THE VALUE OF SCINTIGRAPHY IN HIPS WITH SLIPPED CAPITAL FEMORAL EPIPHYSIS AND THE VALUE OF RADIOGRAPHY AND MRI AFTER 10 YEARS

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Preoperative bone scintigraphy of the femoral head in 33 hips with slipped capital femoral epiphysis, showed no relation to duration of symptoms or degree of slip. The preoperative uptake was always normal or increased. Two hips had postoperative femoral head uptake below normal, both had complications affecting the vascular supply, resulting in necrosis of the femoral head and severe arthrosis. At follow-up after 10 (5-15) years of 28 hips, no relation could be demonstrated between Adolescent Hip Questionnaire which included clinical data, and radiography or magnetic resonance imaging. We only recommend scintigraphy after complications jeopardizing the vascular supply of the femoral head in slipped capital femoral epiphysis.

Keywords : slipped capital femoral epiphysis ; scintigraphy ; follow-up.

Mots-clés : épiphysiolyse fémorale proximale ; scintigraphie ; suivi.

Bone scintigraphy, indicating the vascular status of the femoral head, has been recommended as a valuable basis for decisions regarding treatment of patients with Slipped Capital Femoral Epiphysis (SCFE) (4, 12), but these series are small and not consecutive. Randomized studies are not available and would bee difficult to perform with these patients.

In order to estimate the value of preoperative scintigraphy, we compared the preoperative scintigraphic uptake of 33 consecutive femoral heads suffering from SCFE, with the degree of slip and duration of symptoms.

We compared the scintigraphic status after operation with the status at follow-up in 14 femoral heads operated with realignment or osteotomy. In case of a change in the femoral head uptake after surgery, the operative procedure as well as the follow-up status were analyzed.

At follow-up after 10 years we recorded the status in 28 hips according to the Adolescent Hip Questionnaire (AHQ), including clinical examination. The patients' status was compared to the findings at follow-up from radiography and Magnatic Resonance Imaging (MRI) in order to evaluate the use of these investigations at follow-up.

PATIENTS AND METHODS

The material consisted of 33 consecutive hips treated for SCFE from 1979 through 1989 in 28 patients with preoperative bone scintigraphy. The scintigraphy was performed less than three days before operation and all patients had pain at that time. One patient had accidently no preoperative scintigraphy and one scintigraphy was inconclusive leaving 31 hips, 13 right and 18 left in 26 patients available for preoperative study. The patients, 10 males and 16 females, were from 9 to 16 (average 13) years old. The preoperative scintigraphic status was compared to duration of symptoms and degree of slip. Four of the hips had had acute SCFE with symptoms for less than three weeks. The degree of slipping was classified according to table I (16).

At follow-up at an average of 10 (5-15) years after operation, one patient had died and two patients lived

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outside Denmark leaving 28 hips in 23 patients available for follow-up investigation. At operation fixation was achieved by two cannulated screws. Twelve hips had in situ fixation and postoperative scintigraphy was not performed, four had gentle closed realignment followed by fixation, 11 had an osteotomy of the femoral neck and one had an intertrochanteric osteotomy. We had three reoperations, one because femoral neck osteotomy following in situ fixation was required and two due to malposition of screws. The screws were removed after fusion except in one patient who denied this procedure. The 16 hips with realignment or osteotomy had postoperative scintigraphy performed on average 12 (range 6-47) days after the operation. One scintigram was lost and one was inconclusive. Accordingly the postoperative scintigraphic status in 14 hips could be compared to the status at follow-up.

Bone scintigraphy was performed using an age related intravenous dose of Tc-99m methylene-di-phosphonate, of 0.20-0.25 mCi (7.4-9.3 MBq) per kg body weight. Planar scintigraphic images in anterior and posterior projections were acquired three hours later using a gammacamera (GE Medical Systems) with a conventional, low energy, high resolution, parallel hole, collimator and a 20 % window centred on the 140 keV peak. For this study all scintigrams were evaluated semi-quantitatively to consensus by three trained observers. The uptake in the femoral head was graded as follows: decreased, focally decreased, normal or increased.

The clinical follow-up investigation was performed according to Adolescent Hip Questionnaire (AHQ) (table II).

Radiography at follow-up was performed using the standing Anterior-Posterior (A-P) view of the pelvis and Lauenstein's projection. From the standing A-P view sequelae from femoral head necrosis were found and signs of arthrosis were graded according to Boyer (1). We made a slight modification and defined the limits for narrowing of the superior joint space (Table II). A superior joint space in the standing A-P view of 3 mm or less has been considered abnormal at follow-up after SCFE (7).

MRI images at follow-up were acquired using a Fonar conducting system operating at 0.3 T using axial T1 weighted scout. In the coronal plane T1 and T2 weighted sequences and in the sagittal plane T1 weighted sequences were obtained with a slice thickness of 5 mm. Six hips in five patients did not have MRI, two patients refused, two were overweight and one had the screws in situ. Accordingly 22 hips were available for MRI. Synovitis and focal changes in the acetabulum and in the femoral head were noted. Sequelae from the screws were excluded.

The investigation was in accordance with the Helsinki declaration II and approved (No. (KF) V 92-282) by the local ethic committee. Non-parametric statistical evaluation using Fisher's exact test for nominal data and Wilcoxon's two sample test (Mann-Whitney U-test) for ordinal data were used with $p = 0,05$ as the significance level.

RESULTS

The 31 preoperative scintigraphies showed 18 femoral heads with increased and 13 with normal uptake. Of the 11 hips with severe (group 3) slipping five had normal and six had increased scintigraphic uptake. No relation between degree of slip and preoperative femoral head uptake was found (Wilcoxon's two sample test). In the four acute cases of SCFE two femoral heads with normal and two with increased uptake were found. Of the 14 hips with realignment or osteotomy followed by postoperative scintigraphy, 4 had increased and 8 had normal uptake, one focally decreased and one decreased uptake (table I).

Comparing the preoperative and postoperative femoral head uptake we found a shift in five hips (table I). In three of these five hips the postoperative uptake were classified as normal or increased. These three patients had no complications and no signs of arthrosis or necrosis of the femoral head at follow-up. One patient changed from increased to focally decreased uptake. This patient had osteotomy of the femoral neck, but during the operation the physis loosened totally. Segmental necrosis of the femoral head developed in spite of non-weight bearing and physiotherapy. At follow-up grade III arthrosis, severe pain and a AHQ score of 30 were found. The fifth patient changed from normal to decreased uptake. As the only patient in this study this patient was primarily operated elsewhere, but fixation was not achieved and the head was displaced. The patient was transferred, realignment and fixation of the femoral head were performed. Necrosis of the femoral head developed in spite of non-weight bearing and physiotherapy. At follow-up sequelae from necrosis of the femoral head, severe pain and an AHQ

Table I

A	B	C	D	E	F	G	H	I	J	K	L	M
1	1	4	1	-	2	N	Y	N	N	1	N	48
2	1	4	1	-	1	N	Y	N	N	2	N	48
3	1	4	1	-	0	N	N	Y	N	2	N	46
4	3	3	2	1	N	-	-	-	Y	1	Y	27
5	2	4	1	-	0	Y	Y	Y	N	1	N	47
6	1	4	3	-	0	-	-	-	Y	2	Y	33
7	3	4	1	-	0	N	Y	N	N	2	N	50
8	2	4	2	3	0	N	Y	N	Y	3	Y	34
9	1	3	3	3	2	-	-	-	Y	1	Y	35
10	3	3	3	3	2	-	-	-	Y	2	Y	37
11	2	3	3	4	0	N	Y	Y	Y	1	Y	39
12	3	4	3	2	3	Y	Y	N	Y	2	Y	30
13	3	4	3	4	0	-	-	-	Y	2	N	46
14	3	4	3	3	0	N	N	N	Y	2	N	38
15	2	3	1	-	0	N	Y	Y	Y	2	N	39
16	2	3	3	3	0	N	Y	Y	N	2	Y	37
17	3	3	1	-	0	N	N	Y	Y	2	Y	44
18	3	3	3	3	1	Y	N	Y	Y	3	Y	46
19	1	4	1	-	0	N	Y	N	N	2	N	48
20	3	4	2	4	0	N	N	Y	Y	3	N	41
21	1	4	1	-	0	N	Y	N	Y	2	N	50
22	2	3	3	3	2	Y	Y	N	Y	2	N	37
23	1	3	1	-	0	N	N	N	N	3	N	50
24	2	4	4	4	0	-	-	-	Y	1	Y	32
25	2	4	3	-	0	N	Y	N	N	2	N	36
26	1	3	1	-	0	N	N	N	N	2	N	47
27	1	3	1	-	0	N	Y	N	N	2	N	47
28	3	3	2	3	0	N	Y	N	N	2	N	46

Principal data from the 28 hips available for follow-up. The following hips belongs to the same patient : 9 and 10, 14 and 15, 17 and 18, 22 and 23, 26 and 27.

A : Hip no.

B : Amount of preoperative slip compared to femoral neck diameter. 1 : < 1/3, 2 : 1/3-1/2, 3 : > 1/2.

C : Preoperative scintigraphic uptake in the femoral head. 1 : Decreased uptake, 2 : Focally decreased uptake, 3 : Normal uptake, 4 : Increased uptake.

D : Type of operation. 1 : In situ fixation, 2 : Realignment and fixation, 3 : Femoral neck osteotomy, 4 : Intertrochanteric osteotomy.

E : Postoperative scintigraphic uptake in the femoral head, classified as under C.

F : Necrosis and grading of arthrosis at follow-up. Grade 0 : no degenerative changes, 1 : no more than one subchondral cyst or one osteophyte, no bone sclerosis and normal width of the joint space, 2 : one or a few subchondral cysts as well as osteophytes, minimum subchondral sclerosis and slight joint space narrowing (3 mm or less, but more than 2 mm), 3 : multiple subchondral cysts and osteophytes, marked subchondral sclerosis and moderate or severe joint space narrowing (2 mm or less), N : Necrosis of the femoral head.

G : MRI at follow-up, focal changes in the femoral head excluding sequelae from the screws Yes/No.

H : MRI at follow-up, focal changes in the acetabulum Yes/No.

I : MRI at follow-up, synovitis Yes/No.

J : AHQ at follow-up, pain Yes/No.

K : AHQ at follow-up, internal rotation. 1 : < 10 degr., 2 : 10-30 degr., 3 : > 30 degr.

L : AHQ at follow-up, limping Yes/No.

M : AHQ at follow-up, total score.

score of 27 were found. AHQ scores of 27 and 30 were the lowest scores in this study. The principal data from the 28 hips available at follow-up are shown in table I. Radiographic examination showing necrosis of the femoral head in one hip and arthrosis was found and classified in seven hips (table I). Arthrosis was not found in the four hips with increased postoperative femoral head uptake. Five of seven patients with arthrosis had pain at follow-up. No significant relation between arthrosis and the AHQ score were found (Wilcoxon's two sample test).

MRI in 22 hips with SCFE showed focal changes in the bone, like subchondral defects, sclerosis or irregularities were seen only in four femoral heads, as sequelae from the screws were excluded, but in 14 acetabulae. Synovitis were found in eight hips of wich five had pain. No relation was found between synovitis and focal changes in the bone both demonstrated on MRI (Fisher's exact test). Synovitis or focal changes in the bone was not related to the AHQ score (Wilcoxon's two sample test).

Questioning and clinical examination at follow-up according to AHQ are shown in detail in table II. Eleven could experience pain, 11 could experience a limp and 24 had internal rotation below 31 degrees. Of the 11 hips with pain only five had arthrosis. Of the 11 patients with a limp only four had arthrosis. Neither between pain and arthrosis nor between limp and arthrosis was a significant relation demonstrated (Fisher's exact test). The average score according to AHQ was 41.4 (range 27-50) points. Data regarding pain, internal rotation and limping are included in table I along with the total AHQ score.

DISCUSSION

None of the 31 preoperative scintigraphies showed decreased uptake not even in acute or severe slipping. The vascular supply of the femoral head in this age group (9-16 years) comes mainly from the lateral epiphyseal arteries located on the superior aspect of the femoral neck (2, 15). As the main direction of slipping is posteriorly (5, 10), the lateral epiphyseal vessels are curved posteriorly with little elongation. Slipping often takes place gradually, giving the vessels time to adjust. This might explain the degree of slip being unrelated to the preoperative scintigraphic uptake in our study where only four hips had symptoms for less than three weeks. In a study of SCFE with physeal instability (9), three cases of epiphyseal avascularity

Table II

Points	1	2 (pain 6)	3 (pain 12)
pain	severe, *5*	mild, *6*	none, *17*
flexion	$<90°$, *2*	90-120°, *15*	normal, *11*
extension defect	$>30°$, *0*	10-30°, *0*	normal, *28*
adduction	$<10°$, *0*	10-30°, *22*	normal, *6*
abduction	$<10°$, *0*	10-30°, *3*	normal, *25*
int. rotation	$<10°$, *6*	10-30°, *18*	normal, *4*
ext. rotation	$<10°$, *0*	10-30°, *7*	normal, *21*
limping	severe, *0*	moderate, *11*	none, *17*
Trendelenburg sign	immediate, *1*	after 30 sec., *1*	negative, *26*
limb length diff.	>2cm, *1*	1-2cm, *10*	normal, *17*
walking	household, *0*	limited, *12*	unlimit. *16*
crutches	two, *0*	one, *0*	none, *28*
sitting	impossible, *0*	spec. seat, *0*	normal, *28*
sports	no, *15*	limited, *4*	yes, *9*

Adolescent Hip Questionnaire used for follow-up of 28 hips in 23 patients with SCFE. Pain has significant influence on the total score which goes from 12 to 51 points. For each group the number of patients are underlined. The questionnaire was presented at the meeting of the European Paediatric Orthopaedic Society in Vienna 1993 by F. Grill.

were noted in preoperative scintigraphies in 12 hips with effusion, only one developed femoral head necrosis. The femoral head avascularity could be due to increased intracapsular pressure from the effusion. Puncture was not performed.

At the time of preoperative scintigraphy all patients had pain. The pain may not be attributed to impaired vascular supply in the femoral head according to the findings from the preoperative scintigraphies. Pain has traditionally been attributed to synovitis often described in SCFE (8). In human synovial membrane, nerve fibers containing the neuropeptides substance P (SP) and calcitonin gene-related peptide (CGRP) both related to sensory function, have been found (6). The presence of nerves has been demonstrated in cartilage canals in uncalcified epiphyseal cartilage in the human femoral head (13). In pigs these nerves have been shown to contain SP and CGRP among other neuropeptides (14). Accordingly nociception from the epiphyseal cartilage is a possibility in SCFE as well as from the synovial membrane.

Radiographic grading of early arthrosis or chondrolysis following SCFE is difficult as reduction of the joint space can be overestimated. The thickness of the articular cartilage varies from 3.5 to 1.5 mm on the adult femoral head (11). The thickest cartilage covers the upper part of the femoral head. When the head slips, a part of the head with a thinner covering of cartilage most likely is brought in articulation with the acetabular roof leading to reduction of the joint space. The height of the joint space at follow-up cannot be compared to the height at the postoperative radiographs since ossification is not completed at this time. These diagnostic difficulties in early radiographic arthrosis following SCFE could account for the missing relation between radiography and AHQ scores.

Of the 22 hips subjected to MRI, focal changes were found in the acetabulum in 14 of the hips with SCFE, but only in four femoral heads, disregarding sequelae from the screws. This observation could be consistent with the findings at arthroscopy in hips with SCFE. Arthroscopy has shown erosion of the antero-superior part of the acetabular cartilage caused by the uncovered part of the metaphysis and detachment of the posterior part of the acetabular labrum caused by the displacement of the femoral head (3). The focal changes in the acetabulum demonstrated by MRI indicate that the primary damage to the acetabular cartilage can lead to permanent sequelae. These sequelae could be of importance to late arthrosis.

Pain or AHQ scores had no significant relation to radiographic arthrosis or findings from MRI at follow-up after 10 (5-15) years. Due to the limited number of patients there exists some risk of not disclosing a significant relation when one actually exists.

The only two complications expected to jeopardize the vascular supply of the femoral head, were found in the two patients who developed segmental and total necrosis of the femoral head. They had both decreased uptake at postoperative scintigraphy. Preoperative scintigraphy is not indicated as a routine procedure. We recommend postoperative scintigraphy following complications or operative procedures bringing the vascular supply of the femoral head at risk.

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SAMENVATTING

H. STRANGE-VOGNSEN, A. WAGNER, K. DIRKSEN, A. RABØL, M. FOLKE (†), A. HEDE, S. CHRISTENSEN. De waarde van scintigrafie bij heupen met een epifysiolyse en de waarde van radiografie en MRI na 10 jaar.

Pre-operatieve botscintigrafie van de femurkop bij 33 heupen met epifysiolyse van de femurkop vertoonde geen relatie met de duur van de symptomen of de graad van afschuiving. De pre-operatieve opname was altijd normaal of toegenomen, 2 heupen hadden postoperatief een lagere opname, beiden hadden complicaties van vasculaire aard, met uiteindelijk resultaat een necrose van de femurkop en een ernstige artrose. Na een gemiddelde follow-up van 10 jaar (5 tot 15 jaar) van 28 heupen werd geen relatie gevonden tussen de heupenvragenlijst met klinische data ten opzichte van de radiografie en de magnetische resonantie. Wij bevelen alleen een scintigrafie aan bij complicaties van vasculaire aard.

RÉSUMÉ

H. STRANGE-VOGNSEN, A. WAGNER, K. DIRKSEN, A. RABØL, M. FOLKE (†), A. HEDE, S. CHRISTENSEN. Intérêt de la scintigraphie dans l'épiphysiolyse de la hanche et intérêt de l'étude radiographique et en RMN après 10 ans.

Les auteurs ont réalisé une scintigraphie osseuse préopératoire de la hanche dans 33 cas d'épiphysiolyse du fémur proximal ; ils n'ont observé aucune relation avec la durée des symptômes ou le stade de glissement. L'incorporation de radio-isotope en préopératoire était dans tous les cas normale ou augmentée. Une hypofixation a été observée dans deux cas en post-opératoire ; ces deux cas ont présenté des complications qui ont affecté la vascularisation de la tête, aboutissant à une ostéonécrose céphalique et à une arthrose sévère. Une étude de catamnèse à 10 ans (5-15) réalisée sur 28 hanches n'a montré aucune relation entre le score clinique et les données radiographiques ou de l'IRM. Les auteurs ne recommandent la scintigraphie qu'en cas de complications qui mettent en danger la vascularisation de la tête fémorale, dans l'épiphysiolyse du fémur proximal.