

Delayed skeletal maturation in Perthes' disease

We have studied skeletal maturation and carpal bone development in 27 girls with Perthes' disease by assessing consecutive radiographs during an observation time of 5 years. At the time of diagnosis of Perthes' disease, delayed skeletal maturation was both frequent and considerable and greater than at the end of observation. The mean age at appearance of carpal bones was delayed compared with controls. In bilateral disease, compared with unilateral disease, the onset of ossification in the carpals occurred later.

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Skeletal immaturity at the hand and wrist has been reported to be common in Perthes' disease (Goff 1954, Ralston 1961, Caffey 1968, Girdany & Osman 1968, Fisher 1972, Harrison et al. 1976, Katz & Siffert 1977, Bohr 1979, Evardsen et al. 1981, Shapiro 1982, Kristmundsdottir et al. 1984). Perhaps Perthes' disease should be considered a focal expression of a general disorder of skeletal growth (Harrison et al. 1976, Evardsen et al. 1981, Kristmundsdottir et al. 1984). We have pursued this hypothesis by studying the longitudinal pattern of skeletal maturation in affected girls using the TW2 system to evaluate skeletal maturity and to assess age at onset of ossification in the carpals and distal epiphysis of the ulna.

Patients and methods

The study population comprised 27 girls. The mean age at diagnosis was 5.6 ± 1.6 (3.22-8.35) years. Both hips were affected in 4 girls, left hip in 12 girls, and right hip in 11 girls. The radiographic severity of the disease was classified as being mild ($n=9$), moderate ($n=12$), or severe ($n=3$) by one observer (M. H.) according to proximal femoral involvement. Four girls remained unclassified because of recent diagnosis.

Radiographs of the hand and wrist were obtained at 6-month intervals. Skeletal maturation was assessed by the TW2 method (Tanner et al. 1975). In this method a maturity score is given independently of each epiphysis of the radius, ulna, 1st, 3rd, and 5th metacarpals and phalanges, and to each of the carpal bones. The scores are given on the basis of recognizable stages of development through which each bone passes between its first appearance to its mature state. Each bone is allotted a score according to the stage it has reached, and the ratings for each bone are summed up to produce an

overall skeletal maturity score. Independent maturity score and bone age equivalents were obtained for the radius, ulna, metacarpals, and phalanges (RUS), and for the carpals. All the radiographs were rated by one of us (F. K.). The ossification of the carpal bones and distal epiphysis of the ulna was assessed as having taken place when an ossification center appeared between one radiograph and the next one. This approximation was done to minimize any error in estimating the age at onset of ossification of the center in question. The control group was obtained from published data (Stuart et al. 1962). The mean follow-up time was 5 (3-7) years.

Results

Skeletal maturation

In plotting the skeletal maturity scores at the time of diagnosis, only 1 of the girls had a RUS score above the 50th centile; but all the girls had carpal maturity scores below the 50th centile. Eight girls had RUS maturity scores below the 3rd centile and 10 girls had carpal maturity scores below the 3rd centile (Table 1).

At the end of follow-up, a number of the girls

Table 1. Centile distribution of RUS and carpal maturity scores for girls with Perthes' disease at diagnosis and end of follow-up

Centile	At diagnosis				End of follow-up			
	Rus		Carpal		Rus		Carpal	
	n	%	n	%	n	%	n	%
<3	8	30	10	37	2	7	6	22
3-10	8	30	6	22	6	22	6	22
10-25	9	30	5	19	3	11	9	33
25-50	1	4	6	22	8	30	4	15
50-75	1	4			3	11	2	7
75-90					2	7		
90-97					2	7		
>97					1	4		

had both RUS and carpal maturity scores above the 50th centile, a feature particularly evident for the RUS scores (Table 1).

At diagnosis the mean bone age delay (chronologic age less bone age) was 1.4 ± 0.8 years for RUS and 1.9 ± 1.8 years for carpals. By the end of follow-up, the RUS bone age delay was 0.4 ± 1.2 years and the carpal bone age delay was 1.3 ± 1.0 years.

Carpal ossification

The capitate and hamate were present in all the girls at initial radiography; and 8 girls had all the carpal bones present at diagnosis. The triquetral had ossified in all but 2 of the girls. The mean age at appearance of each of the lunate, scaphoid, trapezium, and trapezoid was delayed compared with the control group (Table 2). The mean age at appearance of the ulnar epiphysis was delayed compared with the control group.

Table 2. Mean age at appearance of carpal bones and distal ulnar epiphysis of normal girls and girls with Perthes' disease

Bones	Control group			Perthes' disease			t-test
	n	Mean	SD	n	Mean	SD	
Triquetral	55	2.22	1.17	2	4.62	0.93	***
Lunate	55	3.01	1.44	11	6.26	1.72	***
Scaphoid	54	4.48	1.15	15	6.66	1.40	***
Trapezium	54	4.30	1.37	14	6.43	1.66	***
Trapezoid	55	4.32	1.03	15	6.29	1.46	***
Ulna	51	6.03	1.01	19	6.99	1.29	**

*** $P < 0.001$, ** $0.001 < P < 0.01$

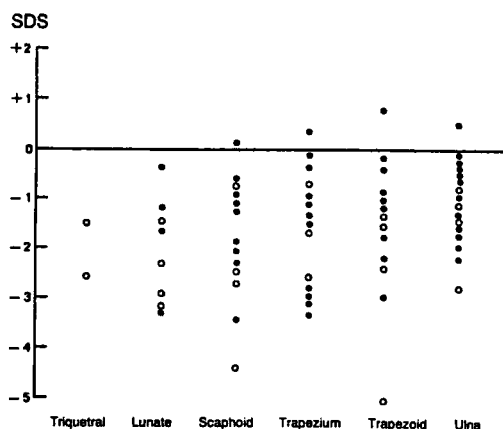


Figure 1. Age at appearance of carpal centers and distal ulnar epiphysis expressed as standard deviation scores (SDS) for girls with Perthes' disease. Many girls have SDSs below -2 SDS (severe bone age delay). ● unilateral, ○ bilateral disease.

The mean age at ossification in the carpal bones and ulnar epiphysis was slightly lower for girls with bilateral than for those with unilateral Perthes' disease (Figure 1, Table 3).

The degree of bone age retardation was not correlated with severity of Perthes' disease.

Table 3. Mean age at appearance of carpal bones and distal ulnar epiphysis for girls with Perthes' disease

Center	Unilateral			Bilateral		
	n	Mean	SD	n	Mean	SD
Triquetral	0			2	4.6	0.9
Lunate	7	6.2	2.0	4	6.6	1.0
Scaphoid	11	6.4	1.2	4	7.4	1.8
Trapezium	11	6.4	1.8	3	6.5	1.3
Trapezoid	11	5.7	1.1	4	7.0	1.8
Ulna	15	6.9	1.3	4	7.6	0.9

Discussion

A number of workers have found that skeletal maturation is delayed in boys developing Perthes' disease (Fisher 1972, Harrison et al. 1976, Kristmundsdottir et al. 1984). In addition, many affected boys demonstrate a severe abnormality in ossification of the carpals and have a consistent delay in the age at appearance of the triquetral and the lunate centers (Kristmundsdottir et al. 1986). Our present study shows that in girls at the time of diagnosis of Perthes' disease there is often a considerable delay in skeletal maturation and in the age of appearance of both the carpal centers and the distal ulnar epiphysis. This consistent delay in ossification seen in the carpus of children with Perthes' disease has not been demonstrated in a normal population despite the variability in the order of appearance of carpal bones in healthy subjects (Garn et al. 1967). In addition, many of our girls, as has previously been shown for boys (Kristmundsdottir et al. 1986), had an age at onset of ossification in one or more carpal bones that was below the 2 standard deviations of normality. Therefore, it must be considered as a severe abnormality of ossification. This abnormality of carpal bone ossification is already present at the time of diagnosis of Perthes' disease. Impairment of skeletal maturation has also been shown to exist before the onset of the disease (Lim 1966). If this general disorder, expressed as a delay in ossification and bone age, contributes to the expression

of the hip disease, then there must be a latent period between its first expression and the ultimate expression of disease at the hip. It is considered that the results in our study support the hypothesis that Perthes' disease of the hip is not merely a local disorder, but most likely involves a general disorder of growth and devel-

opment (Goff 1954, Harrison et al. 1976, Harrison & Burwell, 1981). It is also possible that the general disorder acts during a latent period together with a local abnormality at the hip joint (Upadhyay et al. 1986) in a selection process from the normal population to determine whether or not a child develops Perthes' disease.

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