

Study of Appearances of Ossification Centers in the Carpal Bones in 3 – 14 Years Age Group in a Teaching Hospital in Telangana

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ABSTRACT

BACKGROUND

Study of ossification of carpal bones in children indicates the level of structural maturity and age estimation. For the assessment of skeletal maturity in children, radiologists often use hand and wrist radiograph because of low level of radiation. Carpals are the most commonly used bones for determining the age of a child. We wanted to study the appearance of ossification centers in the carpal bones in age group of 3 - 14 years.

METHODS

This is a prospective observational study of one-year duration conducted between January 2019 and December 2020 in the Department of Forensic Medicine and Toxicology at Maheshwara Medical College and Hospital, Patancheru, Telangana. Children 3 to 14 years of age from nearby schools were randomly selected, and X-rays of the carpal bones were taken. Appearance of carpal bones and ossification were studied to estimate the age.

RESULTS

The study included 70 school children. We found that capitate and hamate carpals ossified during the first year of life in children of both sexes. Triquetral and lunate appeared at 3 - 4 years, trapezium, trapezoid and scaphoid carpals appeared between 5 and 8 years. Pisiform appeared at 9 years of age in females and at 13 years in males.

CONCLUSIONS

Capitate and hamate ossify at an early age. Triquetral and lunate carpals appear after capitate and hamate. Their appearance is slightly earlier in females than in males.

KEYWORDS

Ossification, Carpal Bones, Capitate, Hamate

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BACKGROUND

The study of ossification of carpal bones in children is very important and indicates the level of structural maturity, age estimation, clinical anatomy. It is important for orthopaedicians and forensic practitioners. Skeleton and teeth are the principal sources of information for estimation of age in younger age group.^{1,2} With the invention of Roentgen rays it become possible to visualize the ossification centres for age determination. Radiological data of the hand and wrist is the commonest and most reliable method for the assessment of actual age of a person.² It became an established fact that appearance of ossification centres are influenced by various factors like age, sex, race, environment, diet, endocrine and some others factors. There is evidence that skeletal maturation may vary between different socioeconomic groups of children or among children living in various geographical locations.² Determination of skeletal maturity is a part of medical examination for many clinical problems. The oldest method noted the age of appearance of epiphyseal centres in x-rays. Later, the Greulich and Pyle³ atlas method and the Tanner and Whitehouse⁴ scoring technique were based on the changes in the forms of ossification centres in the course of growth. These two methods have improved accuracy and enhanced skeletal age assessment.⁵

The difference in skeletal maturity has been observed among children differing in a variety of ways including geography, income, nutrition, home conditions and psychological factors.⁶ There are various methods for age determination of an individual, in which eruption of teeth and ossification activities of bones are important. For the assessment of child skeletal maturity, radiologists use a hand and wrist radiography because of low level of radiation. Carpals are the most important ones in determining the age of a child as there are eight carpals, the first one appears in first year of life and the last at 12th year.⁷

We wanted to study the appearances of ossification centres in the carpal bones in the age group of 3 years to 14 years.

METHODS

This was a prospective study done over a period of one year from January 2019 to December 2019 at Department of Forensic Medicine and Toxicology, Maheshwara Medical College and Hospital, Patancheru, Hyderabad, Telangana. Written informed consent was obtained from the parents and school head for all the children included in the study. No ethical issues were involved.

Inclusion Criteria

- Children whose parents gave consent to participate in the study.
- Age group range from 3 to 14 years.
- Presence of date of birth certificate.
- Confirmation of date of birth certificate by school record section.

Exclusion Criteria

- Children whose parents did not give consent to participate in the study.
- Age below 3 years and more than 14 years.
- Children whose parents did not give consent for radiological examination of carpal bones.
- Children not having valid date of birth certificate.
- Presence of congenital deformities, fracture cases, chronic illness.

Methodology

Children examined were from the schools near the medical college and children were selected randomly. A proforma was prepared and all demographic features were noted including age, gender, class of study, area of residence and date of birth. All the children included in the study were sent to radiology department for x ray wrist (carpal bones) with anterior-posterior (AP) view. Consent was taken from the parents for radiological examination of carpal bones.

RESULTS

There was a total of 70 cases. The patient age ranged from 3 years to 14 years. There were 38 boys and 32 girls and the male to female ratio was 1.1:1

Age Distribution (Years)	Males (n = 38)	Females (n = 32)	Total (n = 70)
3 - 4	03 (4.2 %)	02 (2.8 %)	05 (7.1 %)
5 - 6	03 (4.2 %)	03 (4.2 %)	06 (8.4 %)
7 - 8	06 (8.5 %)	04 (5.7 %)	10 (14.2 %)
9 - 10	10 (14.2 %)	08 (11.4 %)	18 (25.7 %)
11 - 12	10 (14.2 %)	10 (14.2 %)	20 (28.4 %)
13 - 14	06 (8.5 %)	05 (7.1 %)	11 (15.7 %)
Total	38 (53.8 %)	32 (45.4 %)	70 (100 %)

Table 1. Age and Gender Distribution

Majority of the cases were from 9 - 12 years (54.2 %). There was a slight male preponderance i.e., 53.8 % males as compared to 45.4 % females and the male to female ratio was 1.1:1

Carpal Bones	3 to 4 Years			5 to 6 Years		
	Males (n = 03)	Females (n = 02)	Total (n = 05)	Males (n = 03)	Females (n = 03)	Total (n = 06)
Capitate	03 (60 %)	02 (40 %)	05 (100 %)	03 (50 %)	03 (50 %)	100 %
Hamate	03 (60 %)	02 (40 %)	05 (100 %)	03 (50 %)	03 (50 %)	100 %
Triquetral	03 (60 %)	02 (40 %)	05 (100 %)	03 (50 %)	03 (50 %)	100 %
Lunate	0	02 (40 %)	02 (40 %)	03 (50 %)	03 (50 %)	100 %
Trapezium	0	02 (40 %)	02 (40 %)	03 (50 %)	03 (50 %)	100 %
Trapezoid	0	0	0	03 (50 %)	03 (50 %)	100 %
Scaphoid	0	0	0	02 (33.3 %)	03 (50 %)	83.3 %
Pisiform	0	0	0	0	0	0

Table 2. Appearance of Ossification Centres of Various Carpal Bones in Children in the Age Group of 3 to 4 Years and 5 to 6 Years

In the present study, capitate and hamate ossified during the first year of life in children of both sexes and we found all 05 cases (100 %) in 3 to 4 years age group.

The triquetral showed its appearance at 3 years and 100 % at 3 to 4 years in both the sexes. Lunate showed its appearance at 4 years in 02 females (40 %). Ossification of trapezium was observed in 02 females (40 %). In cases of males, ossification of lunate, trapezium, trapezoid, scaphoid,

pisiform bone did not appear at 3 to 4 years. Whereas, in cases of females, trapezoid, scaphoid, pisiform bone did not show ossification at 3 to 4 years. In the present study, capitate and hamate ossified during the first year of life in children of both sexes and found all 06 cases (100 %) in 5 - 6 years age group. The triquetral and lunate showed its appearance in all 06 cases (100 %) in both the sexes. Ossification of trapezium was observed in 06 cases (100 %) in both the sexes. Trapezoid showed its appearance at 5 years in females and at 6 years in males. Scaphoid bone ossification was seen in only 02 (33.3 %) cases among males and 03 cases (50 %) among females. Ossification was not observed in pisiform bones of both males and females.

Carpal Bones	7 - 8 Years			9 - 10 Years		
	Males (n = 06)	Females (n = 04)	Total (n = 10)	Males (n = 10)	Females (n = 08)	Total (n = 18)
Capitate	06 (60 %)	04 (40 %)	100 %	10 (55.5 %)	08 (44.4 %)	100 %
Hamate	06 (60 %)	04 (40 %)	100 %	10 (55.5 %)	08 (44.4 %)	100 %
Triquetral	06 (60 %)	04 (40 %)	100 %	10 (55.5 %)	08 (44.4 %)	100 %
Lunate	06 (60 %)	04 (40 %)	100 %	10 (55.5 %)	08 (44.4 %)	100 %
Trapezium	06 (60 %)	04 (40 %)	100 %	10 (55.5 %)	08 (44.4 %)	100 %
Trapezoid	06 (60 %)	04 (40 %)	100 %	10 (55.5 %)	08 (44.4 %)	100 %
Scaphoid	06 (60 %)	04 (40 %)	100 %	10 (55.5 %)	08 (44.4 %)	100 %
Pisiform	0	0	0	0	08 (44.4 %)	08 (44.4 %)

Table 3. Appearance of Ossification Centres of Various Carpal Bones in Children in the Age Group of 7 - 8 Years and 9 - 10 Years

In the present study, capitate, hamate, triquetral, lunate, and trapezium, trapezoid and scaphoid bone showed ossification in all 10 cases (100 %) in both males and females at 7 to 8 years. Whereas, ossification was not observed in pisiform bones of both males and females. In the present study capitate, hamate, triquetral, lunate, trapezium, trapezoid and scaphoid bone showed ossification in all 10 cases (100 %) in both males and females at 9 to 10 years. Ossification was observed in pisiform bones of 08 females at 9 years age. Whereas, ossification was not observed in pisiform bones of males.

Carpal Bones	11 - 12 Years			13 - 14 Years		
	Males (n = 10)	Females (n = 10)	Total (n = 20)	Males (n = 06)	Females (n = 05)	Total (n = 11)
Capitate	10 (50 %)	10 (50 %)	100 %	06 (54.5 %)	05 (45.4 %)	100 %
Hamate	10 (50 %)	10 (50 %)	100 %	06 (54.5 %)	05 (45.4 %)	100 %
Triquetral	10 (50 %)	10 (50 %)	100 %	06 (54.5 %)	05 (45.4 %)	100 %
Lunate	10 (50 %)	10 (50 %)	100 %	06 (54.5 %)	05 (45.4 %)	100 %
Trapezium	10 (50 %)	10 (50 %)	100 %	06 (54.5 %)	05 (45.4 %)	100 %
Trapezoid	10 (50 %)	10 (50 %)	100 %	06 (54.5 %)	05 (45.4 %)	100 %
Scaphoid	10 (50 %)	10 (50 %)	100 %	06 (54.5 %)	05 (45.4 %)	100 %
Pisiform	-	10 (50 %)	50 %	06 (54.5 %)	05 (45.4 %)	100 %

Table 4. Appearance of Ossification Centres of Various Carpal Bones in Children in the Age Group of 11 - 12 Years and 13 - 14 Years

In the present study, among 11 to 12 years, capitate, hamate, triquetral, trapezium, trapezoid and scaphoid bones showed ossification in all 20 cases (100 %) (both males and females). Ossification was observed in pisiform bones of 10 females (50 %). Whereas, ossification of pisiform bone was not observed in 10 males.

In the present study, capitate, hamate, triquetral, lunate, trapezium, trapezoid, scaphoid and pisiform bones showed ossification in all 11 cases (100 %) (both males and females) at 13 to 14 years.

DISCUSSION

Sample Size, Age and Gender Distribution

In our study, the sample size was of 70 cases with age ranging from 3 to 14 years. Majority of the children were among 11 - 12 years (28.5 %) followed by 9 - 10 years (25.7 %). Bishnoi et al⁸ in a similar study had 85 cases with age ranging from 5 - 12 years and all were females. Majority of their cases were among 10 to 11 years (23.5 %) followed by 9 - 10 years (17.7 %). In our study, there was a slight male preponderance and the male to female ratio was 1.1:1. Anita et al⁹ performed a similar study in 200 subjects with age range of < 6 month to 12 years. They had 102 (51 %) males and 98 (49 %) female cases. Patil et al¹⁰ in their study had 306 apparently healthy children of both sexes (161 male and 145 female) up to 14 years.

Capitate and Hamate

In our study, the capitate and hamate ossified during the first year of life in children of both sexes and we found all cases (100 %) within one year of life. (Among 3 to 14 years). In Anita et al⁹ study ossification centre of capitate and hamate appeared within one year of life. In Patil et al¹⁰ study also the capitate and hamate ossified during the first year of life in 66.7 % children of both sexes and found 100 % in 1 - 2-year age group children of both sexes. Srivastav et al¹¹ observed appearance of capitate slightly earlier than hamate. Our findings correspond well with the findings of the above authors.

Triquetral

In our study, triquetral showed its appearance in all (100 %) cases in both the sexes and 100 % at 3 to 4 years. In the study by Anita et al⁹ triquetral appeared at 3 - 4.5 year in both males and females whereas Patil et al¹⁰ reported its appearance at 1 to 4 years and 100 % at 4 - 5 years in both the sexes. In Srivastav et al¹¹ reported its appearance at the age of 3 to 5 years.

Lunate

In the present study, lunate showed its appearance at 4 years in females whereas ossification of lunate was observed at 5 to 6 years. Anita et al⁹ reported appearance of lunate at 4 to < 6 years in both sexes. Patil et al¹⁰ observed the appearance of lunate at 4 to 7 years and 100 % at 7 - 8 years in males while in females it appeared at 4 to 6 years and 100 % at 6 - 7 years. Srivastav et al¹¹ observed ossification of lunate at 4 to 6 years of age in their study. Our findings compare well with those of above studies.

Scaphoid, Trapezoid and Trapezium

In the present study, in cases of females, scaphoid and trapezoid showed its appearance at 5 - 6 years and trapezium appeared at 3 - 4 years. In case of males, scaphoid appeared at 5 - 8 years, whereas, trapezium and trapezoid appeared at 5 - 6 years. Bishnoi et al⁸ reported the time of appearance of scaphoid as 6 to 7 years. Anita et al⁹ observed gender variation in the age of ossification of trapezium, trapezoid and scaphoid as ossification centre appeared earlier in females i.e., in the age of 6 to 6.5 year in 100 % of cases. In males, it appeared at the age of 7 to 7.5 years in 100 % of cases.

Patil et al¹⁰ in their study observed that in case of females, scaphoid and trapezoid appeared at 4 - 7 years while trapezium at 4 - 8 years. In case of males, trapezoid appeared at 5 - 9 years while scaphoid and trapezium at 5 - 10 years. Srivastav et al¹¹ observed that trapezium, trapezoid and scaphoid ossified between the ages of 5 to 9 years in both the genders in their study and showed slight variation (1 - 2 years) in their ossification in the two genders. Our observations are almost similar to the findings of other studies.

Pisiform Bone

In our study, in case of females, ossification of pisiform bone was observed at 9 to 14 years and 100 % at 10 years and in case of males, ossification of pisiform bone was observed at 13 to 14 years and 100 % at 13 years. Bishnoi et al⁸ observed the time of appearance of pisiform to be 10 to 11 years among the girls of Jodhpur region. Anita et al⁹ observed that pisiform was last to ossify in both the genders. In females it appeared between 11 to 11.5 years of age and in males it appeared between 11.5 to 12 years of age. Patil et al¹⁰ observed that pisiform showed its appearance at 10 to 13 years and 100 % at 13 - 14 years in males while in females it appeared at 9 to 12 years and 100 % at 12 - 13 years. Srivastav et al¹¹ noted the appearance of last carpal i.e., pisiform was at the age of 9 to 12 and 10 to 12 years in males and females respectively. Our observations correlate well with these authors.

CONCLUSIONS

X-rays help in age determination. Capitate and hamate ossify at an early age in both genders. Triquetral and Lunate appear after Capitate and Hamate and their appearance is slightly earlier in females than in males.

Data sharing statement provided by the authors is available with the full text of this article at jebmh.com.

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