Tooth rotation associated with aplasia of nonadjacent teeth

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Several studies suggest the existance of a genetic component in the etiology of tooth malpositions.[1-8] Familial studies have demonstrated a definite genetic effect in the variation of tooth positions (especially premolars and first molars)[9] in the onset of ectopic eruption of first permanent molars causing resorption of the distal surface of second deciduous molars,[10] and in the phenomenon of infraoccluded deciduous molars.[11]

Clinical investigations have added valuable information to the controversial chapter on the etiology of maxillary canine displacement. Peck and coworkers provided evidence of the genetic origin of the palatally displaced maxillary canine[4] and of the maxillary canine-first premolar transposition[3] on the basis of multiple evidential categories: familial occurrence, bilateral occurrence, sex differences, population differences, and occurrence of other concomitant dental anomalies. As a matter of fact, the search for associated dental anomalies is one of the most efficient investigative tools in the clinical study of genetic aspects underlying an observed tooth anomaly or disturbance. In keeping with a genetic background, it is expected that in a sample of subjects selected according to one anomaly, an increased prevalence of associated anomalies would also be found when compared with the prevalence assessed in the general population or in control samples. In this way, Bjerklin and coworkers[2] and Baccetti[8] demonstrated a genetic basis for several different types of dental anomalies, including anomalies of tooth number, size,

Abstract

The prevalence of tooth rotation concomitant with aplasia of nonadjacent teeth in uncrowded, nonsyndromic subjects was assessed. The sample consisted of 1620 subjects (mean age 14 years 9 months). The findings were compared with the prevalence calculated for a matched control group of 1000 subjects. Rotation of maxillary lateral incisors in subjects with premolar aplasia and rotation of premolars in subjects presenting with maxillary lateral incisor aplasia were studied. Associations between both tooth position anomalies and tooth aplasia were significant ($p < 0.01$). In addition, the presence of rotated maxillary lateral incisors was also associated with aplasia of the homologous tooth on the opposite side of the dental arch; the same result was found for premolars. These data suggest a genetic component in the etiology of tooth malpositions, such as tooth rotation, which may be considered a covariable in a complex of genetically controlled dental disturbances, including tooth aplasia.

Key Words

Tooth rotation • Tooth malpositions • Tooth agenesis • Missing teeth • Malocclusion • Dental genetics

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Table 1
Prevalence of tooth rotation associated with aplasia of nonadjacent teeth, compared with reference values

Tooth aplasia	Associated tooth rotation	Ratio, tooth rotation/ tooth aplasia	Tooth rotation Prevalence (%)	Tooth rotation Prevalence reference value (control group, %)	Chi-square	*p*
P1-P2 aplasia	Maxillary I2 rotation	11/74	14.9	4.7	8.94	0.0027
Maxillary I2 aplasia	P1-P2 rotation	8/46	17.4	5.1	7.41	0.0065
Unilateral maxillary I2 aplasia	Contralateral maxillary I2 rotation	5/25	20.0	2.1	20.24	0.0000
Unilateral P1-P2 aplasia	Contralateral P1-P2 rotation	5/36	13.8	3.2	6.85	0.0088

position, structure, and eruption.

The aim of the present study was to analyze the prevalence of clinical associations between tooth rotation and aplasia of nonadjacent teeth in a sample of subjects during the developmental stage in order to substantiate a genetic component in the origin of tooth malpositions, such as tooth rotations.

Materials and methods

An initial sample of 3450 subjects from the files of the Department of Orthodontics of the University of Florence was examined. All subjects were observed before any orthodontic treatment. A group of 830 subjects was excluded from the initial sample due to the presence of one or more of the following features: non-Caucasian, cleft lip and/or palate or craniofacial malformations, sequelae of traumatic injuries to the dentition, familial relationships with other examined subjects, and tooth crowding within the dental arches.

The remaining sample of 2620 subjects (1246 males, 1374 females, age range 12 to 16 years, mean age 14 years 8 months) was randomly divided into two groups:

(a) experimental group (1620 subjects, 744 males, 876 females, mean age 14 years 9 months);

(b) control group (1000 subjects, 502 males, 498 females, mean age 14 years and 6 months).

The two groups were therefore matched for origin, age, and sex distribution.

In the experimental group, 46 subjects with aplasia of maxillary lateral incisors and 74 subjects with aplasia of premolars were found. Aplasia of maxillary lateral incisors was unilateral in 25 cases, while aplasia of premolars was unilateral in 36 cases. The charts of all examined subjects with diagnosis of tooth aplasia were checked to exclude the possibility of extractions. The prevalence of tooth rotations associated with aplasia of nonadjacent teeth was recorded in the experimental group as follows:

(1) rotation of maxillary lateral incisors in subjects presenting with aplasia of premolars;

(2) rotation of premolars in subjects presenting with aplasia of maxillary lateral incisors;

(3) unilateral rotation of maxillary lateral incisors associated with aplasia of the homologous tooth on the other side of the arch;

(4) unilateral rotation of premolars associated with aplasia of the homologous tooth on the other side of the arch.

Tooth rotation was defined subjectively as observable mesiolingual or distolingual intra-alveolar displacement of the tooth around its longitudinal axis.

The reference prevalence rates for rotation of maxillary lateral incisors and of premolars (both totally and unilaterally considered) were calculated for the control group.

The diagnosis of tooth aplasia was both by clinical inspection and by radiographic examination. Tooth rotation was diagnosed clinically by means of direct inspection of dental casts and was assessed only on fully erupted teeth. The evaluation of tooth rotation and of tooth aplasia was performed twice with an interval of 3 months. Reproducibility of assessment was 98% and 100% for the two dental anomalies, respectively.

The prevalence rates of tooth rotations in association with nonadjacent, congenitally missing teeth were compared with the reference prevalence rates in the control group by means of chi-square tests.

Table 2
Distribution of tooth rotation according to tooth aplasia category

Tooth aplasia category	MxI2		MxP1		MxP2		MnP1		MnP2	
	ML	DL	ML	DL	ML	DL	ML	DL	ML	DL
MxI2 (n=46)	2	3 (contralateral)	1	1	1	-	-	2	1	2
MxP1 (n=3)	-	1	-	-	1 (contralateral)	1	-	-	-	-
MxP2 (n=24)	1	3	-	-	-	-	-	-	-	-
MnP1(n=4)	1	-	-	-	-	-	-	-	-	-
MnP2 (n=43)	1	4	-	-	-	-	-	-	1 (contralateral)	2

ML = mesiolingual rotation; DL = distolingual rotation

Results

The prevalence rates of tooth rotations associated with aplasia of nonadjacent teeth are shown in Table 1, together with the prevalence rates of tooth rotations in the control group and with the results of chi-square tests.

A total of 98 subjects (38 males, 60 females) with rotation of maxillary lateral incisors or premolars was found in the control group. In the experimental group, 26 subjects (10 males, 16 females) presented with rotated maxillary lateral incisors or premolars in association with aplasia of nonadjacent teeth.

The occurrence of tooth rotation in association with aplasia of nonadjacent teeth in the experimental group was significantly higher ($p < 0.01$) when compared with the occurrence in the control group for all the examined categories of tooth rotation.

Table 2 shows the nature of tooth rotations and reports the distribution of tooth rotations in association with aplasia of different teeth. Two-thirds of the cases with aplasia of premolars (62.5%) exhibited distolingual rotation of maxillary lateral incisors.

Discussion

Evidence has been gathering that demonstrates a biologic relationship between several types of tooth malpositions and other associated dental anomalies in number, size, structure, and eruption.[1-8] The results of the present study provide support for the hypothesis that tooth rotation may be a covariable in this pattern of associations among tooth disturbances. In particular, the expression of rotated maxillary lateral incisors is significantly associated with aplasia of premolars, and, conversely, rotation of premolars is significantly associated with congenitally missing maxillary lateral incisors. Significant associations were also found between unilateral aplasia of maxillary lateral incisors and rotation of the lateral incisor on the other side of the arch, and between unilateral aplasia of premolars and rotation of premolars on the other side of the arch.

In order to avoid any interference in the interpretation of data due to local tooth alignment factors, only nonadjacent tooth categories were considered for the analysis of associations among dental anomalies. The same reasoning led to the exclusion of crowded dental arches and of dental trauma from the examined material. Another methodological aspect that should be emphasized is that the experimental and control groups belonged to the same original population, and that they were matched as closely as possible, even according to the shared bias of being part of an untreated orthodontic sample.[12]

On the basis of the present findings, an increase in the occurrence of rotated teeth in the absence of other apparent etiologic determinants has to be expected in subjects with congenitally missing teeth, as a consequence of a genetic mechanism in the etiology of intra-arch tooth malpositions. These data are in agreement with the observations by Hu and coworkers, who analyzed familial similarity in tooth position and demonstrated a significant autosomal additive effect on the location of premolars in the dental arch.[9] Moreover, other anomalies in tooth position (infraocclusion of deciduous molars, ectopic eruption of first molars, palatally displaced canines) are known to be biologically linked to the phenotypic expression of associated tooth disturbances, aplasia of premolars included.[2,8] Tooth rotation in absence of dental crowding is then

likely to be a covariant in a complex of genetically controlled tooth abnormalities that often occur in combination.

An issue that needs to be more clearly elucidated is the possible role of rotation of maxillary lateral incisors as a polymorphism of missing/peg-shaped lateral incisors. The association between one rotated lateral incisor and one peg-shaped lateral incisor in the maxillary arch of the same subject has been observed in the examined sample. It should also be noted that the highest differential prevalence rate between experimental and control groups (tenfold increase) was recorded for the association of unilateral rotation of maxillary lateral incisors and aplasia of lateral incisors on the other side of the upper arch (Table 1).

Environmental factors, such as space availability for tooth alignment, tooth eruption order, and functional influences exerted by the tongue and lips, must also be recognized in the pathogenesis of tooth rotations, consonant with a multifactorial model in the origin of tooth malpositions,[13] and, in general, of tooth disturbances.[14,15] The results of this study, however, point to an important additive genetic component leading to the phenotypic expression of rotated maxillary lateral incisors and of rotated premolars, as a starting point for the analysis of a broader spectrum of possibly associated tooth and tooth-arch anomalies.

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