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Dental Maturation Assessment by Nolla's Technique on a Group of Egyptian Children

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Abstract: Human dental growth and development have been recorded by many ways over the centuries, ranging from the drawings found in the tombs of ancient Egypt to the computer drawn plots of modern times. The present study carried out to assess the maturation of permanent dentition by applying Nolla's technique on a group of panoramic x-ray films (378 males and females) of Egyptian children within the age range of 6 to 15 years. The panoramic radiographs were used for evaluation of tooth maturation on a scale from 0 to 10 and the obtained data was statistically analyzed. The data was presented in tables and used to plot dental maturation curves for Egyptian boys and girls. No significant differences were found between right and left teeth so, only the left side was used. The findings of the present study showed significant sexual dimorphism in the degrees of dental development of Egyptian children from the beginning of the studied age (6 years) until the last two groups (13-15 years). Lower teeth were found to be ahead of upper teeth in all age groups. The results of maxillary and mandibular teeth including or excluding the third molars gave similar values. The results given in this article is an attempt to estimate the norms of dental maturation for Egyptian children at the studied age span, which facilitate the way for clinicians to assess the growing children during diagnosis and treatment planning.

Key words: Dental Maturation, Nolla's Technique, Permanent teeth

INTRODUCTION

One of the most important issue for dental clinicians especially those treating children and researchers dealing with growth and development is to understand the process of dental development. Although the eruption of the teeth may differ greatly in its time of appearance in the oral cavity of various children, the majority of children exhibit some pattern in the sequence of eruption (Klein,1939 and Moyer,1953). However, a consideration of eruption alone makes one cognizant of only one phase of the development of dentition (Nolla, 1960). Tooth development is a continuous process that is considered as a better measure of developmental age than other more environmentally dependent phenomena as tooth emergence (Gleiser,1955 and Fanning,1961).

Differences in the development among children of the same chronologic age have led to the concept of physiologic age as a means to define progress toward completeness of development or maturity in the individual child. The dentition is one of the four systems used for physiologic age estimation (the other three developmental indicators refer to bone development, secondary sex characters and stature or weight) (Moorrees, 1963).

Many authors agreed that dental growth and development should be adapted as a more reliable criterion of biological age and teeth maturation has been found to have intimate relationship to the chronological age (Lewis, 1960; Green, 1961; Nanda, 1966 and Kurita *et al*, 2007)

Various methods were recorded for the assessment of the dental maturation depending on tooth calcification (Fanning, 1961; Loevy, 1983; Gleiser, 1955; Garn, 1958; Nolla, 1960, Moorrees, 1963; and Demirjian, 1973). Nolla's technique, 1960 is considered one of these methods and it was reported to be more precise for assessing dental calcification at a wide range of age (Rai, 2006).

This study aims to estimate dental maturation norms of permanent dentition among a group of Egyptian

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boys and girls that serve the interpretation of individual race differences in dental development by age unite method.

MATERIAL AND METHODS

The present study was carried out on children that were six to fifteen years of old, of Egyptian parent, free from any apparent medical disease and had no dental abnormities or any permanent teeth extractions. The total number of children was 378 of which 186 were boys and 192 were girls. The sample was divided into nine age groups of one-year interval starting from six to less than seven years (first group) until fourteen to fifteen years (ninth group). The dental panoramic radiographs were scanned and examined on a computer monitor to permit an accurate reading for rating the degree of calcification of each tooth according to Nolla's technique in which ten stages of calcification (1 to 10) were described for each tooth, (Figure1, a, b, c).

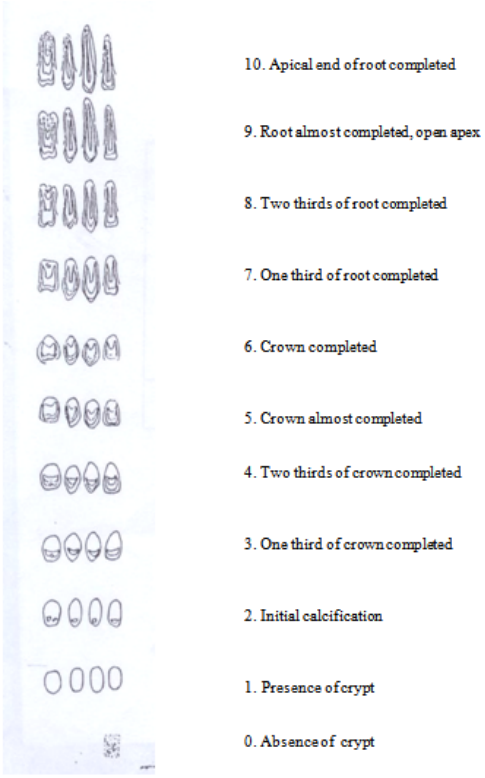

Fig. 1, a: Nolla's normal developmental stages of mandibular and maxillary teeth

Fig. 1, b: Panoramic X-ray film for an Egyptian boy aged 7 Years

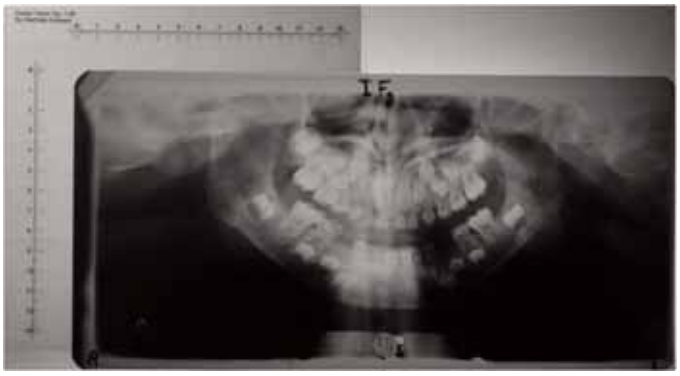

Fig. 1, c: Panoramic X-ray film for an Egyptian girl aged 6 Years

In order to obtain an appraisal of the development of a particular tooth, the radiograph was matched as closely as possible with the comparative figure. When the radiograph reading lay between two grade, this appraisal was indicated as the value of 0.5, when the radiograph showed a reading that was slightly greater than the illustrated grade, but not as much as halfway between that stage and the next, the value 0.2 was added and when the development were slightly less than the grade indicated, the value of 0.7 was added. The obtained data for each tooth were summarized to gain the average level of the tooth's development at each age for boys and girls separately both for maxillary and mandibular arches. Statistical analysis and interpretation were done using SPSS program version 11 of UCLA (University of California at Los Angelos).

RESULTS AND DISCUSSION

The distribution of the subjects by age and sex are presented in Table 1.

The minimum number of children in each group was 18 while the maximum number was 24.

No significant differences were found between right and left sides so, only the scores of the left side were used for the statistical analysis.

The means of maturation scores for all the teeth separately as well as the results of t-test between upper and lower antagonist are shown in Table 2.

Throughout their development, the central and lateral incisors show significant differences for girls while for boys the significance is shown only in groups' I and IV.

The canines also show significant difference throughout most age groups for both sexes whoever it starts earlier in females.

As regards the premolars, the first premolars showed no significance in all age groups for both sexes , while the second premolars showed sporadic significance in different age / sex groups.

The first molar showed a significant difference only in the first group in both sexes and second group of females.

Significant difference for the second molar appears only in some of the subgroups in the younger half of the study.

As for the third molar no significance was found except for the third and fourth group in females but only in the third group in males.

Table 3 shows the means and standard deviations of the sum of developmental scores for all maxillary teeth (excluding the third molar), all mandibular teeth (excluding the third molar) and their combined total scores.

The significance between the upper versus the lower jaw as well as between boys versus girls marked on Tables 3 and 4.

Table 4 is a replica of Table 3 but including the developmental scores of the third molars.

Dental maturation curves for each of the seven maxillary and mandibular teeth are presented in Figure 2 and 3 respectively for boys and girls, while the growth norms for the combined maxillary and mandibular teeth is shown in Figure 4.

Table 1: Distribution of children according to age and sex.

Age (years)	Girls	Boys
6 < 7	20	22
7 < 8	22	20
8 < 9	20	20
9 < 10	20	20
10 < 11	22	22
11 < 12	22	22
12 < 13	24	22
13 < 14	20	20
14 < 15	22	18
Total	192	186

Table 2: Maturation scores for permanent teeth of Egyptian children.

Age group	Sex	Girls								Boys							
	Tooth	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	Jaw																
I	U	8.1	7.1	6.4	5.6	5.5	7.9	4.6	0.0	7.8	7.0	5.9	5.7	5.1	7.5	5.1	0.0
	L	8.4	7.6	6.6	5.8	5.4	8.1	5.4	0.0	8.4	7.9	6.0	5.1	5.0	7.7	4.8	0.0
	t	-4.8	-4.4	-2.3	-1.8	1.0	-2.5	-3.7	0.0	-9.3	-9.1	-0.6	5.4	0.7	-2.5	2.2	0.0
II	U	9.1	8.6	7.6	7.0	6.9	9.0	6.7	0.2	8.7	8.2	7.3	6.5	6.2	9.0	6.3	0.9
	L	9.5	9.2	7.9	7.1	6.9	9.3	6.7	0.3	9.0	8.6	7.7	6.7	6.7	8.9	6.6	0.9
	t	-5.9	-4.6	-3.9	-1.0	0.4	-4.9	0.1	-1.1	-1.8	-2.0	-3.1	-1.3	-3.1	2.0	-1.9	-0.3
III	U	9.6	9.1	7.9	7.8	7.7	9.3	7.2	1.0	9.5	8.9	7.4	7.3	6.9	9.5	6.2	1.4
	L	9.8	9.9	8.1	7.7	7.4	9.4	7.1	2.0	9.6	9.0	8.0	7.2	6.6	9.5	7.1	2.5
	t	-3.2	-2.1	-0.7	1.3	2.4	-0.5	0.3	-2.1	-1.0	-0.9	-5.2	0.4	0.8	-0.2	-5.4	-3.2
IV	U	9.9	9.4	8.6	8.6	8.2	9.8	7.6	1.5	9.7	9.1	7.8	8.5	7.7	9.8	7.1	2.6
	L	10.0	9.8	8.8	8.5	8.0	9.9	7.7	2.0	10.0	9.7	8.5	7.7	7.5	9.8	7.2	2.8
	t	-2.8	-3.6	-1.6	0.7	1.9	0.7	-1.9	-2.3	-3.4	-3.9	-3.0	1.7	1.3	-1.5	-0.6	-0.7
V	U	9.9	9.8	8.9	8.8	8.6	9.9	8.1	3.1	9.9	9.9	8.9	8.5	8.2	9.9	8.2	3.5
	L	10.0	10.0	9.2	8.8	8.5	10.0	8.4	3.6	10.0	9.8	8.5	8.7	8.6	10.0	8.2	3.3
	t	-2.7	-3.3	-2.9	0.2	2.3	-1.8	-3.5	-0.8	1.4	1.8	4.0	-1.1	-2.9	-1.4	-0.1	0.3
VI	U	10.0	9.9	9.4	9.5	9.3	9.9	8.7	3.9	10.0	10.0	9.2	9.2	8.7	10.0	8.5	3.7
	L	10.0	10.0	9.7	9.6	9.1	10.0	8.6	4.0	10.0	9.9	8.9	9.2	9.0	10.0	8.5	4.0
	t	0.0	-1.3	-3.8	-0.5	2.1	-1.0	1.2	-0.1	0.0	2.1	2.9	0.1	-2.0	0.0	0.3	-0.8
VII	U	10.0	10.0	9.5	9.5	9.5	10.0	9.2	5.1	10.0	10.0	9.1	9.2	8.9	10.0	8.8	3.8
	L	10.0	10.0	9.8	9.8	9.6	10.0	9.1	5.0	10.0	10.0	9.5	9.3	9.1	10.0	8.9	4.1
	t	0.0	0.0	-4.7	-1.0	-1.5	0.0	0.9	0.1	0.0	0.0	-2.5	-0.4	-0.9	0.0	0.6	-0.6
VIII	U	10.0	10.0	9.5	9.7	9.6	10.0	9.4	6.1	10.0	10.0	9.4	9.6	9.0	10.0	9.1	5.9
	L	10.0	10.0	9.9	9.9	9.8	10.0	9.5	6.6	10.0	10.0	9.6	9.7	9.6	10.0	9.3	6.0
	t	0.0	0.0	-2.7	-1.9	-1.9	0.0	0.1	-1.1	0.0	0.0	-3.2	-1.4	4.0	0.0	-0.5	-0.4
IX	U	10.0	10.0	9.8	9.8	9.2	10.0	9.6	7.0	10.0	10.0	8.8	10.0	9.8	10.0	9.4	6.6
	L	10.0	10.0	9.9	9.9	9.8	10.0	9.7	7.2	10.0	10.0	9.7	9.9	9.4	10.0	9.5	6.3
	t	0.0	0.0	-1.3	-1.5	-6.3	0.0	-1.8	-0.4	0.0	0.0	-1.7	0.6	3.6	0.0	-1.2	0.5

Table 3: Nolla's scores for maxillary and mandibular teeth of Egyptian boys and girls (excluding third molars)-

Age group	Mean and standard deviation of stages for Girls		Mean and standard deviation of stages for Boys		Mean and standard deviation of stages for maxillary and mandibular teeth	
	Upper	Lower	Upper	Lower	Girls	Boys
I	45.1 ± 2.7*	47.1 ± 2.8	44.1 ± 1.6	44.9 ± 3.3†	92.2 ± 5.2	89.0 ± 4.7†
II	54.8 ± 1.8*	56.4 ± 2.9	52.2 ± 3.1*†	54.1 ± 4.0†	111.3 ± 4.5	106.3 ± 6.8†
III	58.8 ± 2.9	59.5 ± 4.0	55.7 ± 2.3*†	57.3 ± 3.2	118.2 ± 6.3	112.9 ± 5.1†
IV	62.2 ± 2.7	62.7 ± 2.1	59.8 ± 1.2†	60.5 ± 2.5†	124.9 ± 4.6	120.3 ± 2.9†
V	64.2 ± 2.9*	64.8 ± 2.9	63.6 ± 2.7	63.7 ± 2.5	128.9 ± 5.1	127.4 ± 5.1
VI	66.7 ± 1.9	66.9 ± 1.6	65.3 ± 2.8	65.5 ± 1.7†	133.5 ± 3.3	130.9 ± 3.9†
VII	67.6 ± 2.3	67.8 ± 1.9	66.2 ± 1.5†	66.6 ± 1.5†	135.3 ± 4.2	132.8 ± 2.6†
VIII	68.2 ± 1.5	69.0 ± 1.0	67.5 ± 1.4	67.6 ± 2.4†	137.2 ± 1.2	135.2 ± 2.7†
IX	68.4 ± 1.3*	69.3 ± 0.6	68.1 ± 3.3	68.5 ± 0.8†	137.7 ± 1.6	136.6 ± 3.5†

* Denotes significant difference between upper and lower scores at $P < 0.05$

† Denotes significant difference between males and females at $P < 0.05$

Table 4: Nolla's scores for maxillary and mandibular teeth of Egyptian boys and girls (including Third Molars)

Age group	Mean and standard deviation of stages for Girls for maxillary and mandibular teeth		Mean and standard deviation of stages for Boys		Mean and standard deviation of stages	
	Upper	Lower	Upper	Lower	Girls	Boys
I	45.1 ± 2.9*	47.1 ± 2.8	44.1 ± 1.6	44.9 ± 3.3†	92.2 ± 5.2†	89.0 ± 4.7
II	55.0 ± 2.0*	56.7 ± 3.2	53.1 ± 3.5*†	55.0 ± 5.0	111.7 ± 5.0	108.1 ± 8.3
III	59.7 ± 3.8	61.5 ± 5.1	57.1 ± 3.3*†	59.8 ± 4.3	121.2 ± 7.8	116.9 ± 7.1
IV	63.7 ± 3.5	64.7 ± 2.9	62.4 ± 2.8	63.3 ± 2.7	128.4 ± 6.1	125.7 ± 4.4
V	67.3 ± 4.5	68.3 ± 3.2	67.1 ± 3.6	67.1 ± 3.8	135.6 ± 7.2	134.1 ± 7.1
VI	70.7 ± 3.3	70.9 ± 3.5	69.0 ± 4.1	69.6 ± 3.0	141.6 ± 6.5	138.6 ± 6.4
VII	72.7 ± 4.4	72.9 ± 3.8	70.0 ± 3.3†	70.7 ± 3.3†	145.6 ± 7.9†	140.8 ± 5.9
VIII	74.4 ± 2.4	75.6 ± 2.2	73.4 ± 1.6	73.7 ± 3.0†	150.0 ± 3.5†	147.1 ± 3.0
IX	75.4 ± 3.8	76.6 ± 1.3	74.7 ± 3.3	74.8 ± 2.1†	152.0 ± 4.4	149.5 ± 3.8

***** Denotes significant difference between upper and lower scores at $P < 0.05$

† Denotes significant difference between males and females at $P < 0.05$

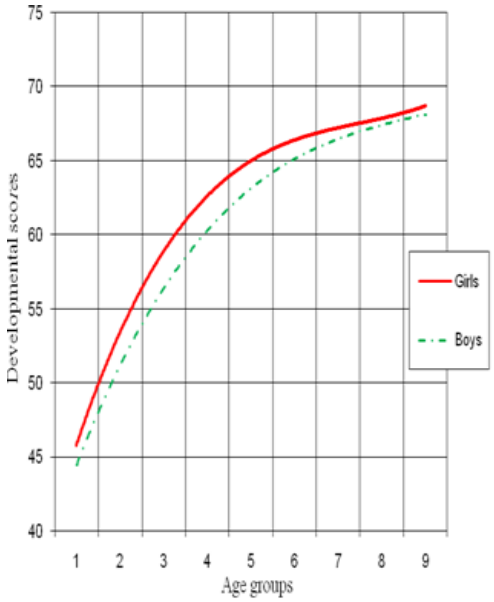

Fig 2: Dental maturation curves for seven maxillary teeth.

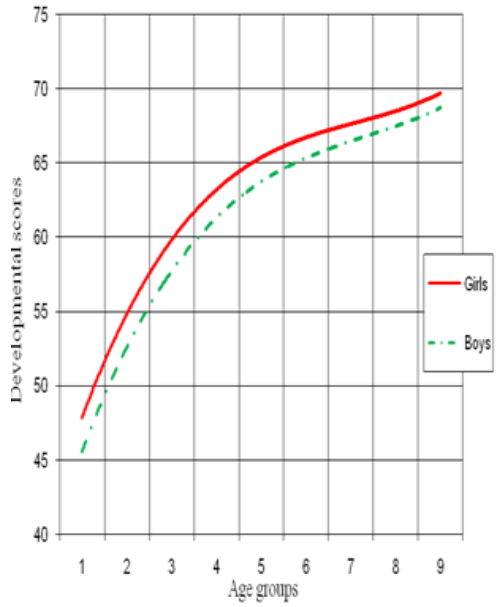

Fig 3: Dental maturation curves for seven mandibular teeth.

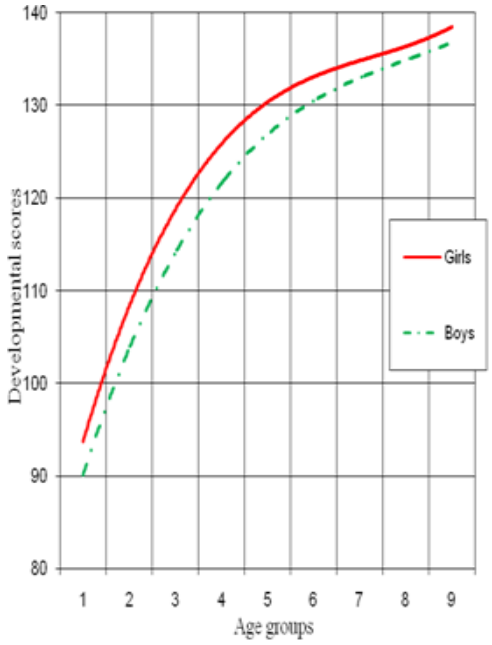

Fig 4: Growth norms for maxillary and mandibular teeth.

Dental maturation norms for maxillary and mandibular permanent teeth of Egyptian children

The importance of obtaining normal developmental curves is that one can show average development. This procedure enables the dentist to see the extent to which the variability of the individual adheres or departs from the average. Thus, individual differences of clinical significance are revealed.

The information of the development of teeth is important not only for reasons of diagnosis and treatment but also for more detailed purposes of research. Calcification of teeth may, in this way, be used as a criterion of dental age of a patient as it provides an index of physiologic maturity of permanent dentition.

Many investigators have studied the development of the dentition by applying different techniques for observation. This study has adopted Nolla's technique due to its applicability and accuracy (Caro, 2001, Maber, 2006 and Gupta, *et al* 2008).

In this study, dental maturation was assessed by means of tooth formation scores established by Nolla's technique but by examining panoramic radiographic films (instead of periapical films) which is more reliable for examining all maxillary and mandibular teeth (Briffa, 2005).

The results of the different right and left teeth showed no significant difference that is why only the left side was used, this is in accordance with Demirjian *et al*, 1973 and Rosen, 1981.

Including or excluding the third molars in determination of the level of dental maturation does not seem to have a significant influence on the overall assessment of dental maturation till the age of 12-13 years. Including the third molar reduces the differences between jaws and sexes; this is probably due to the wide variability of third molar development as shown by the higher standard deviations (table 4).

Our results clearly show the advancement in development of lower teeth over upper ones individually and collectively. This tendency of mandibular teeth developmental acceleration coincides with the previous findings of Nolla, 1960.

Throughout the studied age span, the total developmental scores of the maxillary and mandibular teeth for girls were significantly higher than those for boys, however when only one jaw was considered the maxillary teeth showed a sexual dimorphism in a less number of age groups.Generally, our results are in agreement with other studies that show sexual dimorphism (Odot, 1958 and Demirjian, 1980) and differences between maxillary and mandibular teeth (Hafez, 1994) even though other studies are contradictory to these findings (Bjork, 1988 and Holtgrave *et al*, 1997). This may be attributed to the differences in radiographic technique and the ethnic variations as Egyptians may be considered to have a mixed features of Negros, Caucasian and Arabs (Iskender, 1965).

The statistical summary of the data obtained and presented throw light on the average dental maturation scores for Egyptian boys and girls throughout the studied age span. This is why clinicians should avoid thinking of the application of a rigid standard for tooth development and dental age equivalent.

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