

A STUDY OF RADIOGRAPHIC VARIATIONS OF THE HIP JOINT

TATSUKI KASHIMOTO & ZACHARY B. FRIEDENBERG

Department of Orthopaedic Surgery, Hospital of the University of Pennsylvania,
Philadelphia, Pennsylvania, USA.

Anteroposterior radiographs of the pelvis were studied in 920 patients free of hip joint diseases. The average joint space was between 3 and 4 mm in width. Narrowing of the superior joint space was seen in 13 percent of the hips and may represent the earliest finding in osteoarthritis. It was noted as early as the second and third decade in some patients. Other changes noted were narrowing of the lateral joint space, uniform narrowing of the space, an irregular joint space and tilting of the femoral head on the neck.

Key words: blurred eyebrow; CE-angle; femoral head ratio; joint space, narrowing

Accepted 5.vii.77

In most instances the etiology of osteoarthritis cannot be related to a specific injury or congenital malformation. Congenital dysplasia, coxa vara, Perthes' disease, overt slipped epiphysis and protrusio acetabuli are some conditions recognized as precursors of osteoarthritis. In order to cast some light on this problem a study was made of hip radiographs to determine what alterations exist in hips considered to be normal.

In an effort to determine the earliest roentgenographic abnormalities which may lead to manifest osteoarthritis of the hip, the anteroposterior views of urograms in 920 patients were studied.

Urograms were employed as they were the only available source of a large number of pelvic films showing the hip joints and because there is no known direct correlation between urinary tract diseases and degenerative joint disease of the hip joint.

MATERIALS AND METHOD

The 920 urograms were selected at random from the radiographic files of the University of Pennsylvania. Any film with established changes of osteoarthritis such as total joint narrowing, sclerosis of the subchondral bone, osteophytes, cysts or irregular surfaces was discarded. Any film in which a true anteroposterior projection was not made was also not used.

The hips were reviewed with particular attention to the interspace distance between the head and the acetabulum and for changes in the acetabular and femoral surfaces. Age, sex and race were known and the CE angle and interspace distance were measured.

The joint space distance was measured on a vertical line through the geometric center of the head. The narrowest joint space distance was also measured on a line passing through the geometric center (Figure 1). The CE angle was measured as described by Wiberg (1939).

Displacement of the femoral head on the neck was measured according to Murray (1965) using the "femoral head ratio", FHR. A line was drawn from the most lateral part of the greater trochanter to the most medial part of the lesser trochanter and the center was determined. The

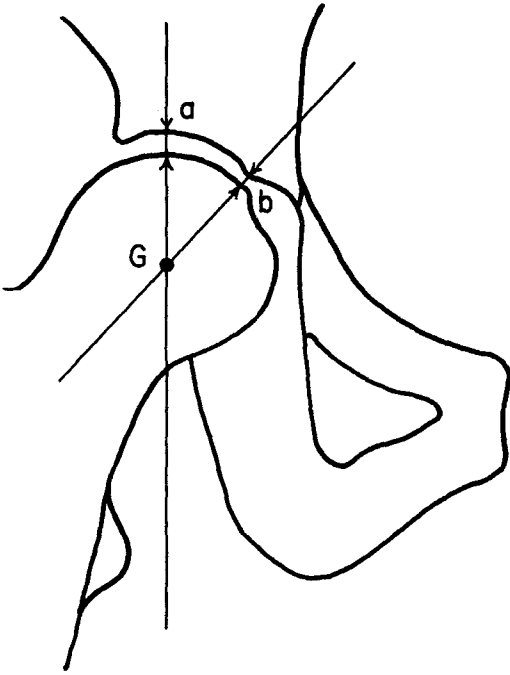


Figure 1. Measurement of joint space distance.
a: Joint space distance on the vertical line that passes the geometric center of the femoral head.
b: Joint space distance at the narrowest part.
G: Geometric center of the femoral head.

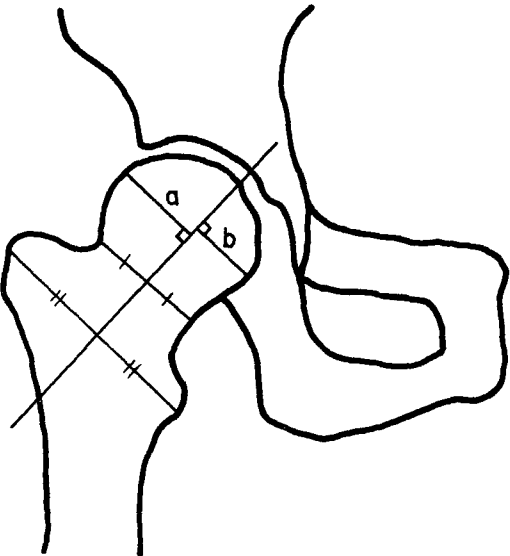


Figure 2. Femoral head ratio.
 $\frac{b}{a}$ = Femoral head ratio

center point at the narrowest part of the neck was also established and a line was then drawn connecting these two points and extending into the proximal femoral head. The maximum distance to each side of the head is measured from this line, the most lateral distance expressed by "a" and the most medial distance by "b". b/a is called the femoral head ratio (Figure 2).

RESULTS

The average joint space distance measured on the vertical line "a" as in Figure 1 was 3.8 mm in males (standard deviation 0.9 mm); in females the average was 3.5 mm (standard deviation 0.8 mm). A joint space of 2 mm or less was regarded as abnormal. Individuals younger than 10 years showed a wider joint space than older individuals but few of our patients were in this age group. The average joint space did not significantly diminish with age (Figure 3).

The variations noted were as follows:

1) A superior narrowed joint space

This was the joint space measured at the narrowest part between the superior surface of the head and the acetabulum and corresponds to the oblique line "b" drawn through the geometric center of the head as in Figure 1. This was the largest group deviating from the normal or average radiograph. 236 of the 1840 hips were in this group (12.8 percent). The joint space was narrowest where the most prominent weight-bearing trabeculae passing from the head to the pelvis were found. This point is usually located in the weight-bearing area at the superior part of the dome of the femoral head. In males this change was first noted in the second decade. The incidence increased gradually and reached a maximum in the fourth decade. It decreased in the fifth and sixth decades, and its incidence again increased in the seventh and eighth decades. The average for males was 14.9 percent.

In females this narrowing was most common in the seventh decade and the

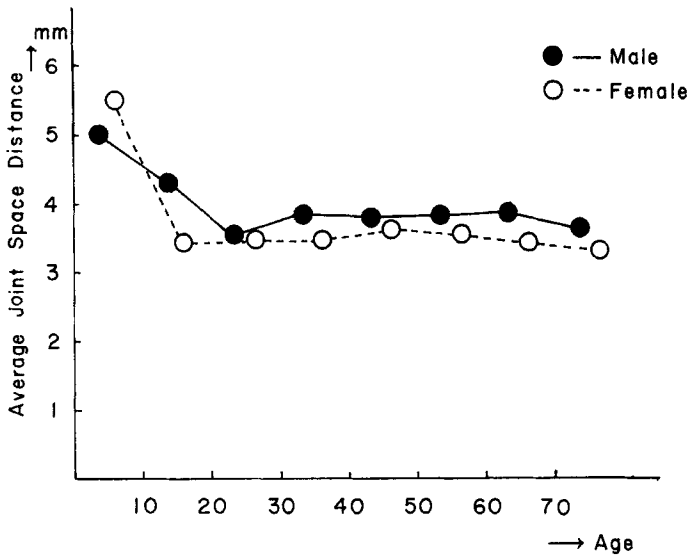


Figure 3. Joint space distance at different ages.

incidence decreased significantly in the eighth decade. The average for females was 10.7 percent. The interesting features of this group were: (1) This finding was first seen in the younger patients in the second or third decade and (2) in the older patients the finding was not associated with radiologic osteoarthritis (Table 1 and Figure 4).

2) Lateral narrowed joint space

The lateral joint space is between the lateral border of the acetabulum and

head. Narrowing of the lateral joint space was seen in 24 hips (1.3 percent). The narrowing was always found at the most lateral part of the joint, which is not in the major weight-bearing area. Changes were first seen in the fourth decade and were present in each subsequent decade but did not increase significantly (Table 2). This finding was more common in females (Figure 5).

3) Uniformly narrowed joint space

The joint space was less than 2 mm in

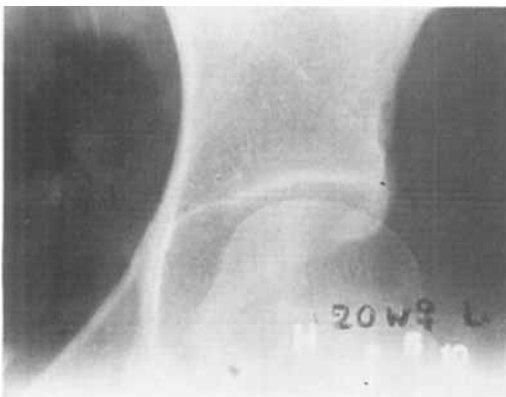


Figure 4. Superior narrowed joint space on the left. 20-year-old white female had left superior narrowed joint space. CE angle: 24°. Over the superior head, joint space was 2 mm.

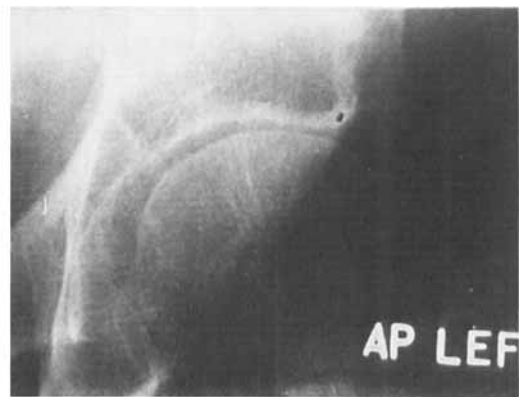


Figure 5. Lateral narrowed joint space on the left. 62-year-old white male had left lateral narrowed joint space. CE angle, 29°. Lateral interspace was 1 mm.

Table 1. Superior narrowed joint space.

	Age	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-89	Total
Male	Narrowed	0	2	6	20	16	30	44	23	141
	Hips in each age group	2	56	88	98	138	212	232	122	948
	%	0	3.6	6.8	20.4	11.6	14.2	19.0	18.9	14.9
Female	Narrowed	0	0	7	8	16	14	38	12	95
	Hips in each age group	8	48	132	114	172	170	146	102	892
	%	0	0	5.3	7.0	9.3	8.2	26.0	11.8	10.7

Table 2. Lateral narrowed joint space.

	Age	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-89	Total
Male	Narrowed	0	0	0	2	0	0	2	2	6
	Hips in each age group	2	56	88	98	138	212	232	122	948
	%	0	0	0	2.0	0	0	0.9	1.6	0.6
Female	Narrowed	0	0	0	2	8	3	5	0	18
	Hips in each age group	8	48	132	114	172	170	146	102	892
	%	0	0	0	1.8	4.7	1.8	3.4	0	2.0

Table 3. Thickened and diffuse lateral acetabular edge (blurred eyebrow).

	Age	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-89	Total
Male	Narrowed	0	2	0	2	5	2	9	1	21
	Hips in each age group	2	56	88	98	138	212	232	122	948
	%	0	3.6	0	2.0	3.6	0.9	3.9	0.8	2.2
Female	Narrowed	0	0	1	2	0	4	4	2	13
	Hips in each age group	8	48	132	114	172	170	146	102	892
	%	0	0	0.8	1.8	0	2.4	2.7	2.0	1.5

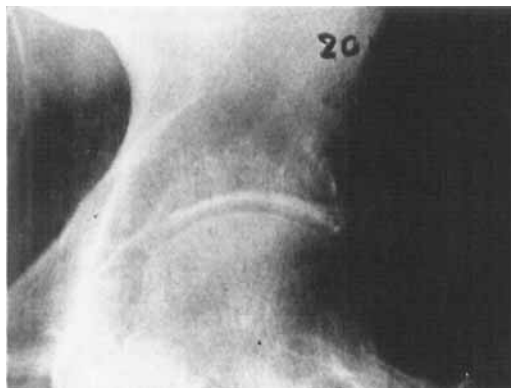


Figure 6. Uniformly narrowed joint space. 20-year-old white male had bilateral uniformly narrowed joint space. CE angle, right 24° , left 34° . Joint space distance: right 2 mm, left 2 mm. Left hip is shown.

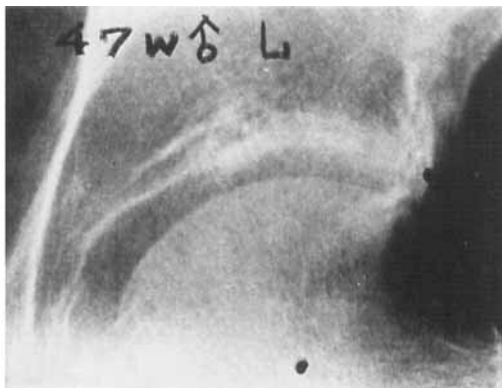


Figure 7. Diffuse lateral acetabular edge (blurred eyebrow). 47-year-old white male had hips with blurred eyebrow. CE angle: right 27° , left 34° . Joint space distance: right 5 mm, and left 4 mm. Left hip is shown.

three measurements along lines drawn through the geometric center on these films. There were three male and four female hips in this group (Figure 6).

4) Thickened and diffuse lateral acetabular edge (blurred eyebrow)

These films showed an interesting loss of clarity of the lateral acetabular edge which was thickened in the para-articular zone. The thickened part was likened to an eyebrow covering the lateral femoral head. The change was distributed rather uniformly in each decade, being highest in the seventh in both sexes. The total number of hips with this "blurred eyebrow" was 34 (1.8 percent), 21 in males and 13 in females (Table 3 and Figure 7).

5) Changes in the shape of the femoral head

Radiographs in this group revealed femoral heads which were asymmetrical in the anteroposterior plane. This group differed from the superior narrowed, the lateral narrowed or uniformly narrowed groups in that there were abrupt alterations of the joint space secondary to ir-

regularity of the femoral head surface. Five such hips were seen (0.3 percent). Three were in males, two in females (Figure 8).

6) Displacement of the femoral head

When a femoral head deviated from the neck axis, it was always in an inferior direction. In each of these hips the femoral head ratio was greater than 1.35 indicating an inferior displacement. Sev-

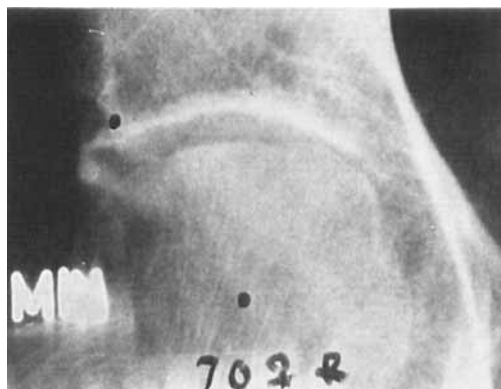


Figure 8. Change in the shape of the femoral head. 70-year-old female with bilateral femoral head irregularity. Interspace was 4 mm in both hips, and CE angle was 36° in both hips. Right hip is shown.



Figure 9. Displacement of femoral head on the neck. 58-year-old white male, both femoral heads deviate inferomedially. CE angle: right 27°, left 25°. FHR: right $\frac{34}{25} = 1.36$, left $\frac{34}{24} = 1.42$. Left hip is shown. (FHR of more than 1.35 shows tendency for inferomedial displacement of the femoral head.)

en hips showed a change of this type (0.4 percent). All were in males (Figure 9).

In 141 male hips in which none of the above abnormalities were noted the average CE angle was 32° (standard deviation 6.6°). The minimum was 15° and the maximum 47°. In 95 female hips showing no abnormalities, the CE angle was 35° (standard deviation 7.4°). The minimum was 19° and the maximum 56°. In both male and female hips showing a superior narrowed joint space no significant change in CE angle was noted. No correlation could be made between the CE angle and the other abnormalities studied (Table 4).

DISCUSSION

Degenerative joint disease of the hip is associated with a narrow, irregular joint space in the advanced state. In this study 85 percent of the hip joints showed a uniform joint space without local narrowing. Superior joint space narrowing occurred in 13 percent of the hips (in 82 percent of these hips, it was bilateral). Bilaterality of the other hip variations was not common (Table 5). This narrowing was more common in the older age groups and may be an early stage of degenerative joint disease. If this type of narrowing is a precursor of an osteoarthritis, it may develop at an early age in some individuals as it was seen in the

Table 4. CE angle versus each group of variations noted.

		No. of hips	Min.	Av.	S.D.	Max.
1	Normal, male	141	15°	32.0°	6.6°	46°
	Normal, female	95	19	35.0	7.4	56
	Superior narrowed, male	141	18	34.2	7.3	55
	Superior narrowed, female	95	14	33.2	6.7	56
2	Lateral narrowed	24	16	32.4	--	42
3	Uniformly narrowed	7	20	37.4	--	46
4	Blurred eyebrow	34	23	33.4	--	56
5	Change in femoral head shape	5	25	30.7	--	36
6	Displacem. of the femoral head on the neck	7	23	29.2	--	37

Av.: Average

S.D.: Standard deviation

Table 5. Incidence of bilaterality.

		Superior narrowed	Lateral narrowed	Uniformly narrowed	Acetabular change	Irregular fem. head.	Head tilt
Male	No. of bilat. pt.	59	1	1	6	1	1
	No. of pt.	82	5	2	15	2	6
	%	72.0	20	50	40	50	16.7
Female	No. of bilat. pt.	46	3	1	4	1	0
	No. of pt.	49	15	3	9	1	0
	%	93.9	20	33.3	44.4	100	0

second and third decades. If a subtle narrowing is a harbinger of joint disease in later life, it should be possible to identify the individuals who may develop this condition at an early age. The narrowed area coincides with the weight-bearing area where prominent trabeculae straddle the joint.

The shifting of the femoral head relative to the neck has been described by Murray (1965) as a tilt deformity and he felt this could be the result of a minimally slipped capital epiphysis. Five hips showed such a deformity which may well lead to an osteoarthritis.

The "blurred eyebrow" was seen in

two percent of the hips. The pathology of this condition has not been described to our knowledge. It would appear to be a very early stage of subchondral sclerosis perhaps related to alteration of weight-bearing stresses with a lateral shift of the weight-bearing axis.

REFERENCES

- Murray, R. O. (1965) The aetiology of primary osteoarthritis of the hip. *Brit. J. Radiol.* **38**, 810-824.
 Wiberg, G. (1939) Studies on dysplastic acetabular and congenital subluxation of the hip joint. *Acta chir. scand.* **88**, Suppl. 58.

Correspondence to: Tatsuki Kashimoto, M.D., 26 Haruna-cho, Tanaka, Sakyo-ku, Kyoto 606, Japan.