Three-phase scintimetry in osteonecrosis of the knee

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Three-phase scintimetry with ^{99m}Tc MDP was analyzed in 40 patients with a clinical history of spontaneous onset of knee pain and a focal static isotope uptake in the femoral condyle indicating osteonecrosis. A strong correlation was found between pool-phase ratios and the static ratios. The pool-phase study did not add to the information obtained from the flow phase and static studies. There was a characteristic change of the pattern of the early flow-phase curves with the duration since the onset of symptoms indicating hyperemia early in the disease. A persistent high flow-phase and static-uptake ratio 6–12 months after the onset of symptoms correlated positively with a poor clinical and radiographic outcome. The 10 patients with a good prognosis had, as a group, a more rapid decrease in isotope uptake after 6 months. There was a positive correlation between a high static uptake ratio and the size of the lesion, and subsequently with the clinical and radiographic outcome. 30 patients developed arthrosis and/or severe clinical symptoms. Five of the 10 patients who did not develop arthrosis never developed radiographic evidence of osteonecrosis.

Spontaneous osteonecrosis of the knee was defined as a clinical entity by Ahlbäck et al. (1968). In its earlier stages, it is clinically (Rozing et al. 1980, Lotke et al. 1988) and scintigraphically (Ahlbäck et al. 1968, Lotke et al. 1977, Greyson et al. 1982) a well-defined disorder affecting the weight-bearing area of the medial or lateral femoral condyle. The etiology is unknown. Early in the course of primary osteonecrosis, radiography is usually normal and the diagnosis is primarily clinical and should be verified with a positive scintimetry. Scintimetry has been reported to be positive as early as 5 weeks after the onset of symptoms (Ahlbäck et al. 1968) and shows typically a high focal uptake at the site of the lesion, usually in the subchondral area of the weight-bearing portion of the medial femoral condyle.

Muheim and Bohne (1970) found that the prognosis with regards to future development of arthrosis could be assessed on the initial scintigraphic examination, where a small focal isotope uptake indicated future repair of the lesion with a low risk of articular cartilage collapse and arthrosis.

According to Greyson et al. (1982), three-phase scintimetry is more sensitive in determining the prognosis. A gradual decrease of hyperemia in the lesion as healing progressed could be demonstrated.

We analyzed the three-phase scintimetric pattern in suspected primary osteonecrosis of the knee and correlated scintimetric pattern with radiographic and clinical findings.

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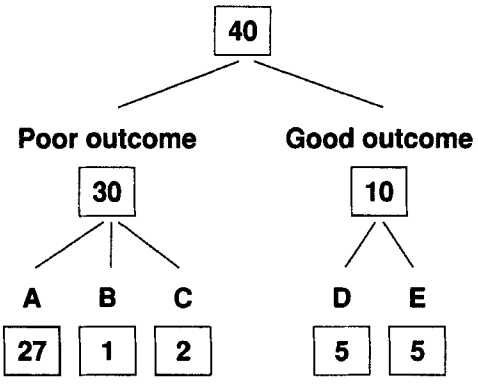


Figure 1. The clinical outcome in 40 patients with scintigraphic suspicion of osteonecrosis.
A. Radiographic osteonecrosis developing into arthrosis.
B. Radiographic osteonecrosis not developing into arthrosis, but with continuing severe pain.
C. No radiographic evidence of osteonecrosis, but developing into arthrosis.
D. Healing radiographic osteonecrosis. No pain.
E. No radiographic osteonecrosis. No pain.

Patients

Forty patients presenting with a clinical suspicion of primary osteonecrosis of the knee from August 1982 through August 1988 were included in the isotope study (Table 3). All the patients (31 females and 9 males) underwent static scintimetry, and 35 underwent three-phase scintimetry on one or more occasions from June 1986 until August 1988. The medial femoral condyle was affected in 37 cases, the lateral femoral condyle in 3 cases. The mean age at the onset of symptoms was 67 (41–85) years. None of our patients suffered from any concomitant significant disease, nor were they treated with any medication known to cause osteonecrosis.

The onset of symptoms was described by 35 patients as acute and by 5 patients as gradual. The mean duration of symptoms at the time of the first conventional radiography was 23 weeks. In 19 patients, conventional radiography was positive for osteonecrosis at the first examination, whereas in 7 patients there was never a positive radiographic verifi cation of the diagnosis during the course of the study. The mean duration of symptoms at the time of a positive conventional radiography was 34 weeks, i.e., the delay in radiographic diagnosis in these patients was 11 weeks. The duration of symptoms at the time of the first isotope study was 43 weeks. All the patients had a positive static scintimetry at this time, which was the prerequisite for inclusion into the study. Thirty patients had a follow-up scintimetry after 89 weeks after onset of symptoms, 19 patients had a third scintimetry at 126 weeks after the onset of symptoms, and 5 patients had a forth scintimetry at 149 weeks after the onset of symptoms.

Two patients (Cases 21 and 33) had previously had a medial unicompartmental arthroplasty in the contralateral knee and were thus excluded from the numerical scintimetric analysis to be described. Medial meniscectomy was performed in three knees in the early phase of the disease, in two of these before the radiographic development of osteonecrosis.

The clinical outcome was classified in two groups. In the good group, there were no radiographic signs of arthrosis, nor any clinical symptoms, at the time of follow-up. In the poor group, there was radiographic evidence of arthrosis and/or, as in 1 case, significant clinical symptoms (Figure 1).

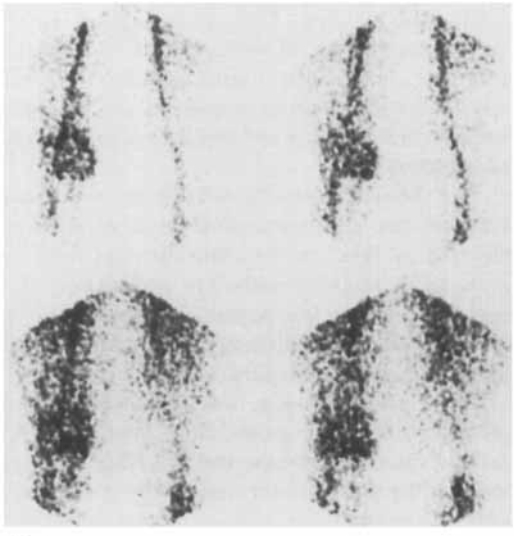
Methods

Scintimetry

The patient was placed in a supine position with the gammacamera in front of and in close contact with the knees. The camera (Technicare Sigma 438) was equipped with a low energy, all-purpose parallel-hole collimator. Totally, 370 MBq (10 mCi) of ^{99m}Tc-MDP was injected as a single bolus through an intravenous cannula in the forearm. The scintigraphic data were recorded in a computer (Technicare MCS 560) and were stored for numerical analysis.

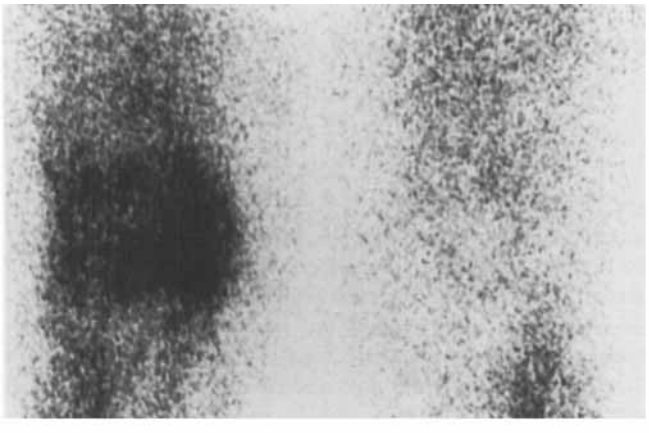
The flow phase was recorded with one frame every 2 seconds for the first minute following the injection (Figure 2). The blood-pool phase was recorded for 1 minute approximately 5 minutes after the injection in a frontal projection covering both knees as well as in a medial aspect of each knee. The static phase was recorded for 6 minutes after 3–4 hours following the injection using the same projections as in the blood-pool phase registration (Figure 3).

Numerical analysis was carried out in the registrations of all three phases as follows: a region of interest (ROI) was selected covering the site of the lesion. So was a region of reference (ROR) covering the corresponding area in the contralateral nonaffected knee. A ratio of isotope uptake in the ROI /ROR region was created in the blood-pool and static analyses. Activity versus time graphs in the ROI



2A

Figure 2. Part of a ^{99m}Tc MDP flow-phase scintimetry registration in a 79-year-old woman (Case 37) 9 weeks after acute onset of right knee pain (A). There is a focal isotope uptake in the medial femoral condyle. The blood-pool phase in the same patient is shown in an AP view (B) and a lateral view (C). A region of interest including the medial femoral condyle with its focal uptake and a corresponding region of reference in the contralateral knee is selected in the AP view for numerical analysis.



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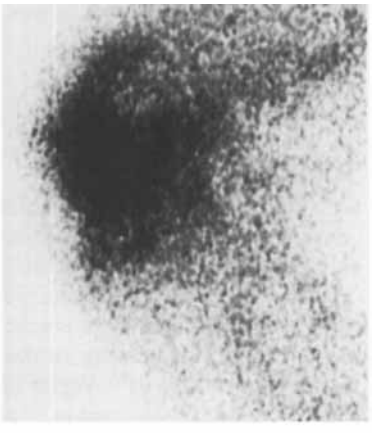

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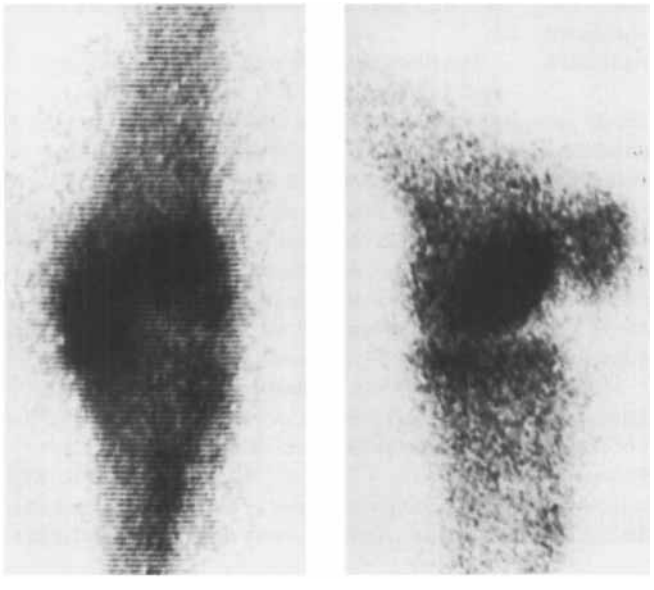

Figure 3. A static registration approximately 4 hours after the injection of isotope in a 49-year-old woman (Case 23) in an AP view (left) and a lateral view (right). The lateral view confirms the localization of the focal uptake to the medial femoral condyle.

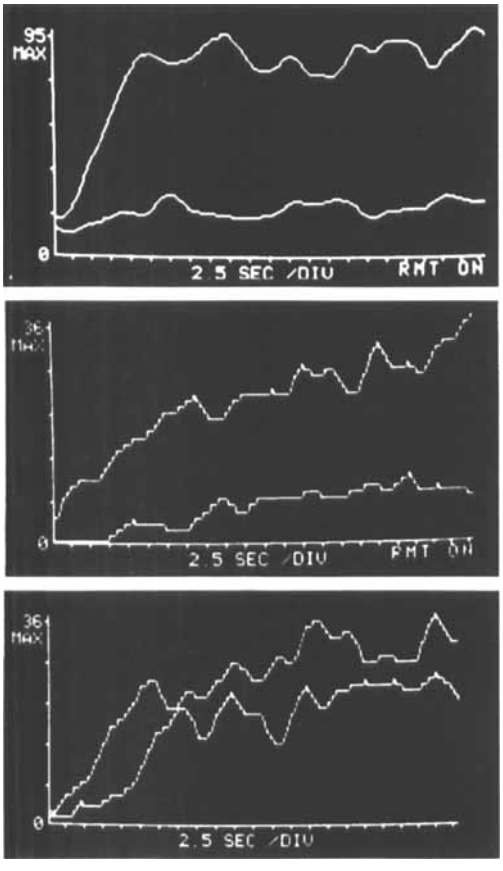

Figure 4. Time versus activity plots during the first minute of three different flow-phase studies. There is a rapid and distinct increase in blood flow in the affected knee; Type 1 flow-phase pattern (top). Type 2 flow-phase pattern with a moderate and slower initial increase in blood flow in the affected knee (middle) and Type 3 flow-phase pattern (bottom) with no significant difference in blood flow in the two knees.

and ROR, respectively, were created in the flow-phase studies, and the uptake ratio during the first minute of registration was calculated (Figure 4).

The scintigraphic findings were classified according to Greyson et al. (1982) and correlated with the clinical and radiographic outcome. The numerical scintimetric data were correlated with the clinical and radiographic outcome.

The mean size of the lesion on all the individual radiographs was measured according to Lotke et al. (1982), and was correlated with the clinical and radiographic outcome.

Table 1. Type of flow-phase pattern at the time of the first, second, third, and fourth scintimetric examination. Number of examinations

Type	1st	2nd	3rd	4th
1	9	9	2	0
2	1	7	1	2
3	1	2	2	1

Table 2. Three-phase pattern according to Greyson et al. (1982) related to the duration of symptoms and final outcome. The number of cases with a prognostically good outcome are within brackets

	Duration of symptoms (weeks)			
	0–26	27–52	53–104	> 104
Three-phase pattern				
acute	13 (4)	13 (3)	8 (0)	4 (0)
subacute		1 (1)	3 (1)	2 (1)
late	1 (1)	1 (1)	1 (1)	2 (0)
negative		1 (1)		1 (1)

Results

The mean age in the patients with a prognostically good outcome was 55 (41–77; SD 11) years, whereas in patients with a poor outcome the mean age was 71 (48–85; SD 10) years ($P < 0.001$).

The initial flow-phase activity ratio followed three types of curves. In Type 1 there was a very rapid and distinct immediate increase; in Type 2 there was a slower and moderate initial increase; in Type 3 there was no increase, i.e., no difference in uptake between the two knees compared (Figure 4). In the earlier stages of the disease, Type 1, reflecting the initial hypervascularization and hyperemia, was most frequent, whereas later in the disease there was a gradual shift towards Types 2 and 3 ($P < 0.01$) (Table 1). During the first 6 months after the onset of symptoms, the flow-phase ratios were prognostically nonsignificant, whereas there was a correlation ($P = 0.01$) between prognostically good results and lower flow-phase ratios from 6 to 12 months after onset of symptoms (Figure 5).

Like in the flow-phase study, there was a ($P < 0.05$) correlation between prognostically good results and lower blood-pool phase ratios from 6 to 12 months after the onset of symptoms.

The static ratios were correlated ($P < 0.05$) with the final outcome, a low static ratio indicating a

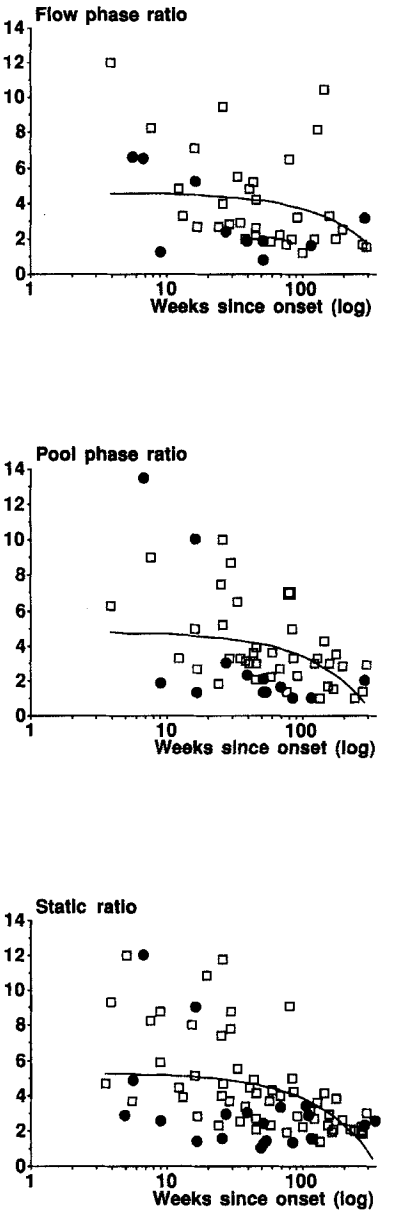

Figure 5. Isotope ratios versus duration of symptoms. Prognostically poor □ or good ● cases.

prognostically good result, more pronounced ($P < 0.02$) from 6 to 12 months after the onset of symptoms.

On scintigraphic nonnumerical classification of the three-phase patterns according to Greyson et al. (1982), no "acute" pattern was observed later than 12 months after the onset of symptoms in cases with a good final outcome (Table 2).

There was a strong correlation between the static ratios and blood-pool phase ratios. This correlation did not differ as regards the "Good" and "Poor" groups.

There was a correlation between the size of the lesion and the static uptake ratio ($P < 0.005$), more pronounced ($P = 0.001$) from 6 to 12 months after the onset of symptoms. There was also a correlation ($P < 0.0001$) between the final outcome and the size of the lesion.

Discussion

The typical clinical, radiographic, and radioisotope pattern of primary osteonecrosis of the knee was first described as a diagnostic entity by Ahlbäck et al. (1968) using strontium-85 scintimetry. A focal uptake in the medial femoral condyle was observed amounting to 5–15 times the uptake in the corresponding region in the contralateral knee. Ahlbäck et al. (1968) described 1 patient where scintimetry was positive with a 7-fold increase in isotope uptake as early as 5 weeks after the onset of symptoms and before a positive radiographic verification of the diagnosis.

Using three-phase scintimetry, Greyson et al. (1982) reported a gradual loss of the initial hyperemia, as reflected in the flow-phase study, as healing progressed. An acute pattern, including a positive flow-, pool- and static-phase study was the prominent finding in examinations performed during the first 6 months, while in the later stages of the disease there was a gradual decrease in blood flow as healing progressed. In accordance with this, we noticed that the dominating three-phase pattern initially, and during the first year, was the acute pattern irrespectively of the prognosis. In examinations performed more than 1 year after the onset of symptoms, the acute pattern was only noticed in the prognostically poor group (Table 2). The 10 patients with a good prognosis had, as a group, a more rapid decrease in both flow-phase and static uptake ratios after 6 months.

The development and the prognosis of arthrosis after primary osteonecrosis have radiographically been shown to depend on the size of the lesion (Ahlbäck et al. 1968, Muheim and Bohne 1970, Lotke et al. 1982). Our study, confirmed this correlation.

In our prognostically good group, 5 patients out of 10 never developed any radiographic evidence of osteonecrosis in spite of a characteristic focal isotope uptake in the medial femoral condyle. The 10

patients with a good prognosis differed scintimetrically in that their ratios were lower and decreased more rapidly over the course of the 6–12 months following the onset of symptoms They did however present with the same history, i.e., acute onset of pain not preceeded by trauma. These cases may represent a form of radiographically abortive osteonecrosis carrying a good prognosis (Lotke et al. 1977, Bauer et al. 1978, Rozing et al. 1980, Houpt et al. 1982, 1983). In most cases the patients could recall the exact day and in some cases even the exact hour when symptoms occurred. Although this is a typical history in radiographically verified osteonecrosis (Ahlbäck et al. 1968, Bauer 1978), it is also a typical history in stress fracture, a rare but well-defined condition of the medial tibial condyle producing an increased isotope uptake (Prather et al. 1977, Wilcox et al. 1977, Bauer 1978, Bauer et al. 1981). Stress fracture of the medial femoral condyle has not been shown radiographically, but could theoretically be the cause of the localized increase in isotope uptake seen in our 7 patients without radiographic evidence of osteonecrosis, and may also be considered as an element in the course of primary osteonecrosis (Engber 1977, Lotke et al. 1977, Houpt et al. 1983).

In algodystrophy a more diffuse and generalized uptake would be expected (Laurin et al. 1986).

Other alternative diagnoses include early osteochondritis dissecans and arthrosis. Although the age and sex distribution in arthrosis and in osteonecrosis are similar, there are substantial clinical, radiographic, and scintigraphic differences. In arthrosis the onset of symptoms is gradual and slowly progressive and the radiographic features of arthrosis are different from osteonecrosis. In the later stages of the disease in our patients, we observed a diffuse increase in isotope uptake in the knee also in the medial tibial condyle. This was not an early finding, which is usually the case in arthrosis (Bauer 1978, Lotke et al. 1982). Osteochondritis dissecans occurs in a much younger population and has another typical more central localization in the medial femoral condyle (Ahlbäck et al. 1968, Scott and Stevenson 1971, Lindén 1977).

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Table 3 Observations in 40 patients with primary osteonecrosis of the knee

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
1	1	2	41	102	102	0	2	105	1	–	–	1	–	2	3.4	1	0	283	2	2	3.1	2	2
2	1	2	53	4	24	19	1	25	1	–	–	1	–	2	4	1	0	246	3	3	–	3	1
3	2	1	67	15	90	75	1	92	1	–	–	1	–	2	–	1	0	251	3	–	–	3	–
4	2	1	68	259	259	0	1	272	1	–	–	1	–	2	2.2	1	1	298	2	–	1.5	2	2.9
5	2	1	51	4	26	22	1	57	1	–	–	1	–	2	3.7	1	1	114	1	–	–	1	–
6	1	1	79	3	6	3	1	5	1	–	–	1	–	2	–	1	0	–	–	–	–	–	–
7	1	2	67	45	45	0	1	49	1	–	–	1	–	2	–	1	1	166	3	–	–	3	–
8	1	2	58	139	139	0	1	144	2	1	10.5	2	4.3	2	4.1	1	1	178	2	1	2	2	3.5
9	2	1	76	11	11	0	1	16	1	–	–	1	–	2	8	1	0	121	1	–	–	1	–
10	2	2	64	1	5	4	1	5	1	–	–	1	–	2	12	1	0	131	2	2	8.2	2	3.3
11	2	1	74	6	–	–	1	9	1	–	–	1	–	2	5.9	1	0	77	3	3	1.7	2	1.4
12	1	2	62	2	69	67	1	92	2	1	3.2	2	2.3	2	2.8	1	1	124	2	2	2	2	3
13	2	1	75	3	13	10	1	46	2	1	2.6	2	2.1	2	2.1	1	1	–	–	–	–	–	–
14	2	2	73	5	5	0	1	6	1	–	–	1	–	2	3.7	1	1	13	2	1	3.3	2	–
15	2	2	61	3	–	–	1	5	1	–	–	1	–	2	2.8	1	0	9	2	1	1.2	2	1.8
16	1	1	55	22	43	21	1	27	2	1	2.4	2	3	2	2.9	1	0	51	2	2	1.8	2	2.1
17	2	2	48	24	24	0	1	30	1	–	–	1	–	2	7.8	1	0	44	2	2	5.2	2	3.6
18	2	2	55	109	–	–	1	111	1	–	–	1	–	2	2.8	1	0	117	3	–	1.6	3	1
19	2	1	71	7	7	0	1	37	1	–	–	–	–	2	–	1	1	–	–	–	–	–	–
20	2	2	85	24	24	0	1	46	2	1	4.2	2	3.9	2	4.1	2	3	–	–	–	–	–	–
21	2	2	70	3	3	0	1	76	3	3	–	2	–	2	–	1	2	–	–	–	–	–	–
22	2	2	59	12	12	0	1	58	2	1	1.8	2	2.2	2	2.3	1	2	–	–	–	–	–	–
23	2	2	49	13	13	0	1	69	3	–	–	2	1.6	2	3.3	1	0	–	–	–	–	–	–
24	2	1	61	2	–	–	2	6	1	–	6.6	1	–	2	4.8	1	0	17	3	–	–	2	1.3
25	2	2	83	23	23	0	2	41	2	1	4.8	2	3	2	4.4	1	3	86	2	–	–	2	3.3
26	2	2	61	6	36	29	1	17	1	–	–	1	–	2	–	1	0	35	2	2	2.9	2	3.3
27	2	1	73	5	5	0	1	80	2	–	6.5	2	7	2	9.1	1	4	–	–	–	–	–	–
28	2	2	81	11	11	0	1	11	1	–	–	1	–	2	–	1	4	25	2	–	–	2	7.5
29	1	1	71	13	13	0	2	30	2	–	–	2	8.7	2	8.8	1	3	–	–	–	–	–	–
30	2	1	65	3	16	13	1	7	2	1	6.5	2	13.5	2	12	1	0	39	2	2	1.8	2	2.3
31	1	1	48	7	–	–	2	16	2	1	5.2	2	10	2	9	2	0	53	3	–	–	2	1.3
32	2	1	42	7	39	32	1	36	1	–	–	1	–	2	–	1	0	52	3	–	0.8	2	1.3
33	2	1	77	7	–	–	1	16	1	–	–	1	–	2	–	1	0	46	2	–	–	2	–
34	2	2	82	2	2	0	1	4	1	–	–	1	–	2	–	1	0	29	2	1	2.8	2	3.3
35	2	2	83	6	6	0	1	20	1	–	–	1	–	2	10.9	2	1	26	2	1	4	2	10
36	2	1	84	1	3	3	1	2	1	–	–	1	–	2	–	1	0	4	2	1	12	2	6.3
37	2	1	79	7	7	0	1	9	1	–	–	1	–	2	8.8	1	0	16	2	1	7.1	2	5
38	2	1	75	5	–	–	1	12	2	2	4.8	2	3.3	2	4.4	1	0	24	2	1	2.7	2	1.8
39	2	1	74	1	9	8	1	4	1	–	–	1	–	2	4.7	1	0	8	2	1	8.3	2	9
40	2	2	84	8	16	8	1	17	2	–	2.7	2	2.7	2	2.8	1	1	–	–	–	–	–	–

A case
B sex: 1 male, 2 female
C side: 1 right, 2 left
D age
E duration of symptoms at 1st X-ray (wk)
F duration of symptoms at positive X-ray (wk)
G delay until X-ray diagnosis (wk)
H type of onset: 1 acute, 2 gradual

First examination
I duration of symptoms (wk)
J flow-phase study: 1 Not done, 2 Positive, 3 Negative
K type of flow-phase pattern
L flow-phase ratio
M pool-phase study: 1 not done, 2 positive, 3 negative
N pool-phase ratio
O static-phase study: 1 not done, 2 positive, 3 negative
P static-phase ratio
Q site of lesion
1 medial femoral condyle
2 lateral femoral condyle
R grade of arthrosis: 0 none , 1–5 Grades I–V

Second examination
S–X same as I–N

A	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW
1	2	2.3	6	345	3	–	–	2	–	2	2.5	6	–	–	–	–	–	–	–	–	–	1	30	1	2
2	2	2	–	273	3	–	–	3	–	2	2	–	–	–	–	–	–	–	–	–	–	2	26	1	1
3	2	–	1	278	3	3	1.7	3	1.4	2	1.8	1	–	–	–	–	–	–	–	–	–	2	29	1	1
4	2	3	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	36	1	1
5	2	3.1	1	206	3	–	–	3	–	–	–	–	–	–	–	–	–	–	–	–	–	2	23	1	1
6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	24	1	1
7	2	1.9	1	191	3	–	–	3	–	2	–	1	227	3	–	–	2	–	2	2.1	1	2	23	1	1
8	2	3.8	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	30	1	1
9	2	1.5	1	172	3	–	–	2	1.5	2	2.1	1	–	–	–	–	–	–	–	–	–	2	20	1	1
10	2	3.6	2	160	2	1	3.3	2	3	2	2.9	2	200	2	2	2.5	2	2.8	2	2.6	3	2	25	1	1
11	2	1.9	6	136	3	3	–	3	1	2	1.4	1	–	–	–	–	–	–	–	–	–	2	–	2	1
12	2	2.7	2	155	2	–	–	2	1.7	2	2.3	2	–	–	–	–	–	–	–	–	–	2	20	1	1
13	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	41	1	1
14	2	3.9	1	69	2	2	2.2	2	2.7	2	4	1	102	3	3	1.2	2	–	2	2.2	1	2	36	1	1
15	2	2.5	6	49	3	–	–	3	–	3	1	6	–	–	–	–	–	–	–	–	–	1	–	2	2
16	2	2.4	6	84	3	–	–	3	1	2	1.3	6	133	3	–	–	3	–	3	–	6	1	18	1	2
17	2	4.9	6	61	2	1	–	2	3.6	2	4.3	6	85	2	2	2	2	5	2	5	6	2	23	1	2
18	2	1.5	6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	2	2
19	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	40	1	1
20	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	48	1	1
21	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	29	1	1
22	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	38	1	1
23	–	–	6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	32	1	2
24	2	1.4	6	26	3	–	–	3	–	2	1.5	6	–	–	–	–	–	–	–	–	–	1	–	2	2
25	2	4.2	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	39	1	1
26	2	2.5	2	51	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	2	30	1	1
27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	50	1	1
28	2	7.4	5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	52	1	1
29	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	21	1	1
30	2	3	6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	28	1	2
31	2	1.4	6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	2	2
32	2	1.2	6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	13	1	2
33	2	–	6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	2	2
34	2	3.7	1	46	2	–	2.2	2	3	2	2.7	1	–	–	–	–	–	–	–	–	–	2	19	1	1
35	2	11.8	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	46	1	1
36	2	9.3	6	38	2	–	2	2	3.1	2	3.4	1	–	–	–	–	–	–	–	–	–	2	23	1	1
37	2	5.1	1	33	2	–	5.5	2	6.5	2	5.5	2	–	–	–	–	–	–	–	–	–	2	41	1	1
38	2	2.3	6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	2	1
39	2	8.3	1	26	2	–	9.5	2	5.2	2	4.7	2	–	–	–	–	–	–	–	–	–	2	32	1	1
40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	21	1	1

A case

Second examination, cont.
Y–AA same as in O–R, Table 3, part 1

Third examination
AB–AJ same as in I–R, Table 3, part 1

Fourth examination
AK–AS same as in I–R, Table 3, part 1

AT clinical outcome: 1 good, 2 poor
AU size of lesion according to Lotke
AV radiographically verified osteonecrosis: 1 yes, 2 no
AW radiographically verified arthrosis: 1 yes, 2 no