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Association Between Canine Calcification and CVMI Using CBCT- A Cross- Sectional Study

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ABSTRACT

Background: The aim of this study was to establish an association between cervical vertebrae maturity assessed with the use of cone-beam computerized tomography (CBCT) and dental calcification stages using Demirjian Index (DI).**Methods**:The study was carried out on the patients visiting the Post-Graduate Department of Orthodontics & Dentofacial Orthopaedics, Government Dental College and Hospital. A total of 50 pre- treatment (25 male and 25 female) CBCT, OPG, were selected from the records of the department for this study. Cervical vertebrae development of the sample was evaluated by Hassel and Farman's method (modification of Lamparski's criteria), which assesses maturational changes of the second, third, and fourth cervical vertebrae as seen on CBCT. The dens (odontoid process) of C2, the body of the third cervical vertebra (C3), and the body of the fourth cervical vertebra (C4) were observed and used to indicate maturity. The development stages of mandibular left canine were assessed according to Demirjian et al (Demirjian Index, DI).**Results**: Females achieved subsequent maturation stage of mandibular canines earlier. Mann Whitney / Wilcoxon Two-sample test (Kruskal Wallis test for two groups) showed highly significant differences among various DI stages in both the genders (Females, $\chi 2 = 3.981$, $P = 0.046$; Males, $\chi 2 = 18.759$, $P < 0.001$). Also, the association and distribution between the DI stages of mandibular canines and CVMI stages in females. The $\chi 2$ was highly significant at 11.36 ($p=0.023$). The Pearson contingency coefficient was 0.613 showing a highly significant association between DI and CVMI. However, there was a scattered distribution of canine DI stages in females. DI stage G and H corresponded to CVMI stages 2,3,4 and 5 while DI stage H corresponded to CVMI stage 6.**Conclusion**:The relationship between the mandibular canine calcification stages and the skeletal maturity indicators can allow the clinician to more easily identify stages of the pubertal growth period. In the present study it was found that the canine stage G in males and canine stage H in females may represent the CVMI 2 stage and can serve as a simple tool for evaluating the onset of the accelerating growth period. It can be easily incorporated into clinical practice by using the intra-oral periapical (IOPA) view for initial growth assessment of an individual.

Keywords: Skeletal Maturity Indicator,Cvmi, Canine Calcification.

INTRODUCTION

Various studies have proposed the assessment of dental calcification stages to determine the level of skeletal maturation. Gran and co-workers[1] showed only weak correlations between third molar and skeletal development; Engstorm and co-workers[2] reported stronger relationships. Relationships between the stages of tooth mineralization of the mandibular canine appear to correlate better with ossification stages than the other teeth. Given the well-established relation between skeletal and somatic maturity, stages of calcification of the mandibular canine might be used as a first level diagnostic tool to estimate the timing of the pubertal growth spurt. As the result of recent advances in the field of radiology, cone-beam computed tomography (CBCT) is becoming more popular as an investigating tool for orthodontic patients. Images of head and neck can be seen in all 3 planes, including cervical vertebrae, with the use of CBCT.

So, the aim of this study undertaken was to assess cervical vertebrae maturity with the use of cone-beam computerized tomography (CBCT) and dental calcification stages using Demirjian Index (DI).

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MATERIALS AND METHODS

Source of the data:

The study was carried out on the patients visiting the Post-Graduate Department of Orthodontics & Dentofacial Orthopaedics, Government Dental College and Hospital. A total of 50 pre- treatment

(25 male and 25 female) CBCT, OPG, were selected from the records of the department for this study. The inclusion criterias were, (i) Chronological age ranging from ten to eighteen years. (ii) Normal overall growth and development. (iii) Absence of a previous history of trauma or disease to the face, neck and hand. (iv) No gross skeletal deformities, for example, clefts, hemiatrophy, hypertrophy, and so on, and no congenital deformity. (v) Absence of previous orthodontic treatment. (vi) No permanent teeth extracted. Following were the exclusion criteria: (i) Patients presenting with congenital or acquired malformations affecting cervical vertebrae. (ii) Patients presenting with developmental alterations of cervical vertebrae (iii) Medical conditions or patients on medication affecting bone metabolism.

Sample Size and power:

A sample size was calculated with G*Power (G* Power Ver.3.0.10). For a power of 80% with an f= 30 effect size, α=0.05 Type I, and β=20 Type II error rates, a sample size of at least 50 patients was determined.

Cervical vertebrae development of the sample was evaluated by Hassel and Farman's method3 (modification of Lamparski's criteria)4, which assesses maturational changes of the second, third, and fourth cervical vertebrae as seen on CBCT. The dens (odontoid process) of C2, the body of the third cervical vertebra (C3), and the body of the fourth cervical vertebra (C4) were observed and used to indicate maturity. Any head tilt of the patient in the CBCT image was corrected on the computer so that the midsagittal plane perpendicular to the floor was running through the intermaxiilary suture and anterior nasal spine.

Cervical vertebrae maturation indicators (CVMI) suggested by Hassel and Farman can be seen in the following figures.

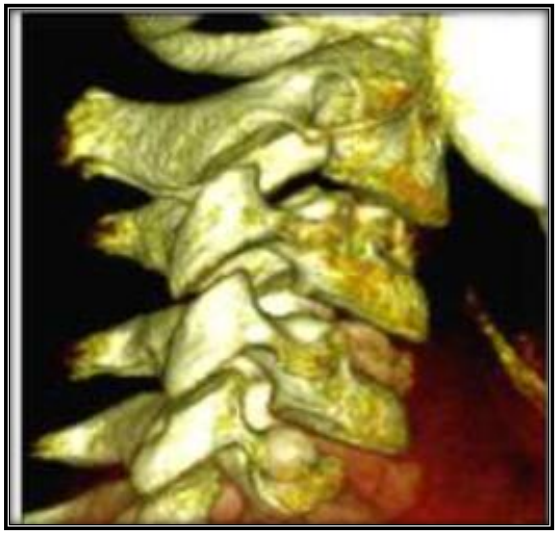

Figure 1: CBCT of a subject showing Initiation Stage (stage 1) of CVMI staging

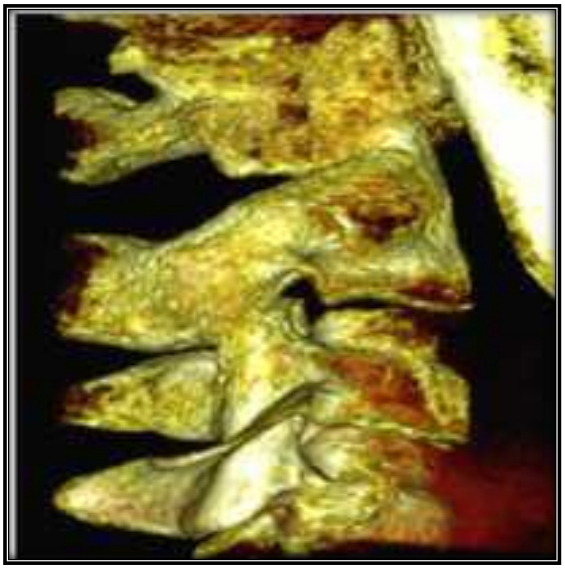

Figure 2: CBCT of a subject showing Acceleration Stag(stage 2) of CVMI staging

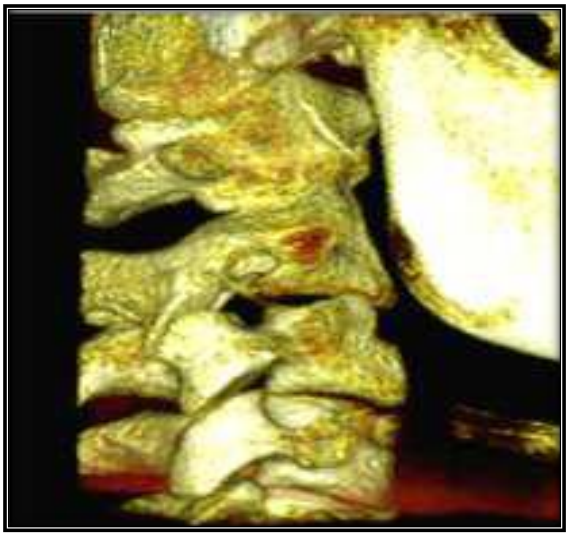

Figure 3: CBCT of a subject showing Transition stage (stage 3) of CVMI staging

Figure 4: CBCT of a subject showing Deceleration stage (stage 4) of CVMI staging

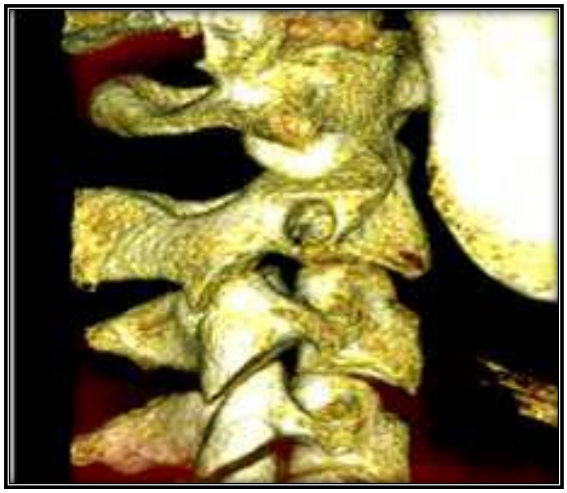

Figure 5: CBCT of a subject showing Maturation stage (stage 5) of CVMI staging.

Figure 6: CBCT of a subject showing Completion stage (stage 6) of CVMI staging.

The development stages of mandibular left canine were assessed according to Demirjian etal (Demirjian Index, DI). If the left side tooth was not clear, then the right side tooth was evaluated.

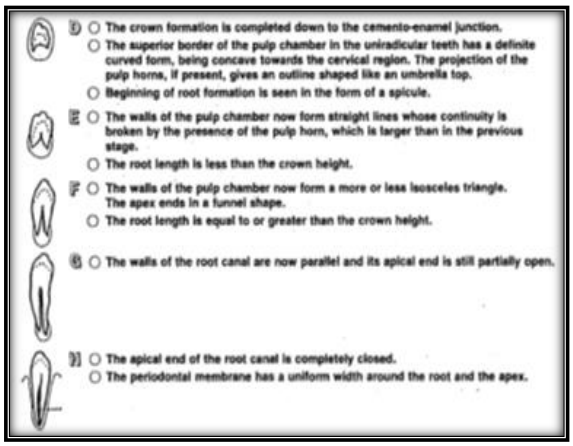

Image 1: Reinterpretation of the dental mineralization stages proposed by Demirjian et al.

Figure 7: OPG of a subject showing stage F of mandibular canine calcification.

Figure 8: OPG of a subject showing stage G of mandibular canine calcification.

Figure 9: OPG of a subject showing stage H of mandibular canine calcification.

RESULTS

[Table 1] shows the mean age at different DI stages of mandibular canines. Females achieved subsequent maturation stage of mandibular canines earlier. Mann Whitney / Wilcoxon Two-sample test (Kruskal Wallis test for two groups) showed highly significant differences among various DI stages in both the genders (Females, $\chi 2 = 3.981$, $P = 0.046$; Males, $\chi 2 = 18.759$, $P < 0.001$).

Table 1: Mean age of different DI stages of mandibular canines in the genders and the gender difference.

DI Stages	Males		Females		Gender Difference
	Mean	SD	Mean	SD	
Stage F	11.6	0.53	-	-	-
Stage G	12.7	0.79	12.3	1.75	0.4
Stage H	15.6	1.13	15.1	2.90	0.5
Chi-square	18.759		3.981		
P-value	<0.001*		0.046*		

[Table 2] shows the association and distribution between the DI stages of mandibular canines and

CVMI stages in males. The $\chi 2$ was highly significant at 7.639 ($P < 0.001$). The Pearson contingency coefficient was 0.723, showing an significant association between DI and CVMI. In males, the DI Stage F showed the highest percentage distribution (100%) at stage 1 of CVMI (pre–peak of pubertal growth spurt) and DI stage G showed a large percentage distribution in stage 2 of CVMI (peak of pubertal growth spurt). The DI stage H was associated with stage 4 of CVMI (end of pubertal growth spurt).

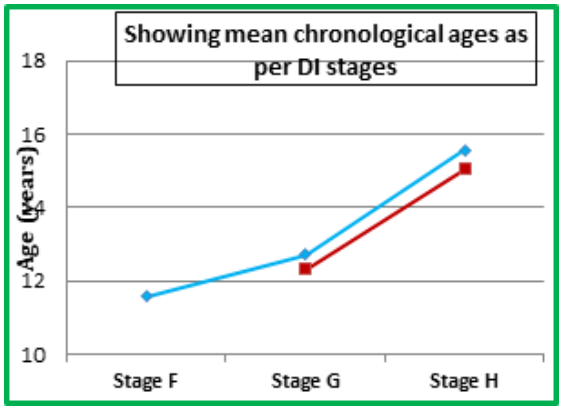

Figure 10: Showing mean chronological ages as per DI stages.

Table 2: Showing association and distribution between DI stages of mandibular canines and CVMI stages for males

CVMI Stages		DI for mandibular canines			Total
		Stage F	Stage G	Stage H	
Stage 1	N	6	0	0	6
	%	100.0%	0.0%	0.0%	100.0%
Stage 2	N	1	6	1	8
	%	12.5%	75.0%	12.5%	100.0%
Stage 3	N	0	5	4	9
	%	0.0%	55.6%	44.4%	100.0%
Stage 4	N	0	0	2	2
	%	0.0%	0.0%	100.0%	100.0%
Chi-square=7.639; Contingency Coefficient=0.723; P-value<0.001					

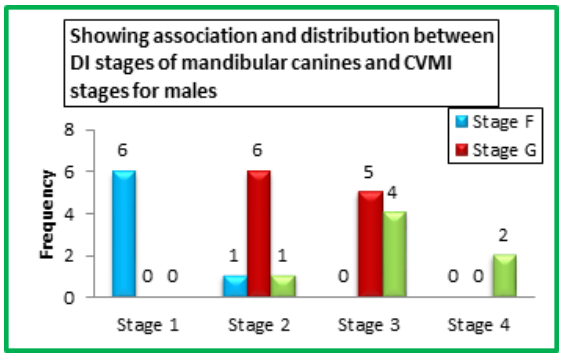

Figure 11: Showing association and distribution between DI stages of mandibular canines and CVMI stages for males.

[Table 3] shows the association and distribution between the DI stages of mandibular canines and CVMI stages in females. The $\chi 2$ was highly significant at 11.36 ($p=0.023$). The Pearson contingency coefficient was 0.613 showing a highly significant association between DI and CVMI. However, there was a scattered distribution of canine DI stages in females. DI stage G and H corresponded to CVMI stages 2,3,4 and 5 while DI stage H corresponded to CVMI stage 6.

Table 3: Showing association and distribution between DI stages of mandibular canines and CVMI stages for females

CVMI Stages		DI for mandibular canines		Total
		Stage G	Stage H	
Stage 2	N	2	4	6
	%	33.3%	66.7%	100.0%
Stage 3	N	1	1	2
	%	50.0%	50.0%	100.0%
Stage 4	N	1	2	3
	%	33.3%	66.7%	100.0%
Stage 5	N	2	1	3
	%	66.7%	33.3%	100.0%
Stage 6	N	0	11	11
	%	0.0%	100.0%	100.0%
Chi-square=11.36; Contingency Coefficient=0.613; P-value=0.023				

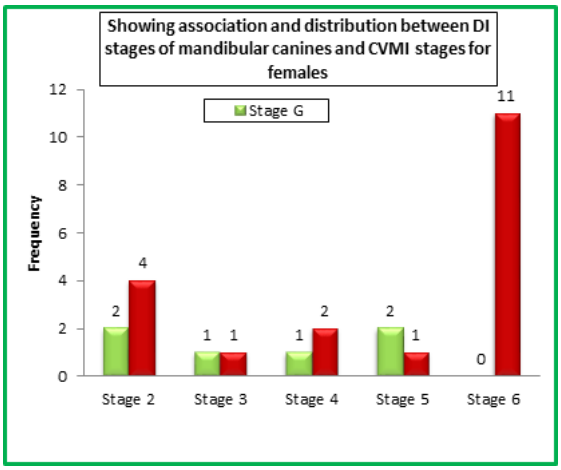

Figure 12: Showing association and distribution between DI stages of mandibular canines and CVMI stages for females.

DISCUSSION

OPGs were chosen for dental maturity assessment, as they are routinely available in orthodontic clinics, and the mandibular region is clearly visible. The Demirjian et al,[21] method was chosen for dental maturation assessment in the present study, because it is based on shape criteria and proportion of root length, using the relative value to crown the height rather than the absolute length. Therefore, the foreshortened or elongated projections of developing teeth will not affect their reliability of assessment.

Conversely, Basaran et al. stated that boys showed late dental development.[5]

The Pearson correlation coefficients between skeletal maturity and canine calcification stages in

our study were 0.613 in females and 0.723 in males ($p < 0.001$), which confirmed the previous findings.[6] It suggested that a moderate association existed between the skeletal and dental maturation stages.

In the present study, DI stage F was coinciding well with CVMI stage 1 in males. Sandeep Goyal et al,[7] found DI stage F to be coinciding well with CVMI stage 2 in males. Divyashree et al,[8] found Stage F to be coinciding well with the pre-peak of skeletal development in the Indian sample.

In the present study DI stage G was coinciding well with CVMI stage 2 in males but there was a scattered distribution of canine calcification stages in females in the CVMI 2 stage. Chertkow et al,[9] had previously reported mandibular canine stage G coinciding with the early appearance of the sesamoid (which was equivalent to CVMI 2) in boys as well as in girls, while Krailassikari and So found no uniformity in canine development in the same skeletal maturity stage.[2,10,11]

In the present study, in CVMI 3 stage, the majority of the males was at DI stage G, while there was a scattered distribution of canine stages in females. At CVMI stages 4 and 5, in both genders, most of the canines were in stage G and H, that is, toward root completion, while 100% canines were in stage H at the CVMI 6 stage. It showed that canine stages could be considered as indicative of growth status in the beginning stage (stage F) and has more reliable significance in males than females. This was in accordance with the findings of Divyashree et al in Indian subjects and Lu in Chinese subjects for the males.[8,12]

It signifies that the interpretation of the relationship between mandibular canine calcification stages with the later stages of skeletal maturity is not meaningful. Mandibular canine calcification stages can only be used reliably in their earlier stages for predicting skeletal maturation levels.

Clinical Implications:

Knowledge of active growth is important for clinical decisions, especially for dentofacial orthopedic, surgical, and prosthetic treatment planning. Studies have reported that there is a greater skeletal response with myofunctional appliances if treatment is given during the peak height velocity period than during the pre-peak period. Thus for more orthopedic effects, the treatment must be started during the CVMI 2-3 stages. Treatment given after these stages may result in more dental than skeletal effects.[13]

CONCLUSION

The relationship between the mandibular canine calcification stages and the skeletal maturity indicators can allow the clinician to more easily identify stages of the pubertal growth period. In the present study it was found that the canine stage G in males and canine stage H in females may represent the CVMI 2 stage and can serve as a simple tool for evaluating the onset of the accelerating growth period. It can be easily incorporated into clinical practice by using the intra-oral periapical (IOPA) view for initial growth assessment of an individual.

REFERENCES

1. Garn SM, Lewis AB, Bonne B. Third molar formation and its developmental course. Angle Orthod 196244:270-6.
2. Engstorm C, Engstorm H, Sagne S. Lower third molar development in relation to skeletal maturity and chronological age. Angle Orthod 1983;53:97-106.
3. Hassel B, Farman A. Skeletal maturation evaluation using cervical vertebrae. Am J Orthod Dentofacial Orthop 1995;107: 58-66.
4. Lamparski DG. Skeletal Age Assessment Utilizing Cervical Vertebrae [Master's Thesis]. Pittsburg (PA): University of Pittsburg; 1972.
5. Guvenç Basaran, Torun Ozer, and Nihal Hamamcia. Cervical vertebral and dental maturity in Turkish subjects. Am J Orthod Dentofacial Orthop 2007;131:447.e13-447.e20.
6. Sandra Coutinho, Peter H. Buschang, Francis Miranda. Relationships between mandibular canine calcification stages and skeletal maturity. Am J Orthod Dentofacial Orthop 1993;104:262-8.
7. Sandeep Goyal, Sonia Goyal, Neeraj Gugnani. Assessment of skeletal maturity using the permanent mandibular canine calcification stages. Journal of Orthodontic Research Jan-Apr 2014 Vol 2 Issue 1
8. Divyashree R, Dinesh MR, Amarnath BC. Reliability of permanent mandibular canine calcification as an indicator of skeletal maturity in Karnataka population. World J Dent 2010;1:5-9.
9. Chertkow S. Tooth mineralization as an indicator of the pubertal growth spurt. Am J Orthod 1980;77:79-91.
10. Krailassiri S, Anuwongnukroh N, Dechkunakorn S. Relationships between dental mineralization stages and skeletal maturation indicators in Thai individuals. Angle Orthod 2002;72:155-65.
11. So LL. Skeletal maturation of the hand and wrist and its correlation with dental development. Aust Orthod J. 1997;15:1-9.
12. Lu Y. Relationships between mandibular canine calcification stages and skeletal maturity. Zhonghua Kou Qiang Yi Xue Za Zhi 1999;34:40-2.
13. Kamal M, Ragini, Goyal S. Comparative evaluation of hand wrist radiographs with cervical vertebrae for skeletal maturation in 10- 12 years old children. J Indian Soc Pedod Prev Dent 2006;24:127- 35.

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