DOI: 10.1111/j.1365-263X.2009.01015.x

INTERNATIONAL JOURNAL OF PAEDIATRIC DENTISTRY

Anterior open bite: a case–control study

MÔNICA VILELA HEIMER, CÍNTIA REGINA TORNISIELLO KATZ & ARONITA ROSENBLATT

Departament of Preventive and Social Dentistry, Faculty of Dentistry of Pernambuco State University, Brazil

International Journal of Paediatric Dentistry 2010; 20: 59–64

Objective. The aim of this study was to assess the influence of sucking habits and facial pattern measurements on the development of anterior open bite (AOB).

Methods. A case–control study was carried out on 60 children aged 7 and 8 years attending municipal public schools in the city of Recife, Brazil. Data collection included interviews with guardians, oral examinations, and facial growth pattern analysis using cephalometric radiographs. The following cephalometric measurements were assessed: SN.Gn, SN.GoGn, FMA, and Facial Axis. Statistical analyses were performed using the Student's *t*-test and Pearson's chi-square test at a 5% level of significance.

Results. The percentage of children with sucking habits in the case group was much higher than in the control group (53.3% *vs* 16.7%) ($P = 0.003$). Children with sucking habits were six times more likely to develop AOB. Regarding the measurements assessed, no statistically significant differences were observed between groups.

Conclusion. This study found no evidence that variations in cephalometric angles (SN.Gn, FMA, SN.GoGn, and facial axis) are risk factors for AOB. Only sucking habits demonstrated a positive correlation with an increased AOB.

Introduction

Anterior open bite (AOB) is a malocclusion that considerably compromises aesthetics and function. It is characterised by dental and/or skeletal alterations that have an impact on quality of life[1]. AOB can be defined as the presence of a negative vertical relationship between the incisor margins of the upper and lower anterior teeth[2]. Prevalence ranges from 13% to 46.3% and is related to age, occurrence of oral habits and genetic inheritance, although no scientific evidence has yet been produced to corroborate the influence of this last factor[3–5].

Despite the close relationship between sucking habits and AOB, this type of malocclusion may also be present among those without such habits[2,6–8]. A full understanding of the aetiological factors is necessary for the establishment of an individualised treatment plan. According to a number of authors, AOB may develop as a result of inherited skeletal patterns that exercise a decisive influence over the growth and development of orofacial structures[2,5,9]. Thus, individuals with an inherited predisposition to this malocclusion are likely to present it and the degree of manifestation may be influenced by favourable or unfavourable environmental factors.

Although cephalometric parameters have been valuable in determining patterns, most patients with open bite do not have the cephalometric criteria suggestive of the condition, whereas most patients who have cephalometric measures considered to be suggestive of open bite do not, in fact, present it Moreover, far more people have sucking habits than have open bite[10,11].

The aim of this case–control study was to determine the influence of risk factors (sucking habits and facial growth pattern) on the aetiology of AOB among a group of children aged 7 and 8 years enrolled in municipal public schools in the city of Recife-PE (Brazil).

Material and methods

This case–control study was conducted in public schools in the city of Recife, the state

Correspondence to:
Mônica Vilela Heimer, Faculdade de Odontologia de Pernambuco/UPE – Avenida General Newton Cavalcanti, 1650 – CEP: 54753-220, Camaragibe, PE, Brazil. E-mail: monica@heimer.com.br

capital of Pernambuco (northeastern Brazil). The project was approved by the Ethics Committee of Pernambuco State University.

A pilot study was first conducted with 100 four-year-old children to determine the sample size of the main study. Next, a cohort study was carried out on a sample of 330 children aged 4–6 years, randomly selected from 14 of the 153 schools using a stratified randomised sampling technique. The nursery schools were randomly selected from each administrative region in proportion to the number of schools in each region[8]. At the end of a 2-year follow up, the dropout rate was 13% with 287 children remaining[12].

In the third phase, a case–control study was carried out to identify associated factors. The sample size was calculated using the formula for case–control studies available in the Statcalc program of Epi Info Version 6.0 (Atlanta, GA, USA). With a 95%CI, 99% test power and odds ratio of 14.84 for the presence of AOB in children exposed to sucking habits[12], a total of 60 children was calculated – 30 cases (presence of AOB) and 30 controls (absence of AOB). Children of both genders between 7 and 8 years of age enrolled in municipal public schools in the city of Recife took part of this study.

Data collection included interviews with guardians, oral examinations and facial growth pattern analysis using cephalometric radiographs. Questionnaires were filled out during personal interviews with each child's mother or caregiver, including questions on gender, date of birth and the presence, absence, or abandonment of nonnutritive sucking habits, such as dummy and/or digit sucking.

Dental examinations were performed under natural light in a classroom environment, using tongue depressors, gloves, and masks, in compliance with the infection control protocol of the Brazilian Ministry of Health. Occlusions were assessed through the manipulation of the jaws to obtain centric occlusion. The examiner was blinded to the data collected from the parental interviews. AOB was recorded when there was a lack of vertical overlap between the incisors with the posterior teeth in occlusion. Physiological AOB related to the eruption of the central permanent incisors was recorded as the absence of malocclusion. During the transition from primary to permanent dentition, the diagnosis of open bite was based on the conformation of the alveolar ridge.

Lateral-view cephalometric radiographs were taken at a radiology clinic in Greater Recife using the method described by Broadbent[13]. An ORTHOPHOS-3C x-ray machine (Firona, Germany) was used, operating at an average kVp ranging from 72 to 76, 10 mA, and 0.6 s exposure time using KodaK T-MAT radiographic film (18 × 24 cm), which was processed automatically using a Macrotec MX-2 processor (São Paulo, Brazil). Legal radiation protection measures were strictly obeyed.

Anatomical drawings, the demarcation of points, lines and planes, and cephalometric measurements were performed directly on the computer over the scanned images using an Epson 4100 CX transference scanner (São Paulo, Brazil) and CEF-X software (CDT, Mato Grosso, Brazil). To reduce method error in the tracing measurement, anatomic drawings, and the demarcation of cephalometric points were performed by a single radiologist (M.A.B.M.). Based on the objectives of the study, the following landmarks were used: S (sella), N (nasion), Go (gonion), Gn (gnation), Me (menton), Po (porion), Or (Orbitale), PTM (pterygomaxillary), and Ba (basion) and the following cephalometric measurements were taken:

- SN.Gn (*y*-axis) – angle formed by the intersection of the SN (sella-nasion) and SGn (sella-gnation) lines.
- SN.GoGn – angle formed by the intersection of the SN (sella-nasion) line with the GoGn plane or mandibular plane.
- FMA – formed by the horizontal Frankfurt plane (Po-Or) and the Tweed mandibular plane (Go-Me).
- Facial Axis – formed by the intersection of the Ba-N (basion-nasion) lines and the facial axis (PTM-Gn).

Figure 1 illustrates the points, planes, and angles used in the study.

Data were statistically analysed using the SPSS Version 13.0 (SPSS Inc, Chicago, IL, USA). All statistical tests considered a 5%

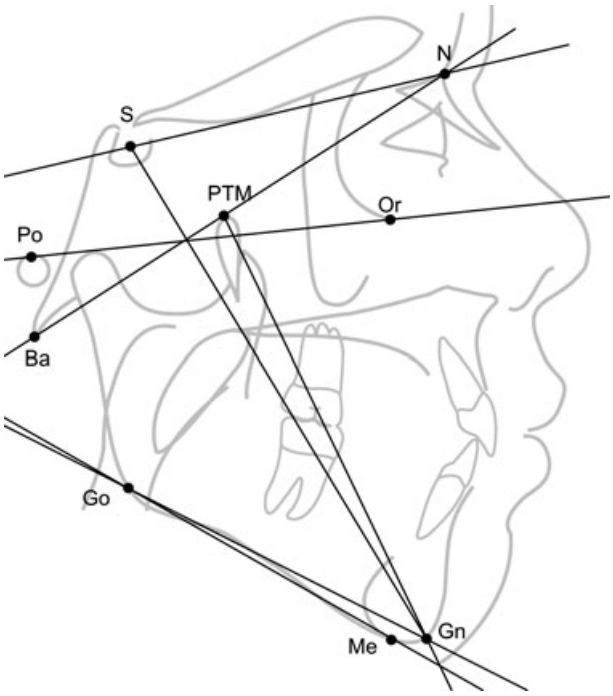

Fig. 1. Illustrate the points, planes and angles used in the study.

level of significance (margin of error) and 95%CI.

Results

A total of 46.7% of the AOB group and 60% of the control group were boys, whereas 53.3% of the case group and 40% of the control group were girls. There was, however, no significant difference between groups with regard to gender distribution ($P > 0.301$; Odds ratio: 1.71; CI: 0.62–4.77). The percentage of children with sucking habits was much higher among the AOB group (53.3%) than the control group (16.7%). This difference was statistically significant ($P = 0.003$; Odds radio: 5.71; CI: 1.72–18.94).

The average cephalometric measurements were higher among the control group for the SN.Gn, FMA, and SN.GoGn angles. Average Facial Axis was more negative among the control group than the AOB group. The two greatest differences in group averages were recorded for the Facial Axis and SN.Gn, with values of 1.23° and 1.22°, respectively. Nonetheless, no statistically significant differences were observed between groups for any of the measurements assessed (Table 1).

Table 1. Assessment of SN.Gn, FMA, Facial Axis, and SN.GoGn according to group.

		Group		
Variable	**Statistics**	**Cases (n = 30)**	**Controls (n = 30)**	***P*-value***
SN.Gn (Degrees)	Average	68.58	69.80	0.191
	SD	3.76	3.33	
FMA (Degrees)	Average	29.39	29.68	0.730
	SD	3.07	3.56	
Facial Axis (Degrees)	Average	−2.26	−3.49	0.166
	SD	3.24	3.54	
SN.GoGn (Degrees)	Average	37.43	38.03	0.563
	SD	3.66	4.24	

*Student's *t*-test with equal variances.

The average SN.Gn, FMA, and SN.GoGn measurements were higher among children that did not exhibit sucking habits. Average Facial Axis was more negative in children without sucking habits. The greatest difference was recorded for the SN.Gn angle. Nonetheless, no statistically significant differences were observed between those who exhibited sucking habits and those who did not for any of the cephalometric measurements assessed (Table 2).

Table 3 displays the results of self-corrected AOB according to the abandonment of sucking habits. The reference period for the analysis of these variables was the beginning of the 2002 cohort study[8] and the beginning of this study in 2005. Among the 51 children who exhibited AOB in 2002, 43.1% exhibited self-correction in this study. This percentage was

Table 2. Assessment of SN.Gn, FMA, Facial Axis, and SN.GoGn according to occurrence of sucking habits.

		Sucking Habit		
Variable	**Statistic**	**Yes (n = 21)**	**No (n = 39)**	***P*-value**
SN.Gn (Degrees)	Average	68.21	69.72	0.120*
	SD	4.27	3.08	
FMA (Degrees)	Average	29.26	29.68	0.639*
	SD	3.27	3.35	
Facial Axis (Degrees)	Average	−2.20	−3.24	0.337**
	SD	4.46	2.71	
SN.GoGn (Degrees)	Average	37.01	38.12	0.299*
	SD	4.03	3.89	

*Student's *t*-test with equal variances, **Student's *t*-test with unequal variances.

Table 3. Assessment of self-corrected anterior open bite according to the abandonment of sucking habits during period analysed.

	Self-Correction of AOB					
	Yes		No			
Variable	*N*	%	*N*	%	*P*-value*	RR (CI 95%)
Abandonment of sucking habits						
Yes	17	54.8	14	45.2	0.036**	2.19 (0.96–5.00)
No	5	25.0	15	75.0		1.00
Total	22	43.1	29	56.9		

*Pearson's chi-square test, **Significant association at 5.0%.

much higher among those who had abandoned sucking habits than those who had not abandoned such habits (54.8% and 25.0%, respectively). A statistically significant association was found between the abandonment of sucking habits and self-corrected AOB ($P = 0.036$).

The average SN.Gn, FMA, and SN.GoGn variables were higher among children who exhibited self-corrected AOB. The most negative average Facial Axis occurred among children who exhibited self-correction. Nonetheless, no significant differences were observed between the two sub-groups for any of the variables analysed (Table 4).

Discussion

The results of this study clearly demonstrate the influence of nonnutritive sucking habits on the presence of AOB. Children with sucking habits were 5.7 times more likely to exhibit AOB. There is consensus in the literature regarding nonnutritive sucking habits as risk factors for malocclusions, particularly AOB[3,7,14–20].

Table 4. Assessment of SN.Gn, FMA, Facial Axis, and SN.GoGn according to self-correction of anterior open bite in the period analysed.

		Self-correction of AOB in period analysed		
Variable	Statistic	Yes (*n* = 22)	No (*n* = 29)	*P*-value*
Sn.Gn (Degrees)	Average	70.07	68.45	0.114
	SD	3.31	3.75	
FMA (Degrees)	Average	30.18	29.36	0.389
	SD	3.64	3.12	
Facial Axis	Average	–3.62	–2.10	0.125
	SD	3.78	3.17	
Sn.GoGn	Average	38.38	37.37	0.370
	SD	4.28	3.71	

*Student's *t*-test with equal variances.

This study found no significant differences between the average cephalometric angle measurements of children with and without AOB. SN.Gn, and SN.GoGn angles were slightly higher and the Facial Axis was more negative among the group with normal occlusion. Based merely on clinical practice, some authors however, have stated that individuals who exhibit vertical facial growth (high facial skeleton) are considered more prone to AOB[2,5,21].

The findings of this study are in disagreement with those described by Cangialosi, but in agreement with those described by Stuani *et al.* and Klocke *et al.* with regard to mandibular plane angle[9,22,23].Cangialosi found that the SN.GoGn angle was significantly higher among individuals with AOB, demonstrating that the downward direction of mandible growth is an important factor in the development of this malocclusion[9]. Neverthless, it should be borne in mind that the group with AOB was composed of both children and adults and this lack of homogeneity in the sample may have caused bias in the results. Klocke *et al.* observed a tendency towards slightly higher values for this angle in the group with AOB[23]. As in this study, however, this difference was nonsignificant. In assessing the skeletal pattern of patients with and without AOB, Stuani *et al.* also found no significant differences in the SN.GoGn angle, indicating that the inclination of the mandibular plane in relation to the base of the cranium was similar between groups[22].

It is important to underscore the similarity between the results of this study and those described by Stuani *et al.*[22]. Both use the same study design, same age group and same sample size. The authors concluded that AOB did not have a skeletal origin and was probably because of the presence of sucking habits. These findings were corroborated when Stuani *et al.*[24]. re-evaluated the same sample to compare dental patterns between patients

with and without AOB. The results demonstrated that the angles of inclination of the upper and lower incisors differed significantly between the groups, suggesting that AOB may be of a dental origin.

In this study, facial pattern was not associated with AOB, which is in agreement with other findings that indicate that genetic factors in the aetiology of malocclusions appear to be less important than was previously believed and that many types of malocclusions may be acquired rather than inherited[25,26]. It should be stressed that, although cephalometric parameters are valid for the determination of facial growth, a large number of patients have cephalometric measurements indicative of open bite that is not confirmed clinically[10,11]. This supports the multi-factor nature of this malocclusion[2,5]. The presence of sucking habits did not influence the cephalometric angle measurements in this study, as no statistically significant differences were found. This suggests that children with sucking habits do not exhibit a tendency towards a greater divergence of angles. This finding is in agreement with that describe by Larsson as well as that described by Moore and McDonald in relation to the SN.GoGn measurement[15,27]. When these authors assessed the influence of persistent sucking habits on the angle formed by the mandibular plane and the base of the cranium, they found no influence from the persistence of the habit.

Self-corrected AOB was associated with the abandonment of nonnutritive sucking habits. Children who had given up this habit had a twofold greater likelihood of correcting the malocclusion. This finding corroborates information in the literature stating that the abandonment of sucking habits may establish self-correction[19–21,23,26–29].

Although no radiographs had been taken prior to the abandonment of sucking habits, the intention of this study was to use available data to assess whether self-correction would occur among children with a supposedly unfavourable vertical facial growth tendency. The results demonstrate that there were no statistically significant differences in average measurements between children who exhibited self-correction and those who did not. In fact, the former had slightly higher average measurements than the latter. These findings are at odds with those described by Ngan and Fields as well as those described by Almeida and Ursi, who argue that high facial skeleton is unfavourable to this malocclusion[2,5].

Most of the children had increased cephalometric measurements, which classified their condition as vertical facial growth tendency. The predominance of this type of facial skeleton may be attributed to the considerable presence of African-descent miscegenation in the sample. This race exhibits facial characteristics that are conducive to a vertical growth tendency[30]. Neverthless, it should be borne in mind that an individual may have a normal growth pattern regardless of facial type. Therefore, if an individual has a high, low, or average facial skeleton, he or she may exhibit balanced characteristics of his or her facial type.

Conclusion

Based on the findings of this study, the following conclusions may be drawn. (i) Sucking habits were a risk factor in the aetiology of AOB. Children with sucking habits had a sixfold greater likelihood of exhibiting this malocclusion. (ii) Facial growth patterns were not associated with the aetiology of AOB. (iii) The presence of sucking habits did not influence the cephalometric measurements taken. (iv) The abandonment of sucking habits was associated with the self-correction of AOB. (v) The cephalometric angle measurements studied were not associated with the self-correction of AOB.

What this paper adds

- Clear evidence from a case–control study regarding the multifactor nature of anterior open bite.

Why this paper is important to paediatric dentists

- Although cephalometric parameters are valid for the determination of facial growth, a large number of patients have cephalometric measurements indicative of open bite that is not confirmed clinically.
- It should be borne in mind that sucking habits can impair the facial pattern or lead to marked malocclusions.

References

1 Agou S, Locker D, Streiner DL, Tompson B. Impact of self-esteem on the oral-health-related quality of life of children with malocclusion. *Am J Orthod Dentofacial Orthop* 2008; **134**: 484–489.

2 Ngam P, Fields HW. Open bite: a review of etiology and management. *Pediatr Dent* 1997; **19**: 91–98.

3 Viggiano D, Fasano D, Monaco G, Strohmenger L. Breast feeding, bottle feeding, and non-nutritive sucking; effects on occlusion in deciduous dentition. *Arch Dis Child* 2004; **89**: 1121–1123.

4 Peres KG, Latorre MRDO, Sheiham A, Peres MA, Victora CG, Barros FC. Social and biological early life influences on the prevalence of open bite in Brazilian 6-year-olds. *Int J Paediatr Dent* 2007; **17**: 41–49.

5 Almeida RR, Ursi WJS. Anterior open bite: etiology and treatment. *Oral Health* 1990; **80**: 27–31.

6 Karjalainen S, Rönning O, Lapinleimu H, Simell O. Association between early weaning, non-nutritive sucking habits and occlusal anomalies in 3-year-old Finnish Children. *Int J Paediatr Dent* 1999; **9**: 169–173.

7 Vázquez-Nava F, Quezada-Castillo JA, Oviedo-Treviño S *et al.* Association between allergic rhinitis, bottle feeding, non-nutritive sucking habits, and malocclusion in the primary dentition. *Arch Dis Child* 2006; **91**: 836–840.

8 Katz CRT, Rosenblatt A. Nonnutritive sucking habits and anterior open bite in Brazilian children: a longitudinal study. *Pediatr Dent* 2005; **27**: 1–5.

9 Cangialosi TJ. Skeletal morphologic features of anterior open bite. *Am J Orthod Dentofacial Orthop* 1984; **85**: 28–36.

10 Dung DJ, Smith RJ. Cephalometric and clinical diagnosis of open bite tendency. *Am J Orthod Dentofacial Orthop* 1988; **94**: 484–490.

11 Klocke A. Does an anterior open bite in the early mixed dentition cause you to consider any form of orthodontic treatment? *Am J Orthod Dentofacial Orthop* 2003; **123**: 123A.

12 Heimer MV, Katz CRT, Rosenblatt A. Non-nutritive sucking habits, dental malocclusions, and facial morphology in Brazilian children: a longitudinal study. *Eur J Orthod* 2008; **30**: 580–585.

13 Broadbent BH. A new x-ray technique and its application to orthodontia. *Angle Orthod* 1931; **1**: 45–66.

14 Katz CRT, Rosenblatt A, Gondim PPC. Nonnutritive sucking habits in Brazilian children: effects on deciduous dentition and relationship with facial morphology. *Am J Orthod Dentofacial Orthop* 2004; **126**: 53–57.

15 Larsson E. Dummy- and finger sucking habits with special attention to their significance for facial growth and occlusion. 4. Effect on facial growth and occlusion. *Swed Dent J* 1972; **65**: 605–634.

16 Farsi NM, Salama FS. Sucking habits in Saudi children: prevalence, contributing factors and effects on the primary dentition. *Pediatr Dent* 1997; **19**: 28–33.

17 Warren JJ, Bishara SE. Duration of nutritive and nonnutritive sucking behaviors and their effects on the dental arches in the primary dentition. *Am J Orthod Dentofacial Orthop* 2002; **121**: 347–356.

18 Chevitarese ABA, Valle DD, Moreira TC. Prevalence of malocclusion in 4–6 year old Brazilian children. *J Clin Pediatr Dent* 2002; **27**: 81–85.

19 Bishara SE, Warren JJ, Broffitt B, Levy SM. Changes in the prevalence of nonnutritive sucking patterns in the first 8 years of life. *Am J Orthod Dentofacial Orthop* 2006; **130**: 31–36.

20 Bishara SE, Larsson E. Finger habits: their effects and their treatments-part 1. *Dent Assist* 2007; **76**: 14–18.

21 Vig KW, Fields HW. Facial growth and management of orthodontic problems. *Pediatr Clin North Am* 2000; **47**: 1085–1123.

22 Stuani AS, Matsumoto MA, Stuani MB. Cephalometric evaluation of patients with anterior open-bite. *Braz Dent J* 2000; **11**: 35–40.

23 Klocke A, Nanda RS, KahL-Nieke B. Anterior open bite in deciduous dentition: longitudinal follow-up and craniofacial growth considerations. *Am J Orthod Dentofacial Orthop* 2002; **122**: 353–358.

24 Stuani AS, Stuani AS, Stuani MBS, Saraiva MCP, Matsumoto MAN. Anterior open bite – cephalometric evaluation of the dental pattern. *Braz Dent J* 2006; **17**: 1–6.

25 Harris EF, Johnson MG. Heritability of craniometric and occlusal variables: a longitudinal sib analysis. *Am J Orthod Dentofacial Orthop* 1991; **99**: 258–268.

26 Varrela J, Alanen P. Prevention and early treatment in orthodontics: a perspective. *J Dent Res* 1995; **74**: 1436–1438.

27 Moore MB, McDonald JP. A cephalometric evaluation of patients presenting with persistent digit sucking habits. *Br J Orthod* 1997; **24**: 17–23.

28 Cozza P, Baccetti T, Franchi L, Mucedero M, Polimeni A. Sucking habits and facial hyperdivergency as risk factors for anterior open bite in the mixed dentition. *Am J Orthod Dentofacial Orthop* 2005; **128**: 517–519.

29 Larsson E. The prevalence and etiology of prolonged dummy and finger-sucking habits. *Eur J Orthod* 1985; **7**: 172–176.

30 Beane RA, Reimann G, Phillips C, Tulloch C. A cephalometric comparison of black open bite subjects and black normals. *Angle Orthod* 2003; **73**: 294–300.