

Allergic rhinitis as a possible risk factor for malocclusion: a case-control study in children

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Background. Prolonged oral respiration is known to cause postural alterations, which can lead to dental malocclusions. Allergic rhinitis, a common cause of upper airway obstruction in children, must therefore be seen as a possible risk factor in the development of malocclusions.

Aim. Aim of this study was to investigate the association between allergic rhinitis and malocclusions in primary and early-mixed dentition.

Design. A case-control study was carried out involving 275 Italian children aged 5–9. The case group and the control group were composed of 125 individuals affected by malocclusions and by 150 healthy patients, respectively. Through a

questionnaire, we assessed the presence of professionally diagnosed allergic rhinitis. Data were analysed to identify associations between these variables and the presence of malocclusions.

Results. Children with a history of allergic rhinitis had a threefold increased risk to develop one or more dento-skeletal alterations [OR = 3.16; 95% CI (1.79–5.58), $P < 0.001$]. Statistically significant associations were found between allergic rhinitis and the development of posterior crossbite and increased overjet. No significant association was found for anterior openbite.

Conclusions. Allergic rhinitis is a significant risk factor for the development of malocclusions in general and is associated with the development of posterior crossbite and increased overjet.

Introduction

Normal craniofacial development is a multifactorial complex phenomenon, influenced by both genetic and environmental factors. According to Moss Theory¹, it is believed that function also plays an important role in craniofacial and occlusal development. Several studies^{2–4} hypothesized that prolonged oral respiration during critical growth periods in children initiates a sequence of events that commonly results in dental and skeletal alterations. The presence of any obstacle in the respiratory system, especially in the nasal and pharyngeal regions, forces the patient to breathe through the mouth⁵. Mouth breathing, in turn, causes postural alterations such as open lips, lower or anterior tongue, postero-inferior rotation of the mandible, alteration

of the position of the head in relation to the neck, protrusion of the upper incisors and distal position of the mandible in relation to the maxilla^{6,7}. In addition to this, there is a change of the pressure that soft tissues exert on teeth and facial bones, altering these structures. Muscle alteration also influences mastication, deglutition and phonation as other muscles are eventually recruited for these function during mouth breathing^{8–10}.

Allergic rhinitis is the first major cause of airway obstruction, followed by the hypertrophy of the tonsils (pharyngeal and/or palatine). It is usually associated with several symptoms: not only absent nasal airflow, sneezing, itching, clear rhinorrhea, but also snoring, possible obstructive sleep apnoea syndrome (OSAS) and increased respiratory infections (otitis, rhinosinusitis, tonsillitis)^{11,12}.

Several previous studies investigated the effect of allergic rhinitis and/or mouth breathing on the development of dental malocclusion^{13–19}. These studies vary both in the age range of the children examined and in the

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methodologies used in the data analysis, thus leading to inhomogeneous results. The aim of our case-control study was to verify a possible relationship between allergic rhinitis and dental malocclusion in a sample of Italian children in the primary school age range.

Patients and methods

The study was performed between September 2010 and June 2011 at the Pediatric Dentistry Unit of the Department of Oral and Maxillo-Facial Sciences, 'Sapienza' University of Rome. A case-control study was carried out involving 275 children in the primary school age range, who came to the Unit for an initial dental examination. The case group consisted of 125 children (60 boys and 65 girls; mean age: 7.33 years; median: 8.00; range, 5–9) affected by one or more of the following malocclusions: posterior crossbite, anterior openbite and overjet. The control group consisted of 150 children (84 girls and 66 boys; mean age: 6.87 years; median 7.00; range, 5–9) without malocclusion, randomly selected from the same cohort of children that had generated the case.

Our sample of 125 children with malocclusion and 150 controls was evaluated as having a 90% power to detect an OR of 2.2 at a 5% significance rate for an exposure (allergic rhinitis) expected in controls equal to 13%. The study protocol was approved by the institutional ethics committee, and written informed consent was obtained from parents of all children.

All children were submitted to clinical examination by a single paediatric dentist, who assessed their malocclusion. The orthodontic evaluation also included the analysis of orthodontic casts obtained from the upper and lower arches and of lateral cephalometric radiographs. We evaluated the presence of posterior crossbite (mono- or bi-lateral), anterior openbite (>2 mm) and increased overjet (>3.5 mm).

During the examination, the presence or absence of mouth breathing was determined by the following factors: lip incompetence, dry lips and fogging on the lower side of a double-faced mirror. These factors were in

agreement with Moyer's criteria, also used by Bresolin *et al.*¹⁷ and by Hartgerink and Vig¹⁸.

Data relative to allergic rhinitis were collected through questionnaires directed to the parents of the children. To assess the presence and the severity of upper airway obstruction due to rhinitis, the following information were recorded:

- 1) existence of a professional diagnosis of allergic rhinitis;
- 2) type of allergic rhinitis and allergens to which the child was most sensitive (seasonal allergic rhinitis, i.e., caused by exposition to grass or pollens, or perennial allergic rhinitis, i.e., caused by exposition to dust mites or animal dander);
- 3) if the allergic child received a specific pharmacologic treatment and the type of treatment (oral or nasal corticosteroid or antihistamine);
- 4) if the child suffered from asthma and its frequency;
- 5) child's behaviour during sleep (snoring oral respiration, obstructive apnoea syndrome);
- 6) if the child had a history of repeated infections (otitis, rhinosinusitis or tonsillitis).

Categorical variables were expressed by count and percentage. We used the chi-squared test, or the Fisher's exact test when appropriate, to evaluate the association between allergic rhinitis and malocclusion. We also calculated odds ratios (OR) with a 95% confidence interval (CI) using the Wilson method. A value of $P < 0.05$ was considered statistically significant.

Statistical analyses were performed by using SPSS 15 software (Statistical Package for the Social Sciences, Chicago, IL, USA). The power analysis was performed using the UBC sample size calculator software.

Results

Table 1 summarizes the prevalence of the type of malocclusion in the case group. The most frequent type of malocclusion was increased overjet (74%, alone or combined with other types of malocclusions), followed by posterior crossbite (50% of the sample),

Table 1. Prevalence of malocclusions among patients in the case group.

Malocclusion	Frequency	Percentage
Overjet	43	34
Openbite	8	6
Posterior crossbite	21	17
Overjet + Openbite	11	9
Overjet + Posterior crossbite	28	22
Openbite + Posterior crossbite	4	3
Overjet + Openbite + Posterior crossbite	10	8
Total	125	100

whereas only 26% of the children were affected by anterior openbite.

Prevalence of allergic rhinitis was 59% in the case group and 13% in the control group (Table 2). Among allergic children with malocclusion, 60% were sensitive to a single allergen and 40% to more than one allergen. Among allergic children without malocclusions, 90% were sensitive to a single allergen and only 10% to more than one allergen. The prevalence of the specific types of allergy and the corresponding allergens is shown in Table 3: allergic children in the case group show a high prevalence of perennial allergy (73%), both alone (41%) or in association with seasonal allergy (32%), whereas children in the control group are mostly affected by seasonal allergy alone (70%). Asthma was reported in 39 (31%) patients of the case group and in 12 (8%) patients of the control group.

According to orthodontic examination, 65% of children that suffered from allergic symptoms were affected by one type of malocclusion (28% increased overjet, 26% posterior crossbite, 11% openbite), 30% were affected by a combination of two types of malocclusions (with the prevalence of posterior crossbite + increased overjet), whereas 5%

showed three types of malocclusions (Table 4).

Among allergic patients of the case group, 96% periodically followed a specific pharmacologic treatment with antihistaminics (34%), corticosteroids (7%) or both (55%). Only 20% of the allergic patients in the control group followed a pharmacologic treatment (Table 5).

We analysed the effect of allergic rhinitis on the development of dento-skeletal alterations. The results from this analysis are summarized in Table 6: children with a history of allergic rhinitis had a threefold increased risk to develop one or more dento-skeletal alterations [OR = 3.16 (1.79–5.58), $P < 0.001$].

Looking at specific malocclusions, our findings indicated that children with allergic rhinitis had a higher risk to develop posterior crossbite [OR = 2.86 (1.57–5.21), $P < 0.001$] and increased overjet [OR = 1.97 (1.13–3.43), $P = 0.016$], whereas no statistically significant association was found between allergic rhinitis and openbite [OR = 2.06 (0.97–4.40), $P = 0.057$].

Discussion

The development of malocclusions in paediatric age is determined by both genetic and acquired factors. Among the latter, an important role is played by the obstruction of the upper airway which induces mouth breathing that, in turn, causes an imbalance between the forces from the cheeks and the tongue leading to an altered position of the mandible and a possible development of malocclusions^{13–15}.

Mouth breathing can be induced by many different factors, some of which are responsible for a persistent obstruction of the air flux

Table 2. Prevalence of allergic rhinitis.

	Case group			Control group		
	Frequency	Percentage on total sample	Percentage on allergic patients	Frequency	Percentage on total sample	Percentage on allergic patients
No allergy	51	41	–	130	87	–
1 allergy	44	35	60	18	12	90
2 allergies	29	23	39	2	1	10
3 allergies	1	1	1	0	0	0
Total	125	100	100	150	100	100

Table 3. Prevalence of specific type of allergy and related allergens.

Type of allergy	Case group		Control group	
	Frequency	Percentage	Frequency	Percentage
Perennial (Dust mites, Animal hair)	30	41	4	20
Seasonal (Grass and Pollens)	20	27	14	70
Both	24	32	2	10
Total	74	100	20	100

Table 4. Prevalence of malocclusions among allergic patients in the case group.

Malocclusion	Frequency	Percentage
Overjet	21	28
Openbite	8	11
Crossbite	19	26
Overjet + Openbite	4	5
Overjet + Crossbite	13	18
Openbite + Crossbite	5	7
Overjet + Openbite + Crossbite	4	5
Total	74	100

inside the nasal cavity (e.g., deformities of the nasal septum, adeno-tonsillar hypertrophy and nasal polyposis)³, whereas others do not present a continuous obstacle to the airflow. Even if its effects are not continuous, allergic rhinitis is considered one of the major causes of airway obstruction in children²⁰ in that it can induce a loss of habit to physiological nasal breathing with the consequent alterations of the child's growth pattern. Our study evaluated the association between allergic rhinitis and the development of malocclusions.

The most important data that confirm the role of allergic rhinitis for the development of malocclusion regarded the different prevalence of this pathology in the case group (59%) and in the control group (13%). In the control sample, allergic rhinitis was not only less frequent, but was also characterized by a less marked expression, as appears from the following considerations:

- 1) among allergic patients of the case group, 40% were sensitive to two or more allergens, whereas this prevalence decreased to 10% in the control group (Table 2);
- 2) among allergic patients of the control group, 70% were affected only by seasonal allergic rhinitis (Table 3): indeed, at least two studies^{11,12} emphasize the different entity of the effect of perennial allergies with respect to seasonal allergies, as the latter manifest its symptoms (mouth breathing) only during limited periods throughout the year;
- 3) among allergic patients of the case group, 96% followed a specific pharmacologic treatment (antihistaminic or corticosteroid) and 55% used both. On the other hand, only 20% of the allergic patients in the control group followed a specific, mostly antihistaminic, therapy (Table 5);
- 4) asthma, considered a typical exacerbation of allergic rhinitis²¹, was detected in 31% of the patients of the case group and in 8% of those of the control group.

Our study highlights a statistically significant relationship between allergic rhinitis and malocclusion: children affected by allergic rhinitis had a threefold increased risk to develop dento-skeletal alterations. With respect to the analysed malocclusions, allergic rhinitis showed a statistically significant association with posterior crossbite and increased overjet. This result confirms that in children affected

Table 5. Frequency of pharmacologic treatment among allergic patients.

Specific pharmacologic treatment	Case group (allergic patients)		Control group (allergic patients)	
	Frequency	Percentage	Frequency	Percentage
Only antihistaminic therapy	25	34	3	15
Only corticosteroid therapy	5	7	0	0
Antihistaminics & Corticosteroids	41	55	1	5
Total	71	96	4	20

Table 6. Association of allergic rhinitis with malocclusions.

	Odds ratio (95% CI)	P value
Allergic rhinitis versus Crossbite	2.86 (1.57–5.21)	<0.001
Allergic rhinitis versus Overjet	1.97 (1.13–3.43)	0.016
Allergic rhinitis versus Openbite	2.06 (0.97–4.40)	0.057
Allergic rhinitis versus Malocclusion	3.16 (1.79–5.58)	<0.001

by allergic rhinitis, the effects of mouth breathing on craniofacial structures, mediated by the low tongue position and by the modifications of the muscular balance, are more pronounced at the maxillary level, in both transversal and sagittal planes.

In view of the results of this study, an early orthodontics examination in children affected by allergic rhinitis would allow an interceptive intervention on the development and aggravation of dental malocclusions.

Why this paper is important to paediatric dentists

- Allergic rhinitis, a common cause of upper airway obstruction in children, must be seen as a possible risk factor in the development of malocclusions.
- Our study identifies associations between allergic rhinitis and malocclusions using a sample of 275 children in primary or early-mixed dentition.
- An early orthodontics examination in children affected by allergic rhinitis would allow an interceptive intervention on the development and aggravation of dental malocclusions.

Conflict of interests

All authors declare to have no conflict of interests relevant to the subject of this article.

References

- Moss ML. A theoretical analysis of the functional matrix. *Acta Biotheor* 1968; **18**: 195–202.
- Rubin RM. Mode of respiration and facial growth. *Am J Orthod* 1980; **78**: 504–510.
- Adamidis LP, Spyropoulos MN. The effects of lymphadenoid hypertrophy on the position of the tongue, the mandible and the hyoid bone. *Eur J Orthod* 1983; **5**: 287–294.
- Solow B, Kreiborhg S. Soft tissue stretching: a possible control factor in craniofacial morphogenesis. *Scand J Dent Res* 1977; **85**: 505–507.
- Valera FC, Travitzki LV, Mattar SE, Matsumoto MA, Elias AM, Anselmo-Lima WT. Muscular, functional and orthodontic changes in preschool children with enlarged adenoids and tonsils. *Int J Pediatr Otorhinolaryngol* 2003; **67**: 761–770.
- Sousa JB, Anselmo-Lima WT, Valera FC, Gallego AJ, Matsumoto MA. Cephalometric assessment of the mandibular growth pattern in mouth-breathing children. *Int J Pediatr Otorhinolaryngol* 2005; **69**: 311–317.
- Harvold EP, Tomer BS, Vargervik K, Chierici G. Primate experiments on oral respiration. *Am J Orthod* 1981; **79**: 359–372.
- Subtenly JD. Effects of disease of tonsils and adenoids on dentofacial morphology. *Ann Otol Rhinol Laryngol* 1975; **84**(2 Pt 2, Suppl. 19): 50–54.
- Limme M. Consequences orthognatiques et orthodontiques de la respiration buccale. *Acta Otorhinolaryngol Belg* 1993; **47**: 145–155.
- Pereira FC, Monotaga SM, Faria PM *et al.* Avaliação cefalométrica e miofuncional em respiradores bucais. *Rev Bras ORL* 2001; **67**: 43–49.
- Skoner DP. Allergic rhinitis: definition, epidemiology, pathophysiology, detection, and diagnosis. *J Allergy Clin Immunol* 2001; **108**(1 Suppl.): S2–S8.
- Bellantini JA, Wallerstedt DB. Allergic rhinitis update: epidemiology and natural history. *Allergy Asthma Proc* 2000; **21**: 367–370.
- Cheng MC, Enlow DH, Papsidero M, Broadbent BH Jr, Oyen O, Sabet M. Developmental effects of impaired breathing in the face of the growing child. *Angle Orthod* 1988; **58**: 309–320.
- Principato JJ. Crossbite and increased anterior vertical height secondary to oral respiration. Proceedings of the 6th International College of Cranio-Mandibular Orthopedics. Florence, Italy, April 22–23, 1989.
- Freng A. Restricted nasal respiration, influence on facial growth. *Int J Paediatr Otorhinolaryngol* 1979; **1**: 249–254.
- Vázquez Nava F, Vázquez Rodríguez EM, Reyes Guevara S *et al.* Effect of allergic rhinitis, asthma and rhinobronchitis on dental malocclusion in adolescents. *Rev Alerg Mex* 2007; **54**: 169–176.
- Bresolin D, Shapiro PA, Shapiro GG, Chapko MK, Dassel S. Mouth breathing in allergic children: its relationship to dentofacial development. *Am J Orthod* 1983; **83**: 334–340.
- Hartgernik DV, Vig PS. Lower anterior face height and lip incompetence do not predict nasal airway obstruction. *Angle Orthod* 1989; **59**: 17–23.
- Souki BQ, Pimenta GB, Souki MQ, Franco LP, Becker HM, Pinto JA. Prevalence of malocclusion among mouth breathing children: do expectations meet reality? *Int J Pediatr Otorhinolaryngol* 2009; **73**: 767–773 [Epub 2009 Mar 12].
- Abreu RR, Rocha RL, Lamounier JA, Guerra AF. Etiology, clinical manifestations and concurrent findings in mouth-breathing children. *J Pediatr (Rio J)* 2008; **84**: 529–535.
- Boulay ME, Morin A, Laprise C, Boulet LP. Asthma and rhinitis: what is the relationship? *Curr Opin Allergy Clin Immunol* 2012; **12**: 449–454.