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Appraisal of the difference between the mesiodistal diameters of deciduous incisors and molars and permanent teeth

ABSTRACT

Aim *Difference in tooth size between deciduous and permanent teeth can resolve space problems during development of the dentition. Aim: To determine the difference in size between deciduous and permanent teeth in the anterior and posterior areas of the mouth in a group of school-age children from Medellin, Colombia.*

Materials and methods *Design: this longitudinal prospective, descriptive investigation was carried out in 139 skeletal Class I dental stone casts from school-age children from Medellin. Patients were followed annually from 6 to 12 years of age. The final sample consisted of 53 children (35 girls and 18 boys). Leeway space and the incisor liability were determined.*

Results *A higher positive leeway space was found in the mandible than in the maxilla (3.622 mm and 1.556 mm, respectively). Incisor liability was negatively higher in the maxilla than in the mandible (-7.884mm and -5.386mm, respectively). Six patients showed a negative leeway space between -1.582 mm and -3.184 mm for the mandible and the maxilla, respectively. No statistical significant differences were found by gender; girls showed higher leeway space and incisor liability than boys.*

Conclusion *Normal values for one ethnic group should not be considered normal for another and each group must be treated according to its own characteristics.*

Keywords *Deciduous dentition, Incisor liability, Leeway space, Permanent dentition, Tooth size.*

Introduction

Dental occlusion undergoes important changes from birth to maturity, and even after this time. These changes can be dramatic, such as in the mixed dentition stage, or can be more subtle. In order to diagnose any abnormal development in the occlusion, it is essential that clinicians understand and recognise the normal range of changes that occur during dentition so conditions that are clinical manifestations of dental and occlusal development will not be treated [Gianelly, 1995].

Considerations regarding the development of occlusion in deciduous teeth and physiologic dimensional changes that take place in the dental arches at such stage are of great importance, since it is in this stage that dentition characteristics are established. Spaced or crowded arches, the presence of primate spaces, and the vertical growth of alveolar processes provide the clinician with tools to initiate the proper diagnosis to predict future abnormalities during the establishment of the permanent dentition. Primary dentition sets a guide for eruption and consolidation of the permanent dentition [Baume, 1950; Bishara et al., 1997, Moorrees et al. [1965; Bishara, 2003; Baume, 1950a; Baume, 1950b; Baume, 1959c].

There are important parameters in the mixed dentition, whose presence help visualise positive tools to achieve the proper dental and occlusal relationships: Class I molar and canine relationships, stable proximal contacts, mesiodistal and buccolingual axial inclinations, positive leeway space, minor rotations and absence of incisor crowding, and leveled marginal ridges and straight occlusal planes [Baume 1950; Bishara 2003; Moorrees, 1959]. The establishment of the mesiodistal width of unerupted canines and premolars in the mixed dentition is one of the most important factors when evaluating a growing patient [Baume, 1950]. Therefore, the proper assessment of the available space is necessary to make competent decisions regarding the interceptive orthodontic treatment planning and its evolution [Baume, 1950a; Baume, 1950b; Baume, 1950c; Moorrees, 1959; Moorrees, 1964].

In the posterior segment, the difference in tooth size between deciduous and permanent teeth (leeway space) is used in diverse aspects during the development

of the dentition: correction of the molar relationship allowing late molar migration of the first permanent molar or the adjustment of primary crowding in the anterior area through an eruption guidance. According to Nance, the leeway space in the mandible is 3.4 mm and 1.8 mm in the maxilla, while according to Moorrees, the space in the mandible is 4.2 mm and Baume states that it is 2.4 mm for the maxilla [Baume, 1950; Baume, 1950a; Baume, 1950b; Baume, 1950c; Moorrees, 1959; Moorrees, 1964]. The size of the passive incisor (the difference in size between the mesiodistal width of deciduous incisors and their successors), named by Mayne [1999], Warren et al. [2003], and Ngan et al [1968], is usually negative, since permanent teeth are larger than deciduous ones (-7.6 mm in the maxilla and -6.0 mm in the mandible). However, there are factors that facilitate proper alignment of erupting permanent teeth, such as interdental spacing between deciduous incisors, increase of the intercanine width, increase of arch length due to a more buccal eruption of permanent successors, and the use of the primate space through secondary displacement [Moorrees, 1964; Mayne, 1968; Dale et al., 1976].

The purpose of this study was to determine the difference in size between primary and permanent teeth both in the anterior and posterior areas on dental stone casts of a group of school-age children from Medellin (Colombia), in such a manner that more precise measurements could be obtained to properly orientate the treatment planning.

Materials and methods

A descriptive longitudinal prospective study was carried out in 139 Class I school-age children from Medellin (Columbia), which were longitudinally followed every year between 6 and 12 years of age. Dental impressions were made with irreversible hydrocolloid and poured in dental stone following the manufacturer's instructions. These impressions were taken by one operator from another study [Mariaca et al., 1997].

The selected sample size was 53 dental stone casts which met the inclusion criteria: overall good condition, no bubbles or broken teeth, the first set had to be taken during the deciduous dentition phase (without any missing teeth), and the second set had to be of the permanent dentition with fully erupted canines and premolars. In the deciduous dentition stone casts, the mesiodistal width of the maxillary and mandibular central incisors, lateral incisors, canines, first molars, and second molars was measured in millimeters (taken in the area of maximum coronal width). In the permanent dentition, the mesiodistal width (taken in the point of maximum mesiodistal width) of maxillary and mandibular central incisors, lateral incisors, canines, first premolars, and second premolars was measured.

A digital electronic microscope (Leitz, model 060-685.000/283, Germany) with a measurement range of 0-150 mm on the X axis and between 0-75 mm on the Y axis and with a minimum reading of 1 µm, was used. This microscope is located at the Department of Metrology, Eafit University (Medellin, Colombia) and is calibrated under ISO standards. This laboratory guarantees the maintenance of traceability of calibrated instruments according to reference patterns, which have been calibrated in the Division of Metrology of Superintendence of Industry and Commerce in Bogota (Colombia). Three repetitions per measurement were made and the average value was used. All the measurements were taken by a single operator who had been previously calibrated. The results were loaded on an Excel for Windows file (2010 version, Microsoft Corporation, U.S.A.) and afterwards the analysis of the results was performed.

In order to calculate the leeway space, the difference between the sum of the mesiodistal width of deciduous canines and molars and the sum of the mesiodistal width of maxillary and mandibular permanent canines and premolars was used. To obtain the incisor liability, the difference between the sum of the mesiodistal width of permanent incisors with respect to the sum of the mesiodistal width of the maxillary and mandibular deciduous incisors was used.

Ethical aspects

An informed consent signed by the children's parents or legal guardians was requested together with their previous authorisation to make the dental impressions. According to resolution 8430 of 1993 by the ethics committee, this investigation is considered as a risk below the minimum [República de Colombia, 1993].

Statistical analysis

A SPSS version 10 for Windows software (SPSS Inc., Chicago, IL) was used for statistical analysis. A descriptive analysis using the mean as the measure of central tendency and standard deviation as the dispersion measure for quantitative variables was used. For qualitative variables, absolute frequencies and percentages were described. Student's t-test was used for independent samples to compare the tooth size between boys and girls. A 5% significance level was always considered, which means that a statistical test was considered as statistically significant if the p-value was lower than 0.05 regardless of clinical significance. In addition, 95% confidence intervals were presented for descriptive analysis.

Results

Fifty-three dental casts that met the inclusion criteria were obtained; 35 were taken from girls and 18 from

	Girls (35)		Boys (18)		Gender differences		Student's t
Tooth	X	S.D.	X	D.E	X	D.E	p-value
Deciduous mandibular lateral incisor	4.717	0.403	4.557	0.557	0.160	0.149	0.2884
Deciduous mandibular central incisor	4.259	0.458	4.057	0.281	0.202	0.134	0.1379
Permanent mandibular lateral incisor	5.995	0.439	6.056	0.774	-0.061	0.185	0.7411
Permanent mandibular central incisor	5.436	0.405	5.460	0.351	-0.023	0.123	0.8504
Deciduous maxillary lateral incisor	5.356	0.378	5.178	0.435	0.178	0.131	0.1825
Deciduous maxillary central incisor	6.504	0.469	6.429	0.564	0.075	0.166	0.6550
Permanent maxillary lateral incisor	6.941	0.686	7.136	0.688	-0.195	0.228	0.3979
Permanent maxillary central incisor	8.688	0.607	8.814	0.822	-0.126	0.225	0.5796
Deciduous mandibular canine	5.714	0.500	5.958	0.668	-0.245	0.163	0.1392
Deciduous mandibular first molar	7.798	0.809	7.873	0.386	-0.075	0.202	0.7134
Deciduous mandibular second molar	9.760	0.663	9.609	1.010	0.151	0.231	0.5158
Permanent mandibular canine	6.775	0.398	7.085	0.479	-0.311	0.124	0.0153
Mandibular first premolar	7.209	0.506	7.381	0.574	-0.172	0.154	0.2695
Mandibular second premolar	7.278	0.566	7.548	0.847	-0.270	0.195	0.1724
Deciduous maxillary canine	6.740	0.400	6.839	0.372	-0.098	0.114	0.3916
Deciduous maxillary first molar	7.061	0.604	7.312	0.611	-0.251	0.177	0.1613
Deciduous maxillary second molar	8.914	0.575	9.115	0.608	-0.202	0.171	0.2438
Permanent maxillary canine	7.798	0.415	8.114	0.469	-0.315	0.126	0.0160
Maxillary first premolar	7.258	0.466	7.420	0.541	-0.162	0.144	0.2661
Maxillary second premolar	6.884	0.463	6.942	0.711	-0.058	0.163	0.7253

TABLE 1 Description of tooth size in dental casts in boys and girls.

boys. However, the measurement of the incisor liability was not possible in all casts since the first cast of the deciduous dentition was not available in all the cases; therefore, from the total sample of girls, 34 were used to obtain the measurement of the maxillary leeway space, 35 the mandibular leeway space, 30 the maxillary incisor liability, and 29 the mandibular incisor liability. For boys, both the maxillary and mandibular leeway spaces were obtained from 18 boys, maxillary passive incisor from 13, and mandibular incisor liability from 15.

When comparing the tooth size between boys and girls, a higher mesiodistal diameter was generally found in girls in the maxillary and mandibular central and lateral incisors. However, this difference was not statistically significant (Table 1). When comparing the tooth size in the permanent dentition between boys and girls, statistically significant differences were found in maxillary and mandibular canines. This difference was higher in boys than in girls ($p<0.05$) (Table 1).

The mandibular leeway space was mostly positive, which shows a higher tooth size in the deciduous dentition than in the permanent successors; however, negative values for the maxillary and mandibular arches were found in 6 boys. On the other hand, the incisor liability always showed negative values, which means that permanent teeth are larger the deciduous ones. The mandibular leeway space was, on average, 3,622 ± 2,768 mm, while the maxillary leeway space was 1,556 ± 2,646 mm. The maxillary passive incisor was higher than the mandibular passive incisor (-7,884 ± 0,889

	Mean	S.D.	95%CI		Min.	Max.
Measurement			Inflim	Suplim		
Maxillary incisor liability	-7.884	0.889	-8.432	-7.288	-11.612	-3.648
Mandibular incisor liability	-5.386	1.942	-5.744	-4.604	-10.1	-0.54
Maxillary leeway	1.556	2.646	0.764	2.326	-3.184	9.862
Mandibular leeway	3.622	2.768	2.838	4.338	-1.582	11.632

TABLE 2 Summary of maxillary and mandibular incisor liability and leeway space descriptive analysis.

	Mean							Mean						
				95%IC							95%IC			
Measurement	n	X	S.D.	Inf L	Sup L	Min.	Max.	n	X	S.D.	Inf L	Sup L	Min.	Max.
Maxillary leeway	34	1.542	2.496	0.67	2.412			18	1.58	2.982	0.098	3.064	-3.184	9.312
Mandibular leeway	35	4.018	2.668	3.102	4.936	-1.582	11.632	18	2.85	2.868	1.424	4.278	-1.236	8.292

TABLE 3 Summary of maxillary and mandibular leeway space by gender.

mm and -5,386 ± 1,942 mm, respectively, see Table 2).

Leeway space showed no statistically significant differences regarding gender; however, girls show a higher space than boys, mainly in the mandibular arch (Table 3, Fig. 1).

Regarding incisor liability, no statistically significant differences were found between genders. In general, negative values were found in both arches. These values were higher in the maxillary arch and slightly higher in boys (see Table 4 and figure 2).

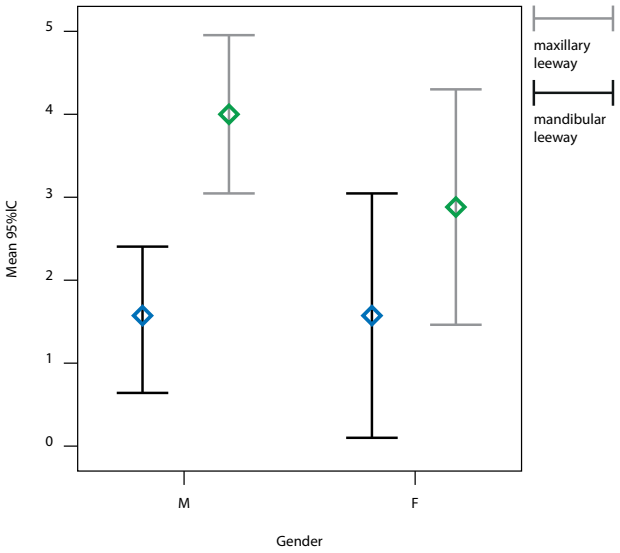

FIG. 1 Maxillary and mandibular leeway space by gender.

Discussion

Tooth size is considered a very important feature in orthodontic diagnosis and treatment. Tooth size is influenced by different factors, such as race, gender, heritage, genetics [Bishara et al., 1989; Brown et al, 1980; Smith et al., 2000] the environment, and secular changes [Bishara et al., 1989].

Sexual dimorphism among tooth diameters is more pronounced in the permanent dentition (20). Boys show larger sizes than girls; however, the magnitude of the difference and the distribution pattern are different among populations [Smith et al., 2000; Garn et al., 1967; Garn et al., 1966] and generations [Ebeling et al., 1973]. Several authors suggest that there is a tendency to increase the mesiodistal size of teeth as generations pass due to secular changes [Bishara et al., 1989; Brown et al., 1980; Smith et al., 2000; Garn et al., 1967; Garn et al., 1966; Al-Khateeb [2006].

In the present study, statistically significant differences were found in tooth size between genders for maxillary and mandibular canines, which shows a relation with results reported in other studies carried out in Greek, African, Arabic, Asian, and South American populations [Al-Khateeb, 2006; Adeyemi et al., 2003; Peng et al., 2000; Singh et al., 2006; Hashim et al., 2005; Marin et al., 2009; Bernabé et al., 2004; Ngom et al., 2007].

Other studies that have compared the mesiodistal size in different populations have reported diverse results with differences between genders in permanent teeth, such as maxillary and mandibular molars, canines, and premolars [Bishara et al., 1989; Ebeling et al., 1973; Al-Khateeb et al., 2006; Singh et al., 2006; Marín et al., 2009; Bernabé et al., 2004; Ngom et al., 2007; Hashim et al., 2005; Merz et al., 1991] showing higher sizes in boys than in girls. No investigation reports differences in the deciduous dentition [Clinch, 2007; Fosberg, 1988; Yuen et al., 1996], which is in agreement with the results of the present study. Regarding the difference in tooth size between right and left sides, no statistically significant differences have been found [Warren et al., 2003; Bernabé et al., 2004; Clinch, 2007; Yuen et al., 1996; Haralabakis et al., 2006].

One of the possible explanations for higher tooth size in men is the genetic connection of X and Y chromosomes with respect to the production of enamel and dentin. Both chromosomes have the effect to increase enamel width, while chromosome X has the effect to decrease dentin width [Alvesalo et al., 1991].

The appraisals of maxillary and mandibular leeway spaces are scarce, although they differ in magnitude. Moyers [1973] found a maxillary space of 2.6 mm and a mandibular space of 6.2 mm, while Baume (6) reports 1.8 mm in the maxilla and 3.4 mm in the mandible. More recent studies report a variation of 0.7 to 1.5 mm in the maxilla and 1.7 to 3.3 mm in the mandible [Baume, 1950b; Moorrees, 1959; Warren et al., 2003; Brown et al., 1980; Clinch, 2007; Black, 1980; Steigman et al., 1982; Little et

	Mean							Mean						
				95%IC							95%IC			
Measurement	n	X	S.D.	Inf L	Sup L	Min.	Max.	n	X	S.D.	Inf L	Sup L	Min.	Max.
Maxillary liability incisor	30	-7.538	1.854	-8.23	-6.846	-10.79	-3.648	13	-8.684	1.334	-9.49	-7.878	-11.612	-7.044
Mandibular liability incisor	29	-4.948	1.708	-5.596	-4.298	-9.158	-0.554	15	-6.232	2.142	-7.42	-5.046	-10.1	-2.798

TABLE 4 Summary of maxillary and mandibular incisor liability description analysis by gender.

al., 1990; Staley et al., 1980; Lundstrom, 1995; Flores-Mir et al., 2003].

In the current investigation, the maxillary leeway space was 1.556 ± 2.646 mm and the mandibular space was 3.622 ± 2.768 mm with negative values in 6 individuals, which are more similar to results reported by Baume [1950a]. No differences are reported between genders regarding such space; however, a higher space for girls, probably due to a smaller tooth size, was observed in this study.

The incisor liability described by Nance [1947] as the difference between the necessary space in the arch and the available space in the anterior region of the dental arch was used by Mayne [1968] and Warren et al. [2003] in 1975 with values of -7.6 mm in the maxillary arch and -6.0 mm in the mandibular arch. These results are in agreement with the results of this investigation (-7.884 ± 0.889 mm in the maxilla and -5.386 ± 1.942 mm in the mandible). The presence of crowding or spacing may be described as the expression of the alteration of tooth size in relation to the tissue or as a dentoalveolar disproportion, probably as a result of an evolutionary tendency toward the reduction in the size of the facial skeleton without the corresponding reduction in tooth size, given by the miscegenation of ethnic groups that are physically different [Radnzic, 1988; Miethke et al., 1988].

Mesiodistal widths and arch perimeter significantly contribute to the disproportion of the incisor liability due to the dentoalveolar imbalance between these two parameters when the eruption of permanent incisors takes place. Both factors are related to each other and both are equally important when crowding is present [Bishara et al., 1989; Smith et al., 2000; Garn et al., 1967, Garn et al., 1966; Ebeling et al., 1973; Merz et al., 199; Radnzic, 1988].

The degree of association between the diameters of the mesiodistal crown of deciduous and permanent teeth has not been reported. However, when individual variations are considered, small deciduous teeth will be substituted by small permanent teeth and vice versa Clinch [2007; Alvesalo et al., 1991; Moorrees et al., 1962; Uysal et al., 2005].

The combined means of mesiodistal crown diameters of maxillary central and lateral incisors were 3.7 and 3.3 mm larger than their deciduous predecessors in men and women, respectively. In the mandible, permanent teeth exceeded deciduous teeth by 2.6 mm in both genders. As it was pointed out by Wetzel Baume [1950c] permanent incisors are, on average, 3.8 and 5.5 mm larger than mandibular and maxillary deciduous incisors, respectively.

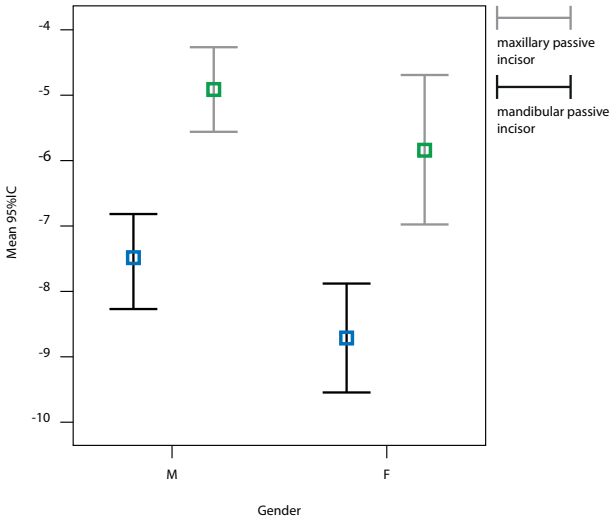

FIG. 2 Maxillary and mandibular incisor liability by gender.

Conclusions

1. Regarding the difference in mesiodistal size between boys and girls, it was found that permanent canines have a higher mesiodistal dimension in boys than in girls, which is statistically significant.
2. The incisor liability shows negative values in all cases due to the discrepancy in the mesiodistal width of deciduous incisors with respect to their permanent successors.
3. Leeway space was higher in the mandible than in the maxilla. However, positive values are often seen and, to a lesser extent, negative values can be seen in both jaws, which show individual variations that are important when deciding on the treatment plan.

This paper is important to paediatric dentists because

they are the first specialist in charge to observe and control growth and development for growing patients, and for this reason they should have all the knowledge regarding to this development. The present study gives tools that, throughout this period, can help the clinician to a more accurate examination.

Tooth size and its relationship with the development of crowding during growth are important for defining treatment protocols. Interceptive treatment could lead to a more conservative procedure or a more efficient approach.

Leeway space presence or absence could be a determinant process during the development period. It can be used to guide tooth eruption, to correct molar relationship or decrease lower incisor crowding.

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