CONTINUING EDUCATION

Early treatment of the Class III malocclusion with rapid maxillary expansion and maxillary protraction

Omar Gabriel da Silva Filho, DDS, MDS,[a] Adriana Cecília Magro, DDS,[b] and Leopoldino Capelozza Filho, DDS, MDS, PhD[c]
Sao Paulo, Brazil

This study comprised a sample of 31 patients with Class III malocclusion (21 girls and 10 boys), with ages ranging from 5 years 2 months to 11 years 6 months. All patients were in the deciduous or mixed dentition. The indicated treatment was rapid maxillary expansion, immediately followed by maxillary protraction with the facial mask. Mean treatment time was 8 months, varying from 4 to 24 months. The therapy induced both dental and skeletal alterations. Skeletal alterations consisted of maxillary anterior displacement and mandibular downward and backward rotation, improving facial profile. Dental alterations, known as dentoalveolar compensations, consisted of a tendency of labial tipping of the maxillary incisors and lingual tipping of the mandibular incisors. (Am J Orthod Dentofacial Orthop 1998;113:196-203.)

Orthodontists often face Class III malocclusions in the permanent dentition and, as a rule, they assume the role of preparing teeth for orthognathic surgery, after the active stage of facial growth has finished. However, a more pertinent question is with the child: when should one treat Class III malocclusion early? The answer for this question has been the center of a controversy which sets on one side the benefits of a treatment without orthognathic surgery, despite a possible dental compensation, and, on the other side, the disadvantages of a treatment that sometimes may be long and with unexpected results for facial esthetics.

Early applied orthodontic therapy has to be effective from a skeletal point of view, as the discrepancy to be corrected is essentially basal. Among the variety of treatments proposed, we have adopted a protocol of correction of the Class III malocclusion for the maxilla (Fig. 1), thus limiting our approach to Class III cases with maxillary involvement. The excellent results of experimental works with animals[1-6] have influenced the clinical adoption of such approach.[7-23]

Studies with animals uniformly show that orthopedic forces are able to provide significant sagittal changes in the growing craniofacial complex, by stimulating the anterior displacement of the entire maxilla,[1,3,18,22] with a significant increase of cellular activity at the circumaxillary sutures and at the tuberosity,[2,5,12] at the bone surfaces through the periosteal influence[2] and even at the deeper cranial structures, such as the synchondrosis of the sphenoid bone.[2] The midfacial spatial changes have been corroborated through implants.[2-4] The concomitant influence on the dental arches from the orthopedic mechanics cannot be avoided as the support of the appliances are on the teeth,[2,3] although it is negligible in some cases.[18] Orthodontic effect only may be ruled out through the use of an exclusively skeletal anchorage, without the mediation of the dental arches, for example, with the aid of implants in the facial bones.[6] Relapse always occurs,[6] and its importance seems to be directly dependent on the extent of the retention period.[9]

Research studying the biomechanics of forces produced within the craniofacial bones by maxillary protraction show an action within the bones[21,24,25] and within the dentoalveolar process,[25,26] which tends to displace the upper dental arch and the midfacial bones in an anterior direction, with varying patterns of vertical behavior. A tendency for constriction at the anterior region of upper dental arch has also been noted.[24,26]

As the clinical, experimental, and biomechanical studies certify, the orthopedic approach on the maxilla for Class III correction, when well indicated, enables a morphologic and functional condition that favors the ensuing normal facial growth, in addition to creating more acceptable esthetics in the early stages. The aim of this study consists in evaluating the immediate clinical effects, on the basis of cephalometry, which are induced on the dentofacial structure by maxillary protraction assisted by rapid maxillary expansion (Fig. 1).

From the Hospital for Research and Rehabilitation of Cleft Lip and Palate, University of São Paulo.
[a]Orthodontist.
[b]Resident of the Department of Orthodontics, [c]Assistant Professor at Faculty of Dentistry of Bauru and Head of the Department of Orthodontics.
Reprint requests to: Dr. Omar Gabriel da Silva Filho, Rua Silvio Marchione, 3-20 - Caixa Postal: 620, 17043-900 - Bauru - São Paulo - Brazil.

0889-5406/98/$5.00 + 0 **8/1/77091**

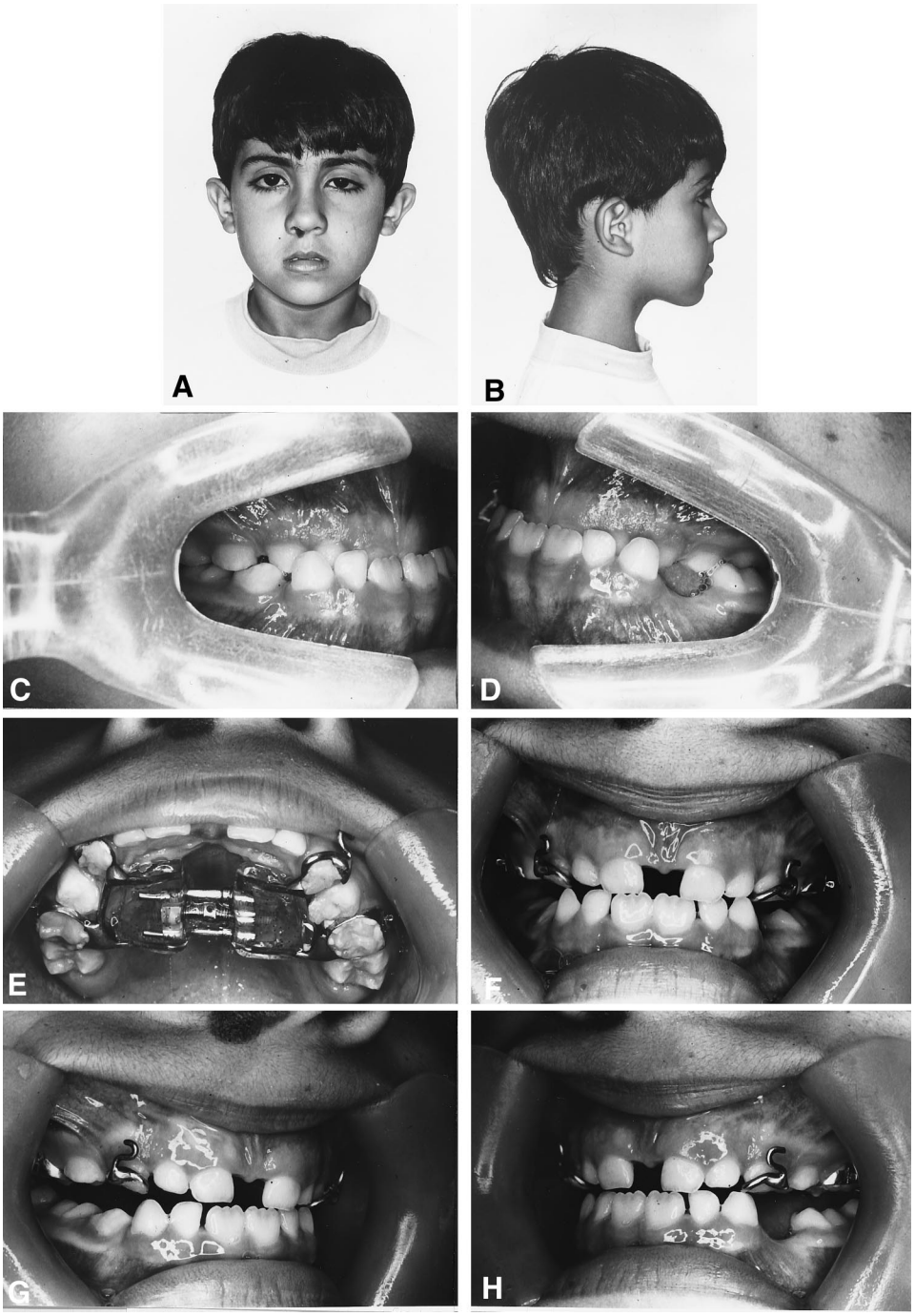

Fig. 1. Patient with dental and facial Class III pattern. Rapid maxillary expansion, in association with maxillary protraction, returned to facial and dental structures Class I relationship after 12-month treatment.

MODUS OPERANDI

The orthodontic treatment protocol that has been chosen at the Hospital for Research and Rehabilitation of Cleft Lip and Palate of the University of São Paulo, Brazil, consists in a transverse orthopedic therapy, with a rapid maxillary expansion, followed by the anteroposterior orthopedic therapy through the maxillary protraction (Fig. 1 and Table I). The expansion is indicated for real and relative maxillary deficiencies and is achieved with the Haas fixed expander appliance containing soldered hooks

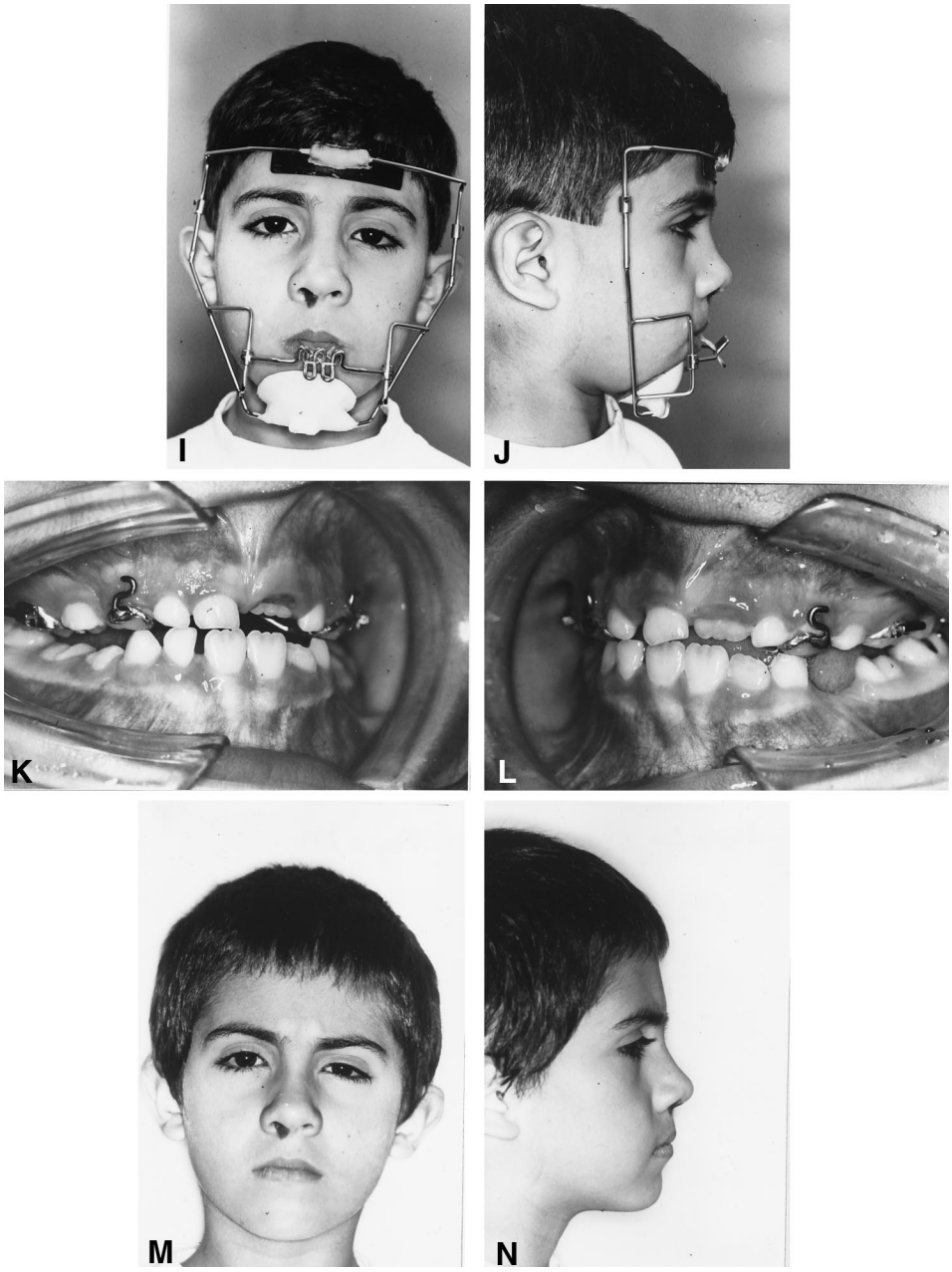

Fig. 1. (Continued)

in the canine regions for the protracting elastics. The acrylic tissue support strengthens the anchorage of the metallic structure for the maxillary traction in an anterior direction. It produces a good anchorage mainly after its dramatic effect of maxillary dysjunction. The sutural dissociation of the maxilla, rebounding in the cellular activity of the circumaxillary sutures, enhances the effect of the maxillary protraction, which must start immediately after the end of the active period of the expansion.[15,20,25,27,28] The expansion appliance also counteracts the contraction effect of the upper dental arch on the canine region during maxillary protraction.[22,26]

The maxillary protraction was performed in this study's sample through a Delaire facial mask (Fig. 1 and Table II), using elastics with a force of about 350 gm. This appliance, anchored on two points of the face, forehead and menton, maintains good stability during the process of maxillary traction, guaranteeing the mechanical efficacy of maxillary

Table I. Cephalometric measurements of the patient from Fig. 1

Cephalometric measurements	*Initial*	*Final*
SNA	80.0	80.5
SNB	77.0	76.5
ANB	3.0	4.0

protraction. The time period for the use of the mask is individual and lasts an average of 1 year, 14 hours daily until the overcorrection of the anterior crossbite, and 10 hours daily thereafter during the retention period. Maxillary protraction is performed from the anterior region of the expansion appliance, specifically at the canine region,[12] as the effect of the maxillary displacement is greater, despite a smaller rotational effect.[14]

If the opportunity exists, treatment must begin in the deciduous dentition, after the child is 5 years old, but it also has a significant orthopedic effect in the mixed dentition. Nevertheless, according to our clinical experience, from the permanent dentition stage on, its effect is essentially limited to dentoalveolar movements.

Neither of these two appliances are new. The orthopedic expansion appliance has been largely disclosed in the American literature since the 1960s,[29] and has been routinely used in our clinic. The facial mask that has been popularized by Delaire is also common in our clinic, as shown by Table II, which compiles data in the literature related to maxillary protraction. The therapeutic philosophy advocated adds the advantages of both appliances, aiming for a three-dimensional orthopedic effect, which is more evident at the middle face.

MATERIAL AND METHOD

The research sample comprised 31 children (21 girls and 10 boys) with Class III malocclusion, with an age range between 5 years and 2 months and 11 years and 6 months. Most of these 31 children were in the mixed dentition.

These children were patients of the preventative and interceptive orthodontics section of the Hospital for Research and Rehabilitation of Cleft Lip and Palate, at the University of São Paulo, Brazil, and have been treated according to the outlined philosophy for the correction of Class III malocclusion (rapid maxillary expansion + maxillary protraction), as illustrated in Fig. 1. Mean treatment time was 8 months, ranging from 4 to 24 months. We tried to get an overcorrection of the overjet or a harmonious face (Fig. 1) through this approach.

The results obtained with this therapy have been evaluated through pretreatment and posttreatment lateral radiographs. Cephalometric measurements that were used allowed for the evaluation of the sagittal behavior of the jaws, (SNA, N-perpA, ANB, NAP), the vertical behavior of the jaws (SNGoGN, SNGn, LAFH), and the behavior of the dental arches (1.PP, IMPA).

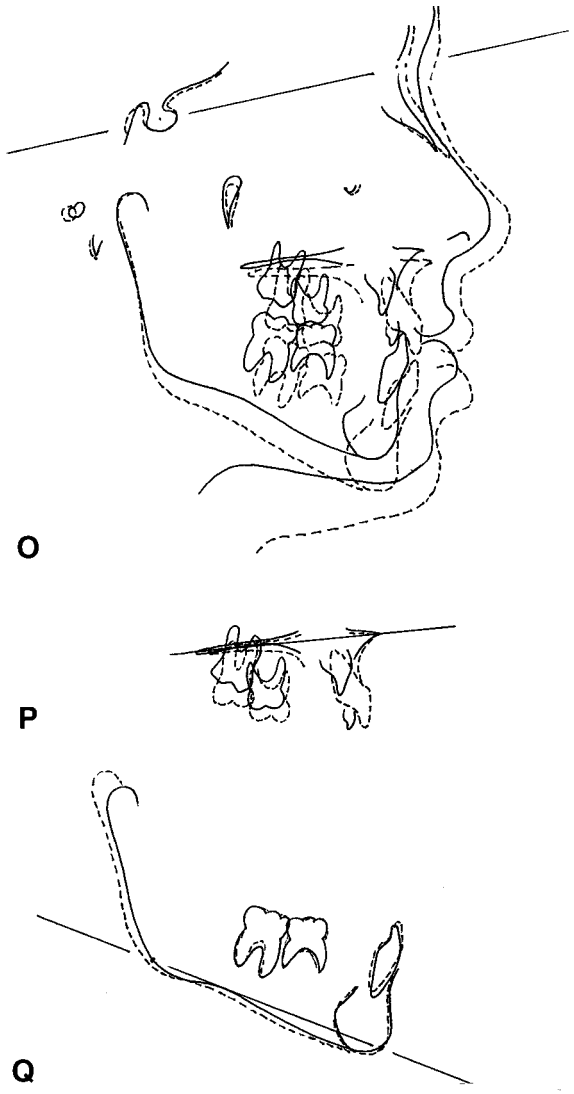

Fig. 1. Cont'd. Superimposition of initial *(continuous line)* and final *(dotted line)* cephalometric tracings (**O, P,** and **Q**).

1. Sagittal behavior of the jaws (Fig. 2): SNA, N-perpA, SNB, ANB, NAP;
2. Vertical behavior of the jaws (Fig. 3): SNGoGN, SNGn, LAFH;
3. Behavior of the dental arches (Fig. 4): 1.PP, IMPA.

The results have been statistically analyzed to determine the means and standard deviations and submitted for the application of the Student's *t* test to evaluate the significance of the results.

RESULTS AND DISCUSSION

All cephalometric measurements used in this study (Tables III, IV and V) showed statistically

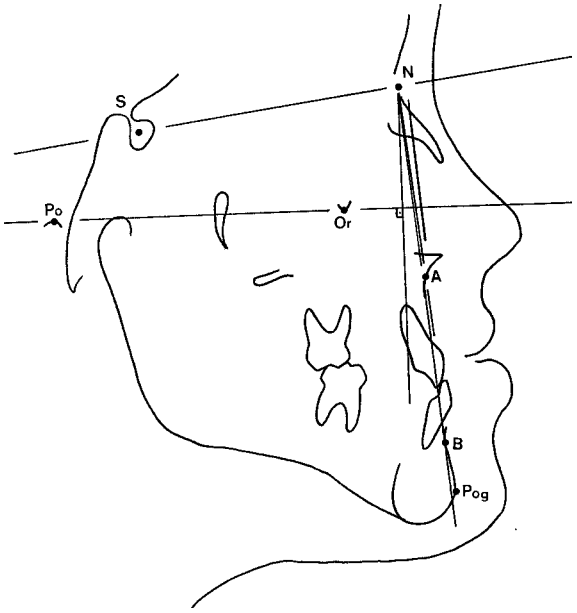

Fig. 2. Cephalometric tracing with measurements indicating sagittal behavior of jaws (SNA, SNB, ANB, NAP, N-perpA).

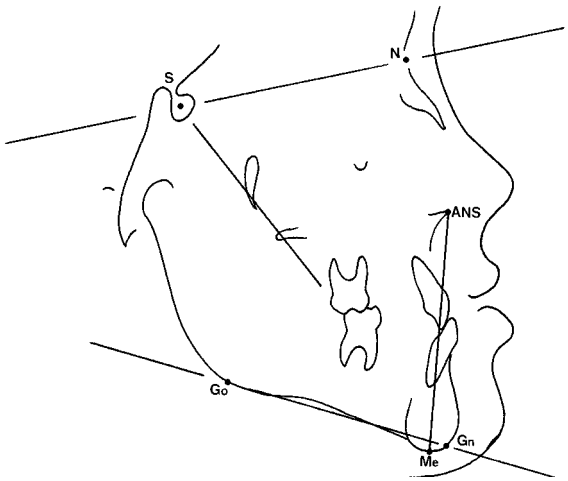

Fig. 3. Cephalometric tracing with measurements indicating vertical behavior of jaws (SN.GoGN, SNGn, LAFH).

Table II. Compilation of data referring to maxillary protraction (chronological order distribution)

Author	*Year*	*RME*	*Maxillary protraction*	*Force magnitude*	*Application point*	*Time usage (months)*	*Hours/day*
Irie	1975	Haas	Sky Hook + chincap	400gm	1st molar	16	—
			Sky Hook	400gm	1st molar	10	—
Nanda	1980	Haas	Sky Hook	500gm/side	1st molar	4	20-22
				750gm/side		7-8	15-18
Cozzani	1981	Haas	Mask	500-1000gm/side	Canine or 1st molar	14,5	Maximum possible
Campbell	1983	Hyrax	Mask or Sky Hook	14 and 16 ounces/side	1st molar	3-12	12
Wisth	1987	Quadhelix	Mask	300gm/side	Canine	3-12	12
Ishii	1987	Does not expand	Sky Hook	200-300gm/side	1st molar or 1st premolar	11-24	—
McNamara	1987	Fixed maxillary splint	Mask	14 ounces/side	Canine or 1st deciduous molar	3-5 active 3-6 retention	24 12
Turley	1988	Haas	Mask	150-200gm (initial) 400-600gm	Canine	2-6 more time	24 14
Tindlund	1989	Quadhelix	Mask	700gm	Canine	12	—
Silva	1989	Haas	Sky Hook	—	Canine	—	—
Merningos	1990	Does not expand	Mask	125gm (2 months) 175gm (2 months) 250gm (rest of treatment)	Canine	15-26	—
Capelozza	1990	Haas	Sky Hook	450gm/side	1st molar	10	—
Hickhan	1991	Hyrax	Mask	600-800gm/side	Canine	—	—
Ngan	1992	Hyrax	Mask	600-800gm/side	Canine	6(assessment)	12-16
Staggers	1992	RME	Mask	500gm/side	Canine or 1st molar	6	14
Major	1993	Hyrax	Mask	100-150gm/side (initial) 300-500gm/side	Canine	4-8 12-16	24 14
This study	1996	Haas	Mask	350gm	Canine	12	14

significant differences. The only exception was the 1.PP angle, which, although increased and contributing to the inevitable dental compensation, did not achieve statistical significance (Table V). The review and discussion of the results follow the order of distribution of the cephalometric measurements in the Material and Method section: sagittal behavior of the jaws (Table III), vertical behavior of the jaws

Table III. Sagittal behavior of the jaws as to the use of rapid expansion and maxillary protraction

	Initial		Final			
	X	SD	X	SD	Difference	t test
SNA	82.00	3.65	83.00	4.05	1.09	*
SNB	80.68	3.49	79.60	3.50	−1.00	*
ANB	1.42	1.74	3.48	1.81	2.06	*
NAP	2.61	4.57	6.76	4.29	4.14	*
N-PerpA	−0.71	2.96	0.77	3.79	1.48	*

*Significant at the 1% level of confidence.

Table IV. Vertical behavior of the jaws as to the use of rapid expansion and maxillary protraction

	Initial		Final			
	X	SD	X	SD	Difference	t test
SN.GoGN	33.35	4.75	34.98	5.13	1.62	*
SN.GN	65.79	3.34	67.25	3.91	1.46	*
LAFH	59.77	4.00	62.87	4.67	3.16	*

*Significant at the 1% level of confidence.

Table V. Behavior of the dental arches as for the use of rapid expansion and maxillary protraction

	Initial		Final			
	X	SD	X	SD	Difference	t test
1.PP	112.34	8.47	114.54	7.19	2.20	NS
IMPA	88.60	8.15	86.42	7.06	−2.18	**

**Significant at the 5% level of confidence.
NS, Not significant.

(Table IV), and behavior of the dental arches (Table V).

The sagittal alterations were considered positive once the posttreatment cephalometric values no longer expressed a Class III pattern, but approached a Class I cephalometric pattern (Table III). From a clinical point of view, the orthopedic therapy also accounted for important facial changes. Both measurements assessing the behavior of the maxilla show its anterior displacement. The SNA angle increased 1° and the N-perpA measurement increased 1.5 mm, bearing in mind that these cephalometric measurements do not usually change in normal conditions.[30] These increments gain importance as they give a contribution to a more expressive middle face and represent the main goal of this therapy. Although some controversy exists in the literature,[31] we have been able to substantiate that rapid maxillary expansion does not readily displace

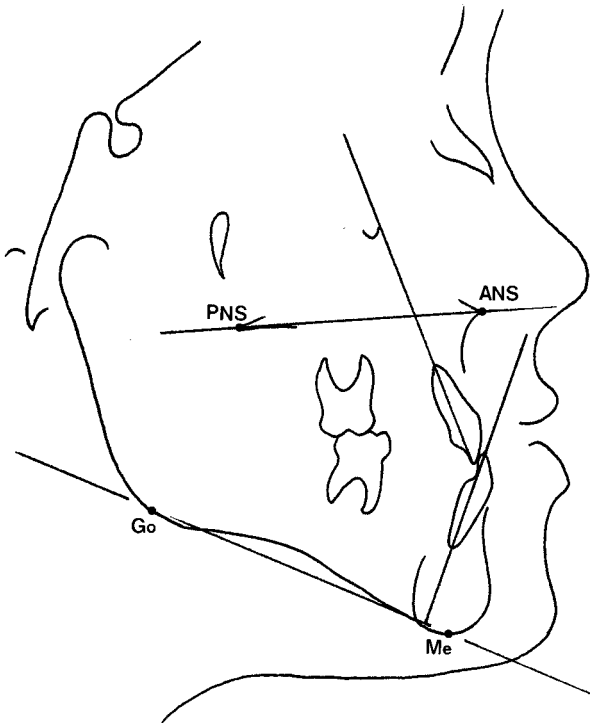

Fig. 4. Cephalometric tracing with measurements indicating behavior of dental arches (1.PP and IMPA).

point A anteriorly, and this is true both in the mixed and permanent dentitions.[20,32] The forward displacement of the maxilla with the use of the facial mask has been demonstrated both clinically and experimentally.[1-4,6,14,17,22]

Although the Haas expander appliance is not able to displace maxilla anteriorly, it is our option in association with the protraction mask, with the intention of anteriorly displacing the middle face. This option is justified by the mechanical factor of anchorage and by the biologic factor, represented by the cellular alteration induced on the circumaxillary sutures with the palatal dysjunction.

Wisth et al.[23] did not find the anterior displacement that they expected, in a protocol very similar to the present one. Most likely, the use of a quadhelix expander appliance instead of a Haas expander may have contributed to the reduced anterior displacement of the nasomaxillary complex.

The measurement referring to sagittal mandibular response (SNB angle) decreased 1°. Similarly to results of Ishii et al.,[14] the rate between maxillary anterior displacement and mandibular retroposition was almost 1:1. This decrease is not a reflection of a change in dimension, but of a change in position, diagnosed by the SN.GoGn and SN.GN angles.

Downward and backward mandibular rotation takes point B backward. This is favorable because it allows an increase in facial convexity, but it can contribute negatively to the lower anterior facial height increase (LAFH). As the effective dimensional response of this therapy is restricted to the maxilla, with only a change in position over the mandibular bone, we conclude that the mandibular role in facial discrepancy, with a clinically significant excess of anterior facial height, can worsen the treatment prognosis for the patient with Class III malocclusion, unless facial height is deficient to begin with.

Facial convexity angles (ANB, NAP) showed a positive change after the Class III correction, as a consequence of the forward movement of the point A and of the retropositioning of the point B. The ANB angle increased 2° and the NAP angle increased 4°. These increases are the main basis for the facial improvement of the patients.

To assess the vertical behavior of the jaws, three cephalometric measurements have been chosen (Table IV). The Steiner's analysis[33] angles (SN.GoGN, SN.GN) and McNamara's analysis[34] measurement (ANS-Me) represent lower anterior facial height. All these measurements showed statistically significant increases, as a reflection of the mandibular downward and backward rotation. This behavior may be explained, in part, by the extrusion of the molars, as a consequence of the rapid maxillary expansion.[20,31] The discreet improvement often observed in the overjet immediately after the rapid maxillary expansion may be due to the mandibular rotation. Nevertheless, this mandibular rotation is mentioned frequently in the literature, even with methods that have not used rapid maxillary expansion before maxillary protraction.

The behavior of the dental arches in view of the applied orthopedic treatment could have been foreseen and could not have been avoided because the anchorage for maxillary protraction is in the upper dental arch. The participation of the teeth in the anchorage for the maxillary protraction enables the anterior displacement of upper dental arch.[2,3,25,26] The observed change of the cephalometric measurements shows what we call dental compensation, or, part of the effort for repositioning of apical bone is lost with tipping of the teeth and alveolar processes (Table V). The upper incisors have tipped 2° in a labial direction, while the lower incisors have tipped 2° in a lingual direction.

CONCLUSION

This study assesses the results of the treatment of patients with Class III malocclusion at an early stage (deciduous or mixed dentition), with an efficient orthodontic therapy of rapid maxillary expansion plus maxillary protraction. Mean treatment time of 8 months induced positive changes in the sagittal configuration of the face with statistically significant cephalometric results. The patients were instructed to use 14 daily hours of maxillary protraction until the overcorrection of incisor relationship was attained.

Cephalometric results show skeletal and dentoalveolar changes. Skeletal changes are the maxillary forward movement (SNA, N-perpA) and the downward and backward mandibular rotation (SNGoGN, SNGn, LAFH), with a decrease of prognathism (SNB). These changes have induced favorable changes in the facial profile (ANB and NAP). Dentoalveolar changes are mainly the linguoversion of the lower incisors (IMPA) and the labial inclination of the upper incisors (1.PP).

The results support rapid maxillary expansion, immediately followed by a maxillary protraction, for the correction of Class III malocclusion.

REFERENCES

1. Dellinger EL. A preliminary study of anterior maxillary displacement. Am J Orthod 1973;63:509-16.
2. Jackson GW, Kokich VG, Shapiro PA. Experimental and postexperimental response to anteriorly directed extraoral force in young Macaca nemestrina. Am J Orthod 1979;71:249-77.
3. Kambara T. Dentofacial changes produced by extraoral forward force in the Macaca irus. Am J Orthod 1977;71:249-77.
4. Nanda R. Protraction of maxilla in rhesus monkeys by controlled extraoral forces. Am J Orthod 1978;74:121-41.
5. Nanda R, Hickory W. Zygomaticomaxillary suture adaptations incident to anteriorly directed forces in rhesus monkeys. Angle Orthod 1984;54:199-210.
6. Smalley WM, Shapiro PA, Hohl TH, Kokich VG, Bränemark PI. Osseointegrated titanium implants for maxillofacial protraction in monkeys. Am J Orthod Dentofac Orthop 1988;94:285-95.
7. Campbell PM. The dilemma of Class III treatment: early or late. Angle Orthod 1983;53:175-91.
8. Capelozza Filho L, da Silva Filho OG. Expansão rápida da maxila: considerações gerais e aplicação clínica. In: Interlandi S (coordinator). Ortodontia: bases para a iniciação. 3rd ed. São Paulo: Artes Médicas; 1994. p. 393-418.
9. Capelozza Filho L, Taniguchi SM, Silva Filho OG. Expansão rápida e tração extrabucal reversa da maxila na dentadura mista: comentários através de caso clínico. Ortodontia 1990;23:66-78.
10. Cozzani G. Extraoral traction and Class III treatment. Am J Orthod 1981;80:638-50.
11. DeLaire J. La croissance maxillaire. Trans Eur Orthod Soc 1971:81-102.
12. Hickham JH. Maxillary protraction therapy: diagnosis and treatment. J Clin Orthod 1991;25:102-13.
13. Irie M, Nakamura S. Orthopedic approach to severe skeletal Class III malocclusion. Am J Orthod 1975;67:377-92.
14. Ishii H, Morita S, Takeuchi Y, Nakamura S. Treatment effect of combined maxillary protraction and chincap appliance in severe skeletal Class III cases. Am J Orthod Dentofacial Orthop 1987;92:304-12.
15. McNamara J. An orthopedic approach of the treatment of Class III malocclusion in young patients. J Clin Orthod 1987;21:598-608.
16. Major PW, Elbadrawy HE. Maxillary protraction for early orthopedic correction of skeletal Class III malocclusion. Pediatr Dent 1993;15:203-7.
17. Memrmingos J, Full CA, Andreasen G. Protraction of the maxillofacial complex. Am J Orthod Dentofacial Orthop 1990;98:47-55.
18. Nanda R. Biomechanical and clinical considerations of a modified protraction headgear. Am J Orthod 1980;78:125-39.
19. Ngan P, Wei SHY, Hagg U, Yui CKY, Merwin D, Stickel B. Effect of protraction headgear on Class III malocclusion. Quintessence Int 1992;23:197-207.
20. Silva Filho OG, Caricati JA, Capelozza Filho L, Cavassan AO. Expansão rápida da

maxila na dentadura permanente: avaliação cefalométrica. Ortodontia 1994;25:69-76.
21. Staggers JA, Germane N, Legan H. Clinical considerations in the use of protraction headgear. J Clin Orthod 1992;24:87-91.
22. Tindlund RS. Orthopedic protraction of the midface in the deciduous dentition. J Craniomaxillofac Surg 1989;17:17-9.
23. Wisth PJ, Tritrapunt A, Rygh P, Boe OE, Nordeval K. The effect of maxillary protraction on front occlusion and facial morphology. Acta Odontol Scand 1987;45:227-37.
24. Hata S, Itoh T, Nakagawa M, Kamogashir K, Ichikawa K, Matsumoto M, et al. Biomechanical effects of maxillary protracton on the craniofacial complex. Am J Orthod Dentofacial Orthop 1987;91:305-11.
25. Tanne K, Hiraga J, Sakuda M. Effects of directions of maxillary protraction forces on biomechanical changes in craniofacial complex. Eur J Orthod 1989;11:382-91.
26. Tanne K, Sakuda M. Biomechanical and clinical changes of the craniofacial complex from orthopedic maxillary protraction. Angle Orthod 1991;61:145-52.
27. da Silva Filho OG, Kina J, Almeida AM, Okada T. Expansão ortopédica da maxila em estágios prococes do desenvolvimento oclusal: confecção laboratorial e apresentação de caso clínico. Rev Bras Odontol 1989;46:25-34.
28. Turley P. Orthopedic correction of Class III malocclusion with palatal expansion and custom protraction headgear. J Clin Orthod 1982;22:314-24.
29. Haas AJ. Rapid expansion of the maxillary dental arch and nasal cavity by opening the midpalatal suture. Angle Orthod 1961;31:73-90.
30. Riolo ML, Moyers RE, McNamara Jr JA, Hunter WS. An atlas of craniofacial growth: cephalometric standards from the University School growth study, The University of Michigan. Monograph 2, Craniofacial Growth Series. Ann Arbor: Center for Human Growth and Development, The University of Michigan; 1974.
31. Haas AJ. Palatal expansion: just the beginning of dentofacial orthopedics. Am J Orthod 1970;57:219-55.
32. Silva Filho OG, Villas Boas MC, Capelozza Filho L. Rapid maxillary expansion in the deciduous and mixed dentitions: a cephalometric evaluation. Am J Orthod Dentofacial Orthop 1991;100:171-81.
33. Steiner C. Cephalometrics for you and me. Am J Orthod 1953;39:729-55.
34. McNamara J. A method of cephalometric evaluation. Am J Orthod 1984;86:449-69.