Assessment of the Skeletal Maturation in Late Childhood Obesity using Hand-Wrist Radiographs in individuals of Central India

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ABSTRACT

Introduction: Maturation status of an individual may be related to the body adiposity status. Obese individuals in late childhood period may show accelerated skeletal maturation. Thus it is necessary to assess skeletal maturity in growing obese patients to determine the best timing for orthodontic treatment as these individuals may require earlier treatment. **Materials and Method:** BMI was assessed for 150 individuals using IOTF chart and categorized into three groups – 50 each in normal, overweight and obese groups. Skeletal age was assessed by Fishman's method using hand wrist radiographs' and the skeletal age difference was calculated and was correlated in between normal, overweight and obese groups. **Results:** Paired t-test showed that the difference between the skeletal age and the chronological age was statistically significant for all the three Groups. Unpaired t-test was used to compare the skeletal age differences between two Groups which was non-significant. Also paired t-test was used to find the correlation of skeletal age difference in between male and female which was non-significant. **Conclusion:** Thus, skeletal age was ahead of chronological age which may be attributed to the pubertal growth period. The obese individuals showed accelerated skeletal maturation as compared to overweight and normal individuals, but the difference was statistically not significant.

KEYWORDS: Obesity, Hand-Wrist Radiographs,

INTRODUCTION

Knowledge of skeletal development is essential in orthodontics because we need a complete understanding of the maturity status of an individual to undertake growth modulation therapy. We can harness the remaining growth potential of an individual to correct the skeletal discrepancies. Moreover, dentofacial and orthopaedic treatment performed after the growth phase is not effective in improving skeletal discrepancies. The age group of 10 to 14 years is the late childhood period, and it is of prime importance to the orthodontist as this is the age in which pubertal growth takes place. The diagnosis of the skeletal problem and its appropriate treatment planning must be planned at this stage in a growing child.[1-3]

Maturation status of an individual may be related to the body adiposity status. Childhood obesity is a condition where excess body fat negatively affects a child's health. Obesity in Prepubertal children is above average in size and advanced bone ages. Despite accelerated growth, growth hormone concentrations are low in obese children because of reduced growth hormone pulsatile release and increased growth hormone clearance.[4] Levels of IgF-1, the main circulating growth factor also is not increased. Thus it is necessary to assess skeletal maturity in growing obese patients to determine the best timing for orthodontic treatment as these individuals may require earlier treatment.

Given the importance of growth in orthodontic treatment, objective assessment of maturation is important. The chronological age based on the date of birth offers little insight in determining the developmental stage or somatic maturity of person.[2,3] Skeletal age is a more reliable and precise method for assessing physical maturity than chronological age.[5,6] Orthodontists most frequently use radiographs of the hand, because the hand-wrist radiograph more accurately assesses biological maturation variations about chronological age. Its use for over a century to determine the maturational status of an individual and its high correlation and lesser variability to chronological age compared to ossification of bones at other sites like foot, ankle, hip, and elbow makes it a gold standard for orthodontic diagnosis purpose.[7]

How to cite this article:
Deb S, Aley M, Chachada A, Mankar M, Bedre V, Rathod C, Atulkar M. Assessment of the Skeletal Maturation in Late Childhood Obesity using Hand-Wrist Radiographs in individuals of Central India. Int J Oral Health Med Res 2017;3(5):24-27.

MATERIALS AND METHODS

This study was conducted to evaluate and assess the skeletal maturation using hand–wrist radiographs in late childhood obesity. It was undertaken in the Department of Orthodontics and Dentofacial Orthopedics in association with Department of Oral Medicine and Radiology of Swargiya Dadasaheb Kalmegh Smruti Dental College and Hospital, Nagpur.

The sample for this study comprised of 150 individuals belonging to age group 10 years to 14 years who were screened from schools by assessing BMI as per the International Classification System for Childhood Obesity given by the International Obesity Task Force (IOTF).[8] Accordingly 50 each was selected in normal, overweight and obese groups. The hand wrist radiographs were taken for each after taking parent concent for assessing skeletal age by Fishman's method[9] and the skeletal age difference was calculated and were correlated in between normal, overweight and obese groups.

RESULTS

Group 1 (Normal) had 16 males and 34 females. Group 2 (Overweight) had 27 males, and 23 females and Group 3 (Obese) had 26 males and 24 females.

Table 1 Mean and S.D. of Chronological age, Skeletal age and Skeletal Age Difference

Paired Samples Statistics		Mean	Std. Dev^n	Mean Diff	Significance
Grp 1	Chronological Age(Ca)	13.32	1.133	0.6±1.212 P=0.001	Significant
	Fishman's Skeletal Age (Fsa)	13.92	1.523		
Grp 2	Chronological Age(Ca)	12.62	1.498	0.58±1.143 P=0.001	Significant
	Fishman's Skeletal Age (Fsa)	13.20	1.591		
Grp 3	Chronological Age(Ca)	12.86	1.471	0.72±1.126 P=0.001	Significant
	Fishman's Skeletal Age (Fsa)	13.58	1.553		

Table 1 Mean and S.D. of Chronological age, Skeletal age and Skeletal Age Difference

Continuous variables (chronological age, skeletal age and skeletal age difference) were presented as Mean± SD (standard deviation). Paired t-test showed that difference between the skeletal age and the chronological age was statistically significant for all the three groups (Table 1).

Unpaired t-test was used to compare the skeletal age differences between two Groups. The mean skeletal age difference was slightly more in Group 1(0.6) as compared to Group 2(0.58), but it was statistically non-significant(p=1.0)(Table 2). Also, The mean skeletal age difference was more in Group 3 (0.72) than in Group 1(0.6) and Group 2(0.58), but it was statistically non-significant p=0.61(Table 3) and p=0.598 (Table 4) respectively.

	Mean Difference	Significance
Group 1	0.6±1.212	P=1 Non-Significant
Group 2	0.58±1.143	

Table 2: Correlation between Mean Skeletal age difference between Group 1 and Group 2

	Mean Difference	Significance
Group 1	0.6±1.212	P=0.61 Non-Significant
Group 3	0.72±1.126	

Table 3: Correlation between Mean Skeletal age difference between Group 1 and Group3

	Mean Difference	Significance
Group 2	0.58±1.143	P=0.598 Non-Significant
Group 3	0.72±1.126	

Table 4: Correlation between Mean Skeletal age difference between Group 2 and Group3

Paired t-test was used to find the correlation of skeletal age difference in between male and female which was non-significant (p=0.114) (Table 5)

	Gender	N	Mean	Std. Deviation	Significance
Skeletal Age Difference	F	81	0.53	1.215	P=0.114 Non Significant
	M	69	0.83	1.028	

Table 5: Correlation of skeletal age difference in between males and females

DISCUSSION

Every individual has his biological clock for development. Some individuals mature early, some delayed and some on time. The skeletal age assessment by radiographs is based on the fact that the different ossification centres appear and mature at different times. This study showed that the skeletal age which was calculated by Fishman method was more than the chronological age for all the three groups and the skeletal age difference was statistically significant. This is because, during the pubertal growth period, the skeletal age is always more than the chronological age as the individuals show the acceleration in growth during this period.

However, the study by Akridge et al. in 2007[10] showed that the normal, overweight and obese children had accelerated skeletal age as compared to the chronological age, but the increase in skeletal age difference was non-significant in all three groups. This difference is probably because Akridge et al. took a wide range of age that is from 9 to 16 years whereas in our study the age range was confined to the pubertal period of 10 to 14 years. Also, the population was different in both studies. Akridge et al. studied on the American population comprising of the whites whereas this study was done on the Indian population.

In the study by Giuca et al. in 2012[11], 50 white subjects were selected. In the normal group, there were 25 individuals who had a mean delayed skeletal maturation of 2.2 ± 3.1 months. This was contrary to this study which showed that due to skeletal acceleration skeletal age is ahead of chronological age in normal individuals.

Also, there were 25 obese individuals who had a mean accelerated skeletal maturation of 11.8 ± 11.4 months. This was similar to this study which also showed that there was accelerated skeletal maturation.

When the Correlation of mean skeletal age difference was done between groups, it was seen that the mean skeletal age difference of Group 1 was slightly more than that of Group 2 and it was non-significant(p=1). The mean skeletal age difference of Group 3 was more than that of Group 1 and Group 2 but was non-significant (p=0.61 and p=0.589 respectively). This shows that the obese individuals were faster in their skeletal maturation as compared to overweight and normal subjects, but it was non-significant.

In the literature, it is suggested that leptin, produced by the adipose tissue when in the higher amount, can stimulate skeletal growth through the activation of various mediators, such as insulin-like growth factor 1 and sex hormones. Therefore an obese subject has an increased sensitivity to leptin at a peripheral level, causing increased differentiation and proliferation of chondrocytes and resulting in precocious skeletal maturation.[12]

Mack et al. in 2013[13] found that for children at the extremes of BMI percentile, it equates to an odds ratio of 2.8, meaning that for 2 children of the same age, a child in the 95th percentile is nearly 3 times more likely to be in CVM stage 4, 5 or 6 versus CVM stage 1-3 than a child in the 5th percentile would be. This is a significant finding as there is an increased likelihood that obese children around 13 years of age are past the point of peak growth, and normal children are more likely to have significant growth remaining.

Duplessis et al. in 2016[14] conducted a study to find the relationship between body adiposity status and skeletal maturation in 197 individuals. There was significant but weak, correlations between BMI percentile and cervical vertebral stage ($r = 0.157$, $P<0.05$). In their study, higher BMI percentiles also correlated with higher cervical vertebral maturation stages.

When skeletal age difference was correlated between male and female, the males tended to have greater skeletal age differences (0.83) than females (0.53), but it was non-significant ($p = 0.114$). However, the skeletal age difference was lesser in females than in males which can be due to a shorter peak of pubertal spurt for females than males as mentioned in the study by Sadeghianrizi in 2005.[15] Fishman in 1987[16] quoted that boys do not demonstrate any extensive differences from girls in length of incremental growth periods. They are just simply older on a calendar when these stages occur.

In the study by Duplessis et al. in 2016[14] which comprised of 115 girls and 82 boys of age 7 to 14 years, similar to this study there was no significant difference between boys and girls for the BMI percentile and cervical vertebral stages(p=0.156).

CONCLUSION

The following are the conclusions of the study:

- Skeletal age was ahead of chronological age which may be attributed to a pubertal growth period.
- The overweight individuals had slightly slower skeletal maturation than the normal individuals. However, the difference was statistically not significant.
- The obese individuals showed accelerated skeletal maturation as compared to overweight and normal individuals, but the difference was statistically not significant.
- The skeletal age difference was less in females than in males which can be due to a shorter peak of pubertal spurt for females than in males, but it was non-significant.

The limitation of the study was that the age limit for the study was 10 to 14 years which covered only the pubertal growth period. The adolescent growth period was not included. Also, BMI was used to calculate the body adiposity status in this study as it is quick, noninvasive and practically possible in a dental setup but other methods like Triceps Skinfold Thickness and Body Mass Impedance Analysis are methods of assessing body adiposity status with more accuracy.

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Source of Support: Nil
Conflict of Interest: Nil