



A STUDY OF WRIST OSSIFICATION FOR AGE ESTIMATION IN PEDIATRIC GROUP IN SOUTH BIHAR

Radiodiagnosis

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ABSTRACT

The age of ossification of different centers at wrist joint i.e. Carpals and lower ends of radius and ulna have been studied in pediatric age group in south Bihar. The study included 244 healthy children of both sexes up to 12 years of age. Capitate and Hamate were first (during infancy) and Pisiform (9-12 years) was last to ossify. Ossification of the 8 carpals and 2 centers for lower ends of radius and ulna respectively have a definite relation with age and can be consider as good indicator for age assessment in pediatric age group.

KEYWORDS

Age, Carpals, Ossification.

INTRODUCTION

In law the crime and punishment is entirely based on criminal responsibility and this in turn is dependant on the age of a person [1]. In the modern society the crimes against the children and by the children are increasing. The pediatric age group (up to 12 years) has got significant medico-legal importance (Table - 1).

There are various criteria for age determination of an individual, of which eruption of teeth and ossification activities of bones are important. Nevertheless age can usually be assessed more accurately in younger age group by dentition and ossification along with epiphyseal fusion [2]. A careful examination of teeth and ossification at wrist joint provide valuable data for age estimation in children [3]. Studies on ossification of the carpal bone are very few in India [4, 5, 6, and 7] and abroad [8,9].

Reporting on medico-legal practice in India, a survey committee recommended to the government of India, in the year 1964 [10], that a zone wise study for the problem of determination of age is to be encouraged. The present study was conducted in Patna (South Bihar) to find out age of the children in pediatric age group (11 to 12 years) from ossification activities of the carpals and the lower ends of radius and ulna. It was found that ossification at wrist joint acts as a "good indicator of age" in children.

MATERIAL AND METHOD

This study was carried out in the department of Anatomy at Indira Gandhi Institute Of Medical Science Patna on 244 healthy subjects of pediatric group i.e. Up to 12 years of age of both sexes. Only the children having certified proof of their birth were included in the study. The pediatric group in the study was further classified into three groups as follows: -

Group I: 0 - 3 years (age of deciduous teeth emption) Group II: 3 - 6 years (age of non emption of teeth)

Table no.1 - Medico-legal importance of pediatric age

Age in years	Medico-legal significance	Relevant IPC / Act
0 - 1 year	Infanticide	Sec. 302 IPC And British Infanticide Act - 1938
> 5 years	In deciding criminal responsibility of a child	Sec. 127-130 of Indian Railway Act, 1890
< 7 years	In deciding criminal responsibility of a child	Sec. 82 IPC
7-12 years	In deciding criminal responsibility of a child	Sec. 83 IPC
10 years	Kidnapping for valuables	Sec. 369 IPC
< 12 years	Oath	Indian Oaths Amendment Act-1939
> 12	Consent for physical	Sec. 89 IPC

Group III: 6 - 12 years (age of mixed dentition)

Ossification of all the eight carpal bones and lower ends of radius and ulna were studied. For the study, the skiagram of both wrists (PA view) were taken and the x-ray plates were developed as per the routine procedure in the department of Radiodiagnosis for observing the above ten centers of ossification.

OBSERVATIONS

Age and sex wise study of cases (table 2)

There were 51.63% males and 48.27% females in the study with male to female ratio being approximately 1: 1. Precaution was taken to select equal proportion of the cases from each year interval of the age, from 0 to 12 years in both sexes. 22.95% children in the study belonged to group I, while 30.32% children were from group II and remaining 46.73% children belonged to group III.

Table no.2 - Distribution of cases according to age and sex

Group	Age in years	Number of cases	
		Male	Female
I	0-1	6	8
	1-2	12	8
	2-3	12	10
II	3-4	8	16
	4-5	12	12
	5-6	12	14
III	6-7	8	10
	7-8	10	8
	8-9	10	8
	9-10	14	8
	10-11	10	8
	11-12	12	8
Total		126(51.63%)	118(48.27%)

Religion, habitat and dietary habit of cases (table - 3)

Most of the children (81.14%) in the study were Hindus followed by Muslims (18.03) and the Christians (0.83%) with male to female ratio of 1: 1 in two major communities of the country. 63.12% children in the study were from the urban area whereas remaining 18.85% and 18.03% were from the semi-urban and the rural habitat respectively. Number of the vegetarian and non-vegetarian subjects in the study was almost same i.e. 36.88% and 35.26% respectively followed by the egg eaters (27.86%). Among the males number of non- vegetarians and egg eaters slightly predominated over the females whereas among the vegetarians number of the females exceeded over the males.

Ossification of carpal bones (table - 4)

Capitate and Hamate ossified during infancy in both sexes. The Triquetral and Lunate showed their appearance at 3 to 4 and 4 to 5 years respectively in both the sexes while trapezium, Trapezoid and

Scaphoid ossified in 16.66% males and 28.57% to 42.85% females at the age of 5 to 6 years in the study.

The Trapezium, Trapezoid and Scaphoid ossified in all the females and males at the age of 8 to 9 and 9 to 10 years respectively. Among the few males trapezoid (9-10 years) appeared later than Scaphoid while females showed reverse pattern i.e. Scaphoid (8-9 years) appeared earlier than the trapezoid.

The Pisiform was last to ossify in both the sexes. In the males, it appeared between 9-10 years (14.28% cases) to 11-12 years (in all children) whereas; it ossified between 10-11 years (25%)

Table no.4 - Showing ossification of carpal bones in both sexes

Age in	Percentage of cases showing ossification of years															
	Lunate		Trapezium		Trapezoid		Scaphoid		Capitate		Pisiform		Hamate		Triquetral	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
<1	100	100	100	100	-	-	-	-	-	-	-	-	-	-	-	-
1-2	100	100	100	100	-	-	-	-	-	-	-	-	-	-	-	-
2-3	100	100	100	100	-	-	-	-	-	-	-	-	-	-	-	-
3-4	100	100	100	100	50	62.5	-	-	-	-	-	-	-	-	-	-
4-5	100	100	100	100	100	100	50	83.3	-	-	-	-	-	-	-	-
5-6	100	100	100	100	100	100	100	100	16.6	28.5	16.6	42.8	16.6	28.5	-	-
6-7	100	100	100	100	100	100	100	80	50	80	50	40	75	40	-	-
7-8	100	100	100	100	100	100	100	100	100	100	100	100	100	75	-	-
8-9	100	100	100	100	100	100	100	100	100	100	100	100	100	100	-	-
9-10	100	100	100	100	100	100	100	100	100	100	100	100	100	100	-	-
10-11	100	100	100	100	100	100	100	100	100	100	100	100	100	100	40	25
11-12	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	75

Table no.5 - Showing ossification at lower ends of radius and ulna

Ossification center at lower end of	Percentage of cases showing ossification at age (years)																	
	< 1		1 - 2		2 - 3		3 - 4		4 - 5		5 - 6		6 - 7		7 - 8		> 8	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
	Radius	-	-	-	-	100	40	100	100	100	100	100	100	100	100	100	100	100
Ulna	-	-	-	-	-	-	-	-	-	-	50	50	143	50	80	80	75	10

Table no.6 - showing ossification at wrist and total number of centers appeared in pediatric age

Age in years	Ossification at wrist		Total No. of centers ossified		Symbols
	Male	Female	Male	Female	
<1	CH	CH	2	2	C=Capitate
1-2	CH	CH	2	2	H=Hamate
2-3	CHR	CH	3	2	Q=Triquetral
3-4	CHRQ*	CHRQ*	3-4	3-4	L=Lunate
4-5	CHRQL*	CHRQL*	4-5	4-5	M=Trapezium
5-6	CHRQLUM*D*S*	CHRQLUM*D*S*	6-9	6-9	D=Trapezoid
6-7	CHRQLUM*D*S*	CHRQLUM*D*S*	6-9	6-9	S=Scaphoid
7-8	CHRQLUSM*D*	CHRQLUMDS*	7-9	8-9	P=Pisiform
8-9	CHRQLUSM*D*	CHRQLUMDS	8-9	9	R=Radius lower end
9-10	CHRQLUSMDP*	CHRQLUMDS	9-10	9	U=Ulna lower end
10-11	CHRQLUSMDP*	CHRQLUMDSP*	9-10	9-10	*=Ossification ±
11-12	CHRQLUSMDP	CHRQLUMDSP*	10	9-10	

cases) and 11-12 years (75% cases) among the females. So up to the age of 12 years Pisiform did not ossify in all females in this study.

Ossification at lower ends of radius and ulna (table 5)

The centre (for lower end of radius ossified at the age of 1 to 2 and 2 to 3 years in all the males and females respectively in this study. At the age of 1 to 2 years only 40% females showed ossification at lower end of radius while ossification started, it the lower end of ulna at 5 to 6 years of age in both the sexes and at the age of 8 years and above it was present in all the children in this study.

Number of ossification centers appeared at wrist during pediatric age (table 6)

In the children of group I (up to 3 years) three centers ossified at wrist which included two for carpals and third for lower end of radius. At 3 to 4 and 4 to 5 years of age the same number (3-4 and 4-5) of ossification centers were observed in both the sexes respectively while at 5 to 6 years of age over all six centers ossified at wrist which, included four centers for carpals and centers for lower ends of radius and ulna. So there was an addition of two more centers for carpals and third for

Table no.3 distribution of cases according to religion; habitat and diet

Parameters		Number of cases		Total	
		Male	Female	Number	Percentage
Religion	Hindu	100	98	198	81.14
	Muslim	24	20	44	18.03
	Christian	2	0	02	0.83
Habitat	Rural	24	20	44	18.03
	Semi urban	24	22	46	18.85
	Urban	78	76	154	63.12
Diet	Vegetarian	40	50	90	36.88
	Egg-eaters	40	28	68	27.86
	Non-vegetarian	46	40	86	35.26

lower end of ulna in group ii (between 3 to 6 years) children.

Centers for remaining four carpals (trapezium, trapezoid, Scaphoid and Pisiform) appeared in group III (between 6 to 12 years) children of which the Pisiform ossified in the last in both the sexes. If we further subdivide group III age into two i.e. 6-9 years and 9-12 years, the appearance of trapezium, trapezoid and Scaphoid was observed between 6 to 9 years and Pisiform at any time between 9 to 12 years in this study.

So out of 10 ossification centers at wrist joint 3 appear up to the 3 years of age, 6 up to the 6 years of age and 9 up to the 9 years of age whereas last one center (Pisiform) appear at any time during last three years of the pediatric age.

DISCUSSION AND CONCLUSION

In the present series Capitate and Hamate ossified during infancy which is almost consistent with other studies [7,8,9], Chaurasia [11] mentioned appearance of Capitate slightly earlier than Hamate, the 3rd carpal which showed its appearance at the age of 3 to 5 years was

Triquetral this carpal ossified earlier in Englishers [8] and Australians [9] than in Indians. Lunate was the 4th carpal to ossify at 4 to 6 years of age in the study.

For first four carpals as mentioned above there was no wide sex variation in their ossification whereas, remaining four carpals i.e. Trapezium, trapezoid, Scaphoid and Pisiform showed slight variation (1-2 years) in their ossification in two sexes.

Trapezium, trapezoid and Scaphoid ossified between the ages of 5 to 9 year's in both the sexes in the present study. Ossification of Scaphoid has been also reported earlier in Englishers and Australians than Indians similar to Triquetral. Appearance of last carpal i.e. Pisiform has been reported at the age of 9 to 12 and 10 to 12 years in the males and females respectively. All other studies (Indian and abroad) showed almost similar age of ossification of Pisiform with a difference of ± 1 year.

Ossification at the distal End of radius and ulna are also helpful in assessment of age along with carpal bones in children below 12 years of age. In the present series, center for lower end of radius ossified (M 1-2 years; F 2-3 years) earlier than ulna (M and F 5-8 years). Both Englishers and Australians showed the ossification at lower end of radius (within one year) and ulna (4.5 years) earlier than Indians while authors in India [1,12] have mentioned the age of appearance of ossification centers for the distal ends of radius and ulna consistent with present study. Variations in the appearance of center of ossification at wrist joint shows influence of race, climate, diet and regional factors. Ossification centers for the distal ends of radius and ulna consistent with present study.

Variations in the appearance of center of ossification at wrist joint shows influence of race, climate, diet and regional factors.

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