Original Article

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DIAGNOSTIC PERFORMANCE OF PERMANENT MANDIBULAR SECOND MOLAR SALCIFICATION STAGES FOR IDENTIFICATION OF CERVICAL VERTEBRAE STAGE 2 (CVS2) IN SYRIAN POPULATION

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ABSTRACT:

The objective of this study is to analyse the diagnostic performance of the permanent mandibular second molar calcification stages for the identification of cervical vertebrae stage 2 (Cvs2) in a group of Syrian population. The samples were derived from panoramic radiographs and lateral cephalograms of 391 Syrian subjects aged from 9 to 17 years . Dental maturity index (DM) was assessed by calcification stages of the mandibular second molar according to the Demirjian method; skeletal maturity was evaluated with cervical vertebrae maturation index (CVM) according to Baccetti . A receiver operating characteristic curve (ROC curve) was created and its area under curve (AUC) was calculated to determine the cut-off permanent mandibular second molar calcification stage to detect Cvs2.

Results: At the confidence level of 95% there were no significant discrimination of permanent mandibular second molar calcification stages between Cvs2 and other CVM stages in male subjects whereas there were significant discrimination in female group. AUC values were near to 0.6 – 0.7, so we conclude that the strength of detecting Cvs2 using permanent mandibular second molar calcification stages was weak for female group .

Keywords: Skeletal maturation, Cervical vertebral, Mandibular second molar .

INTRODUCTION:

It is well established that treatment timing has a significant role in the outcome of nearly all dentofacial orthopaedic treatments for dentoskeletal disharmonies in growing patients.[1,2] Therefore, correct identification of the different phases of skeletal maturation represents a crucial issue in orthodontic diagnosis and treatment planning .

The appraisal of a patient's skeletal maturity is a key factor for the application of the concept of treatment timing to clinical practice. Several biological indicators of skeletal maturity have been used in many studies in orthodontics: increases in statural height.[3] and radiographical methods based on analysis of bones of the hand and wrist.[4,5] and analysis of cervical vertebral maturation (CVM).[1-6-10]

Optimal timing for treatment is different in the various malocclusions. Recently, it was highlighted that treatment protocols aimed to enhance or restrain maxillary growth take advantage of treatment performed before the adolescent growth spurt (CS1 or CS2), whereas treatment regimens aimed to enhance or restrain mandibular growth produce greater

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effects when the pubertal growth spurt is included in the treatment interval.[1]

Dental maturity index (DM) is also an indicator of the biological maturity of growing children.[11,12] The classification by Demirjian et al.[13] has been in use for many years now, with a distinction of up to 8 different groups (AH), based on the stage of calcification .

The calcification stage of individual teeth has already been associated with skeletal maturity in hand-wrist bone analysis and cervical vertebrae.[14,24] showing a strong correlation considering second molars.[15-18] On this basis, dental maturation has been proposed to be a clinically useful diagnostic aid for the identification of individual skeletal maturation stages.[19,20,21] In spite of these previous investigations, Perinetti et al.[12] found that the clinical performance of the dental maturation stages for the identification of specific skeletal maturation stages is limited despite the high correlations seen in their study . However, there is evidence of significant alterations due to racial and environmental characteristics among different populations.[21-23]Therefore, the present study was aimed to analyse the diagnostic performance of the permanent mandibular second molar calcification stages for identification of cervical vertebrae stage 2 (Cvs2) in Syrian population.

MATERIALS AND METHODS:

Pre-treatment panoramic and lateral cephalometric radiographs of 391 subjets (246 female and 145 male) aged from 9 to 17 years scheduled at the Unit of Orthodontics Dentistry of the University of Tishreen, Syria . The selection criteria were: only Syrian subjects; no genetic deformities; no agenesis, no transposition; no previous orthodontic treatment; no history of facial trauma; no previous extraction of permanent teeth; interval between the lateral cephalogram and the panoramic radiograph not exceed 1 month. A total of 782 radiographic images were evaluated.

Evaluation of cervical vertebrae maturity (CVM) on lateral cephalogram :

CVM were evaluated by classifying C2, C3, C4 into six stages depending on their maturation patterns on lateral cephalogram using a Cephalometric analysis method given by Mcnamara, Baccetti and Franchi.[1]

Cephalometric analysis :

On the lateral cephalograms, the following points for the description of the morphologic characteristics of the cervical vertebral bodies were traced and digitized [Figure 1]:

C2p, C2m, C2a: The most posterior, the deepest, and the most anterior points on the lower border of the body of C2.

C3up, C3ua: The most superior points of the posterior and anterior borders of the body of C3. C3lp, **C3 m, C3la**: The most

posterior, the deepest, and the most anterior points on the lower border of the body of C3. C4up, C4ua: The most superior points of the posterior and anterior borders of the body of C4.

C4lp, C4m, C4la: The most posterior, the deepest, and the most anterior points on the lower border of the body of C4.

For the location of landmarks, the indications described by Hellsing were adopted partially. With the aid of these landmarks, the following measurements were performed:[1]

C2Conc: A measure of the concavity depth at the lower border of C2 (distance from the line connecting C2p and C2a to the deepest point on the lower border of the vertebra, C2m), similarly C3 Conc and C4Conc were measured.

C3BAR: Ratio between the length of the base (distance C3lp-C3la) and the anterior height (distance C3ua-C3la) of the body of C3.

C3BAR: Ratio between the posterior (distance C3up-C3lp) and anterior (distance C3ua-C3la) heights of the body of C3, similarly C4BAR and C4BAR were determined.

Evaluation of dental maturity on panoramic radiograph :

In this study, the permanent mandibular left second molar was used as a sample . Tooth calcification was rated according to the index described by Demirjian *et al.* (Demirjian index DI; 1973) in which one of eight stages of calcification (A to H) was assigned to the tooth [Figure 2].

Statistical analysis:

We performed statistical analysis using the Microsoft Office Excel 2007 and SPSS 13.0 software. Descriptive statistics were done by determining means and standard deviations of subject's age (in years) according to gender. Frequency and percentage distribution of permanent mandibular second molar calcification stage according to Cvs2 and other cervical vertebrae stage were evaluated separately for males and females. To determine the degree of correlation between the two maturational indices, the Spearman rank correlation coefficient was used. Moreover to determine the clinical performance of the dental maturation stage for the diagnosis of Cvs2, a receiver operating characteristic curve (ROC curve) was created and its area under curve (AUC) was calculated to determine the cut-off permanent mandibular second molar calcification stage to detect Cvs2 according to gender variable.

RESULTS:

The means and standard deviations of subject's age (in years) according to gender are shown in

Table 1 . Table 2 represents Cvs2 and other CVS frequency according to gender variable .

The correlation coefficients for the second molar maturation stages with the CVM stages ranged from 0.76 to 0.84 for the males and females, respectively. All the correlation coefficients were statistically significant, at $P < 0.05$. (Table 3) . From table 4 it is clear that stage F (61%) in males and (67.4%) in females included the highest percentage distribution at stage 2 of CVM .

A Mann-Whitney U test was applied to know if there were significant differences in permanent mandibular second molar calcification stage between Cvs2 and other cervical vertebrae stages group according to gender variable like it is shown in table 5.

The diagnostic tests with the corresponding 95% confidence intervals are shown in table 6. AUC calculation results to determine the cut-off permanent mandibular second molar calcification stage to detect Cvs2 according to gender showed low values in the diagnostic tests for the females, whereas there were no significant discrimination in males group of the studied sample. This outcome indicates that accuracy value were better for (F) second molar calcification stage (sensitivity was equal to (1) and specificity was equal to (0.425) **)** for females group (figure 3). So, (lower than or equal) (F) permanent mandibular second molar calcification stage can be considered as a cut-off between Cvs2 and other CVS for female subjects (table 7) .

DISCUSSION:

The ALARA principle is especially important for children and young adults, as high-radiation methods are not advised to be used frequently to assess the growth. The ease of recognizing the stages of dental development and the availability of panoramic radiographs are practical reasons for attempting to assess the physiologic maturity without resorting to hand-wrist or lateral cephalometric radiographs.[25] Many studies have reported high correlations between tooth calcification stages and skeletal maturity indicators, which would probably allow clinicians to easily identify pubertal growth stages from panoramic radiographs.(19,20)

Racial variations between the calcification stages of individual teeth and skeletal maturity have been reported in the previous studies.[1] Therefore, the present study was carried out to investigate the diagnostic performance of the maturation stages of permanent mandibular second molar for the identification of the cervical vertebrae stage 2 (Cvs2) in this population.

We used the classification of dental maturity of the Demirjian method. This method evaluates shape and development phase of the roots without taking into consideration any numeric measurement parameters which could be possibly altered by projections by the x-rays.[13] Various studies have already proven the correlation between skeletal

development and DM, showing different correlation depending on the teeth considered.[11,12,18,24] To this effect, it has been highlighted a strong correlation when taking into account the maturity of the second mandibular molar. Due to the presence of calcified structures that superimpose on the maxillary teeth, mandibular second molar was taken as a sample instead of maxillary molar to eliminate the estimation errors caused by maxillary molar roots which overlap with anatomic structures such as palate, inferior border of zygomatic arch or maxillary sinus septum. [17,25,21]

From a statistical point of view, our study found a good correlation between the dental and skeletal maturity phases were generally high (Table 3) and are similar to those of previous investigations that reported significant and high correlation coefficients between mandibular second molar and skeletal maturity.[19,21]

In the present study, only the dental stage F is mainly associated with the pre-pubertal stage CS2 (Table 4). Similar results were reported in samples of Italian subjects.[12]

However the data show that in spite of the high correlation coefficients, the clinical usefulness of permanent mandibular second molar maturational stages for the identification of individual (Cvs2) of skeletal maturity is limited in both male and female subjects according to the a receiver operating characteristic curve (ROC curve) and its area under curve (AUC) .

Table (6) shows AUC calculation results:

1) P-Value for male subjects was much greater than 0.05, so, at the confidence level of 95% there were no significant discrimination of permanent mandibular second molar calcification stages between cervical vertebrae stage 2 and other cervical vertebrae stages in male subjects of the studied sample .

2) P-Value for female were much lower than 0.05, so, at the confidence level of 95% there were significant discrimination of permanent mandibular second molar calcification stages between cervical vertebrae stage 2 and other cervical vertebrae stages in female subjects of the studied sample . AUC values were near to 0.6 – 0.7, so we conclude that the strength of detecting Cvs2 using permanent mandibular second molar calcification stages was weak for female subjects .

Finally, the accuracy incorporates both the sensitivity and the specificity of the test, were better for (F) dental stage for female subjects. Therefore, (lower than or equal) (F) permanent mandibular second molar calcification stage can be considered as a cut-off between Cvs2 and Other CVS for females .

CONCLUSION

1. Statistically it appears to be a significant correlation (0.76 for males and 0.84 for females) considering DM and CVM stages. although the diagnostic performance of dental maturity for the identification of CS2 of skeletal maturity

is limited, therefore, when trying to identify the CS2 it is necessary to assess the dental maturity in association with further parameters such as CVM .

2. The dental maturation stage (F) of the mandibular second molar calcification show weak diagnostic performance only for the identification of CS2 for female subjects, with no reliable indications for CS2 for male subjects .

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TABLES:

Table 1: Minimum, Maximum Average and Standard Deviation of subject's age (in years) according to Gender.

Studied Variable	Gender	N	Minimum	Maximum	Average	Standard Deviation
Age (in years)	Male	145	9	17	11.7	2.0
	Female	246	9	17	11.9	2.3
	All Subjects	391	9	17	11.8	2.2

Table 2: Cvs2 frequency according to Gender variable.

Cervical Vertebrae Stage	N			Percent		
	Cvs2	Other CV Stages	Total	Cvs2	Other CV Stages	Total
Males Group	41	104	145	28.3	71.7	100
Females Group	46	200	246	18.7	81.3	100
All Subjects	87	304	391	22.3	77.7	100

Table 3: Correlation coefficient between CVM and DM in males and femal

CVM and DM Correlation		P-Value	Significant Effect?
Males	0.76	0.000	YES
Females	0.84	0.000	YES

Table 4 : Mandibular Second Molar Calcification Stages frequency according to CVM and Gender variables.

Studied Variable = Permanent Mandibular Second Molar Calcification Stage					
Gender	Cervical Vertebrae Stage	N		Percent	
		Cvs2	Other CV Stages	Cvs2	Other CV Stages
Males Group	C	1	3	2.4	2.9
	D	4	12	9.8	11.5
	E	9	25	22.0	24.0
	F	25	27	61.0	26.0
	G	2	27	4.9	26.0
	H	0	10	0	9.6
	Total	41	104	100	100
Females Group	C	0	1	0	0.5
	D	3	11	6.5	5.5
	E	12	40	26.1	20.0
	F	31	63	67.4	31.5
	G	0	58	0	29.0
	H	0	27	0	13.5
	Total	46	200	100	100

Table 5 : Mann-Whitney U Test results to know if there were significant differences in Permanent Mandibular Second Molar Calcification Stage between CVS-2 and Other Cervical Vertebrae Stages according to Gender variable.

Gender	Cervical Vertebrae Stage	N	Mean Rank	U value	P-Value	Significant Diff.?
Males Group	Cvs2	41	64.50	1783.5	0.113	No
	Other CV Stages	104	76.35			
Females Group	Cvs2	46	88.54	2992	0.000	YES
	Other CV Stages	200	131.54			

Table 6 : AUC calculation results to determine the cut-off Permanent Mandibular Second Molar Calcification Stage to detect Cvs-2 according to Gender.

Studied Variable = Permanent Mandibular Second Molar Calcification Stage					
Gender	**Area**	**Std. Error**	**P-Value**	**Significant Effect?**	**Asymptotic 95% Confidence Interval**
Males Group	0.582	0.047	0.126	No	0.489 - 0.674
Females Group	0.675	0.035	0.000	**YES**	0.607 - 0.742

Table 7 : Sensitivity and Specificity calculated values of some Permanent Mandibular Second Molar Calcification Stages as Cut-off points for detecting Cvs2 Stage in Female Subjects.

Gender	Cvs2 if Less Than or Equal To:	Sensitivity	Specificity
Females Group	E	0.326	0.740
	F	**1**	**0.425**
	G	1	0.135
	H	1	0

FIGURES:

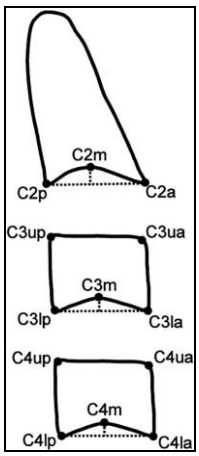

Figure 1: cephalometric landmarks for the quantitative analysis of the morphologic characteristics of the vertebral bodies of C2, C3 and C4

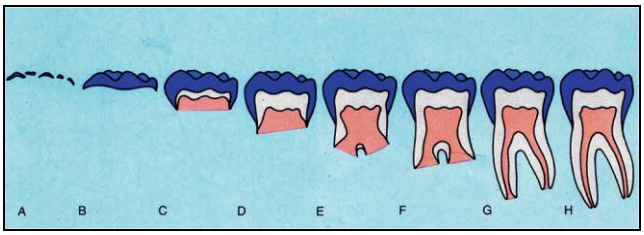

Figure 2: Developmental stages of tooth — Demirjian *et al*. (1973); color atlas of dental medicine; orthodontic diagnosis; Thomas grabber;1992 .

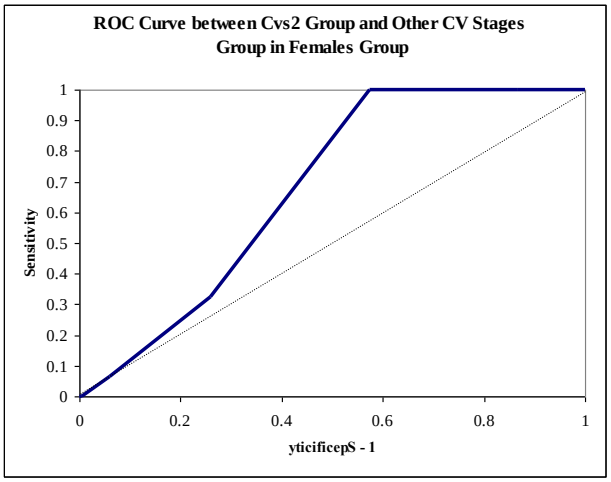

Figure 3: ROC Curve between Cvs2 Group and Other CV Stages Group in Females Group.