CORRELATION OF DENTAL AND SKELETAL MATURITY USING DIMIRGIAN AND CERVICAL VERTEBRAL MATURATION INDICES IN ORTHODONTIC PATIENTS

Shahab Adil[1], Zafar Ul Islam[2], Kulsoom Kareem[3], Hassan Ali Raza[4], Sanam Tauheed[5], Sohaib Hassan[6]

ABSTRACT

OBJECTIVES

To determine the correlation between skeletal and dental maturity using the cervical vertebral maturation (CVM) index (CVMI) and Demirjian index (DI) in orthodontic patients.

METHODOLOGY

Panoramic and lateral cephalogram radiographs of 105 patients pretreatment records were retrieved. Tooth calcification stages for mandibular left molar were recorded using Demirjian Index on the panoramic radiograph. The skeletal maturation stages were evaluated on a lateral cephalogram through CVMI staging. Fisher's exact test and Cramer's V values were estimated to determine the correlation between DI and CVMI. Weighted kappa statistics were used to determine the reproducibility of inter-observer assessment of DI and CVMI. A p-value of ≤ 0.05 was taken to be statistically significant.

RESULTS

A statistically significant correlation is present among the various stages of DI and CVMI for the males (Fisher exact = 25.006, Cramer's V = 0.848, p = < 0.001) and females (Fisher exact = 41.006, Cramer's V = 0.623, p = <0.001). A comparison of DI with respect to CVMI shows a more advanced skeletal stage in males than for female subjects.

CONCLUSION

The correlation between CVMI and DI stages was found to be highly significant. Stage D and F of DI were significantly correlated with stage 3 and stage 4 of CVMI in females and males respectively.

KEYWORDS: *CVMI, Demirjian Index, Dental Maturity, Skeletal Maturity*

How to cite this article:
Adil S, Islam ZU, Kareem K, Raza HA, Tauheed S, Hassan S. Correlation of Dental and Skeletal Maturity Using Dimirgian and Cervical Vertebral Maturation Indices in Orthodontic Patients. J Gandhara Med Dent Sci. 2022;9(4) 20-24
https://doi.org/10.37762/jgmds.9-4.312

Correspondence
[1]Shahab Adil, Professor of Orthodontics, Peshawar Dental College, Peshawar
✆: +92-343-9009494
✉: shahabadil@hotmail.com
[2]Associate Professor Orthodontics, Peshawar Dental College, Peshawar
[3]Resident Orthodontics, Peshawar Dental College, Peshawar
[4]Assistant Professor Orthodontics, Peshawar Dental College, Peshawar
[5]Assistant Professor Orthodontics, Jinnah Medical and Dental College, Karachi
[6]Associate Professor Orthodontics, Multan Medical & Dental College, Multan

INTRODUCTION

Dentofacial orthopedics is a modality used in orthodontics to modify the growth of the maxilla and the mandible. The evaluation of physiologic growth status is of prime importance in growth modification and correction of skeletal disparity in both adolescents and in pediatric patients.[1] This can be observed in skeletal class II patients showing amplified skeletal effects with functional appliance therapy during peak mandibular growth.[2] Chronological age has a weak correlation with the developmental status of an individual because many variations are observed in various studies performed, thus, imparting the need for the concept of physiological age.[3] Physiological age shows the amount of structural maturity which can be determined by using various somatic, skeletal, dental, and sexual maturity indicators.[4] The

skeletal maturity can be evaluated by radiographing the various bony structures.[5,6] Also, these radiographs will require additional radiation exposure than the essential diagnostic radiographs for orthodontic treatment. In orthodontics, hand wrist radiography and lateral cephalograms are considered more accurate to calculate the skeletal age.[7,8] Dental maturity in various studies has been been investigated to be an influential forecaster of skeletal maturity.[9,10] Dental maturity can be evaluated by the eruption phase of teeth and more accurately through the calcification stages of the second molar.[11] It has been found already that calcification of the second molar and skeletal maturation show the highest correlation.[12] Panoramic and lateral cephalograms are essential diagnostic records for an orthodontic examination. Skeletal and dental maturation, if evaluated by means of these essential diagnostic records would avoid exposure to additional radiation as in a hand-wrist radiograph. This is in accordance with as low as reasonably achievable (ALARA) principle.[13] Therefore, the determination of the correlation between second molar development using DI and skeletal maturation using CVMI in patients visiting Peshawar Dental College is needed to see the possible variations in the maturation process.

METHODOLOGY

This cross-sectional study was carried out at the orthodontic department of tertiary care hospital. After Approval from Institutions Review Board (Prime/IRB/2021-379), pretreatment panoramic and lateral cephalogram of patients were retrieved from orthodontic records from November 2021 to January 2022. Consent for the usage of records for research purposes is taken at the time of pretreatment records from each subject. Tooth calcification stages for the mandibular left second molar were recorded using Demirjian Index on the panoramic radiograph of the subject. The skeletal maturation stages were evaluated on a lateral cephalogram. The data were analyzed using IBM SPSS version 20. The descriptive statistics were generated for the sample parameters. The means and standard deviations of the chronological ages for the six stages of CVMI were calculated. Weighted kappa statistics were used to determine the reproducibility of inter-observer assessment of DI and CVMI. After analysis of the data for distribution, which came out to be skewed, Fisher's exact test and Cramer's V value were used to seeing the correlation between DI and CVMI. The level of significance was set at ≤ 0.05.

RESULTS

The mean ages of the subject for DI and CVMI are shown in Table 1. The chronologic ages of the subjects increased as the stages of DI and CVMI advanced. Correlations between Stages of DI and CVMI for male subjects have been presented in Table 2. A statistically significant correlation was present among the various stages of DI and CVMI for the males (Fisher exact = 25.006, Cramer's V = 0.848, p = < .001) and females (Fisher exact = 41.006, Cramer's V = 0.623, p = < 0.001). Table 2 showed the earlier stages of DI and CVMI were correlated with each other. The later stages of DI and CVMI were also correlated with each other. The highest per cent (100%) distribution of CVMI stage 1 was presented in stage E of DI. Equal distribution of stages F and H of DI were seen for CVMI stage 4. Most of the subjects at CVMI stage 5 were represented in stage H of the DI. The subject at stage H of DI displayed 100% distribution with CVMI stage 5 and stage 6. Correlations between Stages of DI and CVMI for male subjects have been presented in Table 3. A statistically highly significant correlation was present among the various stages of DI and CVMI for the females (Fisher exact = 41.01, Cramer's V= 0.623, p = < 0.001). Again the earlier stages of DI corresponded with earlier stages of CVMI and conversely, later stages the DI stage later the CVMI stage. The DI Stages F and H in female subjects showed equally representation in stages 3 and 4 of CVMI. Tables 2 and 3, when compared mutually, showed that all the stages of DI in relation to CVMI in male subjects were more advanced than in female subjects. Weighted kappa statistics showed a strong interobserver agreement for DI (0.88) and CVMI (0.84).

Table 1: Mean Ages of Subjects for DI and CVMI.

Variable	Mean ± SD	Variable	Mean ± SD
CVMI 1	11.0 ± .001	DI Stage E	11.0 ± .001
CVMI 2	10.0 ± .001	DI Stage F	12.0 ± 1.5
CVMI 3	15.7 ± 7.05	DI Stage G	14.1 ± 3.6
CVMI 4	18.6 ± 5.19	DI Stage H	19.3 ± 4.3
CVMI 5	17.5 ± 2.81	-	-
CVMI 6	18.4 ± 2.96	-	-

Table 2: Correlations between DI and CVMI for Males.

Variable	Stage E	Stage F	Stage H	Total
CVMI 1	04 0.5 100%*	0	0	04 04 100%
CVMI 4	0	03 0.6 50%	03 4.6 50%	06 06 100%
CVMI 5	0	0	15 11.6 100%*	15 15 100%
CVMI 6	0	0	06 4.6 100%*	06 06 100%

N = 31, Fisher exact = 25.08, Cramer's V = 0.848, P< 0.001

Table 3: Correlation between DI and CVMI for Females.

Variable	Stage F	Stage G	Stage H	Total
CVMI 2	03 0.2 100%*	0	0	03 03 100%
CVMI 3	0	06 2.4 66.7%	03 06 33.3%	09 09 100%
CVMI 4	03 1.7 12%	03 6.7 12%	19 16.6 76%	25 25 100%
CVMI 5	0	15 8.9 45.5%	18 21.9 54.5%	33 33 100%
CVMI 6	0	0	19 12.6 100%*	19 19 100%
Total	6 6 6.7%	24 24 27%	59 59 66.3%	89 89 100%

N = 89, Fisher exact = 41.01, Cramer's V = 0.623, P< 0.01.

DISCUSSION

This study was conducted to determine the correlation of skeletal and dental maturity using the CVM index (CVMI) and Demirjian index (DI) in orthodontic patients, for this purpose panoramic and lateral cephalogram of 105 patient's pretreatment records were retrieved. In this study, a statistically significant correlation was present among the various stages of DI and CVMI for the males and females with more advanced skeletal stages in males than for female subjects. Determining the skeletal age of the patient is an important aspect of orthodontic treatment. Utilizing the growth of the maxilla and mandible for the correction of three-dimensional facial skeletal deformities, need the determination of critical timing in skeletal growth status. For this reason, several methods have been devised to assess the skeletal maturity status of the patients. Cervical vertebral maturation index (CVMI) is the most common method used to assess the skeletal growth status in orthodontic patients. In addition to CVMI, other methods are used to assess growth status which include, the hand wrist radiograph and dental maturity index.[7,8,9] Several studies have been carried out to determine the correlations among these indices.[11,12,14,15] This approach makes the identification of the skeletal maturity stage more cost-effective and accurate. The required information is obtained from the radiographs most commonly available without exposing the patient to extra radiation harmful dosage and decreasing the cost. The use of a panoramic radiograph for assessing the dental age and thus growth maturation is practical and convenient. The radiation exposure with an additional hand wrist radiograph for assessing the growth maturation status can be avoided with the panoramic radiograph fulfilling the same purpose.[16] The relative additional cost and harmful radiation exposure with hand wrist radiographs make them impractical and unnecessary to be used for growth maturation assessment. Several studies have evaluated the association between dental maturity index and CVMI and have found statistically significant results.[17,18] However, some have also found a weak or insignificant correlation between skeletal and dental maturity.[19] In the present study we have found a highly significant association between the DI and CVMI. Males and female subjects have different biological clocks set for the development of skeletal and dental maturity. Therefore, it is most important to evaluate the maturity stages of males and females separately. A study reported that girls, when compared to male subjects, appear more advanced in each CVMI stage. Females were highly distributed towards late dental development in this present study at the same cervical maturation stage. To elaborate more in-depth, the evaluation of male and female subjects for DI and CVMI were made separately in the present study. The male subjects in this study showed that DI stages are more advanced with respect to the stages of CVMI. On the contrary, the female subject showed earlier stages of DI in relation to CVMI. Moreover, the DI of the second molar in the mandible was highly correlated with the CVMI of subjects. The findings of the previous study showed more advanced tooth maturation in boys in relation to skeletal maturation when compared to female subjects. The CVMI 3 is an important stage of skeletal maturity for the best treatment time. This stage denotes the accelerated growth spurt which follows within a year after its appearance. The identification of the DI stage which shows the greatest correspondence with the

CVMI stage 3 has been shown to be variable in different studies. In the present study, most of the female subjects at CVMI stage 3 were represented at DI stage G while in male subjects the highest distribution was observed in stage F of DI at CVMI 4. In female subjects, stage H of DI showed the highest distribution at CVMI 4. This showed that as compared to males, the females have advanced DI stages in relation to CVMI stages. The previous study by Sushil and Singla demonstrated stages F and G of DI to be related to CVMI stages 3 and 4 for both males and females. A study by Mithun et al.[20] Also showed a clear differentiation that stage F of DI corresponded to stage 3 of CVMI. In the present study, stage H of DI showed 100% distribution at CVMI stage 6 and the highest per cent distribution at CVMI stage 4 and 5 in either gender. Similar results have been produced by another study.[16] As the correlations of the various stages of DI are variable in relation to CVMI stages, therefore, it is very important that it must be determined for male and female subjects in our population. The various studies mentioned above showed variation which may be in part due to the different criteria used for the assessment of DI and CVMI. However, the role of ethnicity cannot be overlooked. Therefore, we have conducted this study to determine the correlation between DI and CVMI in our patients.

LIMITATION

The sample size of this study was small it would be better if this study was conducted on increase sample size and from multiple dental teaching hospitals.

CONCLUSION

The male subjects, as compared to females, are more advanced in DI stages with respect to CVMI. The stage D of DI highly correlates with CVMI stage 3 in female subjects. The stage F of DI highly correlates with CVMI stage 4 in male subjects. The stage F of DI highly correlates with CVMI stages 5 and 6 in both genders.

CONFLICT OF INTEREST: None

FUNDING SOURCES: None

REFERENCES

1. Mohan R, Jain RK, Balakrishnan N. Correlation between chronological age and skeletal age using cvmi and modified MP3 methods. Bioinformation. 2020;16(12):1045-50.
2. Fleming PS. Timing orthodontic treatment: early or late? Aust Dent J. 2017;62 Suppl 1:11-19.
3. Cho SM, Hwang CJ. Skeletal maturation evaluation using mandibular third molar development in adolescents. Korean Journal of Orthodontics. 2009;39(2):120-9.
4. Jeon JY, Kim CS, Kim JS, Choi SH. Correlation and Correspondence between Skeletal Maturation Indicators in Hand-Wrist and Cervical Vertebra Analyses and Skeletal Maturity Score in Korean Adolescents. Children (Basel). 2021;8(10):910.
5. Palanisamy V, Rao A, Shenoy R, Baranya SS. Correlation of dental age, skeletal age, and chronological age among children aged 9-14 years: A retrospective study. J Indian Soc Pedod Prev Dent. 2016;34(4):310-4.
6. H. O. Al-Balbeesi, N. W. Al-Nahas, L. F. Baidas, S. M. Bin Huraib, R.'a. Alhaidari, and G. Alwadai. Correlation between skeletal maturation and developmental stages of canines and third molars among Saudi subject. The Saudi Dental Journal. 2018;(30):74–84.
7. G. Songra, T. K. Mittal, J. C. Williams, J. Puryer, J. R. Sandy, and A. J. Ireland. Assessment of growth in orthodontics. Orthodontic Update. 2017;10(1):16–23.
8. Yang R, Wang L, Wu C, et al. Nomogram for Predicting Bone Development State of Female Children and Adolescents-A Fast Screening Approach Based on Pubes Stages for Growth and Development. Front Pediatr. 2021;9:694958.
9. Palanisamy V, Rao A, Shenoy R, Baranya SS. Correlation of dental age, skeletal age, and chronological age among children aged 9-14 years: A retrospective study. J Indian Soc Pedod Prev Dent. 2016;34(4):310-4.
10. Avinash B, Shivalinga M, Balasubramanian SS. The index of orthodontic treatment need-a review. International Journal of Scientific Research. 2015;6(8):1.
11. Esan TA, Schepartz LA. The timing of permanent tooth development in a Black Southern African population using the

Demirjian method. International Journal of Legal Medicine. 2019 Jan;133(1):257-68.
12. Vedovello SA, Dos Santos PR, de Carvalho AL, Vedovello Filho M, Ambrosano GM, Pereira AC, Meneghim MD. Exploring the perception of orthodontic treatment need using the Dental Aesthetic Index and Index of Orthodontic Treatment Need. American Journal of Orthodontics and Dentofacial Orthopedics. 2019 Dec 1;156(6):818-22.
13. Siegel JA, McCollough CH. 5.4. Advocating for use of the ALARA principle in the context of medical imaging fails to recognize that the risk is hypothetical and so serves to reinforce patients' fears of radiation. Controversies in Medical Physics: a Compendium of Point/Counterpoint Debates Volume 3. 2017 Dec:253.
14. Verma M, Verma N, Sharma R, Sharma A. Dental age estimation methods in adult dentitions: An overview. Journal of forensic dental sciences. 2019 May;11(2):57.
15. Yadav V, Loomba A, Autar R. A comparative evaluation of dental calcification stages and skeletal maturity indicators in North-Indian children. National Journal of Maxillofacial Surgery. 2017 Jan;8(1):26.
16. Ojha A, Prasanth MA, Singh V, Sihag T, Bhati V, Tomar H. Assessment of correlation between dental calcification stages and skeletal maturity indicators. Journal of Forensic Dental Sciences. 2018 Sep;10(3):132.
17. Macha M, Lamba B, Avula JS, Muthineni S, Margana PG, Chitoori P. Estimation of correlation between chronological age, skeletal age and dental age in children: a cross-sectional study. Journal of clinical and diagnostic research: JCDR. 2017 Sep;11(9):ZC01.
18. Hashim HA, Mansoor H, Mohamed MH. Assessment of skeletal age using hand-wrist radiographs following Bjork system. Journal of International Society of Preventive & Community Dentistry. 2018 Nov;8(6):482.
19. Lecca-Morales RM, Carruitero MJ. Relationship between dental calcification and skeletal maturation in a Peruvian sample. Dental press journal of orthodontics. 2017 May;22:89-96.
20. Mithun, K. Evaluation of skeletal maturation using Mandibular second molar calcification in south Indian population. International Journal of Current Research. 2017;9(07): 54632-54637

CONTRIBUTORS
1. **Shahab Adil –** Concept & Design; Data Acquisition; Data Analysis/Interpretation; Drafting Manuscript; Critical Revision; Supervision; Final Approval
2. **Zafar Ul Islam –** Concept & Design; Data Acquisition; Data Analysis/Interpretation
3. **Kulsoom Kareem -** Data Analysis/Interpretation; Drafting Manuscript
4. **Hassan Ali Raza** - Data Acquisition; Critical Revision
5. **Sanam Tauheed** - Data Acquisition; Supervision
6. **Sohaib Hassan** - Data Analysis/Interpretation; Final Approval