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Dental repercussions of maxillary lateral incisor agenesis

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SUMMARY The aim of this study was to assess the influence of maxillary lateral incisor agenesis (MLIA) on the position of other teeth in the dental arch. The sample consisted of 147 individuals (66 males and 81 females) divided into two age groups: a growth phase group (A) comprising 43 individuals (18 males and 25 females, ages ranging from 9 to 16 years) and an adult group (B) (with females older than 14 and males older than 18 years) comprising 104 individuals (48 males and 56 females, ages ranging from 15 to 45 years). Within these groups, the individuals were then divided into three subsets: group 1 with MLIA, group 2 relatives of group 1 but without MLIA, and group 3 individuals from the general population (without agenesis and unrelated). Clinical evaluation of the maxillary dental midline and of the antero-posterior relationship between the upper and lower arches at the first permanent molars and canines was performed. Variables were compared by a chi-square test.

There was a significant ($P < 0.05$) clinical association between the presence of MLIA (more often unilateral) and the deviation of the maxillary dental midline. MLIA was associated with a Class II malocclusion; this was more frequent on the same side as the agenesis.

Introduction

Maxillary lateral incisor agenesis (MLIA) in the permanent dentition is one of the most frequent types of agenesis. Its frequency varies with the population studied and gender, with values in the permanent dentition ranging between 0.8 and 4.25 per cent (Horowitz, 1966; Muller *et al.*, 1970; Thilander and Myrberg, 1973; Magnusson, 1977; Rølling, 1980; Aasheim and Ogaard, 1993; Johannsdottir *et al.*, 1997; Tavajohi-Kermani *et al.*, 2002; Polder *et al.*, 2004; Harris and Clark, 2008). In the Portuguese population, the prevalence of MLIA has been estimated at 1.3 per cent with a slightly higher frequency in females (Pinho *et al.*, 2005).

Among individuals with missing teeth, those who most frequently request treatment are those with missing maxillary anterior teeth (Bowden and Harrison, 1994) and especially the lateral incisors (Tuverson, 1970; McNeill and Joondeph, 1973).

An objective examination is essential for the diagnosis of hypodontia of permanent teeth. Some clinical signs are attrition, ankylosis, infra-occlusion, persistence and/or asymmetric loss of primary teeth, tooth migration, overeruption of the permanent antagonists, diastemas, and microdontia (Millar and Taylor, 1995; Bergendal *et al.*, 1996; Baccetti, 1998; Taylor, 1998; Dhanrajani, 2002).

There is an association between permanent MLIA and other tooth anomalies such as maxillary lateral incisor microdontia, both in individuals and their relatives (Pinho *et al.*, 2009). This might indicate a common genetic mechanism controlling these phenomena, influenced by several factors interacting at different levels (Pinho *et al.*, 2010a).

Several factors such as molar ratio, degree of protrusion of the incisors, facial and skeletal pattern, arch length, dental inclination, and aesthetics should be considered in the therapeutic options to open or close the space. Based on careful diagnosis, therapeutic goals can be defined and priorities set to achieve them (Pinho and Neves, 2001; Pinho, 2003).

The aim of the present study was, therefore, to evaluate the influence of MLIA on the position of other teeth in the dental arch.

Subjects and methods

The study was approved by the Ethics Committee of the Medical Dental School of the University of Porto. Patient or parental written informed consent was obtained.

All participants were examined by the same orthodontist.

Subjects

The sample consisted of 147 individuals (66 males and 81 females) divided into two age groups (Table 1): a growth phase group, A, comprising 43 individuals (18 males and 25 females, ages ranging from 9 to 16 years) and an adult group, B (with females older than 14 and males older than 18 years) of 104 individuals (48 males and 56 females, ages ranging from 15 to 45 years). The individuals in these groups were then divided into three subsets (Tables 2–7): group 1 with

Table 1 Age distribution between the groups analysed. A-1.1, bilateral maxillary lateral incisor agenesis (MLIA); A-1.2, unilateral MLIA (R = right; L = left); A-2, relatives without MLIA of group 1; A-3, general population (without agenesis and unrelated).

Subjects	Ages	
	Range (years)	Mean ± SD
A-1		
A-1.1	9–13	10.8 ± 1.3
A-1.2	9–14	12.0 ± 1.5
A-2	9–15	11.1 ± 2.2
A-3	9–16	11.6 ± 2.0
B-1		
B-1.1	15–36	24.8 ± 6.9
B-1.2	15–45	26.1 ± 8.6
B-2	15–45	28.0 ± 9.4
B-3	19–25	22.4 ± 1.7

Table 2 Maxillary dental midline, growth phase (A). A-1.1, bilateral maxillary lateral incisor agenesis (MLIA); A-1.2, unilateral MLIA (R = right; L = left); A-2, relatives without MLIA of group 1; A-3, general population (without agenesis and unrelated).

	Centred (%)	Shift to the right (%)	Shift to the left (%)	Total
A-1.1	7 (78)	0	2 (22)	9
A-1.2	3 (37.5)	4 (50)	1 (12.5)	8
A-1.2-R	1 (20)	4 (80)	0	5
A-1.2-L	2 (67)	0	1 (33)	3
A-2	13 (100)	0	0	13
A-3	12 (92)	1 (8)	0	13
Total	35	5	3	43

Table 3 Maxillary dental midline, adult phase (B). B-1.1, bilateral maxillary lateral incisor agenesis (MLIA); B-1.2, unilateral MLIA (R = right; L = left); B-2, relatives without MLIA of group 1; B-3, general population (without agenesis and unrelated).

	Centred (%)	Shift to the right (%)	Shift to the left (%)	Total
B-1.1	19 (79.2)	3 (12.5)	2 (8.3)	24
B-1.2	8 (42)	7 (37)	4 (21)	19
B-1.2-R	5 (45)	6 (55)	0	11
B-1.2-L	3 (37.5)	1 (12.5)	4 (50)	8
B-2	30 (94)	1 (3)	1 (3)	32
B-3	27 (93)	2 (7)	0	29
Total	84	13	7	104

MLIA, group 2 relatives of group 1 but without MLIA, and group 3 individuals from the general population (without agenesis, unrelated, and which were not orthodontic patients).

Children under 9 years of age, individuals who had undergone orthodontic treatment and/or maxillofacial surgery, those with obvious persistence of deleterious habits or a crossbite (skeletal, functional, or dental), scissor bite (when there is one tooth in the lateral segment in this condition), history of tooth extraction in the anterior and premolar area or more than one in the molar area, individuals with other agenesis (third molars not considered; Roald *et al.*, 1982; Sarnäs and Rune, 1983; Ogaard and Krogstad, 1995; Yuksel and Ucem, 1997) or associated diagnosed syndromes were excluded.

Evaluation methods

For clinical evaluation of the maxillary dental midline, the facial midline was considered in the median sagittal plane, dividing the face in half. The median sagittal plane was related to the mid-glabella, mid-nasion, mid-philtrum of the upper lip, and mid-menton since there were no visible differences in any of these references. During smiling, it was determined that this line was either coincident or deviated from interdental. As a direct inspection method was used, only deviations greater than 2 mm were assessed as recommended by Leitão (1993a).

The antero-posterior first molar relationship was determined according to Angle's classification (Angle, 1899): Class I, the mesiobuccal cusp of the upper first molar occluded in the buccal groove of the lower first molar; Class II, a distal relationship of the mandibular teeth relative to the maxillary teeth of more than one-half the width of the cusp; and Class III, the buccal groove of the lower first molar was mesial to the mesiobuccal cusp of the upper first molar. For the canine relationship, the definition was as follows: Class I, the cusp of the maxillary canine occluded at the contact point of the lower first premolar and canine; Class II, the upper canine occluded with a contact point of the lower first premolar and canine; and Class III, the cusp of the maxillary canine was distal to the contact point of the lower first premolar and canine. In order for these factors to have diagnostic value, there should be no migration of adjacent teeth to dental extractions sites since it can distort the results (Gregoret, 1997).

The canine relationship could not be characterized in some cases in the growth phase due to exfoliation of the primary canine and as the permanent canine was unerupted (Horowitz, 1966; Leitão, 1993b).

Statistical analysis

Variables were compared by a chi-square test. The results were considered significant at $P < 0.05$. Statistical analyses were performed using GraphPad Prim 4 (GraphPad Software, Inc., La Jolla, California, USA).

Results

Maxillary dental midline

Group A. Individuals with MLIA had a maxillary dental mid line that was not coincident, mostly shifted to the

Table 4 Right and left first molar relationship, Angle classification, and growth phase (A). A-1.1, bilateral maxillary lateral incisor agenesis (MLIA); A-1.2, unilateral MLIA (R = right; L = left); A-2, relatives without MLIA of group 1; A-3, general population (without agenesis and unrelated).

	Right first molar				Left first molar			
	Class I (%)	Class II (%)	Class III (%)	Total	Class I (%)	Class II (%)	Class III (%)	Total
A-1.1	3 (33)	6 (67)	0	9	1 (11)	8 (89)	0	9
A-1.2	6 (75)	1 (12.5)	1 (12.5)	8	5 (62.5)	2 (25)	1 (12.5)	8
A-1.2-R	4 (80)	0	1 (20)	5	4 (80)	0	1 (20)	5
A-1.2-L	2 (67)	1 (33)	0	3	1 (33)	2 (67)	0	3
A-2	11 (85)	2 (15)	0	13	11 (85)	2 (15)	0	13
A-3	13 (100)	0	0	13	13 (100)	0	0	13
Total	33	9	1	43	30	12	1	43

Table 5 Right and left first molar relationship, Angle classification, and adult phase (B). B-1.1, bilateral maxillary lateral incisor agenesis (MLIA); B-1.2, unilateral MLIA (R = right; L = left); B-2, relatives without MLIA of group 1 B-3, general population (without agenesis and unrelated).

	Right first molar						Left first molar					
	Cases correctly classified						Cases correctly classified					
	Class I (%)	Class II (%)	Class III (%)	Subtotal	Excluded (%)	Total	Class I (%)	Class II (%)	Class III (%)	Subtotal	Excluded (%)	Total
B-1.1	10 (47.6)	10 (47.6)	1 (4.8)	21	3 (12.5)	24	11 (61.1)	6 (33.3)	1 (5.6)	18	6 (25)	24
B-1.2	8 (53.3)	4 (26.7)	3 (20)	15	4 (21)	19	7 (53.8)	4 (30.8)	2 (15.4)	13	6 (31.6)	19
B-1.2-R	3 (37.5)	3 (37.5)	2 (25)	8	3 (27)	11	4 (50)	2 (25)	2 (25)	8	3 (27)	11
B-1.2-L	5 (71.4)	1 (14.3)	1 (14.3)	7	1 (12.5)	8	3 (60)	2 (40)	0	5	3 (37.5)	8
B-2	16 (84.2)	2 (10.5)	1 (5.3)	19	13 (40.6)	32	20 (95.2)	1 (4.8)	0	21	11 (34.4)	32
B-3	21 (80.8)	5 (19.2)	0	26	3 (10.3)	29	20 (76.9)	5 (19.2)	1 (3.8)	26	3 (10.3)	29
Total	55	21	5	81	23	104	58	16	4	78	26	104

Table 6 Right and left canine relationship, growth phase. A-1.1, bilateral maxillary lateral incisor agenesis (MLIA); A-1.2, unilateral MLIA (R = right; L = left); A-2, relatives without MLIA of group 1; A-3, general population (without agenesis and unrelated).

	Right canine						Left canine					
	Cases correctly classified						Cases correctly classified					
	Class I (%)	Class II (%)	Class III (%)	Subtotal	Excluded (%)	Total	Class I (%)	Class II (%)	Class III (%)	Subtotal	Excluded (%)	Total
A-1.1	0	8 (100)	0	8	1 (11)	9	0	8 (100)	0	8	1 (11)	9
A-1.2	3 (42.9)	4 (57.1)	0	7	1 (12.5)	8	3 (50)	3 (50)	0	6	2 (25)	8
A-1.2-R	1 (25)	3 (75)	0	4	1 (20)	5	3 (100)	0	0	3	2 (40)	5
A-1.2-L	2 (67)	1 (33)	0	3	0	3	0	3 (100)	0	3	0	3
A-2	11 (84.6)	1 (7.7)	1 (7.7)	13	0	13	9 (69.2)	2 (15.4)	2 (15.4)	13	0	13
A-3	13 (100)	0	0	13	0	13	13 (100)	0	0	13	0	13
Total	27	13	1	41	2	43	25	13	2	40	3	43

right. A shift was found more often in those with unilateral agenesis of the right side. This deviation from the maxillary dental midline was therefore significantly higher in individuals with MLIA ($P < 0.05$; Table 2).

Group B. A significant percentage of individuals with MLIA also had a non-coincident maxillary dental midline, mainly shifted to the right. For individuals in the growth phase, the deviation of the dental midline in adults was

Table 7 Right and left canine relationship, adult phase (B). B-1.1, bilateral maxillary lateral incisor agenesis (MLIA); B-1.2, unilateral MLIA (R = right; L = left); B-2, relatives without MLIA of group 1; B-3, general population (without agenesis and unrelated).

	Right canine				Left canine			
	Class I (%)	Class II (%)	Class III (%)	Total	Class I (%)	Class II (%)	Class III (%)	Total
B-1.1	2 (8)	22 (92)	0	24	4 (17)	20 (83)	0	24
B-1.2	9 (47)	10 (53)	0	19	5 (26)	12 (63)	2 (11)	19
B-1.2-R	1 (9)	10 (91)	0	11	5 (45.5)	5 (45.5)	1 (9)	11
B-1.2-L	8 (100)	0	0	8	0	7 (87.5)	1 (12.5)	8
B-2	22 (69)	9 (28)	1 (3)	32	26 (81)	6 (19)	0	32
B-3	25 (86)	4 (14)	0	29	23 (79)	6 (21)	0	29
Total	58	45	1	104	58	44	2	104

more frequent in those who had a right sided unilateral MLIA. This deviation from the maxillary dental midline was significantly greater in individuals with MLIA ($P < 0.05$; Table 3).

First molar relationship (Angle's classification)

Group A. Individuals with MLIA (especially bilateral) had a Class II molar relationship on the right significantly more frequently than groups A-2 and A-3 ($P < 0.05$; Table 4).

In A-1 individuals, for the left molar relationship and different from that found for the right molar relationship, a Class II malocclusion was significantly predominant ($P < 0.05$) and also in individuals with bilateral agenesis (Table 4). Regarding the other parameters evaluated, no significant differences were found in relation to those described for the right molar relationship.

Group B. The right molar relationship could not be adequately characterized in 22.1 per cent of subjects, due to the absence of these teeth in the arch. Thus, if there were only 81 cases correctly characterized regarding the three groups, an altered distribution was found. Despite these differences between the groups, they were not statistically significant ($P > 0.05$; Table 5).

Assuming that full interpretation of the results could be affected by the cases that were not classified (mainly the B-2 group, with 40.6 per cent of cases classified according to Angle) even with the above reservations, a Class I malocclusion was more frequent in the three groups. In the group of individuals with agenesis, a Class II malocclusion was significantly more frequent than in relations without agenesis or individuals without MLIA ($P < 0.05$).

Regarding the left molar relationship, 25 per cent of cases could not be correctly classified, which was not significantly different from the 22.1 per cent of cases classified regarding the right molar relationship. Thus, if 78 cases were taken into account, correctly characterized regarding the three sub groups, the distribution is altered. Despite the differences observed between the groups, they were not statistically significant ($P > 0.05$).

Assuming again that the cases not classified can affect the full interpretation of the results, it is possible to say that a Class I was more frequent. In the subjects with agenesis, a Class II malocclusion was more frequent than in patients without agenesis, with (group B-2) or without relatives with agenesis (B-3). However, that difference was not statistically significantly ($P > 0.05$).

Canine relationship

Group A. In the growth phase, it was not possible to describe the right canine relationship in 4.7 per cent and for the left in 7 per cent since the canines were not yet erupted (Table 6).

In the A-1 group, a Class II malocclusion was the most frequent. In individuals without MLIA, a Class I was more frequent (84.6–100 per cent). Only three subjects (7 per cent) had a Class III canine relationship.

Group B. As observed for individuals in the growth phase, a Class II was more frequent in adults with MLIA ($P < 0.05$). In individuals with MLIA (unrelated or not), a Class I was predominant. Only three subjects (2.8 per cent) had a Class III canine relationship (Table 7).

In both phases (growth and adult), the ratio of a Class II canine relationship was more frequent in subjects with bilateral MLIA. Regarding unilateral agenesis, the ratio of a Class II canine relationship was more frequent on the side of absence, while the ratio of Class I was more frequent on the side with no agenesis.

Discussion

Deviations of the maxillary dental midline are important in dentofacial aesthetics and should be taken into consideration in treatment planning (Pinho, 2003).

In this study, individuals with MLIA in the growth phase and adults had a non-coincident maxillary dental midline, largely shifted to the right. In both groups, the dental midline was more frequently shifted in those who had unilateral agenesis on the same side of the MLIA, i.e.

to the right. This deviation from the maxillary dental midline was also greater in individuals with MLIA than in patients without agenesis. Even in adults, there seems to be a significant clinical association with non-coincidence of the maxillary dental midline. If orthodontic correction is not performed at the appropriate time, particularly during growth, the dental midline will undergo a major deviation that will be perpetuated into adulthood (Pinho, 2003).

In this study, the occlusion was observed in the antero-posterior plane, as recommended by Angle (1899), and similar to some studies, individuals with dental agenesis were also considered (Horowitz, 1966; Leitão, 1993b).

The combined result for the two age groups indicates that MLIA is related to a Class II molar relationship significantly more often than in those without agenesis of the same teeth, which can be interpreted as dental compensation towards the mesial sectors to camouflage the MLIA. The results of this study are in agreement with those of Vichi and Franchi (1996) indicating that MLIA can be a predisposing factor for mesial positioning of the permanent maxillary canines. This may justify the low recognition of the patients' problems, reported by Hobkirk *et al.* (1994). Those authors found that more than 50 per cent of patients attending for initial consultation were over 12 years of age. MLIA is important because of its prevalence and clinical characteristics (Pinho 2003, Pinho *et al.*, 2005, 2009) and by its genetic and a aetiopathogenic mechanisms (Pinho *et al.*, 2010a; b). Incisor agenesis is relevant regarding the hypothetical effects on the surrounding facial, maxillary, or tooth structures.

In a study of agenesis and malocclusion in subjects aged 7–16 years, Horowitz (1966) found that the majority of cases (53.84 per cent) were Class I and 18.46 per cent were Class II. Thus, the majority of subjects with agenesis had a normal molar relationship. These differences may be due to the fact that most individuals in the study of Horowitz (1966) presented agenesis of the second premolars, with a higher frequency of lower (34.3 per cent) than upper (21.8 per cent) incisors or lateral incisors (17.1 per cent). Thus, the results are not comparable.

Bowden and Harrison (1994) and Pinho (2003, 2004) observed that various canine sagittal occlusal relationships limit the interaction between various dental structures, with diverse functional and aesthetic impacts. In the current study, a comparative analysis was conducted between two age groups in order to investigate the possible consequences of MLIA on the canine occlusal relationship. In both age groups, the ratio of a Class II (molar and canine) relationship was more frequent in subjects with bilateral MLIA than in individuals with unilateral agenesis. However, in some subjects with bilateral or unilateral MLIA, the molars and canines may be in a Class I position and due to MLIA, a diastema occurs in the antero-superior sector (Pinho and Neves, 2001).

Conclusions

There is a significant clinical association between the presence of MLIA (more often in unilateral cases) and the deviation of the maxillary dental midline. The presence of MLIA is also associated most often with a molar and canine right and left Class II malocclusion. This association is more frequent on the same side of the agenesis.

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