The venous pattern in femoral head necrosis
Digital subtraction angiography and phlebography in 5 patients

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According to digital subtraction angiography in 5 cases of idiopathic ischemic necrosis of the head of the femur, the arterial and venous circulation was normal. However, pertrochanteric phlebography showed stasis of contrast indicating venous obstruction. We suggest that this could be due to arteriovenous-venous shunting, possibly resulting from sympathetic dysfunction, as in the diabetic foot.

Using digital subtraction angiography and injecting contrast solution into the deep femoral artery, it is possible to visualize both the arteries and the veins of the head of the femur (Ludwig 1983). Because interruption of the venous circulation may be a factor in idiopathic ischemic necrosis, we carried out both digital subtraction angiography and pertrochanteric phlebography in 5 patients.

Patients and methods

Five cases of idiopathic necrosis of the femoral head were investigated (Table 1). Digital subtraction angiography in combination with pertrochanteric phlebography and pressure measurements were carried out under general anesthesia. The exposures were made with a Philips DVI 2 x-ray apparatus. A catheter (Sidewinder 5 F, type 2) was introduced according to the Seldinger technique through the contralateral femoral artery into the deep femoral artery while attempting to place the tip of the catheter in front of the lateral femoral circumflex artery. Contrast (4–5 ml Iodineiothalamate 300) was injected followed by exposures at a frequency of 1 per second until a good venous outflow was visible. As a rule, 10 exposures were sufficient, and if necessary the run was repeated. A bone needle was then introduced through the trochanter with the point of the needle in the neck of the femur. The pressure was measured with a Nikon Kodin. Then, 5 ml Macro- dax was injected and the pressure was recorded continuously for 5 min. Subsequently, 10-ml of contrast was injected and exposures were made at a rate of 1 per 3 s for 45 s and then 1 exposure per min up to 5 min following the injection. The criteria for stasis according to pertrochanteric phlebotomy were reflux of contrast to the diaphysis and presence of contrast for more than 5 min after the injection.

Results

In all the cases the intraosseous pressure was elevated, and it rose further after injection of Macrodex. In all the cases, digital subtraction angiography was normal; but trochanteric phlebography showed stasis of the contrast.

Discussion

Ficat and Arlet (1977) suggested arteriovenous shunting as a cause of idiopathic ischemic osteonecrosis, i.e., a mechanism similar to that found in the diabetic foot because of sympathetic neuropathy: arteriovenous-venous shunts open up causing a rise in venous pressure, edema, decrease in capillary circulation, fall in oxygen consumption, and a rise in venous pO₂ (Boulton et al. 1982, Consensus diabetische voet 1986). Arterioven-
A 57-year-old woman with pain in the left hip for 4 months. Plain radiographs normal.

- **A.** The arterial phase of digital subtraction angiography shows a capillary flush around an avascular subchondral fragment and a good arterial circulation.
- **B.** The venous phase of digital subtraction angiography shows normal venous outflow.
- **C.** Femoral phlebotomy shows stasis and reflux of contrast on this exposure made after 5 minutes.

<table>
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<th>Diagnosis</th>
<th>Radiography</th>
<th>Digital subtraction angiography and femoral phlebography</th>
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<tr>
<td>1. Woman 57 ischemic coxopathy</td>
<td>Arthritis</td>
<td>Normal arterial and venous circulation, but stasis and reflux.</td>
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<tr>
<td>2. Woman 57 idiopathic ischemic necrosis Stage 1</td>
<td>Normal</td>
<td>Normal arterial and venous circulation around an avascular subchondral fragment. Reflux and filling of metaphyseal veins.</td>
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<tr>
<td>3. Woman 55 idiopathic ischemic necrosis Stage 1</td>
<td>Normal</td>
<td>Normal arterial and venous circulation, but stasis and reflux.</td>
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<tr>
<td>4. Man 48 idiopathic ischemic necrosis Stage 3, bilateral</td>
<td>Sequestrum</td>
<td>Normal arterial and venous circulation around a necrotic fragment, extra artery to the necrotic fragment, reflux and leakage of contrast along the necrotic fragment to the joint space.</td>
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<tr>
<td>5. Woman 76 idiopathic ischemic necrosis Stage 2</td>
<td>Slight arterial changes, discontinuity in the contour of the femoral head</td>
<td>Normal arterial and venous circulation, but stasis and reflux.</td>
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Figure 2. Case 4. A 48-year-old man with bilateral idiopathic ischemic necrosis.
A. Right hip with Stage 3 necrosis.
B. Digital subtraction angiography of the right hip shows normal arterial circulation and an extra artery to the necrotic fragment.
C. The venous phase with still a capillary flush and a good venous outflow.
D. Pterochanteric phlebotomy shows the contrast flowing to the distal veins, and leaking alongside the necrotic fragment to the joint space.
E. The same projection as in A, B, and C without subtraction to show the bone contours.
ous-venous shunts have been demonstrated in bone marrow (Brånemark 1959). If they open up as a result of a disturbance of the vasomotor innervation, the venous pressure rises, but the arterial and venous circulation, as seen with digital subtraction angiography, will still appear normal. In pterochanteric phlebography the contrast is taken up in the sinusoids and flows away through the veins; if the circulation in the sinusoids is reduced or completely interrupted because of increased venous pressure, the contrast is no longer absorbed, but diffuses slowly through the medullary space. Idiopathic ischemic osteonecrosis has features in common with compartment syndrome (Solomon 1987). If the pressure in the medullary space rises more than 10 percent, for instance because of hematoma or medullary hyperplasia (Gaucher’s disease), the sinusoids become compressed (Simonet 1982, Wang et al. 1977). Possibly the arteriovenous-venous shunts then open up, allowing a normal arterial and venous circulation according to digital subtraction angiography, but stasis of contrast according to pterochanteric phlebography.

Camp and Colwell (1985) reported poor results with core decompression in patients with idiopathic ischemic necrosis. Although in Case 4 the contrast leaked alongside the necrotic fragment, there was still evidence of stasis. This speaks in favor of vasomotor disturbance rather than a primary rise in the medullary pressure. Stasis of contrast is associated with, but not specific for, idiopathic ischemic osteonecrosis. It is also found in coxarthrosis (Arnoldi et al. 1977), reflex dystrophy, Paget’s disease (Ficat and Arlet 1977), and Perthes’ disease (Suramo et al. 1974).

References


