Bilateral Asymmetry and Sexual Dimorphism in Teeth Width and Dental Arch within Egyptian Children

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Abstract: During the replacement of the deciduous dentition with the permanent set in the diphyodont phenomenon of humans, dynamic changes occur leading sometimes to asymmetry between the right and left sides. In individuals with asymmetric development, the slight differences may be acquired due to environmental factors or without specific identifiable etiology. Most asymmetries are subtle, and go unnoticed on casual clinical appraisal; however detecting it requires a precise bilateral measurement of paired structures. As symmetry of the skeletodental structures generally is a treatment goal so this study was intended to throw light on some of these asymmetries. **Subjects and Methods:** This study applied a digitalized methodology with the measurements of upper and lowers dental models -of one hundred and ninety one Egyptian children aged six to twelve years -by a computer software program to analyze the teeth widths and asymmetry between right and left sides of the dental arches. The significance was measured at level $P \leq 0.05$ for the statistical tests. **Results:** No significant differences were found for any of the studied teeth ($p > 0.05$) with a highly significant coefficient of correlation (r) between antimeres. Significant sexual dimorphism was regarded in permanent canines, first premolars, deciduous canines and lower second molars. For the boys; asymmetry of the dental arch was most prominent in the upper canine - premolar area and lower canine and lateral incisor area while for girls it was less prominent, where it is only noted in the upper deciduous first molar area and lower permanent canine area. Sexual dimorphism was obvious in upper deciduous canine area as well as at the upper and lower permanent left first molar areas where's boys are longer than girls. **Conclusion:** The obtained results provide important data that can be used by clinical professionals and researchers in Pedodontics and Orthodontics, both in the diagnosis and treatment planning for cases to be treated and as a stepping stone for further researches in these fields.

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1. Introduction

Tooth morphology studies have in the past been conducted using either intraoral measurements or measurements on casts. Barrett *et al.* (1963) have observed that intraoral measurements are less reliable while Kaushal *et al.* (2003) found no significant difference between the two methods. Sex determination with aid of skeletal remains poses a great dilemma to forensic experts particularly when only parts of the body are remained. To solve this difficulty, tooth size standards based on odontometric data can elucidate age and sex determination (Madhavi *et al.*, 2012). It is rare to find totally symmetric individual therefore minor asymmetries are regarded as normal (Ferrario *et al.*, 1993). The midpalatal suture and the center of the maxillary dental arch are almost coincident, validating the use of the suture as a symmetry axis. Dental arch asymmetry can be caused by a combination of genetic and environmental factors, with skeletal, dental or functional repercussions (Bishara *et al.*, 1994). Most individuals with normal occlusion may show almost coinciding midlines with minute deviation smaller than 1 millimeter (Paulo *et al.*, 2012). Older individuals tend to feature greater arch asymmetry than children which results from lifelong external environmental factors. Most of right and left differences have no specific identifiable etiology while sometimes it may be due to external factors such as thumb sucking, unilateral chewing, loss of contact due to cavities and extraction or trauma (Maurice *et al.*, 1998). Authors have observed skeletal asymmetries both in normal occlusion and malocclusion especially in cases with Angle Class II and Class III malocclusions (Nie *et al.*, 2000 and Janson *et al.*, 2001). Another study done by Maurice *et al.* (1998) showed asymmetries in the dental arches of individuals with normal occlusion during the passage from adolescence to adult age further questioning the possibility of achieving post treatment stability. Correcting malocclusions and skeletal and dental midlines as well as coordinating the position of teeth in each side of the arch leads to maximum intercuspation, correct function, reduced potential for tempromandibular joint dysfunction, facio-dental aesthetics and stability of achieved results (Jerrold *et al.*, 1990). The mesiodistal widths of teeth were first formally investigated by G.V. Black in 1902 (Mojgan *et al.*, 2011). There are six known essential 'keys' required to achieve the normal occlusion; Mc Laughlin *et al.* (2001) stated that tooth size should be considered the 'seventh key' and without coordination between the sizes of the upper and lower teeth, it would be impossible to obtain a good occlusion so, without a correct match of the mesiodistal widths of the maxillary and mandibular teeth, it is difficult to obtain an ideal overjet and overbite and good occlusion. Nair *et al.* (1999) have found the mandibular canines to exhibit the greatest sexual dimorphism among all teeth and considered mandibular canines as the 'key teeth' for sex identification. Studies suggest that symmetric faces are deemed more attractive. Clinically, the left-right symmetry of the underlying skeletodental structures generally as well as teeth size is a treatment goal. Most asymmetries are subtle, requiring precise bilateral comparisons for their detection; these are evident when comparing the measurements of paired structures, but go unnoticed on casual clinical appraisal (Edward *et al.*, 2007).

Aim of the study

The present study was undertaken to:

1. Find out the average width of the studied teeth in males and females among a group of Egyptian children.
2. Evaluate the presence or absence of asymmetry in the maxillary and mandibular dental arches between the right and left sides in Egyptian children with normal occlusion.
3. Investigate sexual dimorphism of teeth width and dental arch asymmetry.

2. Subjects and Methods:

The materials used in this study consisted of three hundred and eighty two maxillary and mandibular plaster models of one hundred and ninety one Egyptian children with ages range between six to twelve years old. The casts were selected from the archive of the dental clinic in the National Research Centre, Cairo, Egypt and fulfilled the following selection criteria: a) Egyptian ethnicity; b) Good quality of study models; c) Mixed dentition; d) Not subjected to any orthodontic intervention; and f) Absence of congenital dental anomalies. A conventional scanner was connected to computer with its monitoring device for digitalizing all study models. A software dental program (Dental Tracer(c) - Nile Delta Co. - version II) was used to locate the special points and lines from which the measurements of the teeth widths and symmetry of the dental arch both right and left sides were calculated. On each of the digitalized plaster cast, mesiodistal teeth widths were registered for each maxillary and mandibular deciduous canines, first and second molars as well as permanent canines, first and second premolars and first molars on one side and the corresponding teeth on the contralateral side. The teeth widths in centimeters were obtained by measuring the greatest distance between two accessible points on the proximal surfaces of the measured tooth (Figs. 1 and 2).

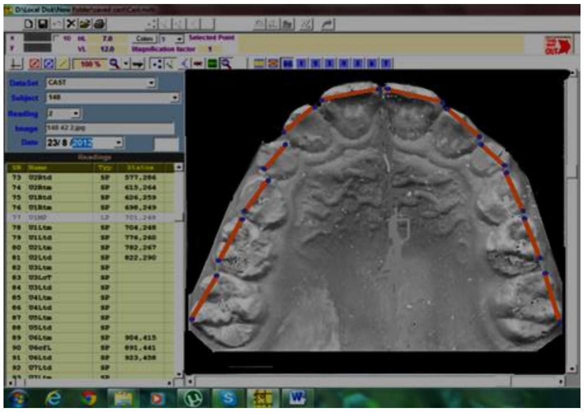

Figure 1: Mesial and distal reference points on an upper cast of a male child aged 8.5 years.

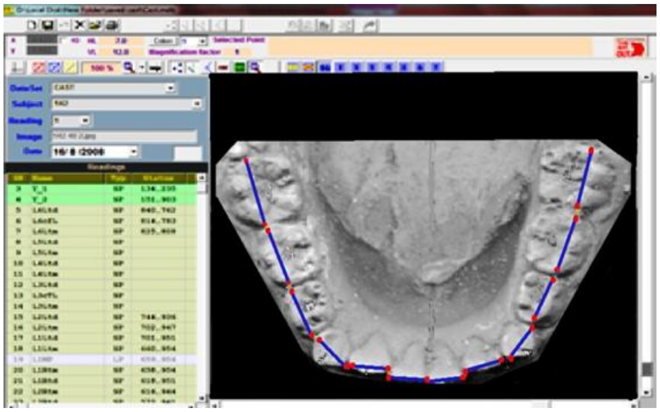

Figure 2: Mesial and distal reference points on a lower cast of the same child in Figure 1.

Lines were measured in centimeters from a midpoint between the mesial surfaces of the permanent central incisors to the accessible distal contact area of each tooth in both the right and left sides to assess the presence or absence of asymmetries in each arch separately (Figs. 3 and 4).

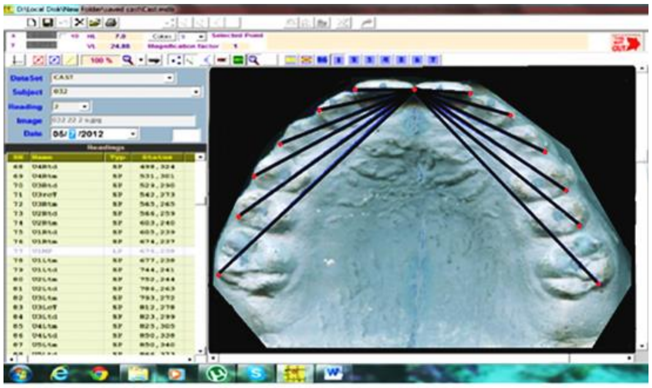

Figure 3: Right and left landmarks on an upper cast of a child aged 11.5 years.

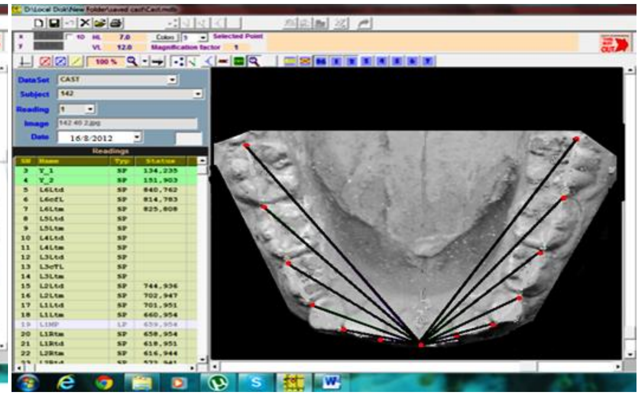

Figure 4: Right and left landmarks on a lower cast of the same child in Figure 2.

The abbreviations of the selected points and lines which were used to measure the teeth widths and arch symmetry planes were shown in Appendix1. Intra observer reliability was evaluated by replicable trials in which nine casts, selected at random, were measured at two occasions. Precision of the measurements was calculated by the method of error statistics (S) (Technical error measurement) in which $S = \sqrt{\sum d^2/2n}$ where (d) is the difference between the repeated measurements and (n) is the number of double determinations. The value (S) was small when it equals 0.08 mm or 1.2% of the mean. Interobserver error was calculated by differences between the means of two sets of measurements using the paired t-test. The differences were not statistically significant if the average was 0.16 mm or 2.1% of the mean measurements. Comparisons between measurements were done using independent t-test and paired t-test. Pearson's correlation coefficient was used to detect the correlation between measurements. The significance was measured at level $P \leq 0.05$. Tests were executed in SPSS Version 17® software program.

3. Results:

Table 1 shows the mesiodistal widths of all the studied teeth in ascending percentiles for boys and girls in both jaws. Percentiles under 30 were considered as small, between 30 and 70 as average, and above 70 as large. Tables 2 and 3 compare the means of the mesiodistal widths of right and left teeth for boys and girls in both arches respectively as well as the correlation between the right and left similar teeth. No significant differences were found for any of the measured teeth ($p>0.05$) as shown by paired t-test. The coefficient of correlation (r) between antimeres was highly significant for all teeth. Table 4 compares the mesiodistal widths of all the studied teeth between boys and girls for both arches using t-test. As regarding the permanent teeth, no significant differences were found except for the canines and first premolars, while for the deciduous teeth; the significant differences were found in canines and lower second molars. Table 5 shows the measured lines for boys and girls within both arches in ascending percentiles. Percentiles under 30 were considered as small, between 30 and 70 as average, and above 70 as large. Tables 6 and 7 compare the means of the lines measured at the right and left sides for boys and girls respectively in both dental arches as well as the correlation between both sides. For the boys; upper dental arch asymmetry is most prominent in the canine – premolar area while in the lower dental arch; it is present in canine and lateral incisor area. While for girls; the asymmetry is less prominent, where it is only noted in the upper arch at the deciduous first molar area and in the lower dental arch in the permanent canine area. Table 8 shows the means of the line measurements in the upper and lower arches of boys and girls. Most of the lines do not show sexual dimorphism except those of the following lines 1MPUCLt, 1MPU4Lt, 1MPUELt, 1MPLERt, 1MPU6Lt and 1MPL6Lt where boys are longer than girls.

4. Discussion:

The dental arch is the product of the mesiodistal dimensions of the teeth; during the replacement of the deciduous dentition with the permanent set in the diphyodont phenomenon of humans, dynamic changes occur leading sometimes to asymmetry in the dental arch formation. So this study was intended to throw light on some of these changes. This study applied a digitalized methodology with the measurements of plaster cast models by computer to analyze the teeth widths and asymmetry of the right and left sides of the dental arches. Tooth size and ratios in Caucasoid, Negroid and Mongoloids were studied. These three terms for three racial groups are originally anthropological and are based on skull dimensions. They can be considered equivalent to the terms white, black and far eastern as used in many English speaking countries. Both the overall and anterior average ratios were greater in Negroid than in Caucasoid while those for Mongoloids being intermediate (Othman *et al.*, 2006). A review of literature in contemporary human populations reveals that the incidence of tooth size discrepancy with a varying degree of sexual dimorphism has been found between different racial and population groups. Smith *et al.* (2000) found significant differences in Bolton's overall, anterior and posterior interarch ratios between Caucasians, Blacks and Hispanics and suggested that population specific standards are necessary for clinical assessments, therefore, different norms and standards have been developed for different ethnic and racial groups. The incidence of tooth size discrepancy has been established for white Americans, black Americans, Chinese, Japanese, Spanish, South Americans, Turkish, and Saudi Arabian populations. Normal measurements for one group should not be considered normal for every race or ethnic group. Different racial groups must be treated according to their own characteristics (Mojgan *et al.*, 2011). Our study proposes means and standard deviations of the mesiodistal widths of permanent and deciduous teeth for Egyptians, it follows the basic international trend for the mesiodistal widths of teeth and this is coinciding with Schwartz *et al.*(2005) and Madhavi*et al.*(2012). The non-significant differences in the mesiodistal widths of teeth between right and left sides indicates symmetry of tooth sizes; this is in agreement with most of the international records, also the significantly high coefficient of correlation denotes that the right and left teeth of an individual follow a very precise genetic monitoring and suggesting that measurements of teeth on one side could be truly representative when the corresponding measurements on the other side was unavailable; this coincides with Hashim *et al.*(1993) and Adeyemi *et al.* (2004). Sexual dimorphism was obvious in our sample in deciduous and permanent canines; this is in agreement with many authors who observed sexual difference in tooth size among American black, European and Mongoloid populations with a highly reported degree of sexual dimorphism in mandibular canine width (Ash *et al.*, 2009 and Madhavi *et al.*,2012) while Kaushal *et al.* (2003) found statistically significant dimorphism in mandibular canines in North Indian population where the mandibular left canine was seen to exhibit greater sexual dimorphism than the right canine. On the contrary Boaz *et al.* (2009) in a dimorphic study of maxillary and mandibular canines in South Indian population revealed reverse dimorphism where the females exhibited larger canines than males. Moreover, the differences which were detected in the mesiodistal dimension of the deciduous lower second molars, this may be related to the fact that it is the deciduous tooth with the greatest mesiodistal width; this is coincidence with Schwartz *et al.*(2005) and Ash *et al.*(2009)

Some author believes that evolution is the prime cause in the reduction or even the absence of sexual dimorphism Boaz *et al.* (2009). Dental arch asymmetry is a widely discussed subject in the literature, from its possible causes (such as heredity, chewing habits, early tooth loss and agenesis with resulting movement of adjacent teeth to the several different diagnostic resources and treatment possibilities (Paulo *et al.*, 2012). The rhythmic development of the right and left sides of the dental arch do not necessarily follow exactly the same pattern. Slight changes may be occurring leading to asymmetry temporarily or permanently for the final dental arch dimensions. The difference in the size of the deciduous and permanent teeth in addition to the variation in the date of shedding and emergence as well as the rate of eruption contributes in the aforementioned asymmetry. In this study, generally the asymmetry in the upper and lower dental arches was present in the canine – premolar area and allocated more anterior in the mandible than in the maxilla, this is due to the fact that during the shedding and eruption of canines and premolars there are dynamic changes in the arch dimensions while anteriorly to this area the presence of a fewer number of teeth decrease the amount of dimensional changes however more posterior to this area the foundation of the key stones of occlusion (first permanent molar which erupts early in a more stable position in the jaws) plays a great role in minimizing the liability of asymmetry between the right and left sides, this coincides with Nie *et al.* (2000) and Janson *et al.* (2001) while other research study found that the degree of asymmetry within mandibular dental arch is greater than its maxillary counterpart regardless of the presence or absence of malocclusion(Kusnoto *et al.*, 2002). Enlow *et al.* (1971) stated that dento alveolar asymmetries tend to be intercorrelated, probably because of dental compensations asymmetries in one part of the arch contribute to other asymmetries in other parts because of the geometry of the dentition. The detected sexual dimorphism in the following areas 1MPUCLt, 1MPU4Lt, 1MPUELt, 1MPLERt, 1MPU6Lt and 1MPL6Lt in favor of boys could be explained by the fact that teeth width and the dental arch dimensions for boys are greater than girls; this is in agreement with Ash *et al.* (2009) and Madhavi *et al.* (2012).

Table 1: Teeth widths in centimeters (percentiles) for boys and girls of both maxillary and mandibular dental arches

Width	Small						Average										Large					
	Min.		10		20		30		40		50		60		70		80		90		Max.	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Upper																						
CRT	0.52	0.50	0.61	0.56	0.64	0.58	0.65	0.60	0.67	0.63	0.68	0.65	0.70	0.66	0.72	0.68	0.73	0.69	0.75	0.70	0.82	0.71
CLT	0.56	0.52	0.62	0.55	0.66	0.58	0.67	0.60	0.69	0.62	0.69	0.64	0.70	0.65	0.71	0.67	0.73	0.69	0.74	0.72	0.79	0.75
DRT	0.46	0.57	0.62	0.57	0.66	0.62	0.68	0.64	0.70	0.65	0.71	0.68	0.73	0.69	0.75	0.73	0.76	0.74	0.79	0.77	0.88	0.79
DLT	0.54	0.60	0.65	0.63	0.68	0.64	0.70	0.65	0.71	0.68	0.72	0.70	0.74	0.70	0.75	0.71	0.78	0.75	0.81	0.80	0.88	0.85
ERT	0.68	0.70	0.75	0.74	0.76	0.78	0.79	0.80	0.81	0.83	0.83	0.84	0.84	0.86	0.86	0.87	0.88	0.89	0.91	0.94	0.97	0.98
ELT	0.66	0.66	0.76	0.67	0.78	0.76	0.80	0.81	0.83	0.82	0.84	0.83	0.86	0.85	0.87	0.88	0.90	0.90	0.94	0.93	0.98	0.96
1RT	0.55	0.50	0.65	0.64	0.69	0.73	0.76	0.78	0.80	0.82	0.83	0.84	0.85	0.86	0.87	0.88	0.90	0.89	0.94	0.95	1.01	1.03
1LT	0.44	0.49	0.63	0.63	0.72	0.73	0.76	0.78	0.79	0.80	0.83	0.83	0.85	0.86	0.88	0.89	0.91	0.90	0.95	0.95	0.98	0.99
2RT	0.48	0.51	0.57	0.54	0.60	0.56	0.62	0.58	0.64	0.61	0.65	0.63	0.67	0.67	0.68	0.69	0.71	0.72	0.75	0.76	0.83	0.79
2LT	0.39	0.49	0.57	0.53	0.58	0.56	0.61	0.60	0.63	0.61	0.65	0.62	0.67	0.66	0.69	0.69	0.71	0.70	0.74	0.74	0.79	0.78
3RT	0.55	0.60	0.67	0.63	0.71	0.65	0.73	0.68	0.74	0.69	0.76	0.71	0.78	0.73	0.81	0.77	0.82	0.79	0.85	0.81	0.87	0.81
3LT	0.65	0.54	0.68	0.63	0.71	0.66	0.74	0.69	0.74	0.70	0.75	0.70	0.78	0.73	0.80	0.75	0.83	0.76	0.85	0.81	0.88	0.85
4RT	0.54	0.52	0.63	0.58	0.66	0.61	0.69	0.64	0.71	0.69	0.73	0.70	0.74	0.71	0.75	0.73	0.78	0.74	0.81	0.77	0.83	0.85
4LT	0.61	0.55	0.63	0.60	0.68	0.62	0.69	0.66	0.71	0.69	0.72	0.70	0.75	0.71	0.77	0.72	0.77	0.73	0.78	0.76	0.89	0.78
5RT	0.58	0.55	0.58	0.55	0.62	0.57	0.65	0.59	0.71	0.62	0.72	0.65	0.72	0.66	0.75	0.70	0.77	0.76	0.82	0.77	0.84	0.77
5LT	0.60	0.58	0.61	0.58	0.66	0.58	0.70	0.59	0.71	0.63	0.72	0.67	0.73	0.71	0.76	0.76	0.78	0.78	0.80	0.79	0.80	0.79
6RT	0.77	0.76	0.88	0.87	0.91	0.92	0.94	0.95	0.97	0.99	1.00	1.01	1.01	1.03	1.03	1.05	1.06	1.09	1.08	1.14	1.23	1.27
6LT	0.83	0.80	0.90	0.88	0.94	0.92	0.95	0.96	0.97	1.00	0.99	1.01	1.00	1.02	1.02	1.04	1.05	1.05	1.09	1.10	1.15	1.21
Lower																						
CRT	0.47	0.31	0.50	0.45	0.52	0.48	0.53	0.50	0.54	0.50	0.56	0.54	0.57	0.55	0.58	0.57	0.60	0.57	0.62	0.59	0.65	0.62
CLT	0.47	0.33	0.49	0.45	0.53	0.47	0.53	0.49	0.55	0.51	0.56	0.53	0.57	0.54	0.59	0.55	0.59	0.57	0.62	0.58	0.90	0.61
DRT	0.48	0.53	0.71	0.68	0.73	0.73	0.75	0.74	0.77	0.76	0.79	0.78	0.80	0.79	0.81	0.80	0.83	0.83	0.84	0.88	0.99	0.92
DLT	0.53	0.62	0.72	0.67	0.74	0.70	0.75	0.74	0.77	0.76	0.78	0.79	0.79	0.80	0.81	0.82	0.84	0.84	0.90	0.86	0.96	0.89
ERT	0.76	0.74	0.91	0.77	0.92	0.81	0.94	0.85	0.96	0.95	0.98	0.95	1.00	0.97	1.03	0.98	1.04	1.00	1.07	1.04	1.11	1.11
ELT	0.82	0.73	0.88	0.78	0.93	0.85	0.96	0.91	0.98	0.94	1.00	0.96	1.02	0.96	1.03	1.00	1.05	1.02	1.09	1.05	1.14	1.10
1RT	0.33	0.34	0.43	0.41	0.47	0.44	0.43	0.46	0.49	0.48	0.50	0.49	0.52	0.51	0.53	0.52	0.55	0.55	0.57	0.58	0.82	0.67
1LT	0.34	0.39	0.43	0.40	0.47	0.46	0.49	0.48	0.50	0.49	0.51	0.49	0.51	0.50	0.52	0.51	0.54	0.52	0.57	0.60	0.81	0.65
2RT	0.41	0.37	0.46	0.44	0.49	0.47	0.51	0.50	0.54	0.52	0.56	0.54	0.57	0.56	0.59	0.57	0.60	0.59	0.62	0.63	0.79	0.75
2LT	0.41	0.38	0.47	0.43	0.50	0.46	0.52	0.50	0.54	0.52	0.56	0.54	0.57	0.55	0.59	0.57	0.60	0.59	0.62	0.63	0.82	0.72
3RT	0.57	0.57	0.62	0.60	0.67	0.61	0.68	0.64	0.70	0.66	0.70	0.66	0.72	0.70	0.73	0.71	0.75	0.75	0.79	0.78	0.91	0.80
3LT	0.59	0.62	0.65	0.64	0.70	0.65	0.69	0.66	0.70	0.67	0.71	0.70	0.72	0.71	0.74	0.73	0.76	0.74	0.79	0.78	0.90	0.82
4RT	0.57	0.58	0.60	0.58	0.64	0.58	0.65	0.64	0.68	0.70	0.72	0.71	0.73	0.72	0.75	0.74	0.80	0.76	0.81	0.78	0.83	0.79
4LT	0.59	0.59	0.64	0.61	0.66	0.64	0.69	0.64	0.73	0.68	0.74	0.70	0.75	0.74	0.76	0.76	0.77	0.77	0.81	0.78	0.82	0.79
5RT	0.61	0.50	0.61	0.50	0.61	0.50	0.64	0.58	0.67	0.65	0.70	0.70	0.74	0.74	0.75	0.77	0.75	0.81	0.75	0.81	0.75	0.81
5LT	0.59	0.46	0.60	0.46	0.63	0.53	0.64	0.60	0.65	0.63	0.66	0.65	0.68	0.67	0.71	0.70	0.75	0.76	0.94	0.95	0.94	0.95
6RT	0.84	0.74	0.96	0.93	1.00	1.01	1.03	1.03	1.08	1.05	1.09	1.08	1.12	1.09	1.14	1.11	1.18	1.16	1.21	1.20	1.28	1.32
6LT	0.89	0.75	0.98	0.94	1.01	0.99	1.05	1.03	1.06	1.05	1.09	1.07	1.12	1.09	1.14	1.11	1.16	1.16	1.20	1.19	1.29	1.30

Table 2: Paired t-test and correlation coefficient (r) of teeth widths between the antimeres for boys

Variables	N	Paired t-test	Sig.	Correlation	Sig.
Upper					
CRT -CLT	77	- 1.78	0.08	0.74	0.00
DRT -DLT	44	0.07	0.94	0.92	0.00
ERT - ELT	61	- 1.32	0.19	0.93	0.00
1RT - 1LT	110	0.90	0.37	0.80	0.00
2RT - 2LT	93	0.25	0.80	0.76	0.00
3RT - 3LT	29	0.75	0.46	0.85	0.00
4RT - 4LT	32	- 0.07	0.95	0.67	0.00
5RT - 5LT	8	- 0.41	0.70	0.90	0.00
6RT - 6LT	111	- 0.01	0.99	0.85	0.00
Lower					
CRT - CLT	63	1.13	0.27	0.93	0.00
DRT - DLT	44	- 1.56	0.13	0.84	0.00
ERT - ELT	19	0.85	0.41	0.83	0.00
1RT - 1LT	113	- 0.30	0.77	0.94	0.00
2RT - 2LT	108	- 0.90	0.37	0.86	0.00
3RT - 3LT	39	- 0.55	0.59	0.97	0.00
4RT - 4LT	9	- 0.78	0.46	0.95	0.00
5RT - 5LT	2	- 1.75	0.33	1.00	0.00
6RT - 6LT	112	- 0.27	0.79	0.90	0.00

Table 3: Paired t-test and correlation coefficient (r) of teeth widths between the antimeres for girls

Variables	N	Paired t-test	Sig.	Correlation	Sig.
Upper					
CRT -CLT	33	0.37	0.71	0.79	0.00
DRT -DLT	17	- 1.09	0.29	0.58	0.02
ERT - ELT	38	1.26	0.22	0.82	0.00
1RT - 1LT	60	0.98	0.33	0.97	0.00
2RT - 2LT	53	1.21	0.23	0.87	0.00
3RT - 3LT	20	0.11	0.91	0.82	0.00
4RT - 4LT	35	- 0.12	0.90	0.85	0.00
5RT - 5LT	3	- 1.89	0.20	0.87	0.33
6RT - 6LT	61	1.56	0.12	0.92	0.00
Lower					
CRT - CLT	28	0.32	0.75	0.94	0.00
DRT - DLT	17	0.16	0.88	0.87	0.00
ERT - ELT	13	- 1.04	0.32	0.78	0.02
1RT - 1LT	58	- 0.05	0.96	0.82	0.00
2RT - 2LT	57	0.08	0.94	0.91	0.00
3RT - 3LT	19	- 1.65	0.12	0.80	0.00
4RT - 4LT	10	- 0.56	0.59	0.79	0.01
5RT - 5LT	00	-----	-----	-----	-----
6RT - 6LT	59	1.72	0.09	0.97	0.00

Table 4: Comparison of mesiodistal widths in centimeters of all the studied teeth between boys and girls using t-test

Jaw		**Upper**						**Lower**					
Width		**N**	**Mean**	**SD**	**Range**	**t-test**	**Sig.**	**N**	**Mean**	**SD**	**Range**	**t-test**	**Sig.**
CRT	**M**	77	0.68	0.06	0.30	4.16	0.00	68	0.56	0.04	0.18	3.26	0.00
	F	34	0.64	0.06	0.21			32	0.52	0.06	0.31		
CLT	**M**	81	0.68	0.05	0.23	4.97	0.00	67	0.56	0.06	0.43	3.66	0.00
	F	34	0.64	0.06	0.23			30	0.52	0.06	0.28		
DRT	**M**	57	0.71	0.07	0.42	1.77	0.08	58	0.78	0.07	0.51	0.30	0.76
	F	20	0.68	0.06	0.22			25	0.77	0.08	0.39		
DLT	**M**	62	0.73	0.06	0.34	1.84	0.07	63	0.79	0.07	0.43	0.74	0.46
	F	20	0.70	0.06	0.25			25	0.77	0.07	0.27		
ERT	**M**	84	0.83	0.06	0.29	-0.94	0.35	54	0.98	0.07	0.34	2.79	0.01
	F	43	0.84	0.07	0.28			28	0.93	0.10	0.37		
ELT	**M**	69	0.84	0.07	0.32	0.98	0.33	52	1.00	0.07	0.32	2.57	0.01
	F	47	0.83	0.08	0.30			19	0.94	0.09	0.36		
1RT	**M**	111	0.81	0.11	0.46	-0.56	0.58	113	0.51	0.06	0.49	1.01	0.32
	F	60	0.81	0.11	0.53			58	0.50	0.07	0.33		
1LT	**M**	110	0.80	0.12	0.54	-0.61	0.55	113	0.51	0.06	0.47	1.11	0.27
	F	60	0.82	0.11	0.50			58	0.50	0.06	0.26		
2RT	**M**	99	0.66	0.07	0.35	1.17	0.24	110	0.55	0.06	0.38	1.27	0.21
	F	55	0.64	0.08	0.28			58	0.54	0.08	0.38		
2LT	**M**	98	0.65	0.07	0.40	1.46	0.15	111	0.55	0.06	0.41	1.60	0.11
	F	53	0.63	0.07	0.29			57	0.54	0.07	0.35		
3RT	**M**	32	0.76	0.07	0.32	2.23	0.03	40	0.71	0.06	0.34	1.62	0.11
	F	20	0.72	0.07	0.21			19	0.68	0.07	0.24		
3LT	**M**	31	0.76	0.06	0.23	2.95	0.01	42	0.71	0.06	0.31	0.99	0.33
	F	21	0.71	0.07	0.31			22	0.70	0.05	0.20		
4RT	**M**	45	0.72	0.07	0.29	2.02	0.05	18	0.71	0.08	0.26	0.60	0.55
	F	38	0.69	0.08	0.33			14	0.69	0.07	0.21		
4LT	**M**	42	0.73	0.07	0.28	2.90	0.01	18	0.72	0.06	0.23	1.06	0.30
	F	37	0.69	0.06	0.23			16	0.70	0.06	0.20		
5RT	**M**	12	0.71	0.08	0.26	1.43	0.17	4	0.69	0.07	0.14	0.23	0.83
	F	8	0.65	0.08	0.22			4	0.68	0.13	0.31		
5LT	**M**	21	0.72	0.06	0.20	1.44	0.16	11	0.70	0.11	0.39	0.62	0.54
	F	8	0.68	0.09	0.21			8	0.66	0.14	0.49		
6RT	**M**	111	0.99	0.08	0.45	-1.47	0.14	112	1.09	0.09	0.43	0.96	0.34
	F	61	1.01	0.10	0.50			59	1.07	0.11	0.58		
6LT	**M**	111	0.99	0.07	0.32	-1.06	0.29	112	1.09	0.08	0.40	1.53	0.13
	F	61	1.00	0.09	0.41			59	1.07	0.11	0.55		

Table 5: Line dimensions in centimeters (percentiles) of boys and girls for both maxillary and mandibular dental arches

Lines	Small						Average										Large					
	Min.		10		20		30		40		50		60		70		80		90		Max.	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Maxillary Arch																						
U1MPCRT	1.75	1.78	1.89	1.91	1.95	1.93	2.01	1.99	2.06	2.01	2.10	2.06	2.19	2.09	2.27	2.13	2.31	2.16	2.36	2.31	2.58	2.52
U1MPCLT	1.31	1.79	1.91	1.87	1.97	1.91	2.02	1.95	2.08	1.97	2.13	2.00	2.20	2.02	2.25	2.18	2.31	2.19	2.38	2.27	2.54	2.53
U1MPDRT	1.95	2.33	2.50	2.55	2.58	2.59	2.60	2.69	2.69	2.70	2.73	2.74	2.80	2.86	2.86	2.93	2.97	2.98	3.04	3.14	3.17	3.22
U1MPDLT	2.06	2.45	2.51	2.47	2.58	2.55	2.66	2.56	2.70	2.71	2.78	2.76	2.83	2.81	2.92	2.86	3.01	2.92	3.04	3.08	3.28	3.27
U1MPERT	2.70	2.98	3.24	3.20	3.35	3.30	3.42	3.33	3.51	3.42	3.57	3.48	3.61	3.50	3.68	3.58	3.76	3.60	3.84	3.80	3.99	4.04
U1MPELT	2.92	2.90	3.19	3.10	3.31	3.25	3.40	3.29	3.49	3.34	3.53	3.40	3.62	3.51	3.68	3.56	3.80	3.63	3.89	3.70	4.03	4.03
U1MP1RT	0.58	0.52	0.69	0.71	0.76	0.77	0.80	0.80	0.83	0.83	0.86	0.84	0.89	0.86	0.92	0.89	0.93	0.91	0.98	0.94	1.14	1.08
U1MP1LT	0.52	0.48	0.68	0.65	0.76	0.74	0.80	0.77	0.83	0.79	0.86	0.82	0.89	0.85	0.90	0.88	0.94	0.91	0.97	0.97	1.03	1.10
U1MP2RT	1.18	1.12	1.28	1.30	1.35	1.36	1.43	1.42	1.48	1.46	1.51	1.49	1.56	1.52	1.60	1.55	1.63	1.58	1.66	1.65	1.76	2.06
U1MP2LT	1.18	1.02	1.27	1.30	1.34	1.35	1.40	1.40	1.51	1.42	153	1.44	157	1.50	1.61	1.53	1.66	1.60	1.70	1.67	1.83	1.86
U1MP3RT	1.78	1.80	1.93	1.87	2.00	1.97	2.04	2.05	2.10	2.10	2.15	2.16	2.20	2.20	2.24	2.27	2.27	2.34	2.31	2.59	2.50	2.74
U1MP3LT	1.74	1.58	1.89	1.73	1.96	1.97	2.07	2.02	2.11	2.05	2.15	2.19	2.23	2.21	2.31	2.23	2.35	2.29	2.37	2.49	2.40	3.00
U1MP4RT	2.16	2.39	2.50	2.48	2.58	2.56	2.65	2.62	2.74	2.66	2.82	2.71	2.86	2.78	2.95	2,83	3.02	2.92	3.09	3.09	3.29	3.38
U1MP4LT	2.42	2.16	2.51	2.46	2.67	2.52	2.72	2.59	2.81	2.64	2.86	2.67	2.95	2.76	3.01	2.84	3.07	2.95	3.12	3.05	3.20	3.46
U1MP5RT	2.85	3.08	2.96	3.07	3.23	3.17	3.40	3.44	3.45	3.54	3.52	3.66	3.64	3.72	3.67	3.75	3.72	3.79	3.88	3.89	3.97	3.90
U1MP5LT	2.68	3.22	3.33	3.22	3.35	3.23	3.43	3.31	3.55	3.35	3.58	3.50	3.64	3.69	3.66	3.74	3.75	3.77	3.80	3.89	4.36	3.81
U1MP6RT	3.46	3.75	4.05	3.93	4.17	4.08	4.28	4.16	4.33	4.28	4.37	4.36	4.44	4.43	4.50	4.48	4.61	4.54	4.73	4.68	4.96	4.92
U1MP6LT	3.65	3.61	4.07	4.00	4.20	4.09	4.26	4.18	4.37	4.25	4.41	4.33	4.47	4.40	4.53	4.47	4.60	4.53	4.75	4.95	5.07	5.02
Mandibular Arch																						
L1MPCRT	1.30	1.34	1.43	1.43	1.53	1.46	1.57	1.52	1.60	1.55	1.65	1.60	1.66	1.63	1.69	1.67	1.76	1.75	1.79	1.84	1.82	2.01
L1MPCLT	0.88	1.27	1.53	1.38	1.57	1.44	1.65	1.54	1.67	1.75	1.70	1.62	1.71	1.65	1.73	1.70	1.79	1.77	1.83	1.86	2.20	2.85
L1MPDRT	1.84	2.02	2.06	2.09	2.19	2.13	2.24	2.15	2.27	2.21	2.31	2.29	2.36	2.36	2.41	2.39	2.44	2.42	2.48	2.59	3.11	2.67
L1MPDLT	1.70	1.89	2.16	2.04	2.23	2,15	2.28	2.24	2.31	2.25	2.37	2.32	2.41	2.36	2.43	2.44	2.47	2.47	2.63	2.60	3.62	2.88
L1MPERT	2.73	2.39	2.80	2.72	2.91	2.83	3.06	2.91	3.14	3.03	3.17	3.05	3.19	3.11	3.24	3.14	3.29	3.19	3.35	3.33	3.62	3.48
L1MPELT	2.36	2.55	2.87	2.70	3.00	2.89	3.07	2.94	3.16	2.97	3.21	3.02	3.25	3.10	3.28	3.22	3.34	3.36	3.44	3.49	4.32	3.65
L1MP1RT	0.42	0.40	0.46	0.45	0.50	0.47	0.52	0.49	0.53	0.51	0.54	0.53	0.55	0.54	0.56	0.56	0.58	0.57	0.61	0.63	0.85	0.89
L1MP1LT	0.42	0.42	0.49	0.47	0.51	0.49	0.52	0.51	0.54	0.52	0.55	0.53	0.56	0.54	0.57	0.56	0.59	0.59	0.60	0.65	0.84	0.70
L1MP2RT	0.86	0.87	0.99	0.93	1.01	0.99	1.05	1.01	1.07	1.05	1.01	1.07	1.13	1.11	1.16	1.14	1.18	1.17	1.22	1.26	1.66	1.37
L1MP2LT	0.85	0.66	1.02	0.99	1.06	1.02	1.09	1.06	1.11	1.08	1.14	1.10	1.15	1.13	1.17	1.16	1.20	1.19	1.23	1.23	1.71	1.33
L1MP3RT	1.41	1.47	1.51	1.49	1.56	1.54	1.58	1.63	1.61	1.69	1.65	1.72	1.68	1.75	1.71	1.78	1.74	1.82	1.84	1.89	2.36	1.89
L1MP3LT	1.44	1.52	1.54	1.55	1.62	1.59	1.63	1.64	1.66	1.69	1.68	1.73	1.73	1.79	1.78	1.83	1.82	1.87	1.86	2.01	2.52	2.09
L1MP4RT	1.98	1.96	2.03	2.00	2.21	2.09	2.31	2.21	2.33	2.29	2.36	2.33	2.40	2.41	2.42	2.49	2.47	2.57	2.55	2.64	2.97	2.65
L1MP4LT	1.67	1.87	1.82	2.03	2.23	2.11	2.25	2.20	2.30	2.34	2.39	2.45	2.44	2.57	2.50	2.60	2.63	2.63	2.73	2.66	2.79	2.69
L1MP5RT	3.07	3.04	3.07	3.04	3.07	3.04	3.07	3.04	3.08	3.04	3.09	3.10	3.10	3.15	3.10	3.19	3.10	3.22	3.10	3.22	3.10	3.22
L1MP5LT	2.95	2.48	2.47	2.48	2.90	2.68	3.03	2.87	3.05	2.90	3.10	2.93	3.18	3.07	3.26	3.15	3.31	3.24	3.37	3.66	3.38	3.66
L1MP6RT	3.51	3.09	3.73	3.66	3.86	3.75	3.89	3.88	4.02	3.96	4.07	4.02	4.12	4.10	4.20	4.14	4.24	4.20	4.34	4.34	4.58	3.55
L1MP6LT	3.24	3.48	3.73	3.76	3.91	3.84	4.01	3.88	4.06	3.91	4.08	3.97	4.12	3.99	4.18	4.13	4.27	4.19	4.37	4.32	4.37	4.60

Table 6: Paired t-test and correlation coefficient (r) of the lines between the antimeres for boys

Variables	N	Paired t-test	Sig.	Correlation	Sig.
Upper					
U1MPUCRT -U1MPUCLT	77	- 0.22	0.83	0.57	0.00
U1MPUDRT -U1MPUDLT	44	0.77	0.45	0.60	0.00
U1MPUERT -U1MPUELT	61	1.19	0.24	0.74	0.00
U1MPU1RT - U1MPU1LT	110	1.45	0.11	0.74	0.00
U1MPU2RT - U1MPU2LT	93	- 1.62	0.11	0.81	0.00
U1MPU3RT - U1MPU3LT	29	- 2.55	0.02	0.87	0.00
U1MPU4RT - U1MPU4LT	32	- 2.40	0.02	0.79	0.00
U1MPU5RT - U1MPU5LT	8	0.84	0.43	0. 56	0.00
U1MPU6RT - U1MPU6LT	111	- 1.69	0.09	0.79	0.00
L1MPLCRT - L1MPLCLT	66	-2.74	0.01	0.54	0.00
Lower					
L1MPLDRT - L1MPLDLT	44	-3.03	0.00	0.36	0.02
L1MPLERT - L1MPLELT	20	1.21	0.24	0.63	0.00
L1MPL1RT - L1MPL1LT	113	-1.43	0.15	0.61	0.00
L1MPL2RT - L1MPL2LT	107	-3.79	0.00	0.65	0.00
L1MPL3RT - L1MPL3LT	39	-3.24	0.00	0.83	0.00
L1MPL4RT - L1MPL4LT	9	-1.19	0.27	0.55	0.00
L1MPL5RT - L1MPL5LT	2	-0.82	0.56	1.00	0.00
L1MPL6RT - L1MPL6LT	112	-1.38	0.17	0.58	0.00

Table 7: Paired t-test and correlation coefficient (r) of the lines between the antimeres for girls

Variables	N	Paired t-test	Sig.	Correlation	Sig.
Upper					
U1MPUCRT -U1MPUCLT	33	1.28	0.21	0.74	0.00
U1MPUDRT -U1MPUDLT	17	2.73	0.02	0.84	0.00
U1MPUERT - U1MPUELT	37	1.63	0.11	0.74	0.00
U1MPU1RT - U1MPU1LT	60	2.03	0.59	0.73	0.00
U1MPU2RT - U1MPU2LT	53	1.57	0.52	0.81	0.00
U1MPU3RT - U1MPU3LT	20	1.02	0.19	0.88	0.00
U1MPU4RT - U1MPU4LT	35	0.64	0.34	0.81	0.00
U1MPU5RT - U1MPU5LT	3	-2.36	0.20	0.97	0.00
U1MPU6RT - U1MPU6LT	60	0.85	0.59	0.69	0.00
Lower					
L1MPLCRT - L1MPLCLT	30	0.13	0.90	0.31	0.10
L1MPLDRT - L1MPLDLT	17	0.14	0.89	0.24	0.36
L1MPLERT - L1MPLELT	13	-0.64	0.54	0.20	0.51
L1MPL1RT - L1MPL1LT	58	-0.56	0.58	0.61	0.00
L1MPL2RT - L1MPL2LT	53	-1.47	0.15	0.74	0.00
L1MPL3RT - L1MPL3LT	19	-2.13	0.05	0.80	0.00
L1MPL4RT - L1MPL4LT	10	-1.27	0.24	0.51	0.13
L1MPL5RT - L1MPL5LT	00	-----	-----	-----	-----
L1MPL6RT - L1MPL6LT	59	-0.32	0.75	0.47	0.00

Table 8: Comparison of all line measurements in centimeters between boys and girls using t-test

Jaw		Upper						Lower					
Lines	**Sex**	**N**	**Mean**	**SD**	**Range**	**t-test**	**Sig.**	**N**	**Mean**	**SD**	**Range**	**t-test**	**Sig.**
1MPUCRT	**M**	77	2.13	0.19	0.84	1.30	0.20	68	1.62	0.13	0.52	0.59	0.56
	F	34	2.08	0.16	0.74			32	1.61	0.16	0.68		
1MPUCLT	**M**	81	2.13	0.20	1.21	2.17	0.03	70	1.68	0.16	1.42	0.98	0.33
	F	34	2.05	0.17	0.75			33	1.64	0.27	1.58		
1MPUDRT	**M**	57	2.73	0.25	1.22	-0.98	0.33	58	2.30	0.17	0.78	-0.01	0.99
	F	19	2.80	0.23	0.89			25	2.30	0.18	0.66		
1MPUDLT	**M**	62	2.78	0.23	1.22	0.41	0.68	63	2.36	0.21	1.41	0.76	0.45
	F	20	2.75	0.22	0.82			25	2.33	0.21	0.99		
1MPUERT	**M**	84	3.55	0.23	1.29	1.80	0.10	55	3.13	0.20	0.89	2.07	0.04
	F	42	3.47	0.22	1.06			28	3.03	0.24	1.10		
1MPUELT	**M**	69	3.54	0.26	1.12	2.55	0.01	55	3.18	0.28	1.96	1.39	0.17
	F	46	3.42	0.24	1.13			20	3.08	0.27	1.09		
1MPU1RT	**M**	111	0.85	0.11	0.56	0.87	0.39	113	0.54	0..06	0.43	0.67	0.50
	F	60	0.84	0.10	0.56			58	0.53	0.08	0.50		
1MPU1LT	**M**	110	0.84	0.11	0.51	1.49	0.14	113	0.55	0.06	0.56	0.93	0.36
	F	60	0.82	0.12	0.62			58	0.54	0.06	0.28		
1MPU2RT	**M**	99	1.50	0.14	0.59	0.43	0.67	109	1.10	0.11	0.80	1.16	0.25
	F	55	1.49	0.16	0.94			55	1.08	0.12	0.50		
1MPU2LT	**M**	98	1.51	0.16	0.65	1.76	0.10	111	1.13	0.10	0.86	1.89	0.06
	F	53	1.46	0.17	0.90			55	1.10	0.11	0.67		
1MPU3RT	**M**	32	2.14	0.17	0.73	-0.64	0.52	40	1.66	0.16	0.96	-0.97	0.34
	F	21	2.17	0.23	0.95			19	1.70	0.13	0.42		
1MPU3LT	**M**	31	2.16	0.19	0.66	0.11	0.92	43	1.71	0.17	1.08	-0.65	0.52
	F	21	2.15	0.29	1.43			22	1.75	0.16	0.57		
1MPU4RT	**M**	45	2.80	0.23	1.13	0.96	0.34	18	2.36	0.21	0.99	0.33	0.74
	F	38	2.75	0.23	0.99			14	2.34	0.22	0.69		
1MPU4LT	**M**	42	2.85	0.22	0.78	2.42	0.02	18	2.36	0.28	1.11	-0.33	0.75
	F	37	2.72	0.26	1.30			16	2.39	0.25	0.82		
1MPU5RT	**M**	13	3.49	0.30	1.12	-0.55	0.59	4	3.08	0.02	0.03	-0.55	0.60
	F	10	3.56	0.28	0.82			4	3.11	0.09	0.18		
1MPU5LT	**M**	21	3.56	0.30	1.68	0.31	0.76	12	3.07	0.29	1.03	0.55	0.59
	F	8	3.52	0.26	0.67			9	3.00	0.34	1.18		
1MPU6RT	**M**	111	4.38	0.27	1.49	1.08	0.28	112	4.05	0.23	1.07	1.54	0.17
	F	60	4.33	0.26	1.17			59	4.00	0.27	1.46		
1MPU6LT	**M**	111	4.40	0.26	1.42	2.33	0.02	112	4.08	0.27	2.14	1.94	0.05
	F	60	4.31	0.25	1.41			59	4.00	0.23	1.12		

Appendix 1: Definitions of abbreviations for points and lines used in tracing analysis

Abbreviation	Title
U/L**C**(R/L)t	Upper or Lower **Deciduous Canine** (Right or Left)
U/L**D**(R/L)t	Upper or Lower **Deciduous First Molar** (Right or Left)
U/L**E**(R/L)t	Upper or Lower **Deciduous Second Molar** (Right or Left)
U/L**1**(R/L)t	Upper or Lower **Permanent Central Incisor** (Right or Left)
U/L**2**(R/L)t	Upper or Lower **Permanent Lateral Incisor** (Right or Left)
U/L**3**(R/L)t	Upper or Lower **Permanent Canine** (Right or Left)
U/L**4**(R/L)t	Upper or Lower **Permanent First Premolar** (Right or Left)
U/L**5**(R/L)t	Upper or Lower **Permanent Second Premolar** (Right or Left)
U/L**6**(R/L)t	Upper or Lower **Permanent First Molar** (Right or Left)
(U/L)**1MP**(U/L)**C**(R/L)t	A line from a midpoint between Upper or Lower **Permanent Central Incisors** to the distal contact point of Upper or Lower **Deciduous Canine** (Right or Left)
(U/L)**1MP**(U/L)**D**(R/L)t	A line from a midpoint between Upper or Lower **Permanent Central Incisors** to the distal contact point of Upper or Lower **Deciduous First Molar** (Right or Left)
(U/L)**1MP**(U/L)**E**(R/L)t	A line from a midpoint between Upper or Lower **Permanent Central Incisors** to the distal contact point of Upper or Lower **Deciduous Second Molar** (Right or Left)
(U/L)**1MP**(U/L)**1**(R/L)t	A line from a midpoint between Upper or Lower **Permanent Central Incisors** to the distal contact point of Upper or Lower Permanent Central Incisor (Right or Left)
(U/L)**1MP**(U/L)**2**(R/L)t	A line from a midpoint between Upper or Lower **Permanent Central Incisors** to the distal contact point of Upper or Lower **Permanent Lateral Incisor** (Right or Left)
(U/L)**1MP**(U/L)**3**(R/L)t	A line from a midpoint between Upper or Lower **Permanent Central Incisors** to the distal contact point of Upper or Lower **Permanent Canine** (Right or Left)
(U/L)**1MP**(U/L)**4**(R/L)t	A line from a midpoint between Upper or Lower **Permanent Central Incisors** to the distal contact point of Upper or Lower **Permanent First Premolar** (Right or Left)
(U/L)**1**MP(U/L)**5**(R/L)t	A line from a midpoint between Upper or Lower **Permanent Central Incisors** to the distal contact point of Upper or Lower **Permanent Second Premolar** (Right or Left)
(U/L)**1**MP(U/L)**6**(R/L)t	A line from a midpoint between Upper or Lower **Permanent Central Incisors** to the distal contact point of Upper or Lower **Permanent First Molar** (Right or Left)

Conclusions:

Teeth widths for permanent and deciduous dentitions were recorded for a group of Egyptian children. Asymmetries of teeth widths and dental arches were reported. Sexual dimorphism was found in some teeth widths and dental arch lines. The canine and premolar areas showed greater asymmetry than other areas of the jaws. Mandibular dental arches showed a more anteriorly positioned asymmetry than the maxillary dental arch.

Recommendation:

This study could be considered as a stepping stone for further researches in relevant fields; so more studies will be of use to make a data base available on dental morphometric measurements with a view to determine variations among the different populations that may be beneficial for clinical, anthropological, genetic, legal and forensic applications.

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