ORIGINAL ARTICLE POJ 2017:9(2) 66-71

Correlation between dental calcification stages and skeletal maturity indicators

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Abstract

Introduction: Skeletal maturity timing and its assessment is paramount for orthodontic diagnosis and treatment planning. Many forms are treatment and best suited at circus-pubertal age and methods to ascertain that have been in practice for years. Hence this study is aimed at comparing mandibular second molar calcification stages with skeletal maturity as indicator through six cervical vertebral maturational (CVM) stages and eight stages of Demirjian's method.

Material and Methods: Lateral cephalograms and panoramic radiographs of 150 patients were included in this study. The tooth development of mandibular second molar was assessed on panoramic radiographs according to eight- grade scale of Demirjian's system. Cervical vertebrae (C2, C3 and C4) outlines traced from the lateral cephalometric radiographs were visually analysed using the CVM method in order to determine the skeletal maturation stage.

To study any direct relationship between the cervical stages and eight stages of Demirjian's method, percentage distribution of dental development stages in the subsequent cervical stages was calculated, taking gender into account. Spearman's rank correlation test was used to see the level of correlation between cervical vertebral maturation and dental calcification stages.

Results: The CVM stage was consistently earlier in females. Dental calcification stages were more advanced in CVM stage 2 and 3 for males and dental calcification stage D corresponded to CVM stage 1 and 2 (pre-peak of pubertal spurt). The CVM stage 3(peak of growth spurt) corresponded to stage E of dental calcification in females and stage G in males. Similarly, dental calcification stage G corresponded to CVM stage 4 (growth spurt peak) and stage H with CVM stage 5 and 6 i.e. end of pubertal spurt.

Conclusions: The dental calcification stages of mandibular second molar may be considered as primary diagnostic tool to determine skeletal maturity on routine orthopantogram radiograph.

Keywords: Skeletal age; dental age; growth spurt

Introduction

In growing patients, the assessment of maturational status has a significant role in the treatment outcome for dento-skeletal disharmonies. In orthodontic diagnosis and treatment planning, the correct identification of the different phases of skeletal maturation is an important issue, especially when clinical considerations are based on assessment of craniofacial growth.[1]

Skeletal maturation assessed on hand-wrist radiographs is considered the best indicator of skeletal maturity.[1] Recently, modifications in the size and shape of the cervical vertebrae have gained increasing popularity in growing subjects for skeletal maturity because this analysis is performed on lateral cephalogram, a routine radiograph used in orthodontic diagnosis.[2] Currently improved CVM method using six maturational stages determined on cervical vertebrae (C2, C3 &C4) morphology is common method for skeletal growth assessment.[2]

Dental development has been investigated as a predictor of skeletal maturity and can be assessed by either phase of tooth eruption or the stage of tooth calcification.[1] Among

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different radiological methods, Demirjian's method is generally used for dental age estimation in children.[3] The ability to assess skeletal maturity by the stages of dental calcification on panoramic radiograph would offer an advantage over hand-wrist radiograph method.

Various studies of correlation between tooth calcification stages and skeletal maturity indicators did not relate.[4-7] The teeth with highest correlation were mandibular second molar, second premolar and canine.[1,4-7] A local study done by Khan et al showed strong correlation between canine calcification and skeletal maturity from hand and wrist radiograph.[6] Racial variations may also play a role in the relationship of dental and skeletal maturation.[4] Mappes et al indicated that the predominant ethnic origin of the population, climate, nutrition, socioeconomic levels and urbanization are the causative factors of these racial variations.[1,4] However, study on correlation of other teeth calcification with skeletal maturity is not available in Pakistan. No additional exposure to radiation would be necessary if assessment of skeletal maturity were performed through routine radiographs keeping in mind the ALARA (as low as reasonably achievable) principle.[4]

It is necessary to evaluate mandibular second molar calcification stages as indicators of skeletal maturity in Pakistani subjects to find strong correlation in skeletal maturity and dental calcification stages. The finding of this study may be helpful as a first-level diagnostic tool to assess timing of pubertal growth spurt in Pakistani population.

Material and Methods

Lateral cephalometric and panoramic radiographs of 150 patients of both genders (ages 08-18 years) were selected from orthodontics department at Fatima Memorial Hospital Lahore, Pakistan. Informed consent was taken from all subjects with no history of orthodontics treatment and without any dental abnormality. The tooth development of mandibular second molar was assessed on the panoramic radiographs by using eight - grade scale of Demirjian's system. In order to minimise method error, each panoramic radiograph was assessed twice by the same assessor.

The cervical vertebrae (C2, C3 and C4) outlines were traced from lateral cephalometric radiographs and visually analysed using CVM method to determine the skeletal maturation stage. The presence or absence of concavity at the lower border of C2-C4 and the shape of C3-C4 (trapezoidal, horizontal, square and vertical) were analysed. All six developmental stages were described from cervical stage 1 (CS1) to cervical stage 6 (CS6).

In order to study any direct relationship between the cervical stages and the eight stages (A to H) of Demirjian's method, the percentage distribution of dental development stages in the subsequent cervical stages was calculated, taking gender into account. Spearman's rank correlation test was used to see the level of correlation between cervical vertebral maturational stages and dental calcification stages of mandibular right second molar.

Results

A significant correlation was seen between dental calcification stages and skeletal maturity indicators ($r = + 0.765$ in all the groups, + 0.805 in males and + 0.754 in females). Cervical vertebral maturational (CVM) stage was consistently earlier in females than in males. Dental calcification stages were more advanced in CVM stage 2 and 3 for males than in females. Dental calcification stage D corresponded to CVM stage 1 and 2 i.e. pre-peak of pubertal growth spurt. CVM stage 3 corresponded to stage E of dental calcification stage in females and G in males i.e. peak of pubertal growth spurt. Dental calcification stage G corresponded to CVM stage 4 i.e. peak of pubertal growth spurt. Dental calcification stage H

corresponded to CVM stage 5 and 6 i.e. end of pubertal growth spurt.

D, E, F, G, H are dental calcification stages of mandibular second molar according to Demirjian's index.[3] CS-1, CS-2, CS-3, CS-4, CS-5,CS-6 are cervical vertebral maturational stages according to Bacetti et al 2005.[2]

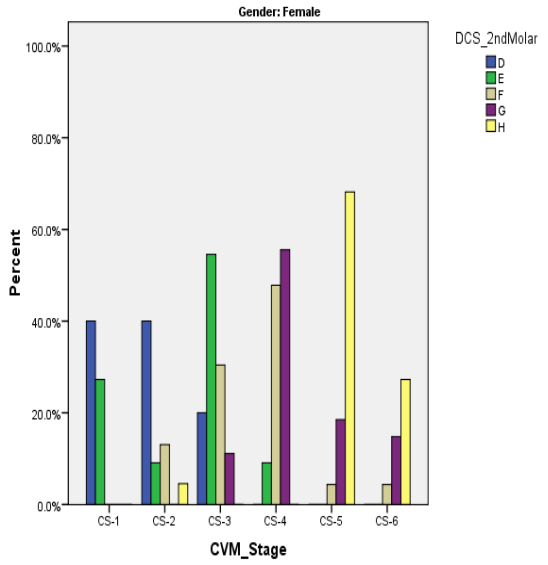

Figure 1: Percentage of different dental calcification stages along all cervical vertebral maturational stage in females

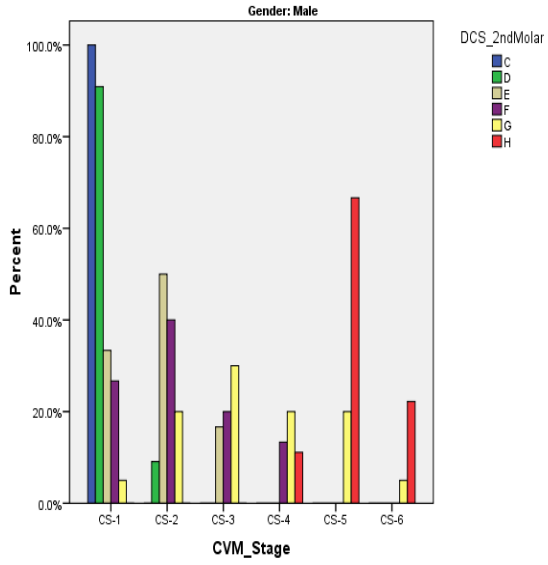

Figure 2: Percentage of different dental calcification stages along all cervical vertebral maturational stage in males

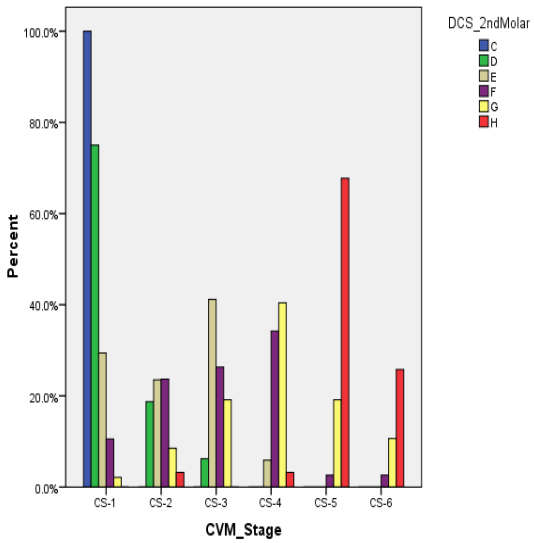

Figure 3: Percentage of different dental calcification stages along all cervical vertebral maturational stage in all subjects

Discussion

The success of orthodontic treatment is based on skeletal maturity of a patient. Many investigators have studied the optimal time for treating orthodontic patients and accelerated growth timing can help to correct these kinds of skeletal imbalances. [8-10]

Panoramic radiographs are routinely available in orthodontic clinic and the mandibular second molar region is clearly visible. Recently cervical vertebral maturation, hand-wrist radiograph and tooth eruption and its calcification are used to estimate the pubertal growth spurt in orthodontic patients.[3,11,12] In the present study, method described by Demirjian et al was chosen based on shape, proportion of root length and relative value of crown height rather than on absolute length.

Morales et al in 2017 studied relationship between dental calcification and skeletal maturation in a Peruvian sample. The pubertal growth spurt was found in the G stage of calcification of the second mandibular molar, and the mandibular growth peak was found in the F stage of calcification of the second molar. The results

of this study were in accordance with results of our study where CVM stage 3 corresponded to stage E of dental calcification stage in females and G in males i.e. peak of pubertal growth spurt.[13]

Autar et al, studied a comparative evaluation of dental calcification stages and skeletal maturity indicators in North-Indian children. Calcification Stage G for second molar represents the prepeak and Stage H represents the peak of pubertal growth spurt in females. The results of this study were in contrast to the present study where CVM stage 3 corresponded to stage E of dental calcification stage in females and G in males i.e. peak of pubertal growth spurt.[14]

Kučiauskienė et al studied evaluation of skeletal maturity using maxillary canine, mandibular second and third molar calcification stages. They found that CVM stage 3 corresponded with lower molar stage 5 (E) which is peak pubertal growth spurt. These results were in contrast to our study in which stage G in males and stage E in females corresponds to peak pubertal growth spurt.[15]

Arvindhbhai et al carried out radiographic evaluation of skeletal maturity using maxillary canine and mandibular second molar calcification stages in Western Maharashtra population. They concluded in their study that in stage D, all males and females are in pre-peak stage, in stage E and F they are within pre-peak and peak stages with more male (54.38%) than female maturity. This was partially in accordance to results of our study in which peak pubertal growth spurt corresponds to stage E in females and stage G in males.[16]

In a previous investigation by G. Perinetti et al, second molar stage H is mainly at CS5 or CS6 in their study. Above study when compared with our results is in agreement with the pre peak pubertal growth spurt and post peak of pubertal growth spurt but does not agree with peak of pubertal growth spurt results.[17] Naik et al studied second molar calcification stages to evaluate skeletal maturation. They found out that calcification stage F of mandibular second molar corresponded to stage 3 of CVMI (peak of pubertal and mandibular growth). This result was not in accordance to our study where stage E in females and stage G in males corresponded to peak pubertal growth spurt.[18]

Valizadeh et al concluded in their study that bone maturation can be predicted by using teeth calcification stages in second molar.[19] Maximum percentage distribution of DI stage G was found at CVM stage 3 and Stage 4.[19] This finding is in agreement with our finding for CVM stage 4 for both genders and and CVM stage 3 for males but result is varying for CVM stage 3 for females where our result shows DI stage F.[19] A local study by Sukhia RH et al showed statistically significant correlation between dental and cervical maturational stages.[20] Second molar stage G for females are mainly at CVM stage 3.[20] This result is not in line with our study since the present study Demirjian's Index stage F correlates with CVM stage 3.[20]

In an investigation by Saloom, it was concluded that in stage E and F they were within pre-peak and peak stages with more females toward maturity than males, in stage G males in peak stage, whereas about one third of females passed to post peak, in stage H less than 10% of males passed to post peak, while 80% of females are within post peak stage.[21] It is in partial agreement with our study as DI stage F was also found in peak of pubertal stage in females in our study.[21]

The differences in the previous studies and our studies are due to different variables like racial differences, questionable reproducibility of CVM method and subjective errors in assessing DI stages. The significant and unique findings from the present study states that the stages of mandibular second molar calcification as observed on panoramic radiographs give fairly accurate results and can be considered reliable indicators of skeletal maturity with

the methodology suggested by Demirjian et al.[3]

Conclusions

Each cervical vertebral maturational (CVM) stage was consistently earlier in females than in male subjects. Dental calcification stages were more advanced in CVM stage 2 and 3 for males compared to females.

1. Dental calcification stage D corresponded to CVM stage 1 and 2 i.e. pre-peak of pubertal growth spurt.
2. CVM stage 3 corresponded to stage E of dental calcification stage in females and G in males i.e. peak of pubertal growth spurt.
3. Dental calcification stage G corresponded to CVM stage 4 i.e. peak of pubertal growth spurt.
4. Dental calcification stage H corresponded to CVM stage 5 and 6 i.e. end of pubertal growth spurt.

Dental calcification stage of mandibular second molar can be considered as simple first level diagnostic test to determine skeletal maturity as indicated by above findings on orthopantomogram, which is available in most of orthodontic and general dental setup and is a routine radiograph easily available everywhere. When treating a Pakistani patient, it is appropriate to put these skeletal and dental maturation relationships into daily orthodontic diagnostic practice.

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