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OSTEONECROSIS IN RENAL TRANSPLANT RECIPIENTS

Early Radiological Detection and Course

JÖRG ANDRESEN & HANS EGON NIELSEN

Department of Diagnostic Radiology R and Medicine C, Aarhus Kommunehospital and University of Aarhus, Aarhus C, Denmark

Early radiologic signs and the radiologic course were examined retrospectively in 20 renal transplant patients who developed osteonecrosis after transplantation. Osteonecrosis appeared in 25 hips, 8 knees, 9 shoulders and 1 elbow. In most patients who developed osteonecrosis of the hip the early radiologic signs of osteonecrosis, with areas of lucencies and increased densities, were preceded by a thin fracture line in the immediate subchondral bone, parallel to the articular surface, appearing within a mean of 14 months after renal transplantation. This change seems to be a specific and very early finding in patients who subsequently develop osteonecrosis after renal transplantation. The initiation of collapsing phenomena of the articular surface was preceded by architectural changes near the articular surface with areas of lucencies and sclerosis. At the time of this investigation 26 per cent of the bones showed signs of regression of the changes with rebuilding of the former shape; 32 per cent showed progression and in 42 per cent the condition was stationary.

Key words: osteonecrosis, early signs, course; renal transplantation

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Osteonecrosis is a frequent and sometimes disabling complication of renal transplantation. The localization is most commonly the weight-bearing areas consisting of cancellous bone, i.e. the femoral head or the knee (Griffiths et al. 1974, Nielsen et al. 1977). The onset varies in different investigations from 5 to 35 months after the transplantation (Pierides et al. 1975, Bewick et al. 1976).

The present study was undertaken to evaluate early radiologic signs of posttransplant aseptic necrosis in the femoral and humeral heads and in the knees and elbows and to study the course of the radiologic changes in the bones involved.

MATERIAL AND METHOD

A total of 276 patients received a renal transplant during 1964–1978 and achieved graft function for more than 6 months. Twenty-four of them, 14 males and 10 females aged 19 to 60 years (mean 37.3 years), developed osteonecrosis after the renal transplantation. Twenty patients with osteonecrosis were available for the radiologic evaluation. Immunosuppressive therapy with prednisone and azathioprine was given with only minor changes in the dosage schedule over the years.

The patients were investigated with radiographs of the skull, the thoracic and lumbar spine, the pelvic bones and hips, the hands and feet, the knees and both clavicles at the time of transplantation and thereafter at intervals of 6 months to 2 years. The observation period after renal transplantation ranged from 1–12 years with a mean of 6 years. The radiographs were evaluated blindly at the time of this investigation.

RESULTS

Localization

The bone necrosis was usually present in the

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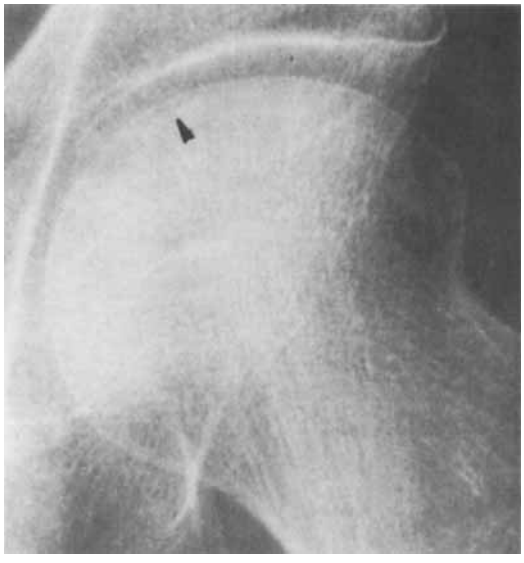

Figure 1. Typical radiolucent subcortical band parallel to the articular surface in the left hip in a 44-year-old man, occurring 5 months after renal transplantation.

weight-bearing bones composed mainly of cancellous bone and was most frequently localized to the femoral head. Table 1 shows the distribution of osteonecrotic areas. In 10 recipients the femoral heads alone were involved, in 4 recipients both the hips and shoulders, in 3 patients the knees alone and in the remaining 3 patients the hip and knee, the knee and elbow and the shoulder, respectively.

Appearance of radiolucent subcortical band. Figure 1 shows a radiolucent subcortical band in the femoral head parallel to the articular surface.

Table 1. Localization of osteonecrosis in 20 renal transplant recipients

	Femoral head	Femoral condyle	Humeral head	Elbow
Bones involved (*n*)	25	8	9	1
Patients (*n*)	15	5	5	1
Bilateral (*n*)	10	3	4	1
Unilateral (*n*)	5	2	1	
Right (*n*)	12	4	5	
Left (*n*)	13	4	4	1

This "crescent sign" was visible in the femoral head in 84 per cent of the patients (21/25) and appeared from 1 month to 36 months (mean 14 months) after renal transplantation. In the caput of one humerus and in one femoral condyle, it occurred 31 and 24 months after renal transplantation, respectively (Table 2). The appearance of the radiolucent subcortical band occurred before the onset of clinical symptoms with pain and restriction of movement and preceded the early architectural changes by a mean of 15 months in the hips and 10 months in the shoulder, whereas it developed at the same time as the architectural changes in the affected knee with areas of lucency and sclerosis.

Course of osteonecrosis (Tables 2 and 3)

The appearance in all bones involved was similar. The demineralization with lucency and increased radiopacity with sclerosis started in localized, circumscribed areas near the articular surface. At

Table 2. Time elapsing before development of radiologic bone changes in 20 renal transplant (RT) recipients who developed osteonecrosis after RT

	Radiolucent subcortical band			Initial architectural changes			Initial collapsing phenomena			Periosteal thickening		
	No. of bones	Months after RT range	mean	No. of bones	Months after RT range	mean	No. of bones	Months after RT range	mean	No. of bones	Months after RT range	mean
Hips (*n*=25)	21	1–36	14	25	6–75	29	25	6–108	34	13	22–66	40
Knees (*n*=8)	1	24		8	10–12	11	6	14–24	18	2	12	12
Shoulders (*n*=9)	1	31		9	1–48	27	6	24–75	37	1		41
Elbow (*n*=1)				1		30	1		57	1		33

Table 3. Radiological changes in 20 renal transplant (RT) recipients, who developed osteonecrosis after RT at the time of this study

	Stationary bone changes			Progression			Regression		
	No. of bones	Months after RT range	mean	No. of bones	Months after RT range	mean	No. of bones	Months after RT range	mean
Hips ($n=25$)	10	12–108	45	8	12–108	65	7	66–113	96
Knees ($n=8$)	2	75	75	3	77–85	80	3	27–96	67
Shoulders ($n=9$)	6	24–80	45	3	80–108	99			
Elbow ($n=1$)							1		60

this stage no collapse was seen and the joint spaces were maintained.

In the hips, collapsing phenomena could be seen within a mean of 5 months after the onset of the architectural changes. The first radiological change was partial collapse in the areas where the demineralization and sclerosis occurred. In two knees and one shoulder the osteonecrosis had the typical appearance of osteochondritis dissecans.

Eight femoral and three humeral heads and three femoral condyles still showed signs of activity with progression in the destructive phase at the time of this study. In all bones with signs of progression one could see areas with totally different appearances. Some localized areas showed signs of healed osteonecrosis with sclerosis and still more dense zones surrounding it, while other areas showed both osteonecrotic and lucent fields, as a sign of progression of the bone changes.

In seven hips, three knees and one elbow regressive bone changes with rebuilding of necrotic areas could be seen. Two knees looked normal, one knee showed obvious regression of the osteochrondritis-looking area and all femoral heads had gained more or less their previous shape.

In 10 hips the condition was stationary at the time of this study. In most patients the major part of the caput had collapsed with irregularity or total destruction of the articular surface. The remaining part of the femoral head showed typical increased density with loss of normal trabecular

Figure 2. Osteonecrosis in the femoral head (a). Radiograph in the frog-like position (b) shows areas of increased density and radiolucencies, and fracture of the articular surface. Same patient as Figure 1, 4 years later.

structure (Figure 2). In six shoulders and two knees the same results of osteonecrosis without signs of further activity were noted.

DISCUSSION

The localization of osteonecrosis after renal transplantation was similar to that found in other investigations, being most often in the weight-bearing areas consisting of cancellous bone, i.e. the femoral head or knee with involvement of the articular surfaces (Boettcher et al. 1970). The changes were most commonly bilateral (Briggs et al. 1972, Levine et al. 1977).

The onset of osteonecrosis after renal transplantation differs in various investigations. The time lag ranges from 5–35 months and the time interval from first symptoms to the first radiologic signs from 0–12 months with a mean of 3.5 months (Pierides et al. 1975). However, it may be difficult to differentiate symptoms of osteonecrosis from diffuse, non-specific, muscular, skeletal aches and pains, which might delay the diagnosis. In other investigations the time interval from renal transplantation to osteonecrosis ranges from 5–18 months (Levine et al. 1977), with a mean of 8 months (Evarts & Phalen 1971) and 17 months (Pierides et al. 1975).

Our material shows a time lag from renal transplantation to the development of the initial radiologic changes of 1–36 months (mean 14 months). An early sign in the present investigation is a lucent subcortical area (the crescent sign) (Griffiths et al. 1974), presenting as a fracture line in the immediate subchondral bone, parallel to the articular surface. Heerfordt et al. (Heerfordt et al. 1978) demonstrated generalized and/or focal scintigraphic changes in renal transplant patients, 15 femoral heads showing an increased uptake. In 12 of the cases radiographic osteonecrosis was evident at the time of scintigraphy, but in the remaining 3 cases the scintigraphic signs of osteonecrosis preceded the radiographic appearance by a few months. The time lag from renal transplantation to generalized or focal scintigraphic changes was about 40 months, whereas we demonstrated early radiologic changes within a mean of 14 months after renal transplantation.

None of our patients showed any other local bone abnormality prior to the appearance of this fracture line. The crescent sign seems to be the first and a specific radiologic change in patients who develop osteonecrosis, appearing as a lucent subcortical area, parallel to the articular surface. Months later areas with lucencies are seen together with more dense zones. These dense zones represent areas with increased amounts of collapsed bone and/or areas with newly formed bone (Levine et al. 1977). At a later stage, the radiologic features seem to be dependent on the ratio between formation of new bone and bone destruction.

Trauma-induced osteonecrosis appears in many ways similar to osteonecrosis after renal transplantation. Norman & Bullough (Norman & Bullough 1963) described a radiolucent crescent sign in the femoral head after fracture and an increased radiological density of the femoral head with a later depression of sequestrated fragments of the articular surface. In our series of renal transplant patients with osteonecrosis, similar changes developed in the bones involved. These findings suggest some similarity in the mechanism of the development of osteonecrosis in renal transplant recipients and that following fracture of the femoral neck.

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Correspondence to: Jörg Andresen, M.D., Department of Diagnostic Radiology R, Aarhus Kommunehospital, University of Aarhus, DK-8000, Aarhus C, Denmark