

# **RELIABILITY OF MP3 (middle phalanx of 3<sup>rd</sup> finger) STAGES IN ASSESSMENT OF SKELETAL MATURATION – A CORRELATIVE STUDY**

*Dr. K. S. Negi*

*Astt. Professor*

*Department of Orthodontics & Dentofacial Orthopedics*

*H.P. Govt. Dental College & Hospital Shimla. (H.P.) - 171001*

**docksnortho@gmail.com**

## **ABSTRACT**

This study was contemplated to find the reliability of MP3 (middle phalanx of third finger) stages for assessing skeletal maturity by correlating it with the CVMI stages. The radiographs of 160 healthy North Indian children (80 males and 80 females) between the age group of 8-16 years were collected to assess the MP3 stage using dental (IOPA) X-ray film and the CVMI stage using lateral cephalogram. A highly significant correlation was observed between MP3 stages and CVMI stages. It was observed in the study that the development stages of middle phalanx of third finger (MP3) can be used as a reliable skeletal maturity indicator for assessment of skeletal maturation.

Key words : Skeletal maturity, MP3 stages, CVMI stages.

## INTRODUCTION

Prediction of both the time and amount of active growth, especially in the craniofacial complex, would be useful to orthodontists and pedodontists. The maturational status can have considerable influence on the diagnosis, treatment planning and eventual outcome of orthodontic treatment. Clinical decisions regarding the use of extra-oral traction force, functional appliances, extraction versus non-extraction treatment or orthognathic surgery are based largely on growth considerations.<sup>1</sup>

A number of growth indicators described in the literature are currently available to the orthodontist. Despite the limitations, skeletal age has advantage over chronological and dental age, particularly for those children whose growth is markedly advanced or retarded.<sup>2</sup>

*Fishman*<sup>3</sup> used skeletal maturity indicators (SMI) in hand-wrist radiographs using four stages of bone maturation at six anatomic sites, which has been amongst the most commonly used methods to assess skeletal maturation. *Hassel & Farman*<sup>4</sup> utilized the cervical vertebrae and found them as reliable and valid as the hand-wrist area for assessing skeletal age. *Hagg and Taranger*<sup>5</sup> introduced a method using the hand-wrist radiograph to correlate certain maturity indicators to the pubertal spurt and noted that the stages of ossification of middle phalanx of third finger of a hand (MP3) follow the pubertal growth spurt from the onset to the end. *Leite et.al.*<sup>2</sup> later on stressed the use of first three fingers of the hand as a reliable marker.

The purpose of this study is neither to discuss the validity of the use of skeletal age or chronological age nor to assess one method over other. Its intent is merely to find a reliability of MP3 (middle phalanx of third finger) stages for assessing skeletal maturity after correlating with CVMI stages and its use to assess growth impetus.

## MATERIAL AND METHOD

The present study was conducted on 160 north Indian children (80 males and 80 females) in the age span of 8 to 16 years. The subjects selected for this study was randomly from patients visited to Department of Orthodontics & Pediatric Dentistry. All the subjects selected were moderately built and in growing age with no history of bone deformities, bone diseases and major illness in the past.

**Table 1: Subject Grouping**

S.No.	Group I (Male subjects)			Group II (Female subjects)		
	Subgroup	Age (years)	No. of subjects	Subgroup	Age (years)	No. of subjects
1	A	8-10	20	A	8-10	20
2	B	10-12	20	B	10-12	20
3	C	12-14	20	C	12-14	20
4	D	14-16	20	D	14-16	20
		<b>Total</b>	<b>80</b>		<b>Total</b>	<b>80</b>

## Method

- The radiograph of middle phalanx of third finger (MP3) was taken with a standard size (31 × 41 mm Kodak) periapical dental X-ray film by placing the hand with the palm downward on a flat table in such a way that the middle phalanx was located in the center of the film. The cone of the standard dental X-ray machine (60 kV and 7mA) was positioned in light contact with the middle phalanx perpendicular to the dental X-ray film, with exposure time of 0.25 seconds.






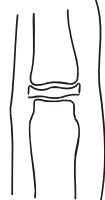


**FIGURE 1.** Method of Recording MP3 Radiograph using dental Intraoral Periapical X-ray Film.

- Standardized lateral cephalometric radiographs of each individual was taken with a Universal counter balancing type of cephalostat.

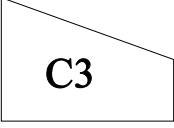
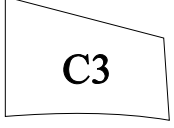
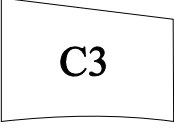
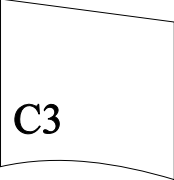
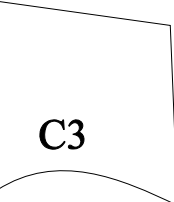
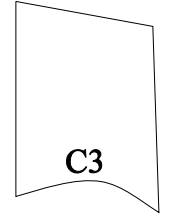
All radiographs were processed with standardized processing technique and numbered for identification. Radiographs of high clarity and good contrast were used, and interpretation of all radiographs was undertaken without referring to clinical data or age of patient.

- For radiographic interpretation of MP3 stages, (E3/4) stage was added in *Hagg and Taranger's (1982)*<sup>6</sup> method of MP3 stages, and numbers were given for each stage for convenience.
- To interpret CVMI, *Hassel & Farman (1995)*<sup>4</sup> method was used in this study.

**Fig. 2: Stages of MP3, Hagg and Taranger (1982)<sup>6</sup>**

	<p><b>Stage I (E3/4)</b></p> <p>The epiphysis reaches 3/4 of the width of the diaphysis (Leite et al.).</p>
	<p><b>Stage-2 (MP3-F)</b></p> <p>The epiphysis is as wide as the metaphysis.</p>
	<p><b>Stage-3 (MP3-FG)</b></p> <p>The epiphysis is as wide as the metaphysis and there is a distinct medial and/or lateral border of the epiphysis forming a line of demarcation at right angle to the distal border.</p>
	<p><b>Stage-4 (MP3-G)</b></p> <p>The sides of epiphysis have thickened and also cap its metaphysis forming a sharp edge distally at one or both sides.</p>
	<p><b>Stage-5 (MP3-H)</b></p> <p>Fusion of epiphysis and metaphysis has begun.</p>
	<p><b>Stage-6 (MP3-I)</b></p> <p>Fusion of epiphysis and metaphysis is completed.</p>

**Fig. 3: CVMI Stages** *Hassel & Farman (1995)*<sup>4</sup>

 <p style="text-align: center;"><b>C3</b> CVMI - 1</p>	<p><b>1. Initiation</b></p> <ul style="list-style-type: none"> <li>■ Very significant amount of adolescent growth expected.</li> <li>■ C2, C3 and C4 inferior vertebral body borders are flat.</li> <li>■ Superior vertebral borders are tapered posterior to anterior.</li> </ul>
 <p style="text-align: center;"><b>C3</b> CVMI - 2</p>	<p><b>2. Acceleration</b></p> <ul style="list-style-type: none"> <li>■ Significant amount of adolescent growth expected.</li> <li>■ Concavities developing in lower borders of C2 and C3.</li> <li>■ Lower border of C4 vertebral body is flat.</li> <li>■ C3 and C4 are more rectangular in shape.</li> </ul>
 <p style="text-align: center;"><b>C3</b> CVMI - 3</p>	<p><b>3. Transition</b></p> <ul style="list-style-type: none"> <li>■ Moderate amount of adolescent growth expected.</li> <li>■ Distinct concavities in lower borders of C2 and C3.</li> <li>■ C4 developing concavity in lower border of body.</li> <li>■ C3 and C4 are rectangular in shape.</li> </ul>
 <p style="text-align: center;"><b>C3</b> CVMI - 4</p>	<p><b>4. Deceleration</b></p> <ul style="list-style-type: none"> <li>■ Small amount of adolescent growth expected.</li> <li>■ Distinct concavities in lower borders of C2, C3 and C4.</li> <li>■ C3 and C4 are nearly square in shape.</li> </ul>
 <p style="text-align: center;"><b>C3</b> CVMI - 5</p>	<p><b>5. Maturation</b></p> <ul style="list-style-type: none"> <li>■ Insignificant amount of adolescent growth expected.</li> <li>■ Accentuated concavities of inferior vertebral body borders of C2, C3 and C4.</li> <li>■ C3 and C4 are square in shape.</li> </ul>
 <p style="text-align: center;"><b>C3</b> CVMI - 6</p>	<p><b>6. Completion</b></p> <ul style="list-style-type: none"> <li>■ Adolescent growth is completed.</li> <li>■ Deep concavities are present for inferior vertebral body borders of C2, C3 and C4.</li> <li>■ C3 and C4 heights are greater than widths.</li> </ul>

**OBSERVATION:****Table 2: Showing Mean Age, Standard Deviation and Standard Error for male and female subjects in different age groups.**

Subgroup	Group I (Male)			Group II (Female)			t	p
	Mean	Sd	Se	Mean	Sd	Se		
A (8-10 yrs)	8.92	0.72	0.16	8.97	0.75	0.17	0.03	NS
B (10-12 yrs)	10.90	0.59	0.13	10.57	0.60	0.14	1.97	NS
C (12-14 yrs)	12.96	0.63	0.14	12.89	0.62	0.14	0.34	NS
D (14-16 yrs)	14.75	0.55	0.12	14.61	0.46	0.10	0.87	NS

p>0.05 NS; p<0.05\*; p<0.01\*\*

**Table 3: Showing Mean, Standard Deviation, Standard Error of CVMI stages for all subgroups (A-D) in both male and female subjects.**

Subgroup	Group I (Male)			Group II (Female)			t	p
	Mean	Sd	Se	Mean	Sd	Se		
A (8-10 yrs)	1.30	0.47	0.11	1.90	0.55	0.12	3.70	**
B (10-12 yrs)	2.10	0.31	0.07	3.30	0.73	0.16	6.75	**
C (12-14 yrs)	3.40	0.75	0.17	4.60	0.99	0.22	4.30	**
D (14-16 yrs)	4.80	0.70	0.16	5.80	0.62	0.14	4.81	**

p>0.05 NS; p<0.05\*; p<0.01\*\*.

**Table 4: Showing Mean, Standard Deviation, Standard Error of MP3 stages for all subgroups (A-D) in both male and female subjects.**

Subgroup	Group I (Male)			Group II (Female)			t	p
	Mean	Sd	Se	Mean	Sd	Se		
A (8-10 yrs)	1.35	0.49	0.11	1.85	0.59	0.13	2.93	*
B (10-12 yrs)	2.15	0.37	0.08	3.30	0.73	0.16	6.28	**
C (12-14 yrs)	3.35	0.67	0.15	4.60	0.94	0.21	4.84	**
D (14-16 yrs)	4.80	0.77	0.17	5.80	0.62	0.14	4.54	**

p>0.05 NS; p<0.05\*; p<0.01\*\*

**Table 5: Showing correlation coefficient (r) for males and females between MP3 & CVMI**

Subgroups	Male	Female
	MP3 and CVMI stages	MP3 and CVMI stages
A (8-10 years)	0.663 **	0.925 **
B (10-12 years)	0.793 **	0.948 **
C (12-14 years)	0.957 **	0.945 **
D (14-16 years)	0.935 **	0.997 **

r >0.450 \*; r >0.562\*\*

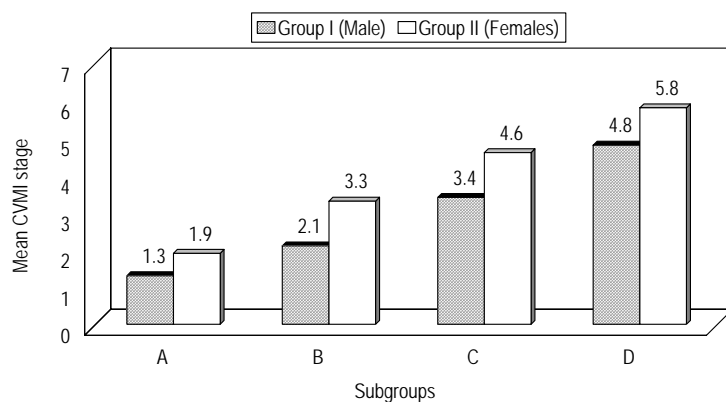


Fig. 4: Mean CVMI Stage for all subgroups in male and female subjects

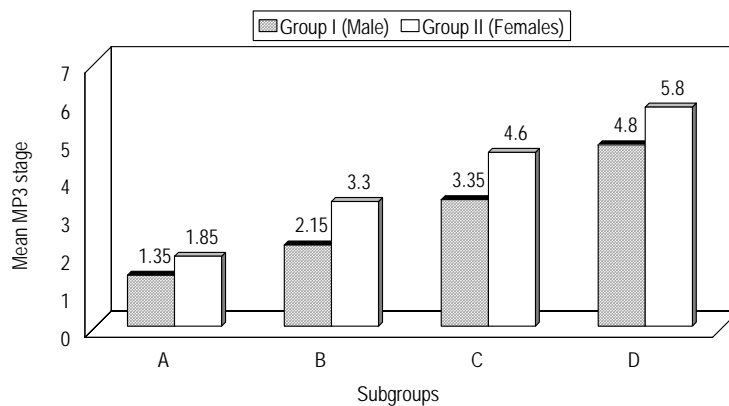


Fig. 5: Mean MP3 Stage for all subgroups in male and female subjects

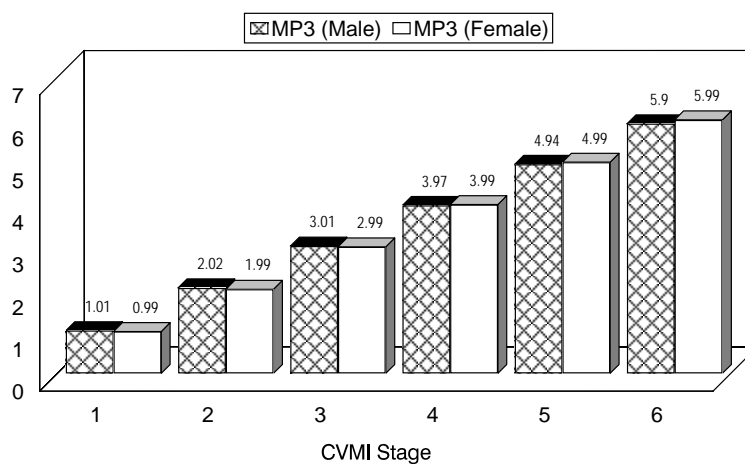


Fig. 6: CVMI Maturity stage Vs. MP3 stages for male and female subjects

## DISCUSSION

In orthodontics and dentofacial orthopedics, it is important to identify the individual maturational levels of a child to evaluate expected developmental events. During the circumpubertal period, children exhibit marked changes in the body dimension and ossification processes. Every bone undergoes a series of changes during growth that can be seen radiographically. The sequence of changes is relatively consistent for a given bone and its timing varies for every individual. It is not necessary for an orthodontist to know the exact skeletal age of patient, but what is important to know is the remaining growth potential during the period of treatment and the percentage of growth expected at the time of treatment.

It has long been recognized that chronological age does not necessarily correlate well with maturational age. One may be skeletally accelerated or delayed in terms of maturational development<sup>1,2,3,6,7,8,9,10</sup>

MP3 (middle phalanx of third finger) stages have been used as a part of the hand and wrist radiographs to assess skeletal maturation or as an indicator of pubertal growth spurt.<sup>2,3,5,11,12,13</sup>

The purpose of this study was to investigate whether the MP3 (middle phalanx of third finger) stages could be used to assess growth impetus and to provide the orthodontist with a reliable tool to determine growth potential in adolescent patients.

The age group (8-16 years) selected in this study was on the basis of other maturation studies<sup>1,14,15</sup>, and as orthodontic treatment is frequently performed at this age group, skeletal assessment becomes most critical.

On comparing the mean age of the male and female subjects in different subgroups (A-D) as shown in Table 2, it is observed that they are insignificantly ( $p > .05$ ) different from each other. Insignificant differences in mean variation indicate that the sample used in this study is homogenous.

The results of the study reveal that the maturation of the middle phalanx of third finger and cervical vertebrae progress with advancing age. It can be seen from the Table 3 and 4 that there are gradually increasing stages of CVMI and MP3 stages with age. It

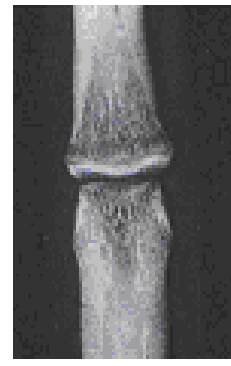
was found that at the same chronological age, there was highly significant difference ( $p < 0.01$ ) in each of the four subgroups (Table 3 & 4). In all the subgroups, the CVMI & MP3 stages were more advanced in females than in males. The sexual dimorphism of the maturational parameters are in agreement with previous observation in growth studies.  
3,6,8,16

The correlation coefficient was studied between MP3 and CVMI stages, (Table 5). A highly significant correlation ( $p < 0.01$ ) was observed between MP3 and CVMI in all subgroups of male and female subjects. Statistically high correlation between the two variables for both sex, indicates that the MP3 & CVMI stages can be used alternatively for assessment of skeletal maturity. The finding of the present study is in agreement with earlier studies<sup>2,4,17,18</sup>

The findings in this study reveal that there is highly significant correlation between the MP3 stages and the CVMI stages. To confirm the reliability of use of MP3 stages to assess a growth impetus, a longitudinal study could be useful.

## CONCLUSION

- Middle phalanx of third finger can be used as a reliable skeletal maturity indicator.
- Maturation stages of MP3 and Cervical vertebrae (CVMI) are closely associated.
- At same chronological age, sexual dimorphism exists in skeletal maturation.

**CORRELATED STAGES OF MP3 (*middle phalanx of third finger*) AND CVMI****CVMI-1****MP3 stage-1  
(E3/4)****CVMI-4****MP3 stage-4  
(MP3-G)****CVMI-2****MP3 stage-2  
(MP3-F)****CVMI-5****MP3 stage-5  
(MP3-H)****CVMI-3****MP3 stage-3  
(MP3-FG)****CVMI-6****MP3 stage-6  
(MP3-I)**

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