ORIGINAL RESEARCH

Analysis of skeletal age based on hand-wrist and cervical vertebrae radiography

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ABSTRACT
Background: Growing occurs at a faster rate during adolescence, peaks at that point, and then slows down until maturity is attained. The present study was conducted to assess skeletal age based on hand-wrist and cervical vertebrae radiography. **Materials & Methods:** 90 subjects of both genders were subjected to hand wrist radiographs and lateral cephalograms. Concavity, anterior height, and angle—three morphometric alterations of the vertebral bodies C2 through C4were measured. **Results:** Out of 90, males were 50 and females were 40. Excellent correlations were found for the concavity of C2, C3, and C4 as well as for the anterior height of C3 and C4. Although statistically highly significant, angle C3 had only a low correlation coefficient and angle C4 did not correlate. There was agreement of the calculated skeletal age (CSA) of the Greulich and Pyle hand-wrist assessment. **Conclusion:** Compared to cervical spine, morphometric assessment of age-dependent changes in chronologic age demonstrated an advantage.
Keywords: adolescence, hand wrist radiographs, chronologic age

INTRODUCTION
Growing occurs at a faster rate during adolescence, peaks at that point, and then slows down until maturity is attained.[1] All people exhibit this pattern, however, there may be a noticeable individual variance in the rates of onset, length, and growth quantities at this stage of life. In some people, the pubertal growth period is brief and the physiologic development happens quickly; in other situations, the growth is slow and takes a lot longer.[2] Understanding a child's developmental stage is crucial for diagnosing the condition, designing a course of treatment, and determining how well it works in the end. The most accurate way to determine a child's developmental stage is not by their chronological age but rather by physiological markers like their standing peak growth velocity.[3]
Numerous scholars concur that skeletal maturity and craniofacial growth are strongly associated, and that the hand, wrist, and cervical vertebrae are excellent markers of skeletal maturity. The entire hand wrist radiograph consists of thirty bones, and evaluating these steps is a complex process that requires knowledge, experience, and higher radiation exposure. For these reasons, the ALARA (as low as reasonably possible) principle is called into doubt.[4]
Based on the intricate endocrine regulation of craniofacial growth, there are phases of acceleration and deceleration during growth.[5] Despite being documented in scholarly literature, a novel strategy that uses insulin-like growth factor I as an indication for the pubertal growth spurt has not yet attained practical relevance.[6]The present study was conducted to assess skeletal age based on hand-wrist and cervical vertebrae radiography.

MATERIALS & METHODS
The present study consisted of 90 subjects of both genders. All were informed regarding the study and their written consent was obtained.
Data such as name, age, gender etc. was recorded. Hand wrist radiographs and lateral cephalograms were performed on each individual. The head was supported by ear rods and nasal support during the lateral cephalogram. There was centric occlusion between the teeth, and the Frankfort horizontal plane was positioned parallel to the ground. Using the Greulich and Pyle approach, the skeleton age was ascertained from the hand-wrist radiographs.

Concavity, anterior height, and angle—three morphometric alterations of the vertebral bodies C2 through C4—were measured. Data thus obtained were subjected to statistical analysis. P value < 0.05 was considered significant.

RESULTS

Table I Distribution of patients

Total- 90		
Gender	**Males**	**Females**
Number	50	40

Table I shows that out of 90 patients, males were 50 and females were 40.

Table II Pearson correlation of morphometric measurements of the cervical vertebrae and skeletal age

Gender	Concavity			Anterior height		angle	
	C2	**C3**	**C4**	**C3**	**C4**	**C3**	**C4**
Boys							
Correlation coefficient	0.66	0.68	0.69	0.79	0.73	0.25	0.08
P value	0.04	0.02	0.03	0.02	0.04	0.02	0.01
girls							
Correlation coefficient	0.59	0.71	0.71	0.76	0.77	0.36	0.38
P value	0.01	0.03	0.03	0.05	0.04	0.01	0.03

Table II shows that excellent correlations were found for the concavity of C2, C3, and C4 as well as for the anterior height of C3 and C4. Although statistically highly significant, angle C3 had only a low correlation coefficient and angle C4 did not correlate.

Table III Agreement of calculated skeletal age (CSA) of the Greulich and Pyle hand-wrist assessment

Gender	Skeletal age according to Greulich and Pyle (y)	CSA (years		Total
		<14	**>14**	
Boys	<14	20	15	35
	>14	10	5	15
	Total	30	20	50
Girls	<14	10	15	25
	>14	5	10	15
	Total	15	25	40

Table III shows that there was agreement of the calculated skeletal age (CSA) of the Greulich and Pyle hand-wrist assessment.

Table IV Agreement of chronologic age with the Greulich and Pyle hand-wrist assessment

Gender	Skeletal age according to Greulich and Pyle (y)	chronologic age (years)		Total
		<14	**>14**	
Boys	<14	19	12	31
	>14	11	8	19
	Total	30	20	50
Girls	<14	12	14	26
	>14	5	9	14
	Total	17	23	40

Table IV shows that there was an agreement of chronologic age with the Greulich and Pyle hand-wrist assessment.

DISCUSSION

In many orthodontic treatment procedures, the assessment of skeletal age is crucial, particularly when it comes to correcting skeletal imbalance.[7] Success in functional orthopedics, which seeks to take use of mandibular growth, is closely related to growth potential. However, the mandible's growth is not linear during development.[8,9] Because growth varies from person to person in terms of timing, pace, and duration, chronological age is an unsatisfactory predictor for identifying growth stages. Child developmental status is typically evaluated in light of events that occur as the youngster grows.[10] Thus, biological markers that have been used to determine growth phases include chronological age, dental development, height and weight measures, sexual maturation traits, and skeletal age.[11,12]The present study was conducted to assess skeletal age based on hand-wrist and cervical vertebrae radiography.

We found that out of 90, males were 50 and females were 40. The validity of using radiographic examination of the cervical vertebrae to forecast skeletal maturation was established by Mahajan et al.[13] One hundred youngsters in Bangalore, aged eighteen to eighteen, who were separated into ten groups of ten individuals each, with an equal number of male and female participants, had their left-hand wrist and lateral cephalometric radiographs measured. Skeletal maturation was evaluated using the Fishman classification on a left-hand wrist radiograph. Utilizing the stages established by Hassel and Farman, the maturation of the cervical vertebrae was assessed using a lateral cephalometric radiograph. The alterations in the cervical vertebrae, hand, and wrist were

We found excellent correlations were found for the concavity of C2, C3, and C4 as well as for the anterior height of C3 and C4. Although statistically highly significant, angle C3 had only a low correlation coefficient and angle C4 did not correlate. There was agreement of the calculated skeletal age (CSA) of the Greulich and Pyle hand-wrist assessment.In a growth research, 352 boys and 378 girls, ages ranging from 6 to 18 years, had 730 sets of radiographs (a cephalogram and a hand-wrist) evaluated; each sex was treated as a separate sample. Using the Greulich and Pyle approach, the skeleton age was ascertained from the hand-wrist radiographs. Concavity, anterior height, and angle variations of the vertebral bodies C2 through C4 were assessed, and their relationships with the Greulich and Pyle method were examined. To quantify skeletal age, a multiple linear regression was performed with all associated variables considered. Bland-Altman plots were created, limits of agreement were determined, and cross-tables (before and after peak height velocity) were produced in order to determine the degree of agreement between the Greulich and Pyle method and calculated skeletal age.In a similar vein, estimates of the agreement between Greulich and Pyle's approach and the chronologic age of each individual were made for comparison. In both sexes, the concavity of C2, C3, and C4, the anterior height of C3 and C4, and the angle of C3 associated highly substantially with skeletal age. A linear regression was used to determine the calculated skeletal age. The degree of agreement between the Greulich and Pyle method and computed skeletal age was rather low (boundaries of agreement: 63.5 years for boys and 63.3 years for girls) and significantly less than the agreement between the Greulich and Pyle method and chronologic age. Similarly, compared to chronologic age (boys, 7.1%; girls, 7.4%), computed skeletal age produced significantly higher inaccurate estimates of maximal height velocity (boys, 18.9%; girls, 12.9%).There was a significant correlation found between the cervical vertebrae maturation indicator stages and the skeletal maturation indicator stages. It was discovered that the correlation coefficient was substantial. The study's findings showed that the hand and wrist skeleton maturation as well as the cervical vertebrae were significantly related.[14]

The shortcoming of the study is the small sample size.

CONCLUSION

Authors found that compared to cervical spine, morphometric assessment of age-dependent changes in chronologic age demonstrated an advantage.

REFERENCES

1. Pirinen S. Endocrine regulation of craniofacial growth. Acta Odontol Scand 1995;53:179-85.
2. Masoud M, Masoud I, Kent RL Jr, Gowharji N, Cohen LE. Assessing skeletal maturity by using blood spot insulin-like growth factor I (IGF-I) testing. Am J Orthod Dentofacial Orthop 2008;134:209-16.
3. Franchi L, Baccetti T, McNamara JA. Mandibular growth as related to cervical vertebral maturation and body height. Am J Orthod Dentofacial Orthop 2000;118:335-40.
4. H€agg U, Taranger J. Menarche and voice change as indicators of the pubertal growth spurt. Acta Odontol Scand 1980;38: 179-86.
5. Greulich WW, Pyle SI. Radiographic atlas of skeletal development of the hand and wrist. 2nd ed. Redwood City, Calif: Stanford University Press; 1959.
6. Fishman LS. Radiographic evaluation of skeletal maturation. Angle Orthod 1982;52:88-112.
7. Flores-Mir C, Nebbe B, Major PW. Use of skeletal maturation based on hand-wrist radiographic analysis as a predictor of facial growth: a systematic review. Angle Orthod 2004;74:118-24.
8. Fishman LS. Chronological versus skeletal age, an evaluation of craniofacial growth. Angle Orthod 1979;49:181-9.
9. Hagg U, Taranger J. Maturation indicators and the pubertal growth spurt. Am J Orthod 1982;82:299-309.
10. Tanner JM, Whitehouse RH, Cameron N, Marshall WA, Healy MJR, Goldstein H. Assessment of skeletal maturity and prediction of adult height (TW2 method). 2nd ed. London, United Kingdom: Academic Press; 1975. 1
11. Hassel B, Farman AG. Skeletal maturation evaluation using cervical vertebrae. Am J Orthod Dentofacial Orthop 1995;107:58-66.
12. Baccetti T, Franchi L, McNamara J. An improved version of the cervical vertebral maturation (CVM) method for the assessment of mandibular growth. Angle Orthod 2002;72:316-23.
13. Mahajan S. Evaluation of skeletal maturation by comparing the hand wrist radiograph and cervical vertebrae as seen in lateral cephalogram. Indian J Dent Res 2011;22:309-16.
14. Beit P, Peltomäki T, Schätzle M, Signorelli L, Patcas R. Evaluating the agreement of skeletal age assessment based on hand-wrist and cervical vertebrae radiography. American Journal of Orthodontics and Dentofacial Orthopedics. 2013 Dec 1;144(6):838-47.