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Prevalence On Stages Of Maturation On Cervical Vertebrae According To Chronological Age And Its Relationship With Mandibular Length

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ABSTRACT
The use of orthopedics and functional appliances in the treatment of skeletal problems is a common thing within thefield of orthodontics. In recent years, there has been an attempt to replace the use of a hand X-ray with the lateral X-ray already used for diagnosis, wherethe maturation of cervical vertebrae can be observed, which has been proven efficient. **Objectives:** To obtain the prevalence of the vertebral maturation according to age and the mandibular length average. **Material and methods:** A total of 220 lateral cephalograms divided by gender (male/female) and by age (ten of each) from eight to eighteen years, were measured with the Ricketts cephalometric analysis with the Dolphin Imaging 11.9 software to obtain mandibular length and to observe vertebrae maturation the Baccetti method was used. Afterwards the results were organized in Microsoft Excel 365 and the results, frequencies and χ^2 were obtained with the IBM SPSS Statistics Base 22.0. **Results:** There is only a significant co-relation between vertebrae maturation and age at 11, 12, 13 and 14 years which means it is more reliable to use de Baccetti method for diagnosis if the patients are among these ages. Furthermore, the mandible length was average according to age. **Conclusion:** The Baccetti method for the assessment of vertebral maturation has been proven efficient for the identification of potential growth and development between ages from 11 to 14 years old and is highly useful to determine the correct diagnosis and treatment of the patients. Another benefit of this method is the elimination of the need of asking the patient for additional studies or radiographs which, in the end, will end up creating a higher monetary cost and time for the beginning of the treatment.

KEY WORDS: Vertebrae, maturation, Baccetti, Ricketts, mandibular length.

I. INTRODUCTION

Baccetti et al. in 2005, performed an analysis of cervical vertebral maturation (CVM) based on the morphology, observed in the lateral cephalogram, of the second (C2), third (C3) and fourth (C4) cervical vertebrae in individuals without orthodontic treatment.[1]

Stages of cervical vertebral maturation according to Baccetti.[2]

- CS1. The lower edges of the three vertebrae (C2-C4) are flat. The bodies of C3 and C4 are trapezoidal in shape. The peak in jaw growth will occur on average 2 years after this stage.

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- CS2. A concavity is present at the lower edge of C2. The bodies of C3 and C4 are still trapezoidal in shape. The peak in mandibular growth will occur on average 1 year after this stage.
- CS3. There are concavities at the lower limits of C2 and C3. The bodies of C3 and C4 can be trapezoidal or rectangular horizontally. The peak of mandibular growth will occur during the year following this stage.
- CS4. Concavities at the lower limits of C2, C3 and C4 are now present. The bodies of C3 and C4 have a horizontal rectangular shape. The peak in mandibular growth occurred 1 or 2 years before this stage.
- CS5. Concavities at the lower limits of C2, C3 and C4 are still present. At least one of the bodies of C3 and C4 is square-shaped. The peak of mandibular growth ended at least 1 year before this stage.
- CS6. Concavities at the lower limits of C2, C3 and C4 are still evident. At least one of the bodies of C3 and C4 has a vertical rectangular shape. The peak in mandibular growth ended at least 2 years before this stage.

II. MATERIALS AND METHODS

The study involved 220 healthy patients, 110 men and 110 women aged 8 to 18 years (10 men and 10 women of each age) 220 lateral skull x-rays of patients attendingthe master's degree in dental sciences with emphasis in Orthodontics of the Faculty of Dentistry of the Universidad Autónoma de Coahuila Unidad Torreón, México.A software was used for cephalometric tracing Dolphin Imaging 11.9a software IBM SPSS Statistics Base 22.0 6.4 cephalometric measurements of mandibular length were performed with Ricketts' tracing, a cervical vertebrae analysis was made with the Baccettimethod anda Descriptive analysis of the sample, frequencies, cross tables, correlation and χ^2.

III. RESULTS

With the data obtained from the measurement and observation of lateral radiographs, the following results were obtained. The first graph (fig.1) shows the frequency of the different stages of vertebral maturation according to age for female patients, and the second graph shows the results for male patients.

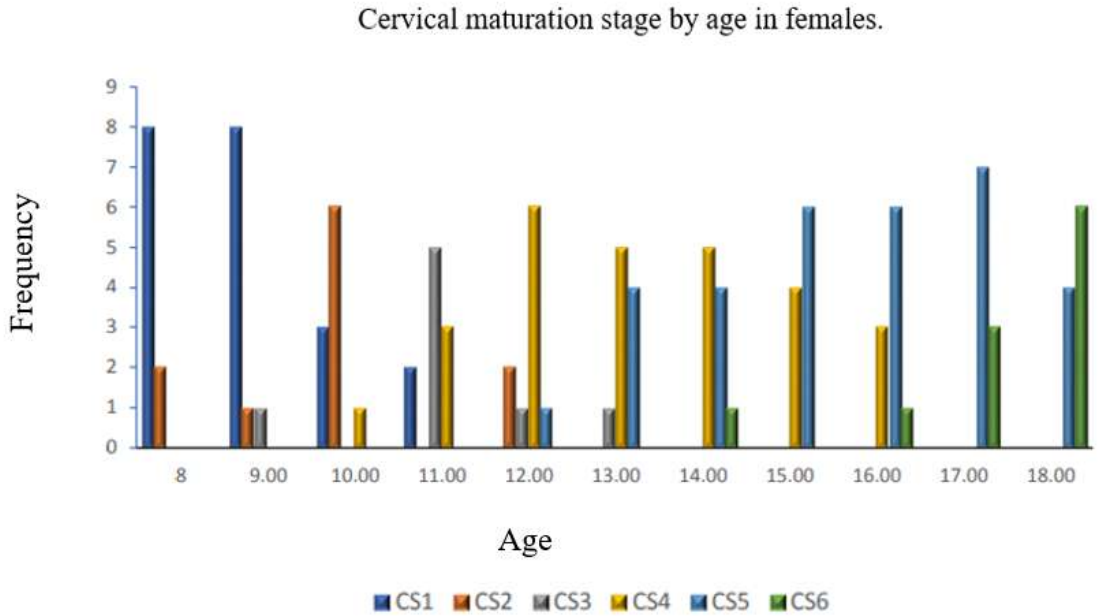

Figure 1. Frequency of stages of cervical ripening by age in female patients.

In females, the most frequent stage of vertebral maturation at 8 years oldis CS1, followed by CS1 at 9 years, CS2 at 10 years, CS3 at 11 years, CS4 at 12 years, CS4 at 13 years, CS4 at 14 years, CS5 at 15 years, CS5 at 16 years, CS5 at 17 years, and CS6 at 18 years(Figure 1).

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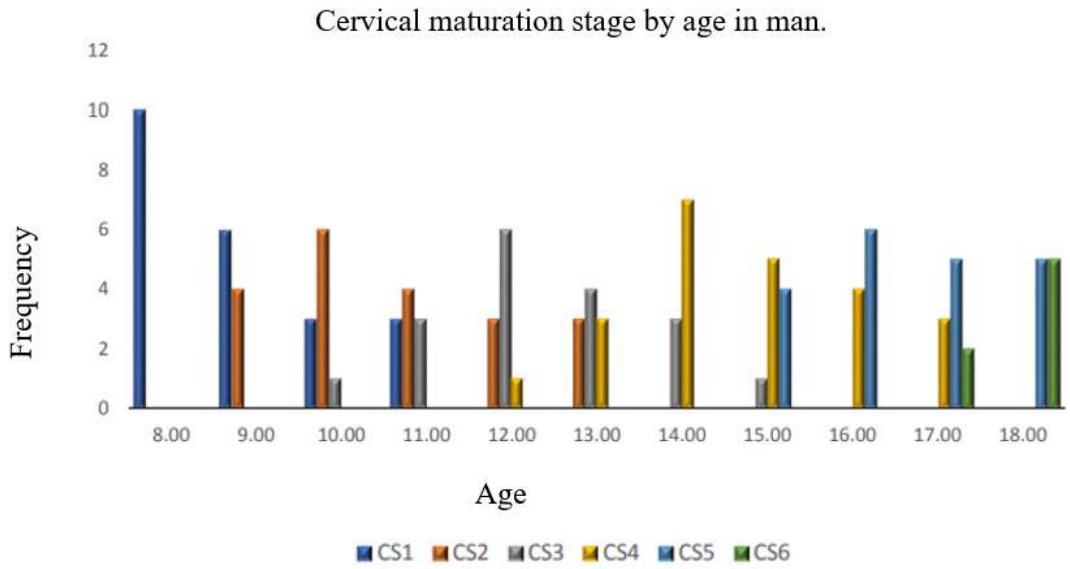

Figure 2. Frequency of stages of cervical ripening by age in male patients.

In males, the most frequent stage of vertebral maturation at 8 years old is CS1, followed by CS1 at 9 years, CS2 at 10 years, CS2 at 11 years, CS3 at 12 years, CS3 at 13 years, CS4 at 14 years, CS4 at 15 years, CS5 at 16 years, CS5 at 17 years, and CS5 and CS6 at 18 years(Figure 2). Furthermore, if we analyze the graphs, we can observe that females reach higher levels of cervical maturation faster than males. Table 1 shows the results of the correlation between mandibular length, patients age, vertebral maturation stage, and age, demonstrating that their relationship are indeed significant.

Gender		N	Mean	Standard Deviation	p	r
Age	F	110	13.00	3.18		
	M	110	13.00	3.18		
Mandib length	F	110	75.06	5.81	0.00	0.552
	M	110	76.36	6.61		
C. Stage	F	110	3.65	1.67	0.00	0.892
	M	110	3.18	1.57		

Table.1 Correlation between mandibular length and age and stages of vertebral maturation and age.
P <.001.
r, Correlation coefficient; F, female; M, male.

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Age	Gender	STAGE						
		CS1	CS2	CS3	CS4	CS5	CS6	r
8	F	8	2					
	M	10	0					
	TOTAL	18	2					
9	F	8	1	1				
	M	6	4	0				
	TOTAL	14	5	1				
10	F	3	6	0	1			
	M	3	6	1	0			
	TOTAL	6	12	1	1			
11	F	2	0	5	3			
	M	3	4	3	0			
	TOTAL	5	4	8	3			
12	F		2	1	6	1		
	M		3	6	1	0		0.069
	TOTAL		5	7	7	1		
13	F		0	1	5	4		
	M		3	4	3	0		0.056
	TOTAL		3	5	8	4		
14	F			0	5	4	1	
	M			3	7	0	0	
	TOTAL			3	12	4	1	
15	F			0	4	6		
	M			1	5	4		
	TOTAL			1	9	10		
16	F				3	6	1	
	M				4	6	0	
	TOTAL				7	12	1	
17	F				0	7	3	
	M				3	5	2	
	TOTAL				3	12	5	
18	F					4	6	
	M					5	5	
	TOTAL					9	11	
TOTAL	F	21	11	8	27	32	11	
	M	22	20	18	23	20	7	
	TOTAL	43	31	26	50	52	18	

Table 2. Correlation between stages of vertebral maturation and age.
r, Correlation coefficient.

On the other hand, in tables 2 and 3, where correlation and χ^2 by age tests were performed, it was found that there is only significant correlation at ages 11, 12, 13 and 14 years, which means that the cervical ripening method is more reliable for patients within that age range.

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AGE		VALUE	gl	ASYMPTOTIC SIGNIFICANCE (bilateral)
8	Pearson Chi-square	2.222[b]	1	0.136
9	Pearson Chi-square	3.086[d]	2	0.214
10	Pearson Chi-square	2.000[e]	3	0.572
11	Pearson Chi-square	7.700[f]	3	0.053
12	Pearson Chi-square	8.343[g]	3	0.039
13	Pearson Chi-square	9.300[f]	3	0.026
14	Pearson Chi-square	8.333[e]	3	0.040
15	Pearson Chi-square	1.511[d]	2	0.470
16	Pearson Chi-square	1.143[d]	2	0.565
17	Pearson Chi-square	3.533[h]	2	0.171
18	Pearson Chi-square	0.202[i]	1	0.653
TOTAL	Pearson Chi-square	10.460[a]	5	0.063

Table 3. X^2 square test between stages of vertebral maturation and age.
Gl. (Degree of freedom)

IV. DISCUSSION

The current interest in non-extraction treatment and/or avoidance of orthognathic surgery involving skeletal growth modification requires a lot of information about the patient's growth potential.[3]Orthopedic appliances (extraoral arch or facial mask) only have desired effects while the patient is growing.[4,5] Carpal radiography has been classically used to determine a child's level of maturation, but to avoid additional x-rays, the cervical vertebrae maturation method has been more popular in recent years.[6]

Sierra found that relationships between chronological age and skeletal age assessment demonstrated relatively high correlations, with correlation coefficients of 0.71. The correlation between chronological age and skeletal maturation assessed by the cervical and hand-wrist vertebrae methods was 0.72 and 0.79, respectively in a study by Tancan et al.[7,8] In our study, the overall correlation between chronological age and age was quite high with an r = 0.89 which tells us that, if it is reliable to use it as a method of predicting growth.

However, when the tests were done by dividing patients by age, the correlation between cervical ripening and age was only significant at 11, 12, 13 and 14 years, with these results, we agree with Hessa et al. who say that a wide age range of the population can affect the outcome of the correlation due to the inability of the methods of skeletal maturity to detect changes in skeletal maturity precisely when subjects are too young or too old, that is, they are too advanced or too far from pubertal growth.[9]It is possible that this situation may occur because during early and late stages, the vertebrae have a more similar and less differentiable shape from each other, which can reduce the identification of the correct stage of maturation.

Sziska and Pancherz sought to determine whether analysis of cervical vertebrae development is reliable and valid in assessing skeletal maturity. They found that the reliability of the method was acceptably high and could replace the focus of carpal radiography in assessing skeletal maturity.

However, the low correlations found between chronological age and GVC and chronological age and HWM showed that chronological age was not adequate to measure skeletal maturity.Although in our study, there is correlation,it is only a moderate correlation and only at certain ages.[10]

V. CONCLUSION

- A high correlation between cervical ripening and overall chronological age was demonstrated.
- When analyzing the results by age, the correlation is significant at ages 11, 12, 13 and 14, when patients are at or closest to their peak growth.
- The similarity in the shape of the cervical vertebrae during early and late stages of growth can make it difficult to correctly identify the stage of maturation, on the contrary, during the peak of growth it will be easier to distinguish the stage of maturation in which the patient is.
- Women have more advanced stages of maturation than men with respect to their age.
- Baccetti's method of obtaining the stage of cervical ripening is useful in reducing the cost and time of timely diagnosis to establish a treatment plan.
- The length of the mandibular body has an average relationship according to the chronological age of the patients.

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