

Comparison of Various Skeletal Maturation Methods Based on CVM And MP3

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ABSTRACT

Aim: To compare the skeletal maturation methods on lateral cephalometric radiographs and MP3 radiographs.

Material and methods: Sixty lateral cephalograms and right hand middle phalanx of the middle finger IOPARs were taken in patients (30 males and 30 females) aged 8-25 years and assessed using Baccetti et al (CS) method and Hassel and Farman (CVMI) method (for assessing lateral cephalograms) and; Hagg and Taranger method and, Rajagopal and Kansal method (for assessing MP3 radiographs). Post-hoc pair wise comparisons were used for statistical analysis.

Results: Statistically significant concordance was seen among and between 6 stages of CVMI and 6 stages of CS and; 5 stages of MP3 (Hagg and Taranger method) and 6 stages of MP3 (Rajagopal and Kansal method).

Conclusion: The results suggested that both cervical vertebrae maturation methods and middle phalanx indices showed statistically significant concordance among and between each other and the any of the above analyzed methods can be used reliably to assess skeletal maturity.

Keywords: Baccetti et al method, Hagg and Taranger method, Hassel and Farman method, Rajagopal and Kansal method, skeletal maturity.

INTRODUCTION

Adolescence constitutes a transition between childhood and adulthood whose onset includes pubertal maturation¹. One objective of orthodontic treatment during adolescence in patients with skeletal discrepancies is to take advantage of the patient's residual growth status. Determination of maturation and subsequent evaluation of growth potential during preadolescence or adolescence is extremely important. It is assumed that through effective management of the growing craniofacial complex during adolescence, optimal results can be

achieved within a relatively shorter period of treatment².

Individual skeletal maturity can be assessed by means of several biologic indicators: increase in body height, skeletal maturation of the hand and wrist, dental development and eruption, menarche or voice changes, and cervical vertebral maturation³. After Roentgen demonstrated his radiographic discovery in 1895, Roland suggested the comparative size and shape of the radiographic shadows of growing bones as indicators of rate of growth and maturity. Todd compiled hand-wrist data that was further elaborated by Greulich and

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Pyle in atlas form⁴. Lamparski introduced a method for assessing cervical vertebral maturation on the cephalometric radiographs which was elaborated by Hassel and Farman⁴ and modified by Baccetti et al³. Hagg and Taranger created a method using the hand-wrist radiograph to correlate certain maturity indicators to the pubertal growth spurt, and a part of it (the MP3 stages) was modified by Rajagopal and Kansal^{5,6}.

Hagg and Taranger have described five stages of MP3 (Middle phalanx of the Middle finger) growth, based primarily on epiphyseal changes for the assessment of skeletal maturity. They are MP3 - F, MP3 - FG, MP3 - G, MP3 - H, MP3 - I stages^{1, 5}. Rajagopal and Kansal added an additional bone stage between MP3 - H and MP3 - I, which was named the MP3 - HI stage. The modified six stages of MP3 can be recorded on a standard periapical X-ray film and dental X-ray machine^{1, 6}. Cervical vertebral analysis for the assessment of skeletal maturity is correlating and is as reliable as hand - wrist radiographic method of assessment. Hassel and Farman described six stages of CVM (Cervical Vertebrae Maturation) growth, based on the changes in the vertebral bodies of C2, C3 and C4⁴. Baccetti et al modified the CVM method for the detection of the peak in mandibular growth³.

The purpose of the present study was to compare the skeletal maturation methods on lateral cephalometric radiographs by using Hassel and Farman method (CVMI) and Baccetti et al method (CS); and on MP3 radiographs by using Hagg and Taranger method and Rajagopal and Kansal method; and to assess the reliability of the methods used.

MATERIAL AND METHODS

The study included right profile cephalometric radiographs and right hand middle phalanx of the middle finger IOPARs of untreated subjects and patients undergoing treatment in the Department of Orthodontics and Dentofacial Orthopaedics, CKS Theja Institute of Dental Sciences and Research, Tirupati.

Subject selection criteria included the following:

1) Subjects aged 8 – 25 years,

- 2) Individuals with normal occlusion, malocclusion and those undergoing orthodontic treatment,
- 3) The absence of growth abnormalities, bleeding disorders, syndromes, endocrine disturbances, malignancy or long-term medication.
- 4) Patients with no congenital or acquired malformations affecting cervical vertebrae or hand wrist.

A total of 60 subjects were selected, who met the selection criteria, with a male-female ratio of 1:1 in the sample.

Equipment used: The right hand middle phalanx of the middle finger was radiographed using Satelec dental radiographic machine on KODAK™ standard X-ray film (Figures 1 and 2). Digital Cephalometric radiographs were taken using the NEW TOM™ digital radiographic machine (Figures 3 and 4). Both examinations were done under ideal conditions.



Fig 1: X-ray machine.

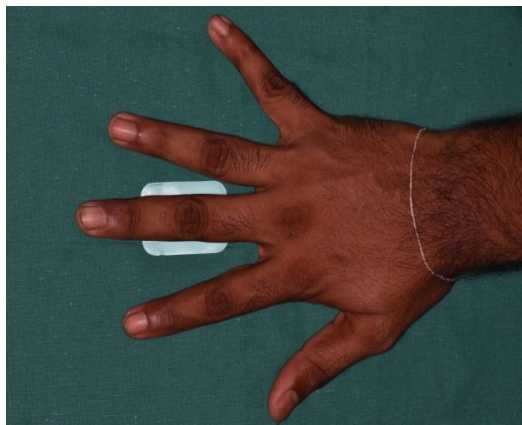


Fig 2: MP3 radiograph.



Fig 3: NEW TOM machine.

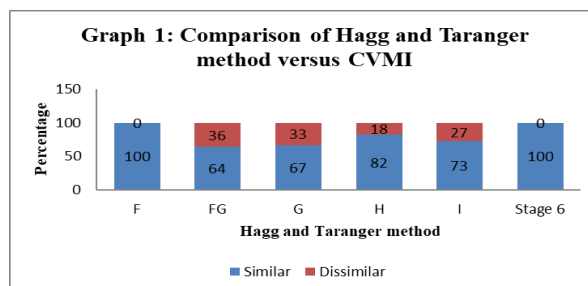


Fig 4: Head positioning for lateral Cephalogram.

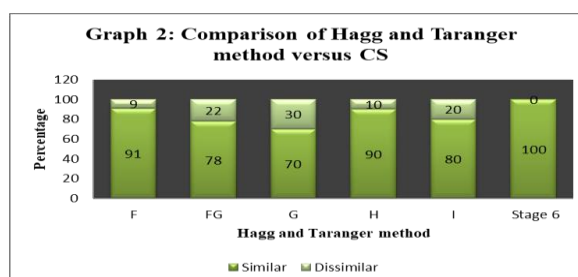
Processing: The MP3 radiographs were processed manually while the lateral cephalometric radiographs were analyzed digitally using the NNT® viewer software. Skeletal maturation was assessed from the MP3 radiograph using the Hagg and Taranger method, and Rajagopal and Kansal method. The lateral cephalogram was assessed for skeletal maturity using Hassel and Farman method (CVMI)⁴, and Baccetti et al method (CS)³. Data analysis was performed using IBM® SPSS Statistics software version 23. Preliminary assessment was done for the normal distribution of data. Post hoc pair wise comparisons were done to evaluate the differences among the considered assessment methods. Pearson correlation was done to assess the correlation values.

RESULTS

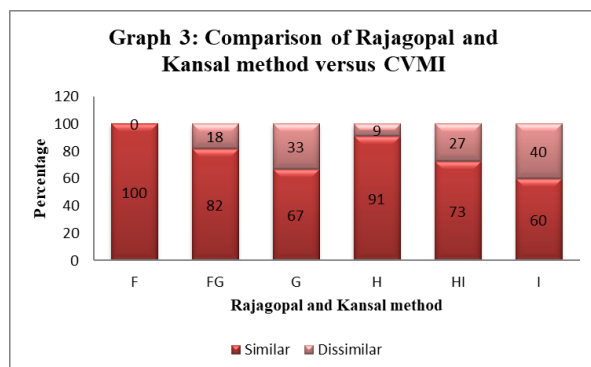
Post hoc pair wise comparisons were used to compare 5 stages of Hagg and Taranger method with 6 stages of CVMI, 5 stages of Hagg and Taranger method and 6 stages of CS; 6 stages of Rajagopal and Kansal method with 6 stages of CVMI, 6 stages of Rajagopal and Kansal method with 6 stages of CS (Graphs 1, 2, 3, 4). The comparison of CVMI and CS with Hagg and Taranger method and Rajagopal and Kansal method in the sample showed a very good Pearson correlation value of 0.96.



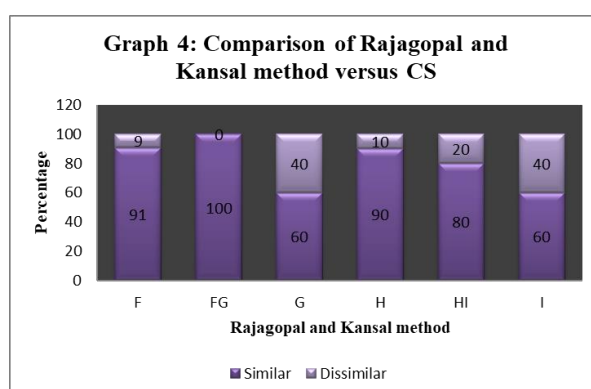
Graph 1: Comparison of Hagg and Taranger method versus CVMI.



Graph 2: Comparison of Hagg and Taranger method versus CS.



Graph 3: Comparison of Rajagopal and Kansal method versus CVMI.



Graph 4: Comparison of Rajagopal and Kansal method versus CS.

DISCUSSION

One of the objectives of orthodontic treatment during adolescence, in patients with skeletal discrepancies is to take advantage of the patient's growth. The timing of recognition of the growth spurt is important in percept of orthodontics. Successful growth modification is related to the amount of remaining growth and accurate prediction of adolescent growth spurts^{7, 8, 9}.

The hand – wrist is an effective method because of numerous centres of ossification which undergo changes at different times and rates. Anatomic changes in the MP3 (middle phalanx of the middle finger) region can be recorded by using dental X-ray film and machine, reducing the X- ray exposure^{10, 11, 12}. The advantages of the cervical vertebrae in the assessment of skeletal maturation include no additional radiation as they can be visualized on a lateral cephalogram taken as a routine orthodontic diagnostic aid. The appraisal of the CVM stage allows for a precise definition of

samples in studies aimed at determining the role of treatment timing in the effectiveness of different treatment methods for the correction of malocclusions. Many authors have supported the efficacy of cervical vertebrae and hand wrist analysis to assess skeletal age^{3, 8, 13}.

In the present study, the reliability of the cervical vertebrae maturation methods and middle phalanx indices was evaluated by comparing the frequently used skeletal maturation methods for assessing lateral cephalograms and middle phalanx of middle finger IOPARs. The findings of our study showed that the agreement strength of CVMI and CS was 0.977; and Hagg and Taranger method and Rajagopal and Kansal method was 0.972. Also, good correlation values (0.96) were obtained among CVM and MP3 methods used, which were significant at 0.01 level. This suggested that there was a good concordance among the CVMI (Hassel and Farman), CS (Baccetti et al) and MP3 (Hagg and Taranger; Rajagopal and Kansal) methods.

A similar study was done by Prasad M et al in 2013¹, comparing Hassel and Farman method (CVM) and Rajagopal and Kansal method (MP3). They concluded that there was a good concordance (correlation value 0.82) between six stages of CVM and the six stages of MP3.

CONCLUSIONS

- ✓ There was a good concordance between CVMI and CS; and between Hagg and Taranger method and Rajagopal and Kansal method.
- ✓ Also, there was a good correlation when Hagg and Taranger method was compared with CVMI and CS; Rajagopal and Kansal method was compared with CVMI and CS.
- ✓ Chronological age was not a valid predictor of assessing skeletal maturity due to significant variations in distribution of CVM & MP3 stages with respect to individual chronological age distribution.
- ✓ Any of the above analyzed methods can be used to assess cervical vertebrae and MP3.
- ✓ There is a need for further study with larger sample size and longitudinal study methodology.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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