



Effect of Malnutrition on the Sequence and Time of Appearance of the Ossification Centres of the Wrist and Hand in Malnourished Children

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Abstract

Appearance of ossification centres of 500 malnourished children (250 boys and 250 girls) from birth to eight years was observed in the radiographs of the wrist i.e. lower end of radius and ulna and the hand i.e. carpals, metacarpals and phalanges. There was no marked difference in the sequence of appearance of ossification centres, capitate and hamate were first to appear followed by other bones as occurs in healthy children. The centres most commonly retarded in the hand and wrist in the children with malnutrition comprising the current series were the middle and distal phalanges and those least retarded were the capitate and hamate.

Key Words

Ossification Centres, Underprivileged Children, Hand Wrist X-Rays

Introduction

The age of appearance and union of ossification centres is of immense significance in assessing skeletal maturity. During the normal growth and development of man and animals the bones grow in length and width and undergo progressive changes in their architecture, a process known as maturation. Moreover, this is the only scale of maturation that covers the entire phase of childhood through teenage years. The status of growth of children is better related with the rate of skeletal maturation. Thus it is the tempo of the maturation of the skeleton that determines the comparative status of physical growth of a child. Therefore, in research, various clinical situations and to assure the worried parents it is important to interpret child growth in terms of skeletal age rather than chronological age alone. Besides, calendar age may not be known especially in rural and tribal populations (1). These normal processes are governed by numerous and complex forces. Differences in skeletal maturity have been observed among children differing in a variety of ways including geography, income, nutrition, home conditions and psychological factors (2). There is considerable evidence in western world literature that malnutrition affects the rate of skeletal maturation (3, 4) and dietary intake is the key to bone acquisition throughout growth (5) but as far as India is concerned there are hardly one or two proper studies conducted on the

appearance of centres of ossification in malnourished or healthy children. The present study, covering geographic area of Jammu, was carried out using radiographs, to investigate in detail, the effect of malnutrition on the time and sequence of appearance of ossification centres of the wrist and hand in underprivileged children.

Material and Methods

500 children affected by malnutrition - 250 boys and 250 girls, attending the pediatric outpatient department of the SMGS Hospital Jammu, up to the age of eight years were studied. The endeavor was to study the maturation of the skeleton of the wrist (lower end of radius and ulna) and the hand (carpals, metacarpals and phalanges) in relation to the age and nutrition of the child. Parents were interviewed for obtaining exact chronological age, average monthly family income, size of the family, nutritional history, history of any chronic illness or any illness that might interfere with skeletal maturity and developmental history to rule out mental retardation. Any disease prone to impede the skeletal maturity and children with mental retardation were excluded from the study. All children belonged to low socio-economic strata with monthly income of or less than 5000 rupees.

Radiographer took radiographs of these children. X-rays were taken of the left hand, which was placed palm

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Table 1. Ossification at Lower Ends of Radius and Ulna of Children (%)

Ossification Centre 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	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Radius	17.6	18	61.6	75.6	97.6	100	100	-	-	-	-	-	-	-	-	-
Ulna	0	0	0	0	0	0	0	0	4.0	10.4	25.6	52.4	80.2	94	100	

Table 2. Showing Ossification of Carpal Bones In Both Sexes (%)

Age in Years	Percentage of cases showing ossification of													
	Capitate		Hamate		Triquetral		Lunate		Trapezium		Trapezoid		Scaphoid	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
0-1	88	90	88	90	0	0	0	0	0	0	0	0	0	0
1-2	100	100	100	100	0	0	0	0	0	0	0	0	0	0
2-3	-	-	-	-	0	0	0	0	0	0	0	0	0	0
3-4	-	-	-	-	58	55	18.8	27.6	9.6	10	4.0	7.6	3.6	6.8
4-5	-	-	-	-	78	82.4	51.2	70.4	27.2	53.2	23.6	45.6	20.8	40.4
5-6	-	-	-	-	80	91.2	56.4	61.6	38.8	52.8	27.2	44.4	25.6	39.6
6-7	-	-	-	-	100	100	75.2	80.4	67.6	83.6	73.6	75.2	70	72
7-8	-	-	-	-	-	-	100	100	100	100	100	100	100	100

Table 3. Presence of Ossification Centres of Metacarpals of Children (%)

Age in years	Metacarpals											
	I		II		III		IV		V			
	M	F	M	F	M	F	M	F	M	F		
<1	0	0	0	0	0	0	0	0	0	0		
1-2	0	0	10.8	12.8	10.8	12.8	6.8	8	6.8	8		
2-3	0	3.6	49.2	67.6	44.4	66.8	32.4	68	22.4	68.8		
3-4	20.0	44	84.4	87	82.8	85.6	64	78.4	81.6	76.4		
4-5	64.4	76.8	90.8	94.4	93.2	97.2	93	95.6	83.6	84		
5-6	80	92	95.6	97.6	96	98.4	97.6	98	89.2	93.2		
6-7	97.2	100	100	100	100	100	100	100	100	100		
7-8	100	-	-	-	-	-	-	-	-	-		

down i.e. PA view, hand flat on the film holder, with fingers slightly separated and the axis of the hand, wrist and forearm in a straight line with X-ray tube centered half way between the tips of fingers and distal end of radius. The radiographs were grouped sex-wise in age groups of twelve months intervals for recording the presence or absence of an ossification centre. A very small amorphous radiopaque shadow of bony mass at an appropriate area has been considered as the evidence of presence of an ossification centre.

Results

As for as sequence of appearance of ossification centres of wrist and hand is concerned, they more or less follow the established pattern as observed in normal healthy children i.e. capitate, hamate, distal end of the radius, proximal phalanges, Metacarpals: first followed by second to fifth, middle and distal phalanges, triquetral, lunate, scaphoid, trapezium and trapezoid and finally distal end of the ulna with occasional variation here and there.

Regarding time of appearance of various ossification centres of wrist and hand there is definite delay ranging from one to four years (Table 1, 2, 3, 4, 5, 6).

Discussion

There are several reasons why the skeleton offers the best evidence of progressive maturation in the growing child. First, the beginning and end points are established; only a few of the accessory centres of ossification are present in the newborn, while the attainment of adult morphology as well as completed epiphyseal union is found in everyone, save the grossly pathological. Second, the skeleton changes continuously throughout the growing period - its appearance records the maturation level at all times. Third, the hand-wrist area, by far the most commonly utilized, is easily x-rayed with minimum effort and with complete safety, provided the gonads are shielded. Finally, the assessment of the maturation level is not difficult for an anatomically trained person, and can be done in a relatively short time with the aid of

Table 4. Presence of Epiphysis of Proximal Phalanges in Children (%)

Age in years	Proximal Phalanges											
	I		II		III		IV		V			
	M	F	M	F	M	F	M	F	M	F		
<1	0	0	0	0	0	0	0	0	0	0	0	
1-2	4	5.2	4.4	5.6	4.4	5.6	4.8	5.2	4.8	5.6	5.6	
2-3	10	30	12.4	30.4	12.4	30.8	12	30.8	12.8	31.6	31.6	
3-4	40	74.8	48	75.2	48	75.2	41.2	75.6	41.6	75.2	75.2	
4-5	81.2	92.8	81.6	92.8	80.6	93.2	82	94	82	94	94	
5-6	92.8	96.8	92.8	96.8	93.2	97.2	93.2	97.6	93.2	97.6	97.6	
6-7	100	100	100	100	100	100	100	100	100	100	100	
7-8	-	-	-	-	-	-	-	-	-	-	-	

Table 5. Presence of Epiphysis of Middle Phalanges in Children (%)

Age in years	Middle Phalanges									
	II		III		IV		V			
	M	F	M	F	M	F	M	F		
<1	0	0	0	0	0	0	0	0	0	
1-2	3.6	4.0	3.6	4.8	2.8	4	4	5.2	5.2	
2-3	8.4	24.8	7.2	29.6	5.2	30.8	5.6	31.6	31.6	
3-4	37.2	70	35.6	66.4	36.8	71.6	34.4	69.2	69.2	
4-5	81.2	78.5	78	79.2	76	79.6	78	78.8	78.8	
5-6	88.8	95.6	89.2	93.2	97.6	98	93.2	94.8	94.8	
6-7	100	100	100	100	100	100	100	100	100	
7-8	-	-	-	-	-	-	-	-	-	

Table 6. Presence of Epiphysis of Distal Phalanges in Children (%)

Age in years	Distal Phalanges											
	I		II		III		IV		V			
	M	F	M	F	M	F	M	F	M	F		
<1	0	0	0	0	0	0	0	0	0	0		
1-2	3.2	3.6	3.6	4.8	4	5.2	4	5.2	4.4	5.6		
2-3	8	24.4	9.2	25.6	8.4	30.8	6.4	32	6.4	32.8		
3-4	36.4	68	39.2	70	37.6	66.8	38.8	72.4	36.4	69.2		
4-5	76.8	78.4	80	76.4	75	77.2	75.2	77.6	76	80		
5-6	82	93.6	86.8	92.8	88.4	91.6	97.6	98.6	91.2	94.4		
6-7	100	100	100	100	100	100	100	100	100	100		
7-8	-	-	-	-	-	-	-	-	-	-		

reliable available standards. The period subsequent to weaning is of vast clinical significance in the skeletal development of child. Development is fast, and ossification centres, signifying profound qualitative changes appear in large numbers. The sequence and time of appearance of various ossification centres of wrist and hand in normal healthy children are as follows - Capitate: in 2nd month, Hamate: at the end of 3rd month, Distal end of the radius: 1st year, Metacarpals: first - late 2nd year in females and early 3rd year in males; second to fifth - 2nd year in females and 1½ to 2½ year in males, Phalanges: proximal - early in 2nd year in females and late in 2nd year in males; middle and distal - 2nd year in females and 3rd or 4th year in males, Triquetral: in 3rd year, Lunate, Scaphoid, Trapezium and Trapezoid: 4th year in females and 5th year in males, Distal end of the ulna: 5th year in females and 6th year in males and Pisiform: 9th or 10th year in females and 12th year in males.

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