TOTAL HIP REPLACEMENT AND DEEP VEIN THROMBOSIS

A VENOGRAPHIC AND NECROPSY STUDY

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Bilateral venography was performed between 12 and 15 days after total hip replacement in 745 consecutive patients, all of whom had heparin prophylaxis. Of these, 81 patients (10.8%) showed evidence of recent deep vein thrombosis: 23 (3%) distal, 44 (5.9%) isolated proximal, five (0.7%) both proximal and distal, and nine (1.2%) extensive thrombosis from calf to thigh. Compared with previous reports heparin appeared to have reduced the number of distal and contralateral thromboses, but was far less effective in reducing proximal femoral thrombosis.

In a cadaver study, the femoral veins were inspected during simulated total hip replacement by either an anterior or a posterior approach. In every case the femoral vein became kinked or folded in the thigh position imposed during the preparation of the femur. Local damage appears to be an important factor in proximal thrombosis; care at operation could help to minimise trauma to the femoral veins and reduce the number of such cases.

Postoperative venography is an accepted standard for detecting deep vein thrombosis (DVT) after total hip replacement (THR). We obtained such venograms in 745 consecutive patients effectively protected against DVT, and investigated the manner in which such prophylaxis acted against the natural venographic pattern of the disease. We then made a necropsy study of the manner in which femoral veins may be damaged during hip arthroplasty.

A natural venographic pattern of DVT after THR has been defined in a number of control studies (Evarts and Feil 1971; Hampson et al 1974; Morris, Henry and Preston 1974; Sagar et al 1976; Johnson et al 1978; Moskowitz et al 1978; Sikorski, Hampson and Staddon 1981; Turpie et al 1986; Beisaw et al 1988). In these reports the total incidence of DVT ranges from 48% to 69%, with proximal DVT in 19% to 53%. The commonly accepted figures (Hirsh, Genton and Hull 1981) for Western Europe and North America are 40% and 60% for all DVTs, and 20% for the proximal type of DVT which was reported to be responsible for about 75% of the cases of fatal pulmonary embolism in the autopsy

study of Havig (1977). The efficacy of any prophylaxis must be assessed against these standards.

Two studies of a large number of patients provide descriptions of postoperative venographic findings (Stamatakis et al 1977; Nillius and Nylander 1979). Stamatakis et al (1977) focus on femoral thrombosis. In spite of prophylaxis the incidence of DVT was 50% in Stamatakis et al and 58% in Nillius and Nylander. Their conclusions, implicit in Stamatakis et al and explicit in Nillius and Nylander, were that after THR there are two types of thrombosis. First, postoperative thrombosis seen equally in the operated and the contralateral leg after all types of surgery, and related to stasis and the 'hypercoagulable state' (activation of coagulation and inhibition of fibrinolysis). Secondly, there is a proximal type of thrombosis, resulting from damage to the wall of the femoral vein during hip surgery. Two intra-operative venographic studies, by Stamatakis et al (1977), and by Johnson et al (1978), provide clear evidence of distortion of the femoral vein during certain phases of total hip replacement. We have compared our venographic and necropsy results with those discussed in this paragraph.

MATERIALS AND METHODS

Radiographic study. A total of 745 consecutive patients had bilateral ascending venography 12 to 15 days after THR. All these patients had received an effective form of prophylaxis against DVT: adjusted doses of standard unfractionated sodium heparin, or of enoxaparin, low molecular weight heparin (Planès et al 1984, 1986, 1988;

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Planès, Vochelle and Mansat 1987). All had given their informed consent to venography. Of these, 81 developed proved and recent DVT in either the operated or the non-operated leg; these patients form the basis of this report.

The postoperative venography was performed according to the technique of Rabinov and Paulin (1972). Thrombosis was diagnosed as acute when venography revealed a constant intraluminal filling defect in a deep vein, as proximal when the thrombus was in the popliteal or more proximal vein, and as distal when the thrombus was in the calf veins. The appearance of non-filling of a segment of the deep venous system with abrupt termination of the column of contrast medium at a constant site below the segment and reappearance at a constant site above it, was recorded as a recent DVT if the abnormality was surrounded by prominent collaterals. Irregularities of the vein wall, loss of valves, and regions of stenosis were considered as evidence of old venous thrombosis with or without recanalisation.

Necropsy studies. Necropsy studies were performed on five fresh cadavers (10 hips). With the body lying supine, an incision was made along the line of the femoral vessels in the proximal thigh. The femoral vessels were visualised without disturbing their close anatomical connections. Then, for alternate hips, either a posterior (Moore) or an anterior (Hardinge 1982) approach to the hip was made.

For the posterior approach the body was turned on to its side. After posterior dislocation of the hip and section of the neck of the femur, the body was replaced into the supine position with a block of wood under the buttock. The femoral vessels were then examined with the leg in the positions used during an operation for THR, first in medial rotation of 90° to 110° only, and then with various degrees of adduction and/or flexion of the hip added to this medial rotation to simulate the positions needed for the preparation of the acetabulum and the femoral shaft.

The anterior approach was made with the patient supine. After anterior dislocation of the hip and section of the neck of the femur, the femoral vessels were examined with the leg in the appropriate operating positions, first retracted backwards to expose the acetabulum, then crossed over the body with flexion, adduction, and lateral rotation, again in the position used for the preparation of the femoral canal.

RESULTS

Distribution of DVT. Of the 745 patients, 81 had a venographically proved, recent DVT; these cases were classified according to Stamatakis et al (1977) (Table I). Of the 81 cases, 23 (3% of all patients) were distal and 58 (7.8%) were proximal. Of the latter group, 44 (5.9%) involved the femoral vein in isolation, five (0.7%) were both proximal and distal with discontinuity and must have arisen independently, and nine (1.2%) were extensive and in continuity from the calf to the femoral veins.

In 41 cases the DVT was on the right side and in 40 on the left. The unoperated leg was involved in nine patients, five of whom had an isolated DVT (two proximal and three distal). The other four patients with DVT of the non-operated leg had bilateral thromboses, three of which were extensive on the operated side. Twenty patients were found to have radiographic signs of old DVT; eight of them showing chronic obstruction of the external or common iliac vein, two complicated by recent DVT.

In the 44 cases of isolated proximal DVT the apparent site of origin was identified: two in the external iliac vein originated from the proximal femoral vein, 19 originated in the femoral vein at the level of the lesser trochanter, 18 in the mid-superficial femoral veins, four from just above the adductor hiatus, and one was in isolation in the popliteal vein.

Necropsy studies. In every case the femoral vein had the appearance of a soft rubber tube and, after resection of the neck of the femur, looked too long for the shortened thigh and tended to fold, starting on the vein itself or over a transverse branch of the femoral artery. The exact level varied but was always in the proximal third of the thigh. Folding was induced by certain definite positions of the hip (Figs 1 and 2).

After a posterior approach and dissection, internal rotation of 90° or even 100° to 110° did not induce a fold when the hip remained in extension. But when the thigh was flexed and even more when it was adducted, a fold appeared and increased dramatically to become a kink at extreme positions. The fold disappeared when the hip was extended and the thigh elongated. After an anterior approach, a fold appeared when the hip was adducted and flexed after the thigh had been brought across the body and the femoral neck had been sectioned. The fold became smaller when these forced positions were relaxed and disappeared when the hip was replaced in the anatomical position. We did not assess the transtrochanteric lateral or Charnley approach, because it became evident that only the position of the thigh was of interest.

DISCUSSION

From our two studies we concluded, first, that the natural venographic pattern of DVT after THR remained apparent despite the use of careful heparin prophylaxis and secondly that the necropsy study had provided some evidence of the mechanism of damage to femoral veins during operation. Some theoretical and practical suggestions can be made.

Comparison of our venographic findings with the two large studies of Stamatakis et al (1977) and Nillius and Nylander (1979) (Table I), showed clearly that even with an effective form of prophylaxis, and despite an overall reduction in the incidence of DVT, distal and proximal deep thromboses occur as separate entities. They tend to be concentrated in the operated leg, and in

some cases were continuous from the calf to the thigh region. Femoral DVT was the most important aspect of the disease.

Our necropsy study confirms and explains the venographic findings made by Stamatakis et al (1977) and by Johnson et al (1978) at the time of the operation. Stamatakis wrote "the femoral vein appeared angulated and narrowed, maximum distortion being at the level of the lesser trochanter with an anterior approach. With a posterior approach the femoral vein was narrowed with

an appearance of torsion at the level of the lesser trochanter. There was also a slowing of blood flow often with a filling of the long saphenous vein". Johnson et al (1978) using an anterior approach, noted at the time of dislocation "a considerable kinking of the femoral veins and a slowing of blood flow on both sides though much more marked on the operated side".

At no stage did we find any torsion, only the characteristic folding of the femoral vein, which appeared in specific forced positions of the hip. These forced

Table I. Comparison of venographic findings in three studies

Author	Total number of patients	Patients with DVT, number and <i>percentage</i> of total					
		DVT	Distal only		Proximal isolated		Proximal and distal
Stamatakis et al 1977	160	81 50.6	32	20	19	11.8	24 15.0
Nilius and Nylander 1979	134	78 58.0	39	29	10	7.4	13 9.7
Planès et al 1988	745	81 10.8	23	3	44	5.9	5 0.7

Fig. 1a

Fig. 1b

Two examples of folding and kinking of the vessels in necropsy specimens. On the left, the original exposure; on the right, with flexion and adduction of the thigh. The femoral artery (above the vein) would normally be protected by internal blood pressure and pulsation, but the femoral vein is unprotected.

Fig. 2a

Fig. 2b

positions are imposed at the time of preparation of the femoral canal. After a posterior approach, simple medial rotation does not induce a fold; this appears only when adduction and flexion are added, so these positions should be avoided if possible. After an anterior approach a fold appeared when the thigh was brought across the body and forced into flexion and adduction.

It may be argued that venography does not detect all cases of DVT when performed routinely at 12 to 14 days after operation, and that at best it offers only a shadow of the reality. Thrombi may have formed and been lysed prior to venography and may also appear later. However, Sikorski et al (1981) showed that after the eleventh day there was no further risk of proximal DVT; this emphasises the link between proximal DVT and the operation itself. The lysis of DVT before venography in our series shows the effectiveness of spontaneous fibrinolysis and of the prophylaxis. It still seems, however, that proximal and distal DVT are separate entities; this validates the hypothesis that there are two types of thrombosis after THR: general and focal.

It has been claimed that another possible cause of damage to the femoral vein is the heat resulting from polymerisation of the cement. Such thermal damage has been demonstrated in some cases of artery, vein, or nerve damage, but it has never been shown after modern cementing techniques, where pressure has been exerted on the cement to force it into a closed cavity. It remains possible that cemented prostheses give rise to more DVTs because of the longer operating time – during preparation, injection and pressurisation of the cement, the hip is maintained in a forced position, and the femoral vein is folded or kinked.

Our results and those of other studies show that general thrombosis related to the 'hypercoagulable state' and to stasis is a separate entity after THR. The fact that DVTs are concentrated in the operated leg emphasises the role of stasis, since 'hypercoagulation' is by definition bilateral. Stasis may be prolonged if the patient remains

seated in his bed, with the thigh flexed against the trunk.

Proximal endothelial cell injury, the third Virchow factor – with change in the blood flow (stasis) and change in blood elements (hypercoagulable state) – does not seem to be very common since only 6.6% of our patients had an isolated femoral DVT. It may be that these patients had either prolonged postoperative stasis, or that an endothelial lesion was created at the time of operation by folding or lateral kinking of the vein; or that they had a functional disorder of the endothelium of the venous wall. Such an endothelium, with a poor fibrinolytic response to stasis, has recently been described (Juhan-Vague et al 1987; Alessi et al 1988; Rocha et al 1988).

The first possibility, prolonged stasis, could be counteracted by sequential external pneumatic compression in addition to the methods we used (raising the foot of the bed, elastic bandaging of the legs and early mobilisation). The second possibility, local damage, could be reduced by careful management of the hip at the time of the operation and the third, abnormal endothelium, could be detected by establishing a link between patients with phlebographically detected DVT and release of deficient levels of tissue plasminogen activator (TPA) or elevated levels of plasminogen activator inhibitor (PA inhibitor) after stasis.

An interesting finding is that the folding and kinking of the femoral vein, and its duration, are under the control of the surgeon, and may be reduced by experience and skill. It is to be hoped that proximal DVT will not remain a chance occurrence and that further comprehensive study of the mechanism of damage to the femoral vein will help to reduce the rate of proximal DVT after THR.

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