Correlation between carpal maturation stages and mandibular canine development stages in patients subjected to orthodontic treatment

Correlación entre los estadios de maduración carpal y los estadios de desarrollo del canino mandibular en pacientes que reciben tratamiento ortodóncico

Graciela Mejía-Garduño,* Joaquín Canseco-Jiménez,§ Ceferino Martínez-López,‖
Alfonso Reyes-López,¶ Vicente Cuairán-Rudíaz**

ABSTRACT

The importance of assessing bone maturation levels in our patients (so as to be able to emit a proper diagnosis and design suitable orthodontic planning) has led us to study different bone maturation indicators. The most extensively used method at the Mexico Children´s Hospital Federico Gomez[1] is the carpal indicator method (Björk method). Nevertheless, for this method, an additional X-ray is required in the patient files. This additional X-ray is not routinely included in the files; therefore, the present study analyzed the relationship between carpal and dental indicators[2] (Demirjian method). This method requires the use of a panoramic X-ray, which is routinely requested for orthodontic treatment. 144 carpus and panoramic X-rays of Mexico Children´s Hospital Federico Gomez patients were used in the study. Carpus and mandibular canine stages were recorded. The results obtained revealed presence of significantly high correlation (standard error 0.39) at some but not all stages (mandibular stages 7, 8 and 9, carpus stages 5, 8 and 9). Bearing these facts in mind we found ourselves unable to advise, as was desired, the use of only panoramic X-rays, discarding carpal X-rays.

Key words: Carpus X-rays, dental orthopantomography, dental stages.

RESUMEN

La importancia de conocer el nivel de maduración ósea de nuestros pacientes para el diagnóstico y plan de tratamiento de ortodoncia, nos ha llevado a estudiar diferentes indicadores de maduración ósea, el método más utilizado en el Hospital Infantil de México, Federico Gómez,[1] son los indicadores carpales (método de Björk), pero para este método se requiere de otra radiografía en el expediente del paciente, ya que no se utiliza de forma rutinaria, por lo que este estudio analizó la relación que existe entre los indicadores carpales y los indicadores dentales[2-5] (método de Demirjian) usando para este último una radiografía panorámica, necesaria de forma rutinaria en el tratamiento de ortodoncia. Se utilizaron 144 radiografías panorámicas y carpales de pacientes del Hospital Infantil de México, Federico Gómez a los cuales se les registraron su estadio carpal y del canino mandibular. Los resultados obtenidos, mostraron que si existe una correlación significativamente alta (error estándar .039) en algunos estadios pero no en todos (estadios 7, 8 y 9 mandibulares con 5, 8 y 9 carpales), por lo que no se pudo emitir la recomendación deseada de dejar de usar la radiografía carpal para sólo usar la radiografía panorámica.

Palabras clave: Radiografía carpal, ortopantomografía dental, estadios dentales.

INTRODUCTION

When undertaking orthodontic treatment, it is important to know the patient´s bone maturation stage, since diagnosis and treatment plan depend on it. To ascertain bone maturation levels there are many indicators, such as cervical vertebrae, carpus indicators and dental stages.[2,6-10] The present study employed carpus and dental indicators.

At the MCHFG, Björk's method is the preferred one. With these indicators, bone age is assessed in patients ranking between 8 and 18 years of age. According to

* Orthodontic Specialty student, Graduate and Research School, National School of Dentistry, National University of Mexico (UNAM).
§ Head of Orthodontics Specialty.
‖ Orthodontics Specialty Professor.
¶ Head of Research Section.
** Head of Stomatology Department.

Federico Gomez Mexico Children´s Hospital.

Björk, (1972) Grave and Brown (1976) there are nine evolutionary stages.

Ossification characteristics are detected at the level of phalanxes, radius and carpus bones. Finger growth stages are assessed according to the relationship between epiphysis and diaphysis. For diagnosis and treatment plans the most important stages are stages 4 and 5, at those stages the greatest amount of growth takes place *(Figure 1)*.

With respect to mandibular stages, the Demirjian method was employed to perform our research, this decision was made as a conclusion after multiple studies. In this method valuation is based upon values assigned to all seven mandibular teeth under study. Nine important phases can be counted: based upon mineralization of cusps tops (A) up to the closure of the apical orifice (H). In orthodontics, the most important stages for diagnosis and treatment plan are stages 7 and 8 (F and G) *(Figure 2)*.
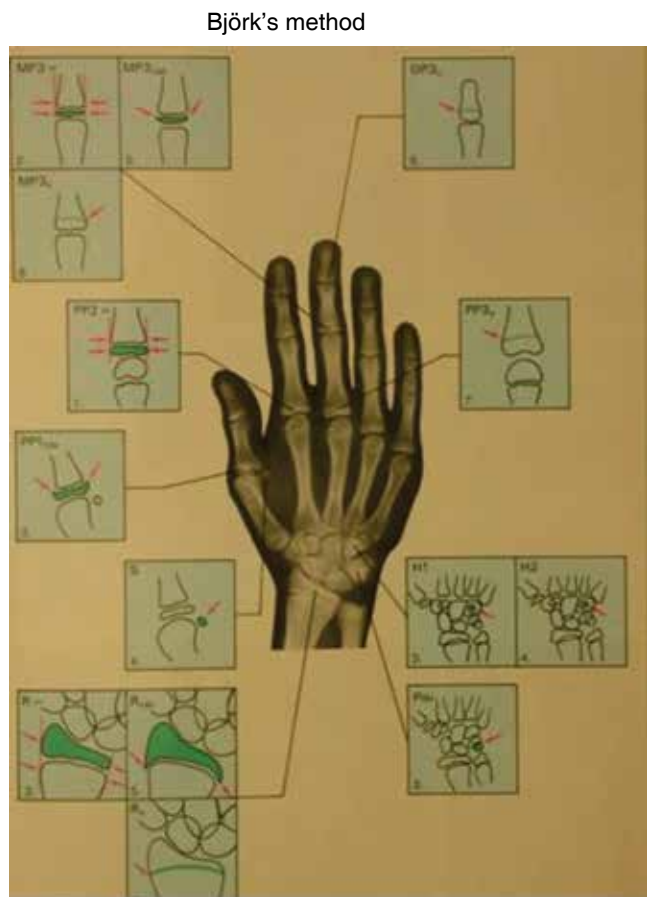
The aim of the present study was to assess correlation existing between development stages of the mandibular canine with stages of carpus maturation,[2,3,5,6,11-13] based upon the theoretical relationship which must exist based upon the patient's age. The aforementioned can be described in the following manner:

Stage 6 (E) mandibular (7 to 9 years) with carpus stages 0, 1, 2 and 3. Stage 7 (F) and 8 (G) mandibular (10 to 11 years) with carpus stages 4 and 5. Stage 9 (H) mandibular (12 to 14 years with carpus stages 6, 7, 8 and 9.

Multiple studies have been undertaken in order to assess the relationship existing among different bone maturation stages. Such is the case of Robinow & al (1942), who found a very low relationship between carpus stages and dentition. Demirjian[14] & al, in 1986, studied the relationships existing among dental age, bone age and sexual (gender) indicators: they found an insignificant relationship among the aforementioned factors. Dr. Martinez,[4] in 2000, studied the relationships among carpus stages, mandibular canine and vertebrae. In that study he found a fairly low relationship. These studies reveal the fact that with respect to relationships between mandibular canine and carpus stages, evidence is not sufficiently solid. Under this light, authors cannot recommend the exclusion of carpus X-rays when emitting diagnosis or designing treatment plans.

METHODS

A cross-sectional, analytical study was undertaken: 144 panoramic X-rays and 144 carpus X-rays of

Björk's method

Figure 1. Diagram of Björk's method based upon X-ray of hand and wrist.
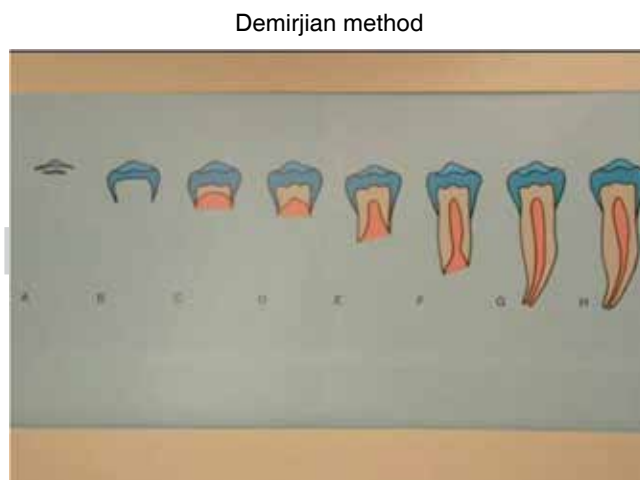
Demirjian method

Figure 2. Diagram of Demirjian method based upon the mandibular canine.

patients attending orthodontic services in 2002. Patents ages ranged from 7 to 16 years. Patient's names, age, gender, stages and relationships among them were recorded.

Exclusion criteria for X-rays were: patients having undergone previous orthodontic treatment, patients lacking canines and patients with systemic conditions involving any type of bone alterations.

Descriptive statistics of all variables were performed. Relationships among studies were analyzed with the help of several correlation measures for ordinal data (Tau-b and Tau-c Kendall, Gamma, R Spearman).

RESULTS

Considering all reviewed X-rays, 140 belonged to female patients, 148 to male patients. Average age was 11.4 years for both genders. With respect to patient distribution according to mandibular canine development it could be noted that most females were concentrated at development stages 7 (F), 8 (G) and 9 (H), which correspond to ages 10 to 14 years *(Table I)*. With respect to carpus maturation most female patients were concentrated in stages 5 and 8, ages ranking 10 to 14 years. In male patients, greater concentration was observed at stages 0, 2 and 3 which pertained to ages 7 to 10 years *(Table II)*.

Table III shows the empiric correlation between both stages. It can be observed that it is very close to the aforementioned theoretical relationship, especially at stage 6 (E) mandibular which perfectly correlates with the corresponding carpus stages. Nevertheless, even though a correlation was indeed found among the rest of mandibular and carpus stages, high frequencies appeared in unexpected cells; such is the case of cells where stage 7 (F) mandibular and carpus stages 2 and 3 intersected. This was reflected in estimated correlation coefficients, whose values oscillated from 0.64 Kendall Tau-b) to 0.8 (Gamma); these results were statistically significant *(Table IV)*.

Table I. Patient distribution according to mandibular canine maturation stage, gender and age.

	Female		Male	
Stage	Frequency	Age range	Frequency	Age range
5 (D)	-	-	1	7
6 (E)	2	7-9	11	7-11
7 (F)	22	10-14	38	10-14
8 (G)	26	7-11	8	11-16
9 (H)	16	10-16	13	12-16
Absent	4		3	
Total	70		74	

Table II. Patient distribution according to carpal maturation stage, gender and age range.

	Female		Male	
Stage	Frequency	Age range	Frequency	Age range
0	-	-	10	7-10
1	4	7	5	7-9
2	8	7-9	15	7-10
3	7	7-9	19	11
4	8	7-11	8	11-14
5	17	10-14	7	10-16
6	2	12	1	15
7	7	10	2	16
8	9	12-16	2	15-16
9	8	14-16	5	14-16
Total	70		74	

Table III. Correlation between both maturation stages.

		Maturation stages of mandibular canine				
		5 (D)	6 (E)	7 (F)	8 (G)	9 (H)	Total frequencies
Stages of carpal maturation	0	1	5	4			10
	1		3	5	1		9
	2		4	18	1		23
	3		1	16	4	2	23
	4			6	5	3	14
	5			10	11	3	24
	6			1		2	3
	7				7	2	9
	8				4	6	10
	9				1	11	12
Total of frequencies		1	13	60	34	29	137

Table IV. Correlation estimations.

	Coefficient value	Standard error	p value
Kendall's Tau-b	0.657	0.37	0.000
Kendall's Tau-c	0.640	0.41	0.000
Gamma	0.808	0.39	0.000
Spearman's R	0.760	0.037	0.000

These results revealed the presence of a moderate to high correlation. Nevertheless, the targeted aim was to find values higher than 0.8, so as to consider that the correlation could be deemed as important.

DISCUSSION

Even though correlation estimates undertaken with several coefficients showed relatively high values, they were still insufficient to be able to emit a recommendation targeting the substitution of one development measurement for another. This would have had more substance if correlation coefficient of 0.85 or higher had been found. Therefore, based on results obtained in the present study as well as results from other researchers[2,4,11,12,15] and adopting a conservative position, it can be argued that there are still no sufficient elements to lead us to abandon carpus X-rays for evaluation of patients' development.

The present study should be the basis for future research projects. Methodologies should be refined, and thus obtain more substantial evidence than the one we count with nowadays and thus be able to emit a firmer recommendation.

CONCLUSIONS

The evidence obtained in the present research study when correlating both variables supports findings of other studies with respect to the strong correlation existing between carpus and canine developmental stages.[2,4,11,12,15] Nevertheless, the pattern described in the theoretical scheme did not exactly adjust to the pattern found in the present study, first stages being the sole exception.

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Mailing address:
Joaquín Canseco Jiménez
E-mail: drjcanseco@gmail.com