

THROMBOSIS FOLLOWING HIP ARTHROPLASTY

A Study Using Phlebography and ¹²⁵I-Fibrinogen Test

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Venous thrombosis after hip arthroplasty was studied using the ¹²⁵I-fibrinogen test and phlebography. Eight out of ten dextran-treated and six out of ten control patients developed thrombosis. The thrombi were small and most frequently dorsal and dorso-lateral veins were involved. There were no thigh thrombi without concurrent calf thrombi. Half of the thrombi were found within the first postoperative week whereas the remainder occurred later. Preoperative venous pathology predisposed to postoperative thrombosis.

Key words: arthroplasty; fibrinogen test; phlebography; thrombophlebitis

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Becker & Schampi (1973) and Bergquist et al. (1973) found, in a study of postoperative venous thrombosis, a diagnostic discrepancy between the ¹²⁵I-fibrinogen test and phlebography in patients treated with dextran 70. It was suggested that this was due to a faster lysis of thrombi in dextran-treated patients. These results together with studies showing an altered fibrin structure after dextran treatment (Tangen et al. 1972) raise the question of whether thrombi formed in dextran-treated patients are lysed more easily than in other patients. Our investigation of patients operated on for hip arthrosis was made to study the frequency, localization and natural history of thrombosis and to analyse the occurrence of thrombolysis after dextran treatment.

MATERIAL

Patients between 45 and 70 years of age with hip arthrosis were included in the study. The operation was carried out via a lateral incision and without trochanteric osteotomy. The Charnley prosthesis was used in all cases and vacuum drainage was applied for 2-3 days postoperatively. Extra-dural analgesia was used in all cases. The legs were kept in abduction postoperatively and the operated leg was prevented from outward rotation by a bar applied to a dorsal plaster of the lower leg. The patients were instructed to do isometric muscle contractions as soon as they came to the intensive care unit. The day after the operation exercises under the supervision of a physiotherapist were begun. The patients left the hospital within 4 weeks.

The patients were randomized into two groups, 10 control patients without prophylaxis and 10 patients given dextran 70 (Macrodex 6 per cent in saline, Pharmacia AB, Uppsala, Sweden). One dextran infusion was given during the operation, one in the first postoperative hour and one on each of postoperative days 1, 3 and 5. The infusion dose was body-weight-dependent; thus patients below 60 kg were given 400 ml, patients between 60 and 80 kg 500 ml and patients above 80 kg 750 ml on each occasion. The first dextran

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infusion was started as soon as the extra-dural injection had been given.

DIAGNOSTIC METHODS AND EVALUATION

¹²⁵I-fibrinogen test

The method originally described by Atkins & Hawkins (1965) was used. For details see Bergquist et al. (1973). The legs were scanned preoperatively, immediately postoperatively and every postoperative day for at least 1 week. An increase in radioactive uptake relative to the heart of 15 per cent or more between two consecutive points was used as a diagnostic criterion of thrombosis. This increase had to be present for two or more consecutive examinations. We have earlier found this to be reliable in comparison with phlebography (Bergquist et al. 1973). Patients with their first uptake increase on day 7 were also scanned on day 8. If thrombosis was diagnosed the investigation was continued for a fortnight and in some cases a re-injection of ¹²⁵I-labelled fibrinogen was necessary. The preoperative leg scans were analysed for the presence of "primary pathological pattern" (Becker 1972).

Phlebography

The method of examination was standardized and in certain respects slightly modified in comparison with phlebographic techniques described by other authors (Greitz 1954, 1955, Gullmo 1956, Nylander 1962, Bronge et al. 1971).

A Siregraph (Siemens) with remote control and TV fluoroscopic monitor was used. The patient was kept in position with the aid of a broad compression bandage across the trunk. The edges of the table were supplied with handles for the patient's support and to facilitate muscular relaxation in the examined leg. The adjustable table was elevated to an angle of about 65° with the horizontal plane. The examined leg was positioned in inward rotation (20–30°). A superficial vein on the dorsum of the foot was punctured, and no tourniquet was applied. Manual injection of 80 ml 45 per cent Urografin (Schering) was started and film exposures in the antero-posterior projection were made after the injection of about 40 ml of contrast medium. Films were taken over the lower leg, knee region, thigh and pelvic region, and then in the lateral projection after an additional injection of 60 ml of contrast medium. Fluoroscopic monitoring was especially useful when taking pictures of the femoral and external iliac veins. In certain cases complementary films were taken after a further injection of contrast medium. In some patients a tourniquet was ap-

plied above the ankle joint to reduce the superficial circulation and to improve the deep venous filling. A bilateral control phlebography was made within the week before operation to show post-thrombotic states, preoperative thrombi, varicose veins and variations in the venous anatomy. If the ¹²⁵I-fibrinogen test was positive bilateral phlebography was performed on days 5–7 after operation. In patients with thrombosis an additional bilateral phlebography was performed on day 14 and all patients were given a bilateral phlebography around day 21. The radiologist was not informed whether the patient belonged to the control or dextran group.

Thrombosis was regarded as present if the examination showed:

1. A contrast defect in a venous lumen, ending in a cranially convex contour.
2. Occlusion of one of the two parallel veins between two communicants in any of the three main trunks of the lower leg.
3. Occlusion of a vein with a demonstrable collateral circulation.
4. Defective filling of a deep vein despite repeated injection of contrast medium.
5. Total lack of filling of the deep crural veins with increased flow in the superficial veins.

In this investigation there was no instance of subfascial soft tissue pressure, raised to a level above the venous pressure, giving the findings described under 5.

These phlebographic criteria of acute and subacute thrombosis are those most generally accepted (Bauer 1940, Nylander 1962, 1968, Hjelmstedt & Bergvall 1965, May & Nissl 1973).

Phlebography performed as described above is a reliable method but often gives incomplete filling of muscular veins and of the deep femoral vein. The deep femoral vein was visualized in 25 per cent of the phlebographies. Small thrombi in the superficial veins are probably often not discovered on phlebograms. No special attempts were made to increase the filling of the muscular veins by muscular contractions or pneumatic cuffs (Almén & Nylander 1962, Nicolaidis et al. 1971).

A total of 106 phlebographies was performed on the 40 legs of the 20 patients. One patient had an allergic reaction with widespread urticaria and erythema at the preoperative phlebography, as a result of which he was excluded from the trial and replaced by another patient. There were no further complications except for some mild orthostatic reactions.

RESULTS

There was no difference in age (mean 65 and 63 years, respectively) or sex be-

Table 1. Preoperative pathological venous systems as revealed by the preoperative phlebography.

| | No. of legs with | | |
|---------------|------------------|--------------------------|-------------|
| | varicose veins | pre-operative thrombosis | venectasies |
| Control group | 3 | 2 | 0 |
| Dextran group | 6 | 1 | 1 |

tween the control and test groups. The results of preoperative phlebography are shown in Table 1. Thus, three patients had deep vein thrombosis already before operation. One of them had been operated on with hip replacement on the same leg 6 months earlier and two had been operated on for other reasons several years earlier. However, none of them had a positive fibrinogen test, indicating an active thrombosis.

In three of the legs there was an increased fibrinogen uptake on the preoperative scans, a "primary pathological pattern", but none of these legs were pathological according to the preoperative phlebography. In one of these legs a postoperative thrombosis developed, verified by phlebography.

A summary of the patients developing thrombosis is shown in Table 2. Phle-

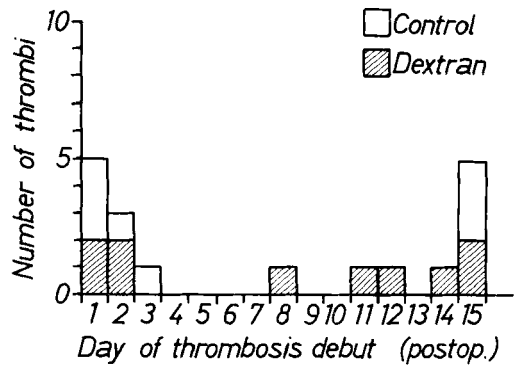


Figure 2. The day of thrombosis debut.

bography showed postoperative thrombosis or propagation of preoperative thrombosis in 16 legs of 12 patients. Eight patients belonged to the dextran group and four to the control group.

Postoperative thrombosis was diagnosed with either the ¹²⁵I-fibrinogen test or phlebography or both in altogether 18 legs of 16 patients, eight patients belonging to the dextran group and six to the control group. In eight patients the thrombi were localized only to the operated leg, in four cases localized to both legs and in two cases to the non-operated leg (one with venectasies and the other with a preoperative thrombosis). Nine thrombi were found in the 13 legs with a preoperative pathological phlebogram. In all three legs with a preoperative thrombosis, progress was seen postoperatively. In only two legs was thrombosis suspected clinically.

One patient (no. 7 in Table 2) with bilateral thrombosis died and autopsy showed fatal pulmonary embolism. This patient was one of the three with thrombosis of the femoral vein.

In Figure 1 the localization of thrombi according to the ¹²⁵I-fibrinogen test is shown. In three patients (nos. 7, 11 and 14 in Table 2) there were phlebographical thrombi in the femoral vein which were not detected by the fibrinogen test, but these patients also had thrombi in the

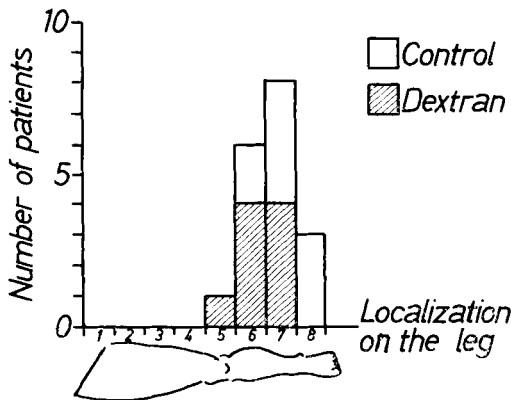


Figure 1. The localization of thrombosis according to the ¹²⁵I-fibrinogen test.

Table 2. Summary of patients in whom diagnostic methods have given positive results.

| Group | Patient | ¹²⁵ I-fibrinogen test | Point | Phlebography | Comments | Operation side |
|---------|----------|----------------------------------|-------|--------------------------------|--------------------------------|----------------|
| Dextran | 1 right | | | Fib. V day 23 | Varicose veins | right |
| Dextran | 2 right | positive day 1-13 | 6, 7 | SV, Fib. V, PTV days 6, 14, 25 | Varicose veins PPP progress | right |
| Dextran | 3 right | positive day 2-7 | 5 | Fib. V, PTV days 7, 14 | | right |
| Dextran | 4 right | positive day 14-18 | 6, 7 | SV, PTV days 11, 18, 25 | Clinical thrombosis | left |
| Dextran | 5 right | positive day 14-18 | 6 | SV days 18, 25 | | right |
| Dextran | 6 right | | | SV, Po. V day 12 | Preop. DVT in Fib. V | right |
| Dextran | 7 right | positive day 8-13 | 6 | Gastr. V days 11, 20 | Preop. venectasies | right |
| Dextran | 8 right | positive day 1-9 | 7 | Fib. V, FV day 7 | Varicose veins | right |
| Dextran | 9 right | positive day 2-6 | 7 | SV day 7 | Varicose veins | right |
| Dextran | 10 right | | | Fib. V day 25 | Fatal pulm. emb. | right |
| Control | 11 right | | | Fib. V day 20 | Clinical thrombosis | right |
| Control | 12 right | | | Fib. V day 25 | | left |
| Control | 13 right | | | Fib. V, PTV day 25 | Preop. DVT. Hip replacement | right |
| Control | 14 right | positive day 1-4 | 7 | SV, Fib. V, FV days 5, 25 | Varicose veins | left |
| Control | 15 right | positive day 1-4 | 6-8 | SV, Fib. V days 5, 25 | Preop. DVT in Gastr. V | right |
| Control | 16 right | positive day 1-2 | 7, 8 | | Varicose veins | left |
| Control | 17 right | positive day 2-6 | 7, 8 | | Varicose veins | left |
| Control | 18 right | positive day 3-5 | 6 | SV, Fib. V, FV days 7, 14, 21 | Regression | right |

'Point' in the fibrinogen-test column refers to the location on the leg of the thrombosis (see Figure 1). PTV = posterior tibial vein, Fib. V = fibular vein, SV = soleal veins, Po. V = popliteal vein, Gastr. V = gastrocnemius vein, FV = femoral vein, PPP = primary pathological pattern. DVT = deep venous thrombosis.

Table 3. The site of the thrombi according to the phlebographic findings in 12 of the 20 patients.

| | Operated leg | Non-operated leg | Total |
|------------------------------------|--------------|------------------|-------|
| Superficial veins of the lower leg | 2 | 1 | 3 |
| Fibular veins | 9 * | 5 * | 14 |
| Posterior tibial veins | 3 | 1 | 4 |
| Soleal veins | 3 | 3 * | 6 |
| Anterior tibial veins | — | — | — |
| Popliteal veins | 2 | — | 2 |
| Superficial femoral veins | 3 | — | 3 |
| Total | 22 | 10 | 32 |

Six patients had thrombi only in the operated leg, two only in the non-operated leg and four bilateral (totally 16 legs). According to Williams (1953) the veins from the soleus usually join the fibular veins.

* indicates propagation of an earlier, preoperatively visualized thrombus.

calf. There was no case of positive uptake above the knee.

In Table 3 the localization of thrombi according to phlebography is shown. Several separate thrombi often occurred in the same leg. The thrombi of the femoral veins as well as one of the two popliteal thrombi had no connection with concurrent thrombi of the calf. Of the 12 patients with visualized thrombi on the phlebograms; in six the thrombi were rather small, in one the thrombus propagated to the popliteal vein and in three there was small to moderate, non-occluding thrombi in the femoral veins.

In Figure 2 the day for thrombosis debut is shown. Half of the thrombi were diagnosed within the first 3 postoperative days whereas the rest were not detected until more than 1 week postoperatively. Six of the thrombi in the dextran group and three in the control group appeared after 1 week.

An estimate of the development of thrombosis was made by a combined analysis of leg scans and phlebograms. There was progress in three of the dextran-treated patients and in one from the

control group. Regression was seen in one control patient (no. 14 in Table 2) (Figure 3).

DISCUSSION

This study does not indicate the occurrence of faster lysis of thrombi in dextran-treated patients. Phlebographically partial lysis could only be demonstrated in one patient belonging to the control group (Figure 3).

There was no difference in the frequency of thrombosis between the dextran and control groups. However, no definite conclusion regarding the prophylactic effect of dextran can be made as the series is small. In hip surgery a reduction of the frequency of thrombosis after dextran prophylaxis has been found by Ahlberg et al. (1968), Johnson et al. (1968), Myhre & Holen (1969), and Evarts & Feil (1971), whereas Daniel et al. (1972) found dextran to have no effect. The prophylactic effect of dextran on fatal pulmonary embolism is well documented (Bygdeman et al. 1970, Kline et al. 1975).

There is a tendency for delayed thrombosis debut in dextran-treated patients which has also been pointed out by Bergqvist & Dahlgren (1973) and was also the case in patients treated with low dose heparin (Hampson et al. 1974). Within the first week after operation only half of the thrombi have appeared and it can be concluded that the true thrombosis frequency is only obtained if the patient is followed for a considerable time postoperatively.

The frequency of thrombosis found here is in agreement with other materials with the same type of patients (Tillberg 1974, Hampson et al. 1974, Morris et al. 1974). The frequency of primary pathological pattern with leg scan is comparable with that of Becker (1972) and Bergman et al. (1975).

The fibrinogen test and phlebography



Figure 3. A case of spontaneous regression of deep venous thrombosis. The patient was not treated with any drugs.

- A. In the middle part of the right thigh there is a thrombosis about 5 cm in length in the femoral vein and its branch. This phlebography was performed on the seventh postoperative day. The preoperative phlebogram was normal.*
- B. Two weeks postoperatively there is a minor regression of the thrombosis.*
- C. Three weeks postoperatively the third phlebography was performed, showing a pronounced regression of the thrombosis.*

do complement each other diagnostically, phlebography being more reliable in the proximal part of the extremity and the fibrinogen test in the distal. The fibrinogen test is well suited for detection of early and also rapidly disappearing thrombi while phlebography can be also used for detection of late thrombi and post-thrombotic states. A preoperative pathological venous system indicated in the phlebograms predisposes to postoperative thrombosis, a development not seen by Becker et al. (1970).

As already postulated by Virchow

(1856) an endothelial lesion is one prerequisite for venous thrombosis, the others being altered blood and flow characteristics. By studying where in the venous system the primary thrombi are formed, it is possible to tell where the thrombotic process starts. The thrombus must, however, have a length of a few centimeters to be detectable, the fibrinogen test being the more sensitive. In addition, it is mainly thrombi in the venous trunks which can be diagnosed by phlebography.

In this study it has been possible to

localize and visualize the thrombi at an early stage of their development and thus determine the area most prone to initiate the thrombotic process. The most common sites of thrombosis have been found to follow this order: the fibular veins, the muscle veins of the calf, the posterior tibial veins and a few in the distal part of the venous veins of the lower leg. There were no thrombi in the anterior tibial veins.

In the three cases with thrombosis of the femoral vein there was no connection between this and the concurrent thrombi in the lower leg. In these cases the fibrinogen test had shown calf vein thrombosis before phlebography showed a thrombus in the femoral vein. In our material we have no case of isolated thrombi above the knee level. Thus, in most cases, thrombi seem to be formed in the dorsal and dorso-lateral venous system of the lower leg and, in a few cases, concurrently in the thigh veins.

As the thrombi are formed far from the field of operation or in the contralateral leg, it seems likely that endothelial lesions are caused mechanically by compression of the veins during the operation and during the inactivity afterwards (Frimann-Dahl 1947, Robertson et al. 1959). Compression may also cause hypoxia of the endothelial cells. The veins most commonly occupied by thrombi are also those having the lowest blood flow (Nicolaidis et al. 1972).

This compression hypothesis has been well formulated by Frykholm (1940), based on autopsy studies, but was already postulated by Virchow (1856). Endothelial lesions in the formation of thrombi have also been demonstrated experimentally by Samuels & Webster (1952) and Stehbens (1965). It seems probable that there must be a combination of endothelial lesion and stasis to form a thrombus (Wessler & Stehbens 1971). As our study supports the compression hypothesis one important prophylactic

measure would be to diminish long lasting compression. This could be done by putting the leg on a support distributing the pressure over a larger area. Another method, known to have a prophylactic effect, is calf muscle stimulation (Browse & Negus 1970, Becker 1972). Administration of dextran improves blood flow.

No single prophylactic measure is able to abolish thrombosis and probably a combination of various procedures with different modes of action is the way out of the problem. Dicumarol and heparin given in the traditional dosage can lead to severe postoperative bleeding and are thus not suited to hip surgery. The effect of low dose heparin in hip surgery is under debate (Hampson et al. 1974, Morris et al. 1974). The prophylactic value of a combination of calf muscle stimulation and dextran infusion is worth investigating.

Conclusions

1. This study has not shown dextran to have any effect on thrombolysis.
2. Half of the thrombi are formed during the first 3 days after operation and half after more than 1 week.
3. Local compression of the veins in combination with inactivity during and after operation are important factors in thrombogenesis.
4. Preoperative phlebography is valuable as it reveals anatomical variations and venous pathology.
5. Legs with preoperative venous pathology are more prone to develop postoperative thrombosis than are non-diseased legs.

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