PHLEBOGRAPHY IN OSTEOARTHRITIS OF THE HIP

R. S. PHILLIPS, MANCHESTER, ENGLAND

From the Robert Jones and Agnes Hunt Orthopaedic Hospital, Oswestry

Problems of the vascular supply of the head and neck of the femur in health and disease have provoked much study. Cheynel (1947) concluded from injection studies in cadavers that in healthy old age there was a reduction in arterial flow to the femoral head and neck. It was this relative avascularity, which, becoming intensified, seemed to be a prominent feature in osteoarthritis of the hip. Trueta and Harrison (1953), using similar techniques, disagreed with all previous claims and said that there was no obvious reduction in blood supply as age progressed. Indeed, in osteoarthritis of the hip, Harrison, Schajowicz and Trueta (1953) demonstrated increased arterial inflow to the proximal femur in spite of the obliteration of the medial epiphysial vessels in the ligamentum teres that occurs in old age.

The techniques developed by Trueta and Harrison (1953) and later modified by Sevitt (1964) showed the arterial side of the circulation clearly, but very little was seen of the venous pattern, other than a few venous sinusoids in the marrow. Furthermore, injection studies in the cadaver give a static picture of the vascular tree.

Phlebography as a diagnostic tool was developed by Dos Santos (1938), and Schobinger (1960) demonstrated the value of intraosseous phlebography. Steinbach, Jergesen, Giffilain and Petrakis (1957) applied the technique to a study of the blood supply of bone rather than to the diagnosis of specific diseases. The value of phlebography in the assessment of viability of the femoral head after neck fractures was discussed by Harrison (1962). The venous pattern in established ischaemic necrosis of the femoral head, as shown by intraosseous phlebography, was considered by Ruffié, Fournié, Ayrolles and Cuq (1960). Mériel, Ruffié and Fournié (1955) described the venous drainage pattern in osteoarthritis of the hip, using the technique of pertrochanteric phlebography.

The present study is a description of the venous pattern of the femoral head in normal hips and the modifications which this pattern undergoes in the presence of primary osteoarthritis of the hip.

Technique—Since both the control patients and those with osteoarthritis were undergoing surgery, the phlebographs were done under general anaesthesia. The hip, with a wire marker on it, was radiographed (Fig. 1) to allow the accurate insertion of a Plewes needle or Barker’s spinal needle (Fig. 2) directly into the infero-medial third of the femoral head. That the needle had in fact been placed correctly was confirmed by aspiration of marrow or by the easy injection of a few millilitres of normal saline. In order to reduce radiation hazards, to allow a continuous injection while radiographs were taken and to stop them from being obscured, a polythene catheter was attached to the needle through which 45 per cent Hypaque (sodium diatrizoate) was injected. Five millilitres were injected, then a further three to four millilitres were run in and an antero-posterior radiograph taken. Whenever possible this was repeated to obtain lateral radiographs. The technique used here was essentially the same as that described by Harrison (1962). No untoward local or systemic reactions occurred afterwards.

MATERIAL AND RESULTS

The need to determine the pattern of venous drainage from the femoral head in normal hips is apparent, but it was not considered justifiable to do intraosseous phlebography of the hip in a fit young adult. Therefore, it was decided to investigate the venous pattern in a group of
patients who had sustained fracture of the femoral neck. Phlebography was done on the sound femur before the fracture on the other side was nailed. The normal hip had to have, on radiological examination, no narrowing of joint space, no evidence of sclerosis, no cystic appearance, no osteophytes, and no subluxation. In addition, the patients had no symptoms referable to this hip and no abnormality in the hip on physical examination.

![Figure 1 and 2](image)

**Figure 1**—An antero-posterior view of the hip joint. The wire grid facilitates accurate insertion of the needle. **Figure 2**—A Plewes needle in the infero-medial segment of the femoral head.

![Figure 3 and 4](image)

**Figure 3**—"Normal" phlebograph, antero-posterior view; there is no clinical or radiological evidence of osteoarthritis. This demonstrates the "limino-capsular" veins (A), circumflex plexus (B), the posterior cervical veins (C). There is a little drainage into the femoral shaft (D). **Figure 4**—"Normal" phlebograph, lateral view, to show the circumflex plexus (A), the digital fossa veins (B), and the posterior cervical veins (C).

Seven hips made up the normal group, of which six were in women and one was in a man. Their average age was seventy-eight years.

In the normal hip the Hypaque rapidly diffuses from the site of injection into the femoral neck and trochanteric region within the medullary sinusoids. The sinusoids, though somewhat tortuous, are not dilated.

Vol. 48 B, No. 2, May 1966
The radiopaque material leaves the medullary cavity by certain well defined channels. Firstly, a double or single channel courses infero-medially along the trochanteric line, then towards the obturator foramen where it drains into the obturator vein. Mériel, Ruffié, Fournié, Baux, Bastide and Gaubert (1955) called this group the "limino-capsular" veins (A in Fig. 3). Secondly, just distal to this, beginning as a diffuse plexus in the basal portion of the femoral neck and greater trochanter, are several well defined channels which pass medially to leave the

**FIG. 5**

Group 1. Figure 5—A normal phlebograph, antero-posterior view, to show the diffuse spread of opaque fluid distally into the femoral neck from the site of injection (A), limino-capsular veins (B), and the outflow from the circumflex plexus (C).

**FIG. 6**

Figure 6—Normal phlebograph, lateral view, showing the outflow from the circumflex plexus (A), the posterior veins of the neck (B), and the veins of the digital fossa (C).

**FIG. 7**

Group 2a. Figure 7—Antero-posterior phlebograph to show predominance of the circumflex plexus (A) and the venous sinusoidal filling distal to the lesser trochanter (B).

**FIG. 8**

Figure 8—Lateral view to show the predominance of the circumflex plexus (A) and sinusoidal filling (B) in the proximal femoral shaft. A few lesser digital fossa veins (C) are visible.
Group 2b. Figure 9—Antero-posterior phlebograph. Much of the opaque fluid escapes through venous channels distal to the lesser trochanter (A). The circumflex plexus (B) is still visible. Figure 10—Lateral view. This demonstrates the escape of fluid distal to the lesser trochanter (A) by veins which communicate with the circumflex plexus (B). Posterior veins of the neck (C) are visible.

Group 2c. Figure 11—Antero-posterior phlebograph. There is distinct pooling of opaque fluid at the site of injection (A). Limino-capsular (B) and circumflex veins (C) are seen. Figure 12—Lateral view. Hypaque is pooled at the site of injection (A). The circumflex plexus (B), digital fossa veins and posterior veins of the neck (C) are also seen.
femur at the level of, and just proximal to, the lesser trochanter. These enter the common femoral veins and constitute the circumflex group of Mériel et al. (1955) (Figs. 3 and 4). Thirdly, a group of small veins arise in the digital fossa of the greater trochanter and course postero-medially towards the greater sciatic notch (Fig. 4). Fourthly, yet another group arising in the posterior aspect of the femoral neck and greater trochanter, the posterior veins of the neck, run medially to anastomose in a plexus on the ischial tuberosity (Figs. 3 and 4). Fifthly, a little radiopaque material drains into the femoral shaft distal to the lesser trochanter. This leaves through the veins of the linea aspera which in turn drain into the profunda femoris vein. This last exit is small and inconstant in its contribution, and the exit vein is never more than one inch distal to the lesser trochanter (Fig. 3). There is a diffuse anastomosis within the femoral head and neck before these main draining veins become delineated. No drainage is seen through the ligamentum teres.

The patients with osteoarthritis of the hip had reached the stage of the disease at which operative treatment was indicated. The phlebographs were done just before osteotomy. Thirty-six patients with thirty-seven hips, hereafter called the "study" group, were included. The patterns of venous drainage in osteoarthritis of the hip may be described thus. Group 1—A phlebograph which in no way differs from the described normal (Figs. 5 and 6). Group 2a—Most of the normal routes of exit are not seen. Much of the radiopaque material escapes by way of the circumflex plexus. There is some drop of opaque fluid into the femoral shaft but this is not very much (Figs. 7 and 8). Group 2b—Although many normal venous channels are seen, there is a significantly increased passage of fluid into the femoral shaft (Figs. 9 and 10). Group 2c—Normal channels are filled; there is no significant passage of fluid into the shaft.
Distinct pooling of opaque fluid is seen at the site of injection (Figs. 11 and 12). Group 3a—Almost all the drainage occurs through the veins of the linea aspera with fluid visible in somewhat tortuous or dilated medullary sinusoids, dropping many inches down the femoral shaft (Figs. 13 and 14). Group 3b—There is little or no drainage at all from the femoral head. The fluid remains pooled at the site of injection (Fig. 15).

Because it was felt that the changes appearing in the phlebographic picture were related to the degree of arthritic change visible radiologically on the routine anteroposterior view, a classification of each osteoarthritic hip was done in which the greatest number of points allocated was eleven for a normal hip (Table I). In the study group, totals ranged from three to nine points; but if it was divided according to the severity of arthritis as judged by the radiological index, there was a relationship between the latter and the pattern of venous drainage (Table II). It is clear that, as the arthritic process advances, so the picture of venous drainage deviates further from that seen in the normal group.

**DISCUSSION**

It may be argued that the so-called normal group does not, in fact, represent the venous drainage pattern of the healthy femoral head and neck. None the less, this group certainly showed no radiological evidence of degenerative arthritis. The degree of osteoporosis present in a group of patients who have sustained a subcapital or transcervical fracture is likely to be greater than that seen in healthy old age (Stevens, Freeman, Nordin and Barnett 1962). There is no evidence as yet that there is a vascular abnormality in senile osteoporosis. The plebographic picture obtained in this group is distinct and varies little from the normal pattern described by Mériel et al. (1955b). Those authors did not say clearly what constituted their normal series but it may well have included the apparently normal hip in cases of unilateral osteoarthritis. A control series in a study such as this should consist of normal young adult hips but the possibility of damaging the femoral head in some way, or of introducing infection, precludes this. Hence the comparisons which can be drawn and the conclusions reached in this study must be guarded.

The description of the venous drainage in the normal hip varies from that of Mériel et al. (1955b) only in that occasionally there are visible linea aspera veins draining overflow into the femoral shaft. This constitutes only a very small route of exit. None the less, it occurs more frequently than these authors would suggest. It may be that the pressure at which fluid was injected forced it into the lesser but already patent channels. The resulting phlebograph would then accentuate what is an insignificant route of drainage from the normal femoral head and neck. Certainly, it is clear that well-defined groups of exit veins exist and these are in a plane at and proximal to the level of the lesser trochanter.

In osteoarthritis, Mériel, Ruffié and Fournié (1955a) showed striking modifications of venous drainage. Not only was there a disappearance of the normal routes with replacement by
more distally situated groups of veins, but also there were distinct changes in the calibre of the efferent veins. These appear more tortuous and somewhat varicose. Medullary reflux and sometimes stagnation of radiopaque material was noted.

In the study group in this investigation, these alterations in venous patterns are equally apparent. When the radiological signs of osteoarthritis are slight there is no change from the normal pattern, but as the disease process advances so the burden of venous drainage falls

### TABLE I

**Method of Classification of Arthritis of the Hip Radiologically**

<table>
<thead>
<tr>
<th>Joint space</th>
<th>Appearance</th>
<th>Cysts Number and site</th>
<th>Subluxation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Points</td>
<td>Points</td>
<td>Amount</td>
</tr>
<tr>
<td>Normal</td>
<td>4</td>
<td>None</td>
<td>4</td>
</tr>
<tr>
<td>Slight narrowing</td>
<td>3</td>
<td>Few and small in head only</td>
<td>3</td>
</tr>
<tr>
<td>Moderate narrowing</td>
<td>2</td>
<td>Few and small in head and acetabulum</td>
<td>2</td>
</tr>
<tr>
<td>Marked narrowing</td>
<td>1</td>
<td>Numerous in head and acetabulum</td>
<td>1</td>
</tr>
<tr>
<td>Obliteration</td>
<td>0</td>
<td>Cystic replacement of femoral head</td>
<td>0</td>
</tr>
</tbody>
</table>

### TABLE II

**Correlation of the Extent of the Arthritis Found Radiologically with the Phlebographies**

<table>
<thead>
<tr>
<th>Radiological index</th>
<th>Study group</th>
<th>Total hips</th>
<th>Average age (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 2a 2b 2c 3a 3b</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 points or less</td>
<td>0 0 2 1 0 5</td>
<td>8</td>
<td>59.3</td>
</tr>
<tr>
<td>5 to 6 points</td>
<td>1 6 6 3 4 1</td>
<td>21</td>
<td>60.6</td>
</tr>
<tr>
<td>7 points or more</td>
<td>3 3 2 0 0 0</td>
<td>8</td>
<td>60.6</td>
</tr>
<tr>
<td>Total hips</td>
<td>4 9 10 4 4 6</td>
<td>37</td>
<td></td>
</tr>
</tbody>
</table>

upon the more distally situated groups of veins. At first there are three changes of significance: 1) predominance of the circumflex plexus; 2) increasing drainage through the veins of the linea aspera while the more proximal channels remain patent; and 3) radiopaque material pooling at the site of injection but the venous flow within the femoral head is still active enough to carry the drainage from the bone through normal channels.

As the hip joint deteriorates with increasing sclerosis, subluxation and cyst formation, opaque fluid is forced distally into the femoral shaft to find a route of exit, or the flow becomes so sluggish that the radiopaque solution remains pooled at the injection site.

These findings suggest that in early osteoarthritis there is no alteration in the blood supply to the femoral head. The pattern of venous outflow remains normal in distribution and intensity. If there is an increased arterial flow then it is as yet insufficient materially to affect the efferent veins. None the less, the radiological evidence of osteoarthritis and the associated clinical findings have reached the stage at which operative treatment was indicated. The degenerative processes had been present for some time. This evidence, perhaps somewhat circumstantial, points to the conclusion that the vascular changes described by Harrison et al. (1953) are secondary in osteoarthritis of the hip.
As the arthritis deteriorates radiologically, so the pattern of venous drainage deviates further from the normal. While the normal channels still persist, the veins of the linea aspera increase their share of venous drainage. This reflects an increased arterial flow or hyperaemia. To deal with the afferent flow of blood and to reduce or prevent medullary stagnation, new channels or already existing channels must increase their drainage. That the normal channels begin to disappear and that the opaque fluid pools is a significant feature in the phlebographs. Hyperaemia persists, but because the outflow of blood becomes more difficult venous hypertension occurs. Confirmation of this is needed: venous pressure studies of the femoral head could give the answer. The rapid injection of fluid into the femoral head certainly produces increased pressure within the medullary sinusoids. Mériel, Ruffié and Fournié (1955a) did their phlebographs under local anaesthesia, and they described a pain pattern which developed as the injection of fluid proceeded which was very similar to the pain from the osteoarthritic hip of which the patient complained.

Why does pooling occur and why do the normal venous channels disappear in advanced osteoarthritis? Cyst formation becomes more extensive, sclerosis becomes enhanced, bony trabeculae become much thicker and more dense in advanced osteoarthritis. Compressed dilated medullary sinusoids are often seen, and sometimes they contain radiopaque material many minutes after injection. The venous flow within the medulla is obstructed by bulky avascular cysts and by thickened dense trabeculae.

The normal veins appear at the cortical surface at or near the attachment of the capsule of the hip to the trochanteric line anteriorly and to the femoral neck posteriorly. Lloyd-Roberts (1955) showed that synovial and capsular fibrosis is a prominent feature in osteoarthritis and is progressive. It is easy to imagine the orifices of these draining veins becoming slowly obliterated as the disease progresses. Venous blood—or Hypaque—must continue to find an exit. This is done by passing distally, swelling the circumflex plexus and eventually causing the veins of the linea aspera to take over the outflow from the femoral head and neck. These later features of the phlebograph are still compatible with heightened intensity of the blood supply of the proximal femur. Clearly the tortuous varicose medullary channels confirm a persistent venous hypertension. However, when there is complete damming up of fluid in the femoral head, it may be that capsular and synovial fibrosis has progressed to the stage of compressing entering arteries. Tense cysts and thickened trabeculae obstruct medullary arterial flow. None the less, it is more logical only to assume that venous obstruction is acute and outflow from the femoral head slow and difficult. The phlebograph can give no direct information about arterial inflow.

<table>
<thead>
<tr>
<th>TABLE III</th>
<th>CORRELATION OF THE DEFORMITY FOUND WITH THE PHLEBOGRAPHS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group 1</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Average fixed flexion and lateral rotation index</td>
<td>14</td>
</tr>
</tbody>
</table>

Soto-Hall, Johnson and Johnson (1964), describing variations in intra-articular pressure in the hip joint, found that pressure was reduced after division of the iliopsoas muscle. Conversely, if this muscle can produce by its contraction—and often its contracture—an increased intra-articular pressure, then a further effect may be to produce compression of the issuing veins of the femoral head and neck.

The fixed flexion and lateral rotation index may be defined as the sum of the figures of the degrees of the deformities of the osteoarthritic hip, and the indices of the study group were related to the phlebographic abnormalities (Table III); from this it is seen that, as the
osteoarthritic hip assumes a more flexed and laterally rotated position, so, perhaps because of
the compressing effect of a tight iliopsoas, the venous outflow from the femoral head and neck
is further impeded. Certainly these deformities do not necessarily increase in proportion to the
radiological deterioration of the osteoarthritic hip.

The explanations of the abnormal venous pattern in osteoarthritis of the hip are somewhat
speculative. It is envisaged that each patient in the study group will undergo further intraosseous
phlebography at least one year after osteotomy. The clinical and radiological improvements
expected will then be related to the phlebographs before and after operation.

SUMMARY
1. Phlebography has been done on seven hips showing no radiological evidence of
osteoarthritis. The findings largely confirm the work of previous authors.
2. Thirty-seven osteoarthritic hips have been examined in the same way. As the degenerative
process worsens radiologically so the pattern of venous drainage deviates further from the
so-called normal.
3. An attempt is made to explain the phlebographic findings in the light of known facts of the
pathology of the disease.

My thanks are due to the consultant staff of the Robert Jones and Agnes Hunt Orthopaedic Hospital, Oswestry,
and the War Memorial Hospital, Wrexham, for permitting me to investigate their patients. I also wish to thank
Mr B. Southern for the reproduction of radiographs and clinical photographs, and Mrs M. Jackson for her
secretarial help. This work would not have been possible but for the skill and cooperation of the radiographic
departments of both hospitals.

REFERENCES
Revue d’Orthopédie, 33, 7.
Revue du Rhumatisme et des Maladies Ostéo-articulaires, 22, 238.
MERIEL, P., RUFFIÉ, R., FOURNIÉ, A., BAUX, R., BASTIDÉ, G., and GAUBERT, J. (1955b): La phlébographie de la
hanche. Presse Médicale, 63, 1381.
Rhumatisme et des Maladies Ostéo-articulaires, 27, 559.
STEINBACH, H. L., JERGENSEN, F., GILFILLAN, R. S., and PETRAKIS, N. L. (1957): Osseous Phlebography. Surgery,

THE JOURNAL OF BONE AND JOINT SURGERY