DEEP VEIN THROMBOSIS AFTER TOTAL HIP REPLACEMENT

A COMPARISON BETWEEN SPINAL AND GENERAL ANAESTHESIA

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The effect of hypobaric spinal anaesthesia or narcotic-halothane-relaxant general anaesthesia on the incidence of postoperative deep vein thrombosis was studied in 140 elective total hip replacements in a prospective randomised manner. Deep vein thrombosis was diagnosed using impedance plethysmography and the ^{125}I fibrinogen uptake test, combined, in selected cases, with ascending contrast venography.

The overall incidence of deep vein thrombosis was 20%. Nine patients (13%) developed deep vein thrombosis in the spinal group and nineteen (27%) in the general anaesthetic group ($p < 0.05$). The incidences of proximal thrombosis and of bilateral thrombi were also less with spinal anaesthesia than with general anaesthesia. It is concluded that spinal anaesthesia reduces the risks of postoperative thromboembolism in hip replacement surgery. The presence of varicose veins, being a non-smoker and having a low body mass index were associated with an increased incidence of deep vein thrombosis.

Postoperative thromboembolism remains a problem after total hip replacement (Salzman and Harris 1976; Sikorski 1984) and pulmonary embolism is the commonest cause of early postoperative death (Johnson, Green and Charnley 1977; Malinque et al. 1986). The aetiology of deep venous thrombosis (DVT) is multifactorial and the potential role of anaesthesia has been largely ignored, the techniques used having rarely been reported, let alone standardised within studies. This is despite the fact that different drugs and techniques produce profound and often markedly different circulatory effects, and many anaesthetic agents by their very nature act on biomembranes and alter cellular function.

In a study of fibrinogen scanning in hip patients (Louden et al. 1978) it was incidentally observed that the frequency of DVT was lower with spinal anaesthesia (SAB) than with general anaesthesia (GA) (Thorburn,

Louden and Vallance 1980). In that study the anaesthetic techniques were not randomised, so we have re-examined the incidence of DVT following total hip replacement under SAB or GA in a randomised prospective study, the results of which are presented here.

METHODS AND MATERIALS

Patients. A total of 137 patients, all with osteoarthritis of the hip and no history of venous thromboembolism, gave their written informed consent to the study, which was approved by the North Canterbury Hospital Board Ethical Committee. Eight patients were subsequently excluded; one because of an idiosyncratic response to chlormethiazole (Laurenson and Davis 1985), one with a life-threatening dermatolytic reaction to penicillin and six for major breaks in the study protocol. Eleven patients entered the trial on two occasions, giving a study group of 140 total hip replacements (THR). Aspirin, if being taken, was stopped one week pre-operatively. Patients were randomised (males and females separately) to receive either spinal anaesthesia (SAB group) or general anaesthesia (GA group).

Clinical and anaesthetic management. The anaesthetic techniques have been described in detail elsewhere (Davis et al. 1987). Briefly, all patients were premedicated with diazepam 10 mg orally. The GA group, following induction with sodium thiopentone, received a narcotic-halothane-muscle relaxant general anaesthetic; the SAB group received a hypobaric spinal anaesthetic with tetracaine, supplemented by light basal sedation

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with a chlormethiazole (Hemineurin) infusion. The aim of both anaesthetic techniques was to achieve modest hypotension for surgery.

In a conventional operating theatre without laminar flow, an Exeter total hip arthroplasty was performed via a posterolateral approach using a standard procedure without trochanteric osteotomy. Pressure injection of methylmethacrylate cement and a polyethylene femoral cement restrictor were used. Peri-operative prophylactic antibiotics were given.

Postoperatively, supplemental oxygen was breathed for one to two days and intramuscular opioid analgesia given as needed. The patients remained in bed with the operated limb elevated in light skin traction (1.5 kg) for three days. On the fourth day, following a satisfactory radiograph of the hip, weight-bearing mobilisation started. TED stockings were worn until mobilisation was well advanced, usually for 10 days. Discharge from hospital was at 11 to 14 days unless delayed by the need for anticoagulation (11 cases) or by other surgical complications (six cases).

Table I. Demographic patient data for both groups, the numbers are frequencies or means (s.d.)

Parameter	SAB group	GA group
Procedures	69	71
Male/female ratio	31:38	31:40
Age in years	68.3(8.2)	66.7(9.3)
Weight in kilograms	71.1(13.5)	70.1(12.5)
Smokers	13	14
Varicose veins	22	23
Body mass index (n = 102)	26.4(4.6)	25.7(3.8)
Hypertension	22	28
Duration of surgery* in minutes	73(13)	79(21)

* p < 0.05

Diagnosis of deep vein thrombosis. The diagnosis of DVT was based on venous occlusion impedance plethysmography and the ^{125}I fibrinogen uptake test, supplemented by ascending contrast venography in some patients.

Plethysmography was performed immediately after operation and on the fourth, seventh and eleventh days. The procedure described by Taylor et al. (1980) was followed, using locally developed instrumentation, and the curves were analysed using the semi-quantitative method described by Seagar, Gibbs and Davis (1984).

Preparation for the **fibrinogen uptake test** started 24 hours before operation, the thyroid gland then being blocked with oral potassium iodide 120 mg daily for two weeks. Immediately after operation 100 uCi of ^{125}I Iodine fibrinogen (Amersham) was injected intravenously. Leg scans were performed daily for a minimum of seven days using a Pitman 235N Isotope Monitor. The scanning technique and diagnostic criteria used were those advocated by Roberts (1975). The upper four thigh counts on the operated limb were ignored for the purpose of diagnosis.

Fig. 1

The incidence of deep vein thrombosis in the spinal (SAB) and general (GA) anaesthetic groups.

From these two tests patients fell into three groups: those with both tests normal (DVT-negative), those with one or the other abnormal (equivocal diagnosis), and those with both abnormal (major DVT present, patient anticoagulated). All but one of the 27 patients in the equivocal group underwent venography (Rabinov and Paulin 1972) which was positive in 17. The other patient had a severe iodine-contrast allergy. As well as a highly abnormal fibrinogen uptake, she developed an abnormal lung scan with a high probability of pulmonary embolism, and on this basis was diagnosed as DVT-positive.

and anticoagulated. Five patients in whom both tests were positive also underwent venography despite the above protocol, and a major DVT was confirmed in all. Patients in whom the thrombosis was confined to the calf on venography were not anticoagulated. All patients who were anticoagulated had a lung scan.

Statistical analysis. The incidence of DVT in the 140 cases was analysed using the Chi-squared test. Clinical and laboratory predictors of DVT were investigated singly, using Chi-squared tests for contingency tables, and then logistic regression to model the data (Dixon 1983).

RESULTS

Clinical course. There were no pre-operative differences between the two anaesthetic groups (Table I). Surgical time averaged about five minutes less with SAB than with GA (Table I). Only eight SAB patients and 13 GA patients required blood transfusion during the operation.

Postoperatively, there were no prosthetic dislocations and no deaths. Four wound infections occurred of which two involved the joint. Six patients had minor respiratory complications. No major cardiovascular problems were seen. Four patients, three in the SAB group and one in the GA group, developed urinary retention postoperatively.

the GA group. Of the other 26 DVT-positive patients, 15, including all those anticoagulated, had lung scans, all of which were negative for pulmonary embolism. In the 20 patients with calf thrombosis only, who were not anticoagulated, no subsequent thromboembolic complications developed clinically during the study.

Factors associated with DVT. Univariate analysis showed that several clinical variables apart from the use of GA appeared to be associated with an increased incidence of DVT. These were the presence of varicose veins ($p < 0.005$), being a non-smoker ($p < 0.1$) and a low body mass index ($p < 0.1$). Age ($p > 0.8$) and sex ($p > 0.1$) did not appear to influence the DVT rate.

Several logistic regression models were tested, but the data were well fitted by a simple three-factor risk model involving only anaesthesia, smoking and varicose veins without interactions. This model suggests that about 50% of patients with all three risk factors (GA, varicose veins, non-smoker) will have DVT, whereas virtually all patients with none of these risk factors will escape (Table II).

Body mass index could be calculated for only 101 patients, as the height of the other patients was not recorded. Stepwise logistic regressions on this group entered low body mass index as an interval or categorical variable in addition to anaesthesia, varicose veins and smoking.

DISCUSSION

Table II. A three-factor logistic risk model as a predictor of DVT, taking GA, varicose veins, non-smoker as risk factors

Risk	Number	Probability of no DVT	
		Observed	Predicted
3	17	0.47	0.50
2	60	0.77	0.73
1	55	0.91	0.88
0	7	1.00	0.95

Incidence of DVT. Twenty-eight patients (20%) were diagnosed as DVT-positive, nine in the SAB group and 19 in the GA group (Figure 1; $\chi^2 = 4.12$, $p < 0.05$). Of these patients, 11 were considered to have a major proximal DVT and were anticoagulated, three in the SAB group and eight in the GA group ($\chi^2 = 3.55$, $0.05 < p < 0.1$). Bilateral DVT occurred in nine patients, one in the SAB group and eight in the GA group ($\chi^2 = 4.09$, $p < 0.05$).

Three patients with evidence of major DVT developed isotopic evidence of pulmonary embolism and this was life-threatening in one. All three patients were in

Both anaesthetic techniques proved clinically satisfactory in our hands. The surgical infection rate at 2.9%, with two patients (1.45%) having deep involvement, was no higher than that reported elsewhere for conventionally ventilated operating rooms (Lidwell et al. 1984). The incidence of urinary retention requiring catheterisation (2.9%) was low compared to other reports (Walton and Robinson 1982; Walts et al. 1985). Therefore, single dose spinal anaesthesia does not appear to be a risk factor for postoperative urinary retention.

Indirect methods for the diagnosis of DVT were chosen for several reasons. First, since over half the patients would be free from DVT there was local ethical concern regarding the use of venography with its attendant risks (Strandness 1977) in patients without clinical, plethysmographic or fibrinogen scan indications. Similar concerns have been expressed elsewhere (Brown et al. 1987). Secondly, venography on a single occasion may miss a postoperative DVT. Thirdly, there is a wide diversity of opinion on the appropriate choice of diagnostic methods for screening THR patients for DVT (Gray and Mackie 1983; Sikorski 1984). Combined screening with fibrinogen uptake and plethysmography with venography in selected cases, particularly to exclude false positive fibrinogen uptake tests, should provide both positive and negative diagnostic

accuracy better than 90% (Hull et al. 1979, 1981; Moser and LeMoine 1981; Brown et al. 1987). Finally, the randomised design in an appropriate-sized population sample with consistent diagnostic criteria would tend to negate any effect related to the accuracy of the diagnostic techniques, provided they were reasonably reliable.

Our observations confirm the protective effect of spinal anaesthesia against DVT suggested by Thorburn et al. (1980). A similar effect has been demonstrated for epidural anaesthesia (Modig et al. 1981, 1983). Modig argued that this difference was primarily due to the observed reduction in blood loss with epidural anaesthesia. However, no difference in DVT has been observed between hypotensive and normotensive GA for THR, despite a significant reduction in blood loss in the hypotensive group (Fredin, Gustafson and Rosburg 1984). It is unlikely, therefore, that reduction of blood loss alone is the explanation.

Quite apart from the anaesthetic effect, the frequency of DVT, as has been reported previously from New Zealand (Gray and Mackie 1983), was considerably lower in our patients than in the three comparable anaesthetic studies on THR. Factors involved may include the use of TED stockings, relatively short operating times and low blood losses. Geographic factors may also be important.

The pre-operative identification of high risk patients would be of great value. Clinically, a history of thromboembolic disease, the presence of varicose veins, malignancy, old age and the use of oral oestrogens seem to be important risk factors for thromboembolic disease (Sikorski 1984).

In our study, a simple risk model emerged with four factors seemingly associated with DVT: the anaesthetic technique, the presence of varicose veins, being a non-smoker, and having a low body mass index. The body mass index association conflicts with previous gynaecological studies where obesity was a risk factor for DVT (Crandon et al. 1980). There is no logical explanation for this observation. It may be that in the elderly the relationship is not the same as in a younger female group. Neither age nor sex were identified as risk variables, and no association with either blood loss or transfusion was seen, unlike some earlier reports (Sikorski, Hampson and Staddon 1981; Gray and Mackie 1983). Even with this risk model it was not possible to predict DVT-positive patients accurately, which from a clinical point of view was disappointing. The reverse seemed true, however, that patients who were smokers, free from varicose veins and receiving SAB would escape DVT.

Because of its multifactorial nature, it is important to adopt a "management strategy" in the prevention of DVT that is not simply a matter of pharmacological prophylaxis. This might include identification of high-risk patients, minimisation of pre-operative hospital delay, the use of simple mechanical prophylactic measures such as TED stockings, the correct choice of

surgical approach (Roberts et al. 1984), a conservative approach to blood transfusion (accepting a postoperative haemoglobin of about 100 g/l), early mobilisation and the use of regional anaesthesia.

We conclude that both theory and clinical evidence now support the belief that anaesthesia is an important variable in the aetiology of postoperative DVT in hip surgery. Therefore, the results of clinical trials of surgical DVT prophylaxis in which the anaesthetic technique has not been standardised should be interpreted with caution, and future studies should always ensure that this is done. There is strong evidence from this and other studies that regional anaesthesia is the method of choice for hip replacement surgery as it helps to minimise venous thromboembolism – the commonest preventable cause of postoperative mortality.

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