ASSESSMENT OF PUBERTAL GROWTH SPURT IN GROWING EGYPTIAN FEMALES USING MODIFIED MIDDEL PHALANX OF THE MIDDEL FINGER STAGES AND ITS CORRELATION WITH THE DEVELOPMENT STAGE OF MANDIBULAR SECOND MOLAR IN AL SHARKIA GOVERNORATE: A CROSS SECTIONAL STUDY

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Abstract

<u>Introduction</u>: Modified middle phalanx of the middle finger stages were used to assess growth and development. Our aim was to assess the time of pubertal growth spurt in a group of Al sharkia governorate females aged 8 to 14 years old and to find the correlation between MP3 maturation stages and mandibular second molar developmental stages.

<u>Methods</u>: Participants were 1740 randomly selected adolescent females from Al sharkia governorate primary and preparatory schools. Each participant's middle phalanx of the middle finger was digitally radiographed to assess her MP3 stage. Seventy eight participants from the included subjects were chosen randomly and their mandibular second molar were also digitally radiographed. All procedures and the safety of the radiation dose were explained to the parents/caregivers and written

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consents were obtained. Data were collected and statistically analyzed.

Results: The study was conducted on 1740 subjects; all females. The mean ± standard deviation values for age of pubertal growth spurt among a group of Al sharkia governorate adolescent females was 10.96 years ± 1.06 years old. The mean pubertal growth spurt in the studied Al sharkia governorate females was earlier than males in the same governorate. There was very good direct (positive) correlation between MP3 stages and mandibular second molar calcification stages. Conclusions: **This study suggests that** there is very good direct (positive) correlation be- tween MP3 stages and mandibular second molar calcification stages.

Keywords: pubertal growth, MP3, mandibular second molar calcification stages.

INTRODUCTION

Growth is the result of biological processes by means of which living matter normally gets larger and it is not uniform throughout life. Adolescence is a period during which the rate of growth acceleration reaches a peak velocity (pubertal growth spurt) and then decelerates until adulthood is achieved. There are marked individual variations in the initiation, duration, rate and amount of growth during this period of life[1].

One of the objectives of orthodontic treatment during adolescence, in cases with skeletal discrepancies, is to take advantage of patient's growth changes. Maturational status can have a considerable influence on diagnosis, treatment goals, treatment planning and the eventual outcome of orthodontic treatment. This is especially true when treatment considerations are based strongly on the facial growth such as the use of extra oral traction, functional appliances, selection of orthodontic retention and orthognathic surgery.

The maturity status of a child is best estimated relative to specific stages of physiologic maturity than chronological age,

being not a reliable indicator. Physiological age is estimated by the maturation of one or more tissue systems. It could also be estimated by somatic, sexual, skeletal and dental maturity[2].

Skeletal maturity (or skeletal age), is frequently determined by assessing the maturational status and level of ossification of bony markers within the skeletal system. Among the various developmental indicators, skeletal age is considered the most reliable method to correlate with the general biological and physiological body maturation[3,4].

Various areas of the skeleton have been used as maturity indicators like the frontal sinus, the foot, the ankle, the hip, the elbow, the hand-wrist and the cervical vertebrae[5,6].

In orthodontics, the skeletal maturity has been assessed using either hand-wrist maturation index (HWMI) as performed by Fishman7, which is one of the most reliable and valid maturation indicators, or cervical vertebrae maturation index (CVMI) as performed by Hassel8 which is reliable and valid as Fishman's in addition to its availability. Lately, the middle phalanx of the third finger (MP3) was used by Hagg and Taranger3 and modified by Rajagopale and Kansal9 using periapical dental radiographic films.

During the development of the teeth, their roots show the same morphological stages. Many authors described these stages, and correlated it to another growth indicator, like hand-wrist and cervical vertebrae; the tooth of interest is mandibular second molar as there is a correlation between starting its apex to calcify and other events of puberty. This can be used to indicate approaching growth spurt

Since assessment of pubertal growth spurt age within the Egyptian female population is lacking, a research project was carried out between the Ministry of Health and Faculty of Oral and Dental Medicine, Cairo University, represented by orthodontic department for the assessment of pubertal growth spurt using (mMp3) growth stages among Egyptian females within the different Egyptian governorates, consequently the aim of this study was to assess the pubertal growth spurt age among

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growing Egyptian females using(mMp3) and to study it's correlation with the developmental stage of lower second molar within Al Sharkia governorate.

Subjects and Methods

The study was conducted on a sample of primary and preparatory schools in Al-sharkia governorate. Subjects were Egyptian females between 8-14 years old to be sure that they are within or around the circumpubertal period.

Developing the sampling frame:

1. The sample size for such cross-section observational study was determined by statistician, based on the number of primary and preparatory schools in Al Sharkia governorate.

2. Simple random sample of schools, chosen equally from each educational region in the governorate, in which all schools were listed numerically, then random number generation was used through online random number generator.

3. A total number of **88** primary and preparatory schools were found in Al Sharkia governorate.

4. Simple random sample chosen **10%** of total number of schools were chosen with total sample of **1740** students.

5. For the second outcome and to study relationship between skeletal maturation index stages(mMP3) and development stage of lower second molar, a total sample size of 78 subjects from all age groups (**13** for each group) was found to be sufficient with power of 95% and 5% significant level.

5. Variables

1- The developmental stages of middle phalanx of the middle finger (MP3)

2- Developmental stages of lower second molar.

Methods:

The following records were obtained for each participant:

1. Personal data:

These data included name, date of birth, age, address. Data were recorded for each patient in an individual record.

2. Assessment of MP3 maturation stages:

Radiographing of Middle Phalanx of $3^{rd.}$ Left Finger (MP3) was done by digital dental radiography technique. The obtained radiographs were as-sessed for MP3 maturation stages.

3. Assessment of dental calcification stages of mandibular second molar:

Digital periapical radiographs of high clarity and good contrast were taken for mandibular second molar and tooth calcification was assessed·

Results

1. mMP3 growth stages

Results of MP3 growth stages revealed that 234/1740 subjects (13.4%) had Stage (F), 400/1740 subjects (23%) had Stage (FG), 290/1740 subjects (16.7%) had Stage (G), 244/1740 subjects (14%) had Stage (H), 311/1740 subjects (17.9%) had Stage (HI) while 261/1740 subjects (15%) had Stage (I). The distribution of MP3 growth stages is presented in Figure (1).
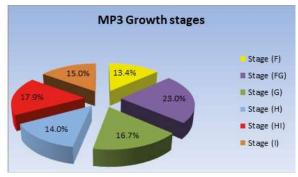

Figure (1): Pie chart representing distribution of mMP3 growth stages

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Comparison between mean age values at different mMP3 growth stages

There was a statistically significant difference between mean age values at different mMp3 growth stages. Pair-wise comparisons showed that the highest mean age was found with Stage (I). Stage (HI) showed statistically significantly lower mean value followed by Stage (H), Stage (G) then Stage (FG) with a statistically significant difference between all these stages. Stage (F) showed the statistically significantly lowest mean age. The mean and standard deviation values of pubertal spurt age were 10.96 ± 1.06 years old at Stage (G).

Table (1): Descriptive statistics and results of one-way ANOVA and Tukey's tests for the comparison between mean age values at different mMP3 growth stages.

MP3 Growth stage	Mean	SD	95% CI for the mean	P-value
F (13.4%)	8.88 [F]	0.68	8.8-8.97	
FG (23%)	9.96 [E]	1.21	9.84-10.07	
G (16.7%)	10.96 [D]	1.06	10.74-11.08	<0.001
H (14%)	11.71 [C]	0.93	11.6-11.83	
HI (17.9%)	12.37 [B]	0.98	12.27-12.48	
I (15%)	13.04 [A]	0.72	12.96-13.13	

*: Significant at P ≤ 0.05, Different superscripts are statistically significantly different

Association between MP3 growth stages and second molar calcification stages

There was a statistically significant association between mMP3 stages and second molar calcification stages

Subjects with MP3 stage (G) showed the highest prevalence among subjects with second molar stage (D) followed by second molar stage (C) then second molar Stage (E).

Table (2): Frequencies, percentages and results of Fisher's Exact test for the association between mMP3 stages and second molar calcification stages.

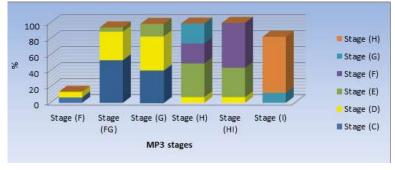|	Stage (C)		Stage (D)		Stage (E)		Stage (F)		Stage (G)		Stage (H)		P-value
	n	%	n	%	n	%	n	%	n	%	n	%	
Stage (F)	1	6.7	1	7.1	0	0	0	0	0	0	0	0	
Stage (FG)	8	53.3	5	35.7	1	5.3	0	0	0	0	0	0	
Stage (G)	6	40	6	42.9	3	15.8	0	0	0	0	0	0	<0.001*
Stage (H)	0	0	1	7.1	8	42.1	3	25	2	25	0	0	
Stage (HI)	0	0	1	7.1	7	36.8	9	75	5	62.5	3	30	
Stage (I)	0	0	0	0	0	0	0	0	1	12.5	7	70	

*: Significant at P ≤ 0.05

Figure (2): Stacked bar chart representing association between mMP3 growth stages and second molar development stages

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Discussion

The mean skeletal maturity age (MP3-G stage) that represents the peak of height velocity (PHV) in Egyptian females of Al-Sharkia was found to be 10.96y ± 1.06 years. The result of the current study agrees with the result of **Vedye et al, (2008)**[10] who assessed the pubertal growth in healthy Turkish girl's subjects with sample size close to that of the present study (1600) and similar methodology. They found that the growth spurt in Turkish occurred at age 11.4 years.

On the other hand, the mean skeletal maturity age of the present study disagrees with the study performed by **Sutow**[11] who assessed skeletal maturation in healthy children in Japan and compared them with Caucasians. He found that the skeletal maturation in Japanese was (13.1 years) later than Caucasians (11.9 years). This disagreement may be due to racial differences.

In addition the study performed by **Kim et al, (2015)**[12] found that the growth spurt in Korean girls occurred at 13.1years. Growth spurt in Korean girls was found to be later than the Egyptian girls which might be due to methodological difference where they used the mandibular canine stages, and could be also due to the racial difference between Egyptian and Korean.

In the present study there was a statistically significant association between mMP3 stages and lower second molar development stages (DI). The significance level was set at P ≤ 0.05.

Concerning pubertal stage (G) it showed highest distribution in DI stage D (complete crown formation which refers to the accelerating phase of growth. This finding of the present study were in disagreement with study performed by **Goyal et al. (2013)**[13] which studied the reliability of the calcification stages of the mandibular permanent canines and the second molars to assess the skeletal maturity level. They found MP3 Stage (G) corresponded to second molar Stage E in females.

The result of the present study concerning pre pubertal stage (F), showing highest distribution of DI stage D were in agreement with the finding of **Joshi et al., (2018)**[14]. While FG stage of modified MP3 (indicating start of peak) were different. In the present study stage FG was in agreement with stage C of DI, while study of **Joshi et al., (2018)** was in agreement with stage E of DI.). This disagreement may be due to sample size difference and racial difference.

Regarding gender variations of skeletal maturity age, the Egyptian females in the present study tended to mature about two years earlier (10.96 years) than Egyptian males (13.64 years) at MP3-G stage as reported by **Salem Awidat, (2015)**[15] who conducted a study to assess the pubertal growth spurt in Egyptian Adolescents males using middle phalanx of the middle finger in the same governorate (Al Sharkia).

Conclusion

Based on the findings of this study, the following conclusions could be drawn:

1. The mean skeletal maturity age (MP3-G stage) that represents the peak of height velocity (PHV) in Egyptian females of Al Sharkia was found to be 10.96 years ± 1.06 years which was approximately 12.02 months after pre-peak stage.

2. The start of the pre-peak stage (MP3-FG) of pubertal growth was reached at 9.96 years ± 1.21 years. This means that the growth modulation treatment by functional orthodontic appliances should be done in females within range of 9.96 years± 1.21 to 11.71 years ± 0.93 that represents the active period of pubertal growth between the pre-peak (MP3-FG) and the post-peak (MP3-H) stages respectively.

3. Since there was a statistically significant association between mMP3 (G) stage and second molar calcification stages(DI) Stage D, Second molar DI stage D could be used as a maturity indicator of the pubertal growth period.

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