 7 boys) between 5 years, 1 month and 11 years, 2 months of



(a) (b) (c)

Figure 1. Measurements used.
(a) Sagittal change in maxilla: SNA, NPerp-A, Co-A
Sagittal change in mandible: SNB, NPerp-Pog, Co-Gn
Maxillo-mandibular relationship: ANB, Wits appraisal
(b) Vertical relationship: SN/Ocl, SN/PP, SN/GoMe, FMA, ANS-Me
(c) Maxillary teeth: 1/NA, 1-NA, 1/PP
Mandibular teeth: 1/NB, 1-NB, IMPA
Facial profile: Steiner 'S' line, S-Ul; Steiner 'S' line, S-Ll

age (Mean age: 7.6 ± 1.9 years) with Class III malocclusion. Consecutive subjects were selected prospectively and treated for nine months. The selection criteria included: Class III malocclusion characterised by an anterior crossbite or edge-to-edge incisal relationship and a Wits appraisal of -2 mm or less; a maxillary deficiency established by facial analysis;[20] a stage of dental development between late deciduous dentition and mixed dentition; no previous orthodontic or orthopaedic treatment; no other craniofacial anomalies. All subjects were treated before their pubertal peak in mandibular growth, as verified by the cervical vertebral maturation method.[21] The study was approved by the Ethics Committee of the University of South Santa Catarina.

Cephalometric analysis

Lateral cephalometric radiographs were taken at the start of treatment (T1) and at 3-month intervals (T2, T3, T4). The radiographs were taken with the teeth in centric relation, and the image magnification was 7 per cent. All radiographs were traced and measured with digital calipers or protractor by the same operator (G.T.). The linear measurements were recorded to the nearest 0.1 mm and the angular measurements to the nearest 0.1 degree. The landmarks and measurements used in the study are shown in Figure 1.

Treatment regimen

The upper appliances were a modified Haas rapid maxillary expansion appliance soldered to bands on the deciduous second molars or first permanent molars (Figure 2). When possible, the first premolars were also banded. Teeth not banded were generally bonded to the appliance with composite resin. Heavy 0.045 inch wires joined the palatal appliance and bands and contacted the palatal and buccal surfaces of the posterior teeth. Hooks for extra-oral and intermaxillary elastics were placed in the buccal wires. The anterior hooks extended to the canine areas. An 11 mm expansion screw, placed in the midline of the palatal appliance, was activated a quarter turn twice daily (0.2 mm per turn) until fully activated. At the end of the second week a protraction force of 450 to 600 g per side with a downward vector of 30 degrees to the occlusal plane was used. The elastics were attached to a Petit facemask (Orthotech, Porto Alegre, Brazil) and the subjects were instructed to wear the appliance for 12 hours a day.

In the lower ach, a modified 0.045 inch lingual arch was soldered to bands on either the deciduous second molars or, generally, the first permanent molars. The buccal surfaces of teeth not banded were bonded to the appliance with composite resin. Buccal 0.045

(a) (b) (c)

Figure 2. Appliances used in this study for Class III correction:
(a) modified Haas expander. (b) modified lingual arch. (c) Class III intermaxillary elastics and extra-oral elastics to the facemask.

inch wires were soldered to the lower molar bands and formed into hooks for Class III intermaxillary elastics. The hooks extended forwards to the canines. The intermaxillary elastics delivered 200 to 350 g per side and subjects were instructed to use the elastics 24 hours per day, only removing them during eating and tooth brushing (Figure 2).

Statistical analysis

The data were normally distributed. The cephalometric measurements were compared at T1, T2, T3 and T4 by the analysis of variance of repetitive measurements, since the same individual was analysed at different times. Tukey's HSD test was then used to determine which time intervals were significantly different. The significance level was set at $p \leq 0.05$ for all tests.

All measurements were re-traced on two separate occasions with a 2-week interval between them. The systematic error was assessed using a paired *t*-test and the combined method errors in location of the landmarks, tracing and measurement with Dahlberg's formula. There was no systematic error and no error exceeded 0.5 mm or 0.5 degree.

Results

Most of the maxillary sagittal changes occurred in the first three months of treatment, as demonstrated by the SNA angle, NPerp-A and Co-A (Table I). The maxillary incisors (1/PP) retroclined in the first three months then slowly proclined over the following six months. The SNB angle and NPerp-Pog remained unchanged throughout treatment.

Mandibular length (Co-Gn) increased significantly from T1 to T4. The lower incisors (IMPA) were tipped progressively lingually from T1 to T4, but there were no significant changes in 1-NB and 1/NB. The ANB angle and Wits appraisal showed significant changes in maxillo-mandibular relations from T1 to T4. The greatest changes in these measurements occurred in the first three months of treatment.

There were no significant changes in either FMA or SN/GoMe, indicating that the therapy did not induce a growth rotation. There was no significant change in the inclination of the palatal plane to the cranial base (SN/PP), although the lower anterior facial height (ANS-Me) and occlusal plane to cranial base (SN/Ocl) increased throughout treatment (Table I). Small, but statistically significant, changes occurred in the positions of the lips (S-U1, S-L1), indicating that the soft tissue profile became more convex with treatment.

Discussion

Subjects with skeletal Class III malocclusion often present with concave facial profiles, nasomaxillary retrusion, and a prominent lower lip and lower third of the face. The goal of early treatment is to produce the greatest orthopaedic effect with minimal dental compensation. Previous attempts to maximise the orthopaedic effects of facemask therapy have used fixed splints with elastics, skeletal anchorage with miniplates and ankylosed deciduous canines.[25–29] Our treatment protocol of combined maxillary expansion, facemask therapy and Class III mechanics straightened the skeletal and soft tissue facial profiles of our young subjects with only a few, small dentoalveolar changes, but it was no more successful than some of the appliance combinations others have

Table I. Combined facemask therapy, comparisons at 3-month intervals.

Measurement	Stages				
	T1 Mean (SD)	T2 Mean (SD)	T3 Mean (SD)	T4 Mean (SD)	*p**
SNA (degrees)	78.12 (2.77) **a,b,c**	80.36 (3.12) **a**	80.43 (2.63) **b**	80.44 (3.11) **c**	**0.0001**
NPerp-A (mm)	-0.53 (2.69) **a,b,c**	2.31 (2.14) **a**	2.32 (2.41) **b**	2.49 (2.29) **c**	**<0.0001**
Co-A (mm)	82.98 (3.21) **a,b,c**	85.55 (3.09) **a,d**	86.07 (3.06) **b**	86.94 (3.09) **c,d**	**<0.0001**
SNB (degrees)	80.56 (3.11)	79.17 (3.23)	79.31 (2.81)	79.14 (3.74)	0. 077
NPerp-Pog (mm)	-0.11 (4.72)	-0.53 (5.01)	-0.16 (4.70)	0.02 (4.79)	0.098
Co-Gn (mm)	110.77 (5.91) **a**	111.35 (6.31)	111.99 (7.40)	112.75 (8.17) **a**	**0.006**
ANB (degrees)	-2.44 (2.81) **a,b,c**	1.19 (2.56) **a**	1.12 (2.71) **b**	1.30 (3.29) **c**	**<0.0001**
Wits (mm)	-5.70 (3.17) **a,b,c**	-0.05 (4.21) **a**	0.18 (4.03) **b**	0.25 (3.07) **c**	**<0.0001**
1/NA (degrees)	24.87 (3.13)	23.97 (2.98)	24.55 (2.87)	25.03 (3.32)	0.061
1-NA (mm)	4.61 (2.77)	4.21 (2.48)	4.35 (2.91)	5.08 (2.49)	0.059
1/PP (degrees)	114.98 (6.32) **a**	112.43 (6.99) **a,b**	113.37 (6.64)	116.53 (7.01) **b**	**0.003**
1/NB (degrees)	23.55 (5.78)	22.53 (4.44)	21.54 (6.01)	21.30 (6.20)	0.099
1-NB (mm)	3.21 (2.01)	3.02 (2.12)	3.01 (2.14)	2.96 (2.32)	0.171
IMPA (degrees)	88.89 (6.13) **a,b,c**	86.03 (6.21) **a**	85.83 (6.35) **b**	85.12 (6.01) **c**	**0.001**
SN/Ocl (degrees)	19.36 (6.74)	19.76 (6.87) **a**	16.02 (7.31) **a**	17.51 (8.39)	**0.029**
SN/PP (degrees)	8.31 (3.23)	7.67 (3.10)	7.76 (3.05)	8.31 (3.28)	0.606
SN/GoMe (degrees)	37.88 (4.64)	40.01 (4.89)	38.87 (5.05)	38.96 (5.53)	0.082
FMA (degrees)	26.21 (5.14)	27.63 (5.97)	26.43 (4.66)	25.84 (5.26)	0.075
ANS-Me (mm)	61.11 (5.60) **a,b,c**	64.60 (5.35) **a,d**	65.17 (4.98) **b**	65.89 (5.19) **c,d**	**<0.0001**
S-Ul (mm)	-0.45 (2.98) **a,b**	0.25 (3.10) **c**	0.96 (3.17) **a,d**	1.98 (2.73) **b,c,d**	**0.0003**
S-Ll (mm)	1.88 (3.92) **a**	0.32 (3.43)	0.45 (3.41)	0.68 (3.61) **a**	**0.040**

Means followed by the same letter are statistically different
*ANOVA, significant values in bold.

used.[2,3,7,8,10,12,13,27,29–33] It has been reported that combined facemask therapy and Class III mechanics are no more effective in treating skeletal Class III malocclusions than facemask therapy alone.[1,2,29,33]

In the first three months of treatment the upper incisors tipped palatally and then tipped labially over the next six months. We attribute the initial palatal movement of the upper incisors (1/PP) to the maxillary expansion, which increased the perimeter of the upper arch, and labial tipping of the upper incisors to the combined effects of Class III traction and facemask therapy.[34,35] The lower incisors (IMPA) tipped lingually throughout treatment, but the changes, although statistically significant, were less than 4 degrees. Pressure from the mandibular pad on the facemask may be responsible for these changes.

We decided to follow our subjects at 3-month intervals because we wanted to determine the incremental changes with a view to identifying the effects of the various components of our therapy. As mentioned above, maxillary expansion and unwanted pressure from the facemask were probably responsible for the incisors tipping lingually in our young subjects. Significant sagittal skeletal modifications occurred in the first three months of treatment (SNA, NPerp-A, Co-A), although lingual tipping of the lower incisors could account for some of these changes. After the initial period, the changes in all three measurements were maintained until the end of the treatment. A statistically significant increase in the vertical dimension (ANS-Me) also occurred during treatment, but some of this increase (Mean difference: 4.58 mm) may be due to the mechanics and some to facial growth. The vertical change was small and may not be of clinical significance.

In this preliminary study, our protocol of maxillary expansion, facemask therapy and intermaxillary

mechanics resulted in the skeletal changes and progressive dental compensations we were aiming for. Although most of the changes occurred in the first three months of treatment, sustained treatment is essential to correct the overjet and molar relationships and maintain the skeletal correction. Ideally, Class III malocclusions in young subjects should be overcorrected and retained as facial growth can undo any favourable changes.[14,16,18] Further studies are required to determine the amount of overcorrection required, the length of retention, the effects of normal facial growth and the contributions made by the various appliances. Moreover, the limitations in the present study, such as the small sample size and the lack of untreated control group should be mentioned.

Conclusions

Correction of a skeletal Class III malocclusion in young subjects with combined facemask therapy, maxillary expansion and intermaxillary mechanics resulted from forward movement of the maxilla and incisor tipping. The most significant skeletal modifications occurred in the first three months of treatment. The therapy improved the positions of the lips and resulted in a more convex profile.

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References

1. Kapust AJ, Sinclair PM, Turley PK. Cephalometric effects of face mask/expansion therapy in Class III children: a comparison of three age groups. Am J Orthod Dentofacial Orthop 1998;113:204–12.
2. Kim J, Viana MA, Graber TM, Omerza FF, BeGole EA. The effectiveness of protraction face mask therapy: a meta-analysis. Am J Orthod Dentofacial Orthop 1999;115:675–85.
3. Ngan P, Wei SH, Hägg U, Yiu C, Merwin D, Stickel B. Effect of protraction headgear on Class III malocclusion. Quintessence Int 1992;23:197–207.
4. Guyer EC, Ellis EE, McNamara JA, Behrents RG. Components of Class III malocclusion in juveniles and adolescents. Angle Orthod 1986;56:7–30.
5. Battagel JM. The aetiological factors in Class III malocclusion. Eur J Orthod 1993;15:347–70.
6. Baccetti T, McGill JS, Franchi L, McNamra JA, Tollaro I. Skeletal effects of early treatment of Class III malocclusion with maxillary expansion and face-mask therapy. Am J Orthod Dentofacial Orthop 1998;113:333–43.
7. Gallagher RW, Miranda F, Buschang PH. Maxillary protraction: treatment and posttreatment effects. Am J Orthod Dentofacial Orthop 1998;113:612–19.
8. Cha KS. Skeletal changes of maxillary protraction in patients exhibiting skeletal Class III malocclusion: a comparison of three skeletal maturation groups. Angle Orthod 2003;73:26–35.
9. Nartallo-Turley PE, Turley PK. Cephalometric effects of combined palatal expansion and facemask therapy on Class III malocclusion. Angle Orthod 1998;68:217–24.
10. Ngan P, Yiu C, Hu A, Hägg U, Wei SH, Gunel E. Cephalometric and occlusal changes following maxillary expansion and protraction. Eur J Orthod 1998;20:237–54.
11. Ngan P, Hägg U, Yiu C, Wei SH. Treatment response and long-term dentofacial adaptations to maxillary expansion and protraction. Semin Orthod 1997;3:255–64.
12. da Silva Filho OG, Magro AC, Capelozza Filho L. Early treatment of the Class III malocclusion with rapid maxillary expansion and maxillary protraction. Am J Orthod Dentofacial Orthop 1998;113:196–203.
13. Sung SJ, Baik HS. Assessment of skeletal and dental changes by maxillary protraction. Am J Orthod Dentofacial Orthop 1998;114:492–502.
14. Baccetti T, Franchi L, McNamara JR. Cephalometric variables predicting the long-term success or failure of combined rapid maxillary expansion and facial mask therapy. Am J Orthod Dentofacial Orthop 2004;126:16–22.
15. Ghiz MA, Ngan P, Gunel E. Cephalometric variables to predict future success of early orthopedic Class III treatment. Am J Orthod Dentofacial Orthop 2005;127:301–6.
16. Hägg U, Tse A, Bendeus M, Rabie AB. Long-term follow-up of early treatment with reverse headgear. Eur J Orthod 2003; 25:95–102.
17. Wells AP, Sarver DM, Proffit WR. Long-term efficacy of reverse pull headgear therapy. Angle Orthod 2006;76: 915–22.
18. Westwood PV, McNamara JA, Baccetti T, Franchi L, Sarver DM. Long-term effects of Class III treatment with rapid maxillary expansion and facemask therapy followed by fixed appliances. Am. J Orthod Dentofacial Orthop 2003;123: 306–20.
19. Holberg C, Mahaini L, Rudzki I. Analysis of sutural strain in maxillary protraction therapy. Angle Orthod 2007;77: 586–94.
20. Staudt CB, Kiliaridis S. A nonradiographic approach to detect Class III skeletal discrepancies. Am J Orthod Dentofacial Orthop 2009;136:52–9.
21. Baccetti T, Franchi L, McNamara JA Jr. The Cervical Vertebral Maturation (CVM) method for the assessment of optimal treatment timing in dentofacial orthopaedics Semin Orthod 2005;11:119–29.
22. Bjork A. The face in profile. Svensk Tandi Tidskr 1947;40: Suppl.
23. Odergaard J. Growth of the mandible studied with the aid of metal implant. Am J Orthod 1970;57:145–57.
24. Riolo ML, Moyers RE, McNamara JA Jr, Hunter WS. An atlas of craniofacial growth: cephalometric standards from the University School Growth Study, The University of Michigan. Monograph No 2. Craniofacial Growth Series. Ann Arbor: Center for Human Growth and Development, The University of Michigan; 1974.

25. Ferro A, Nucci LP, Ferro F, Gallo C. Long-term stability of skeletal Class III patients treated with splints, Class III elastics, and chincup. Am J Orthod Dentofacial Orthop 2003; 123:423–34.
26. Hong H, Ngan P, Han G, Qi LG, Wei SH. Use of onplants as stable anchorage for facemask treatment: a case report. Angle Orthod 2005;75:453–60.
27. Kircelli BH, Pektas ZÖ, Uçkan S. Orthopedic protraction with skeletal anchorage in a patient with maxillary hypoplasia and hypodontia. Angle Orthod 2006;76:156–63.
28. Liou EJ, Tsai WC. A new protocol for maxillary protraction in cleft patients: repetitive weekly protocol of alternate rapid maxillary expansions and constrictions. Cleft Palate Craniofac J 2005;42:121–7.
29. da Silva Filho OG, Osawa TO, Okada CH, Okada HY, Dahmen L. Anquilose intencional dos caninos decíduos como reforço de ancoragem para a tração reversa da maxila. Estudo cefalométrico prospectivo. Dental Press Ortodon Ortop Facial 2006;11:35–44.
30. Baik HS. Clinical results of maxillary protraction in Korean children. Am J Orthod Dentofacial Orthop 1995;108: 583–92.
31. Pangrazio-Kulbersh V, Berger J, Kersten G. Effects of protraction mechanics on the midface. Am J Orthod Dentofacial Orthop 1998;114:484–91.
32. Saadia M, Torres E. Sagital changes after maxillary protraction with expansion in Class III patients in the primary, mixed and late mixed dentitions: a longitudinal retrospective study. Am J Orthod Dentofacial Orthop 2000;117: 669–80.
33. Macdonald KE, Kapust AJ, Turley PK. Cephalometric changes after the correction of Class III malocclusion with maxillary expansion facemask therapy. Am J Orthod Dentofacial Orthop 1999;116:13–24.
34. Chung C, Font B. Skeletal and dental changes in the sagittal, vertical, and transverse dimensions after rapid palatal expansion. Am J Orthod Dentofacial Orthop 2004;126: 569–75.
35. Wertz RA. Skeletal and dental changes accompanying rapid midpalatal suture opening. Am J Orthod 1970;58:41–66.