Comparing Cervical Vertebra Maturation and Modified Middle Phalange of Finger Maturation(MP3) for Assessment of Pubertal Growth Spurt

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ABSTRACT

Objective: To assess the pubertal growth spurt by keeping Cervical Vertebra Maturation Index as standard and comparing modified middle phalange of 3rd finger maturation (MP3) stages with it.

Study Design: Comparative cross- sectional study.

Place and Duration of Study: Orthodontic Department, Sandeman Provincial Hospital, Quetta Pakistan, from Jan to Jun 2019.

Methodology: One hundred and ten patients, aged 9 to 19 years with an evident appearance of bones on radiograph. First four cervical vertebrae with evident inferior border were included. Patients with previous history of bone disease and major illness, muscular dystrophy cases, congenital malformation of hand, cervical vertebrae, and wrist region cases and low quality X-ray with poor contrast were excluded.

Results: Cervical Vertebra Maturation Index and modified middle phalange of 3rd finger maturation (MP3) were occurring earlier in the females (36 patients (33%) & (36 patients (33%) respectively in the comparison of males (13 patients (11%) & (13 patients (12%) respectively; moreover, there was the significant association between the Cervical Vertebra Maturation Index and modified middle phalange of 3rd finger maturation (MP3) stages as found by the chi-square test (*p*-value= <0.001).

Conclusion: The significant association was found in the Cervical Vertebra Maturation Index stages and the MP3 stages. Females showed earlier signs of physiological maturity with same chronological age.

Keywords: Cervical vertebra maturation, Modified middle phalange maturation, Pubertal growth spurt.

INTRODUCTION

All forms of dentofacial orthopedic treatments for dentoskeletal imbalance, play an important role in the outcome in the growing patients.[1] The abiding growth will be very helpful for outcome prediction while having prior knowledge and would be advantageous with an attempt of minimizing growth.[2] The chronological age not used more frequently as a skeletal maturity indicator. Chronologic age is reported to be an inaccurate indicator of the developmental stages through adolescence to adulthood.[3] Dental age has been found to be in a significant weak correlation with biological age.[4-6]

The treatment of orthodontic in growing individuals depends upon the skeletal growth.[7] while mandibular growth is at peak velocity, this would be the best time for initiating treatment of growth modification.[8] The patient's growth change is advantage and one of the objective of orthodontic treatment while adolescence in case with skeletal

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inconsistences. The outcomes of orthodontic treatment, treatment planning and treatment diagnosis is influenced by maturational status.[9]

The skeletal growth changes while having puberty has shown correlation with middle phalange of 3rd finger and cervical maturation stages.[9] Hagg and Taranger five stages are recommended for medial phalange of third finger and six stages of modified version are proposed by Rajagopal and kansal.[9] The MP3-HI occurring between MP3-H and MP3-I and indicating metaphyseal region change of the third finger. Cervical vertebrae, which are many times ignored by orthodontists who are not familiar to its analysis, have been increasingly used to assess skeletal maturation of the individual because it comprises an easy assessment method and eliminates the need for an additional radiograph (hand and wrist) for such ends.[10] The rationale of this study was to determine the maturational age with the help of periapical of mp3 and making comparison of it with cervical vertebra maturation index (CVMI) on lateral cephalometric measured as standard, involving the patients who do not require lateral cephalometric mandatorily such as in forensic dentistry or patients

seeking orthodontic treatments later in life for its cost effectiveness and less radiation exposure than lateral cephalogram. Several research studies focused on skeletal maturity indicators, but little attention paid to the comparative relations between CVMI and maturation of middle phalange of 3rd finger.

METHODOLOGY

This comparative cross sectional study was conducted at Sandeman Provincial Hospital, Quetta. The study was conducted in the time period of 6 months. The sample size for the study was n=110. Non-Probability consecutive technique was the sampling technique adopted for the study.

Single proportion formula for "Sample size calculation" was used for Sample calculation with the use of proportion of Correlation between CVMI and MP3. Reference prevalence was 89.3% and 95% confidence interval from the previous literature.[14]

Inclusion Criteria: Patients of either gender, aged 9 to 19 years. Patients without facial asymmetry and prior history of facial, hand and wrist trauma/injury or surgery. Patients with an evident appearance of Bones on radiograph. Including inferior border of First four cervical vertebrae.

Exclusion Criteria: patients with previous history of bone disease and major illness, cases of muscular dystrophy, congenital malformation of hand, cervical vertebrae, and wrist region. cases with low quality X-ray.

After the permission granted by ethical committee of hospital, the study was carried out. Patient's written informed consent was obtained.

Visual inspection was used for the evaluation of CVMI using the method of Hassel and Farman. This method had its dependence on the anatomical changes of the three cervical vertebrae (C2, C3, and C4), evaluated in concern of two sets of variables:(1) the presence or absence of a concavity at the inferior border of the C2 (odontoid process), C3, and C4; and (2) the body shape differences of cervical vertebrae along with the progressive ages, considering four shapes: Square, trapezoid, rectangular vertical and rectangular horizontal. Further, these two variables were sub categorized into six consecutive stages in cervical maturation (CVMI-1 to CVMI-6), Hassel and Farman definition determined the six cervical vertebral maturation (CVMI) index.

This study used Rajagopal and Kansal[11] method for evaluation of middle phalange of 3rd finger radiographs. Only six stages of bone maturation were used, six discrete skeletal maturational indicators of adolescent were established on the indicated anatomical sites.

Lateral cephalogram involved natural head position with the help of standard procedures, with erected standing position of patient and eyeing straight into a mirror on the wall and for periapical of middle phalange of 3rd finger consuming high quality periapical X-ray machine. The left hand of patient was used with directing cone to the MP3 perpendicularly and touched the finger slightly.

SPSS 20 was used for data entry and data analysis. Categorical variables were calculated with frequencies and percentages. Different stages of CVM and modified MP3 were compared. The pearson chi square test was conducted in order to find out the relationship between the CVMI and MP3 stages. A p-value <0.05 was considered significant.

RESULTS

Out of total 110 patients 55(50.00%) were male and 55(50.00%) were female. Age was categorized into 3 groups i.e. 9-12 years 49(22.27%), 13-15 years 43(19.55%) and 15-19 years 128(58.18%). The age of the participants was 13.41+1.97 years. Table-I represent the Comparison of Cervical Vertebra Maturation Index (CVMI) and Modified Middle Phalange of 3rd Finger Maturation (MP3) in Males and Table-II showed that the Comparison of Cervical Vertebra Maturation Index (CMVI) and Modified Middle Phalange of 3rd Finger Maturation (MP3) in Females.

Table-III showed that less number of males were repor ted for various SVMI stages; maximum number males from the age group of 13-15 were reported for CVMI 4 stage. Similarly for the same stage maximum number of females (26) were reported as well from the same age group.

According to the frequency distribution of patients in the context of various MP3 stages, maximum number of male patients 21(19%) were reported for MP3 H stage and maximum number of females 27(25%) were reported for MP3 I stage as shown in the Table-IV.

Table-I: Comparison of Cervical Vertebra Maturation Index (CVMI) and Modified Middle Phalange of 3rd Finger Maturation (MP3) in Males (n=110)

	Cervical vertebra maturation index -1 n(%)	Cervical vertebra maturation index -2 n(%)	Cervical vertebra maturation index -3 n(%)	Cervical vertebra maturation index -4 n(%)	Cervical vertebra maturation index -5 n(%)	Cervical vertebra maturation index -6 n(%)	*p*-value
MP3-F	6(5%)	-	-	-	-	-	0.155
MP3-FG	2(2%)	9(8%)	4(4%)	-	-	-	0.070
MP3-G	-	-	11(10%)	5(5%)	4(4%)	-	0.650
MP3-H	-	-	0(0%)	21(19%)	-	-	0.035
MP3-HI	-	-	-	-	19(17%)	6(5%)	0.055
MP3-I	-	-	-	-	4(4%)	19(17%)	0.879

Table-II: Comparison of Cervical Vertebra Maturation Index (CMVI) and Modified Middle Phalange of 3rd Finger Maturation (MP3) in Females (n=110)

	Cervical vertebra maturation index -1 n(%)	Cervical vertebra maturation index -2 n(%)	Cervical vertebra maturation index -3 n(%)	Cervical vertebra maturation index -4 n(%)	Cervical vertebra maturation index -5 n(%)	Cervical vertebra maturation index -6 n(%)	*p*-value
MP3-F	12(11%)	-	-	-	-	-	0.365
MP3-FG	-	7(6%)	0(0%)	-	-	-	0.845
MP3-G	-	3(3%)	16(15%)	-	-	-	0.045
MP3-H	-	-	-	16(15%)	-	-	0.324
MP3-HI	-	-	-	12(11%)	3(3%)	0(0%)	0.987
MP3-I	-	-	-	-	15(14%)	26(24%)	0.085

Table-III: Frequency Distribution of Cervical Vertebra Maturation Index (CVMI) in Males and Females across Different Age Groups (n=110)

Cervical vertebra maturation index (CVMI) in males						
Age Groups	Cervical vertebra maturation index -1 n(%)	Cervical vertebra maturation index -2 n(%)	Cervical vertebra maturation index -3 n(%)	Cervical vertebra maturation index -4 n(%)	Cervical vertebra maturation index -5 n(%)	Cervical vertebra maturation index -6 n(%)
9-12	6(5%)	7(6%)	-	-	-	-
13-15	-	4(4%)	15(14%)	26(24%)	23(21%)	-
15-19	-	-	-	-	4(4%)	25(23%)
Cervical vertebra maturation index (CVMI) in females						
Age Groups	Cervical vertebra maturation index -1 n(%)	Cervical vertebra maturation index -2 n(%)	Cervical vertebra maturation index -3 n(%)	Cervical vertebra maturation index -4 n(%)	Cervical vertebra maturation index -5 n(%)	Cervical vertebra maturation index -6 n(%)
9-12	10(9%)	12(11%)	14(13%)	-	-	-
13-15	-	-	2(2%)	28(25%)	18(16%)	12(11%)
15-19	-	-	-	-	-	14(13%)

Table-IV: Modified Middle Phalange of 3rd Finger Maturation (MP3) in Males and Females across Different Age Groups (n=110)

Modified middle phalange of 3rd finger maturation (MP3) in males						
Age Groups	Modified middle phalange of 3rd finger maturation –F n(%)	Modified middle phalange of 3rd finger maturation –FG n(%)	Modified middle phalange of 3rd finger maturation –G n(%)	Modified middle phalange of 3rd finger maturation –H n(%)	Modified middle phalange of 3rd finger maturation –HI n(%)	Modified middle phalange of 3rd finger maturation –I n(%)
9-12	4(4%)	9(8%)	-	-	-	-
13-15	2(2%)	6(5%)	20(18%)	21(19%)	15(14%)	4(4%)
15-19	-	-	-	-	10(9%)	13(12%)
Modified middle phalange of 3rd finger maturation (MP3) in females						
Age Groups	Modified middle phalange of 3rd finger maturation –F n(%)	Modified middle phalange of 3rd finger maturation –FG n(%)	Modified middle phalange of 3rd finger maturation –G n(%)	Modified middle phalange of 3rd finger maturation –H n(%)	Modified middle phalange of 3rd finger maturation –HI n(%)	Modified middle phalange of 3rd finger maturation –I n(%)
9-12	12(11%)	7(6%)	17(15%)	-	-	-
13-15	-	2(2%)	-	16(15%)	15(14%)	27(25%)
15-19	-	-	-	-	-	14(13%)

DISCUSSION

There are several methods to assess the skeletal maturity that includes chronological age, dental development,[1] body weight, height, menarche, voice and breast changes,[12] cervical vertebra maturation (CVM),[13] epiphyseal changes of middle phalange of 3rd finger and ossification of hand and wrist bone.[10] The standardized method for the assessing of skeletal maturity is CVM and wrist bones ossification at different levels and other had shown unreliable and impractical for evaluating pubertal growth spurt.[14] The patient skeletal maturity assessment is dominant factor for the assigning of treatment time for clinical practice.[15] We used cervical vertebra maturation index (CVMI) and modified middle phalange of 3rd finger maturation (MP3) methods in our study to assess the pubertal growth spurt.

The effectiveness of functional appliances was indicated by using it at peak mandibular growth rate relatively than earlier.[16] Advanced maturity stages indicate frequency of females with faster maturation[13] as compared to males. The study reported similar results of occurrence of CVMI and MP3 earlier in the females comparatively males (refer to Tables-III and IV respectively). From the age group of 9-12 years in males, 6 and 7 patients were reported to be in stage of CVMI-1 and CVMI-2 respectively; whereas in females of the same age group, the number of patients were reported to be in the CMVI-1,2,3 stages was 10, 12, 14 respectively. Which is the indication of earlier maturation in more females in the comparison of males with in same age groups. The greater number of females from each of the age group to be reported for each of the CVMI stage.

The study population reported a very good Kappa correlation value of 0.82 between CVMI and MP3 stages Hassel and Farman - Rajagopal and Kansal analysis.[13] The study also reported significant correlation (0.937) between the stages of CVMI and MP3 with the statistical significance of 0.000(<0.05).

Early treatment indicates normalization of the skeletal pattern, reduction in the length of treatment in the permanent dentition, leading to a reduction of over jet and overbite, improvement in the function and expectation towards more stable results.[17-19] Mitani and Sato[20] demonstrated the profile silhouettes of children who had received early orthodontic treatment for Class-II malocclusion were perceived to be more attractive by peers than those of children who did not receive treatment and also showed the variability in jaw growth, direction, in quantity, speedy, time and sequence. The time proves to be the most significant variable for a treatment planning. Smaller samples size is counted to be the major limitation of this study.

CONCLUSION

The significant strong correlation (0.937) with the statistical significance of 0.001 was found in the CMVI stages and the MP3 stages. Females were reported having earlier physiological maturity than males in comparison to the opposite sex individuals of same chronological age.

Conflict of Interest: None.

Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

SH & NM: Study design, drafting the manuscript, data interpretation, critical review, approval of the final version to be published.

HB & FN: Data acquisition, data analysis, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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