Heal Talk

Correlation of Skeletal Maturity Indicators -(CVMI, MP3 & Frontal Sinus)

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Abstract

Objective: To compare frontal sinus indices (FSI) as a skeletal maturation indicators with various stages of cervical vertebrae indices (CVMI) and MP3

Material and Method : In this retrospective cross sectional study 60 subjects in age group of 12-16 years were randomly selected from patients visiting the OPD of Department of Orthodontics and DentofacialOrthopaedics and were equally divided into two groups according to gender. Lateral cephalograms of all the subjects were taken for Orthodontic diagnosis and Cervical vertebral maturation was assessed by the indices given by Hassel and farman. Frontal sinus indices and surface area were calculated as given by Ruf and Pancherz et.al. periapical radiograph of middle finger was taken to assess stages of calcification of MP3 according to Rajgopal and Kansal. SPSS version 21.0 was used to find out correlation between frontal sinus index MP3 and CVMI.

Results: Mean value of FSI in females and males was found 3.00

Conclusions: In comparison to CVMI and MP3 stages, Frontal sinus (FS) is less reliable method for assessment of skeletal maturity.

Keywords-Frontal sinus, cervical, cephalogram, pubertal

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Introduction

Growth is a critical variable in Orthodontic diagnosis and treatment planning, therefore prior knowledge of the amount, rate, timing and direction of growth would be extremely useful in forecasting treatment outcome[1]. Body height, body weight, menarche period, chronologic age and skeletal maturity as assessed by ossification of bones on radiograph are considered as classical parameter of body growth[2] but these parameters are inadequate in assessing skeletal maturation. Amongst the various methods to assess growth by visualization of ossification events, hand wrist radiographs are the oldest and reliable methods. The main drawback associated with them is the need of additional radiograph, thereby increasing radiation exposure to the patient.

In past few decades, lateral cephalograms taken routinely for orthodontic diagnosis had been used to assess skeletal maturation by assessing morphologic changes in bodies of cervical vertebrae or by assessing changes in height and width of frontal sinus. To overcome the limitation of excessive exposure in the radiograph Rajgopal and Kansal[3] suggested use of periapical film to take Radiographs of middle phalanx of the middle finger (MP3) and assess skeletal maturation and Various studies have shown good correlation and applicability of using cervical vertebral maturation indices or MP3 stages of Rajgopal and Kansal in assessing the skeletal maturation but literature on the frontal sinus indices is limited. Frontal sinus index (FSI), Frontal sinus width (FSW) and Frontal sinus surface area (FSSA) has been assessed by different studies and correlated to puberty peak but results has been controversial hence it was decided to conduct these study with the aim was to find relationship between the cervical vertebre maturation indices (CVMI), MP3 stages and frontal sinus indices (FSI)

Materials and Method

A retrospective cross- sectional study was done in Department of Orthodontics, BBDCODS University Lucknow. Using power 80% and alpha error of 12% sample size of 60 was calculated. Good quality standard lateral cephalograms of 30 females (group 1) and 30 males (group 2) in the age range 12-16 years were included in the study. Periapical radiographs of MP3 was taken of all the subjects.

Assessment of CVMI stages on lateral cephalograms was done .The six different stages of CVMI were evaluated from the radiographs as described by Hassel and farman[4]. .Specific entities looked at the presence or absence of curvature in the inferior borders of the dens, C3, and C4 were inspected to classifying different stages.

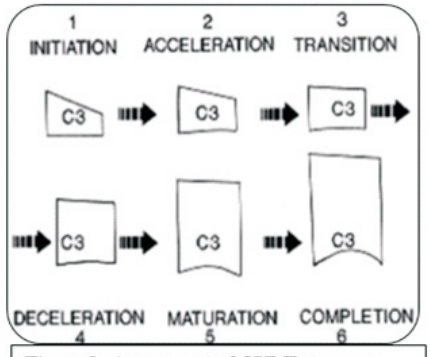

Figure 1: Assessment of CVMI stages on Lateral cephalogram

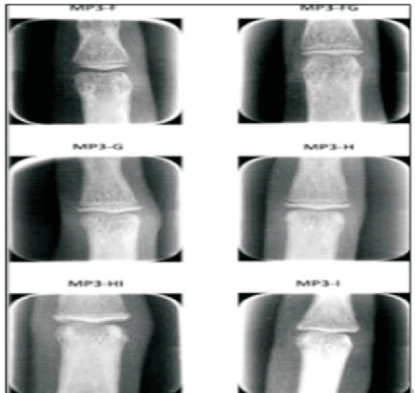

Figure 2: Assessment of MP3 stages on middle phalanx of the middle finger

Assessment of skeletal maturation using MP3 radiograph as an indicator-The five distinct stages of MP3 as described by Hagg and Taranger[5] were further modified by Rajagopal and Kansal who gave a sixth stage, MP3-HI. Their assessment was divided in to six different stages (F, FG, G, H, HI, and I) corresponding to the change in shape and fusion of epiphysis to the metaphysis as seen on the MP3 radiographs recorded using a periapical IOPA film

Assessment of Frontal sinus as seen on Lateral cephalogram- Assessment of frontal sinus was done as seen on lateral cephalogram as described by Ruf and pancherz[6]. The cephalogram was oriented with the nasionsella line horizontally. The peripheral border of the frontal sinus as seen on a lateral cephalogram was traced. The highest (SH) and lowest (SL) points of sinus extension were marked. The maximum height was obtained by connecting these points and maximum width of the sinus was assessed perpendicular to this interconnecting line, and the ratio of maximum height to width of the frontal sinus (sinus index) was calculated and surface area was calculated on graph paper by placing it below the tracing of frontal sinus

The score obtained were tabulated with the respective CVMI stages and MP3 stages for each patient and subjected to statistical analysis

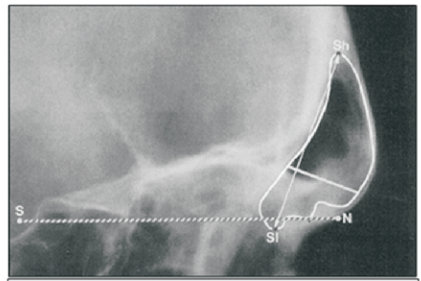

Figure 3: Assessment of the frontal sinus as seen on lateral cephalogram. (S - Sella, N - Nasion, SH - Highest point on the frontal sinus, SL - Lowest point on the Frontal sinus.

Statistical Analysis:

The data were entered in MS excel

spreadsheet and analysis was done using Statistical Package for Social Sciences (SPSS) version 21.0. As most of our variable were quantitative, Unpaired t-test was used for comparison. A p value of <0.05 was considered statistically significant and ANOVA test was used for comparison of mean.

Result:

The results was tabulated as follows-Table 1 shows mean values of Frontal sinus index (FSI), Frontal sinus width (FSW) and Frontal sinus surface area (FSSA) in male and the female subjects.

Table 2 shows Comparison of the mean measurement obtained from Frontal sinus index (FSI), Frontal sinus width (FSW) and Frontal sinus surface area (FSSA) analysis at respective CVMI stages.

Table 3 shows Comparison of the mean measurement obtained from Frontal sinus index (FSI), Frontal sinus width (FSW) and Frontal sinus surface area (FSSA) analysis at respective MP3 stages

Discussion:

An understanding of growth events is of primary importance in the practice of clinical orthodontics. Maturational status can have considerable influence on diagnosis, treatment goals, treatment planning, and the eventual outcome of Orthodontic treatment. Clinical decisions regarding the use of extra oral traction forces, functional appliances, extraction versus non extraction treatment or Orthognathic surgeries are, at least partially based on growth considerations[7]. Prediction of both the times and the amount of active growth, especially in the craniofacial complex, would be useful to the Orthodontist for Growth modulation procedures that are initiated during active growth periods. Various methods had been proposed to assess skeletal maturation, of which Hand- Wrist radiographs had been the gold standard but radiation exposure was quite high for this additional radiographs. Frontal sinus and cervical vertebre are seen on lateral cephalogram that is routinely taken as a diagnostic aid before starting fixed Orthodontic treatment. If skeletal maturation is assessed using them, patient is saved from unnecessary radiation exposure. While making decision to start or wait for Orthodontic treatment, based on amount of growth remaining, radiograph of middle phalanx of the middle finger (MP3) is an easier, simpler, economical method with reduced radiation exposure. It is a reliable method, to assess the skeletal maturity and to know the leftover growth potential during the period of treatment and the % of growth expected at the time of treatment.

Many studies have been conducted using CVMI and MP3 stages to assess skeletal maturation but literature on use of Frontal sinus as a skeletal maturity indicators is limited. Hence, it was decided to compare Frontal sinus as a skeletal maturity indicators with CVMI and MP3 stages. The frontal sinus, which are located between the external and internal cortical layers of the frontal bone, are anatomically called pneumatic cavities[8]. Frontal sinuses which are not visible radiographically at birth, begin to appear from 3 years and 3 months in males and 4 years and 6 months in females[9]. The size of frontal sinuses increases with age and consequently continues to grow until the age of 20 years[10, 11].

The results of the present study indicated that FSW and FSSA were significantly higher in males than females whereas FSI did not show any significant sexual dimorphism. The FSW and FSSA gradually increased through CVMI stage V. FSI gradually increases till CVMI stage IV. Inconsistent relationship between MP3 and FSIwas seen which was maximum in H stages of MP3, FSW and FSSA was maximum in HI stages of MP3.

Similar to our study Frontal sinus area (FSA) and FS height were larger in males in studies by Camargo et al [12],Buyuk et al[13] and Mahmood et al[14].

Buyuk et al and Gagliardi et al [15] found significant correlation between Frontal sinus development and height with hand wrist radiographs.Mahmood et al found statistically significant relationship between width and height of frontal sinus and development stages of cervical vertebrae in males but the difference in FS development between adjacent cervical stages was non-significant. Similarly in our study the insignificant relation between frontal sinus measurement and adjacent CVMI and MP3 stages was non- significant.

Ruf and Pancherzconducted study on males with a relatively small sample size and found that the average age at frontal sinus index peak was 15.1 years and in a l-year observation interval, a peak growth velocity in the frontal sinus index was of at least 1.3 mm/yr. In a 2-year observation interval, a peak growth velocity in the frontal sinus index was of at least 1.2 mm/yr.Rossouw et al [16]studied skeletal growth pattern on a mixed sample consisting of 53 adult skeletal with Class I malocclusion and 50 adult skeletal with Class III malocclusion, the surface area of Frontal sinus was examined to assess the abnormal mandibular growth and concluded that the Frontal sinus can be used as an additional indicator for predicting mandibular growth. Valverde et al [17] conducted a study on growing Japenese girl and they advocated the use of variations in the frontal sinus morphology as a reliable maturity indicator to assess a child's developmental status.

Like our study Patil et al conducted a study to know the reliability of frontal sinus as skeletal maturity indicators by comparing with CVMI and MP3 in 75 males and females subjects and concluded that frontal sinus is not reliable as a sole criterion for prediction of skeletal maturity. Another study by Sarabjeet et al [18] also found that inconsistent correlation of Frontal sinus width (FSW) with CVMI was seen. Changes in frontal sinus width and height showed significant correlation with chronological age in many studies but not with CVMI stages or MP3 stages as found in other studies as well as our study. The reason could be that changes in dimension of FS were not clear out to be classified in to different stages as possible with changes in shape of cervical vertebrae or changes in ossification pattern of MP3. Assessment of FSW, FSI and FSSA can provide additional information along with CVMI but cannot predict skeletal maturation reliably on its own.

Conclusion

- FSW, FSSA were significantly higher in males than females.
- None of the parameters of frontal sinus analysis could be significantly correlated with the individual stages of CVMI and MP3
- For routine pre-treatment orthodontic diagnostic procedure the CVMI and MP3 is more reliable methods for assessing the growth pattern of an individuals.

Reference:

1. PatilAA, Revankar AV. Reliability of the frontal sinus index as a maturity indicator. Indian Journal of Dental Research, 2013; 24(4)
2. Malgorzata M, Tiziano B. Duration of pubertal peak in skeletal Class I and Class III subjects. Angle Orthod 2010; 80: 54-57.
3. Rajagopal R, Kansal S. A comparison of modified MP3 stages and the cervical vertebrae as growth indicators. J ClinOrthod 2002;36:398-406.
4. Hassel B, Farman AG. Skeletal maturation evaluation using cervical vertebrae. Am J OrthodDentofacialOrthop 1995;107:58-66.
5. Hägg U, Taranger J. Maturation indicators and the pubertal growth spurt. Am J Orthod 1982;82:299-309.
6. Ruf S, Pancherz H. Can frontal sinus development be used for the prediction of skeletal maturity at puberty? ActaOdontolScand 1996;54:229-34.
7. Swapnil J. Korde, Daigavane P, Shrivastav S. Skeletal Maturity Indicators - Review Article International Journal of Science and Research (IJSR) 2017.6(3) 361-70
8. Grave KC, Brown T. Skeletal ossification and the adolescent growth spurt. Am J Orthod 1976; 69: 611-619.
9. Brown WA, Molleson TI, Chinn S. Enlargement of the frontal sinus. Ann Hum Biol 1984; 11: 222-226.
10. Kjaer I, Pallisgaard C, Brock-Jacobsen MT. Frontal sinus dimensions can differ significantly between individuals within a monozygotic twin pair, indicating environmental influence on sinus sizes. ActaOto-Laryngol. 2012; 132: 988-994.
11. Yun IS, Kim YO, Lee SK, et al. Three-dimensional computed tomographic analysis of frontal sinus in Asians. J Craniofac Surg. 2011; 22: 462-467.
12. Camargo JR, Daruge E, Prado FB, et al. The frontal sinus morphology in radiographs of Brazilian subjects: its forensic importance. Braz J Morphol Sci. 2007; 24: 239-243
13. Buyuk SK , Simsek H ,Karaman A. The relationship between frontal sinus morphology and skeletal maturation. Folia Morphologica (Ahead to Print)
14. Mahmood HT, Shaikh A, Fida M. Association between frontal sinus morphology and cervical vertebral maturation for the assessment of skeletal maturity. Am J OrthodDentofac. 2016; 150: 637-642
15. Gagliardi A, Winning T, Kaidonis J, et al. Association of frontal sinus development with somatic and skeletal maturation in Aboriginal Australians: a longitudinal study. Homo. 2004; 55: 39-52
16. Rossouw PE, Lombard CJ, Harris AM. The frontal sinus and mandibular growth prediction. Am J OrthodDentofacialOrthop 1991;100:542-6
17. Valverde Y, Watanabe N, Yamaki M, Saito I. The frontal sinus enlargement as an indicator of growth maturity in Class III patients – A pilot study. Int J Med Sci Public Health 2013; 2:451455.
18. Saberjeet et al, A Study of Correlation of Various Growth Indicators with Chronological Age Int J ClinPediatr Dent. 2015 Sep-Dec; 8(3): 190–195

Group Statistics						
	Parameter	MEAN	N	Mean	Std. Deviation	P Value
1	Frontal Sinus Index (mm)	Group I (Females)	30	3.0073	0.61363	0.434
		Group II (Males)	30	2.8713	0.71871	
2	Frontal Sinus width (mm)	Group I (Females)	30	9.2867	1.82412	0.024*
		Group II (Males)	30	10.6100	2.53681	
3	F.S. Surface area	Group I (Females)	30	18.467	47.40168	0.037*
		Group II (Males)	30	21.707	68.22626	

Table 1: Mean, Std. deviation of Frontal sinus index (FSI), Frontal sinus width (FSW) and Frontal sinus surface area (FSSA) in male and female subjects

	MALES CVMI STAGES	N	Mean	Std. Deviation	P Value	FEMALES CVMI STAGES	N	Mean	Std. Deviation	P Value
Frontal Sinus width (mm)	Stage I	1	2.5700	-		-	-	-	-	
	Stage II	9	2.9956	0.86578	0.643	Stage II	6	2.9467	.61187	
	Stage III	7	3.0729	0.75663		Stage III	7	2.9886	.63719	
	Stage IV	1	3.1800	-		Stage IV	6	3.4483	.79876	0.643
	Stage V	10	2.7690	0.63804		Stage V	8	2.8012	.45511	
	StageVI	2	2.1150	0.16263		Stage VI	3	2.8400	.42226	
	Total	30	2.8713	0.71871		Total	30	3.0073	.61363	
Frontal Sinus Index (mm)	Stage I	1	11.0000	-		-	-	-	-	
	Stage II	9	9.3333	2.25000	0.638	Stage II	6	9.1000	1.86548	
	Stage III	7	10.7143	3.30224		Stage III	7	8.6429	1.37581	
	Stage IV	1	11.0000	-		Stage IV	6	9.0000	1.26491	0.409
	Stage V	10	11.4300	2.42306		Stage V	8	10.3750	2.50357	
	Stage VI	2	11.5000	2.12132		Stage VI	3	8.8333	1.04083	
	Total	30	10.6100	2.53681		Total	30	9.2867	1.82412	
F.S. Surface area	Stage I	1	125.00	-		-	-	-	-	
	Stage II	9	184.89	42.88486	0.345	Stage II	6	169.57	35.54528	
	Stage III	7	227.29	93.79892		Stage III	7	163.57	30.97234	
	Stage IV	1	234.00	-		Stage IV	6	197.33	41.26823	0.503
	Stage V	10	237.90	66.43368		Stage V	8	198.00	61.98848	
	Stage VI	2	259.50	31.81981		Stage VI	3	203.00	70.05712	
	Total	30	217.07	68.22626		Total	30	217.07	47.40168	

Table: 2 Comparison of the mean measurement obtained from Frontal sinus index (FSI), Frontal sinus width (FSW) and Frontal sinus surface area (FSSA) analysis at respective CVMI Stages

	MALES MP3 STAGES	N	Mean	Std. Deviation	P Value	FEMALES MP3 STAGES	N	Mean	Std. Deviation	P Value
Frontal Sinus width (mm)	F	-	-	-		F	12	2.9867	.87447	
	FG	7	2.9057	.56897	0.243	FG	-	-	-	
	G	5	3.0380	.75982		G	5	3.0400	.55498	0.538
	H	3	3.7467	1.13161		H	-	-	-	
	HI	9	2.9844	.29669		HI	9	2.5700	.40373	
	I	6	2.7650	.51555		I	4	2.9925	.97544	
	Total	30	3.0073	.61363		Total	30	2.8713	.71871	
Frontal Sinus Index (mm)	F	-	-	-		F	12	10.2500	3.14426	
	FG	7	9.3000	1.78326	0.808	FG	-	-	-	
	G	5	8.6000	1.14018		G	5	9.4000	.89443	0.438
	H	3	8.6667	1.52753		H	-	-	-	
	HI	9	9.7778	2.48886		HI	9	11.2222	2.10819	
	I	6	9.4167	1.56258		I	4	11.8250	2.64370	
	Total	30	9.2867	1.82412		Total	30	10.6100	2.53681	
F.S. Surface area	F	-	-	-		F	12	203.92	83.73275	
	FG	7	173.57	34.05318	0.680	FG	-	-	-	
	G	5	167.00	22.48333		G	5	186.60	23.39444	0.381
	H	3	211.67	50.93460		H	-	-	-	
	HI	9	185.89	65.60572		HI	9	236.22	65.93136	
	I	6	197.00	46.95530		I	4	251.50	45.24378	
	Total	30	184.67	47.40168		Total	30	217.07	68.22626	

Table 3: Comparison of the mean measurement obtained from Frontal sinus index (FSI), Frontal sinus width (FSW) and Frontal sinus surface area (FSSA) analysis at respective MP3 stages