Yorkers. Bradlow *et al.* (1962) showed that some of the coagulation factors were lower and that fibrinolysis was accelerated in South African Bantus compared with white controls. Pre-operative and postoperative coagulation studies in our patients may help to explain the relatively low incidence of postoperative deep vein thrombosis among them.

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Deep Vein Thrombosis in a Queensland Hospital*

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Summary

Investigation in the postoperative period of 75 patients by means of the radioiodinated fibrinogen uptake method, by the use of the Doppler ultrasonic flow detector, and by clinical assessment revealed an incidence of deep vein thrombosis of only 12%. This is distinctly lower than has been reported by other investigators using the same techniques both in Australia and elsewhere. It appears from this study and associated work that the Doppler ultrasonic technique is sufficiently accurate to be of value in the clinical diagnosis of significant deep vein thrombosis.

Introduction

The Greenslopes Repatriation General Hospital in Queensland, Australia, provides medical services for ex-servicemen, mostly those who served in the first and second world wars. Because of the age of these patients and the fact that many of them suffer from chronic cardiac and respiratory diseases it was thought that many would develop deep vein thromboses after surgery.

Methods and Subjects

RADIOIODINATED FIBRINOGEN UPTAKE

Freeze-dried human fibrinogen tagged with ^{125}I , prepared by the Radiochemical Centre, Amersham, England, was obtained from the Commonwealth Radiation Laboratory, Melbourne.

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This preparation was transported rapidly from England and the activity of the isotope was checked before its administration. It was usually possible to use each ampoule on or before the reference date at which the activity was 100 microcuries, thus ensuring that the isotope dose was sufficient to provide adequate counts during the period over which readings were taken. The fibrinogen was from donors with known donation records and was screened for Australian antigen. No degradation in the quality of the fibrinogen has been observed, and other groups in Australia are using the same product with equally satisfactory results. Before administering this material the thyroid gland was saturated with non-radioactive iodine by giving a sodium iodide mixture by mouth. A flavoured solution of 100 mg sodium iodide per 10-ml dose was acceptable to most patients, and this was continued for six weeks from the time of administration of the isotope.

A 100 microcurie dose (approximately) of the ^{125}I tagged fibrinogen was given intravenously on the day before operation, and measurements were performed at marked sites over both lower limbs preoperatively and on alternate days postoperatively for at least a week. A Pitman model 235 isotope localization monitor was used in this study. The legs of the patients were raised 10° above the horizontal and measurements were taken over three sites on each thigh and five sites on each calf. Counts were measured as a percentage of the precordial count (this being taken as 100%). A sustained rise of 20% or more was taken to indicate the development of a deep vein thrombosis at the site where the rise was noted. Details of this method of investigation have been previously described by Kakkar *et al.* (1970) and Flanc *et al.* (1968).

DOPPLER ULTRASONIC FLOW DETECTOR

Either a Parks Model 802 or Model 806 machine was used in this study. The output from the transmitting crystal is a narrow focused beam of 10 MHz frequency and the probe is coupled to the skin using an acoustic coupling gel (Parker Aquasonic). The shift in the reflected signal is proportional to the velocity of blood flow in the vessel under study. The difference between the transmitted and received frequencies is amplified and is audible in high fidelity headphones. The Parks models have several advantages over other models used in similar studies because of the focused nature of the beam and the frequency used. The probe is applied over the femoral artery pulse and then moved

medially to pick up femoral vein flow. Wide experience is needed in the identification of venous flow noise, and in the variation caused by application of pressure to the calf and to the thigh. The method has been described previously by Sigel *et al.* (1968), and is particularly suitable for detecting thrombosis above the level of the knee. The experienced observer using the 806 directional machine can diagnose thrombotic lesions of the calf veins.

CLINICAL ASSESSMENT

Clinical signs and assessments are reputed to be unreliable guides in the diagnosis of deep vein thrombosis. In this series the following features were assessed on alternate days by two observers working independently. Their records were correlated each with the other and with the results of the iodinated fibrinogen and Doppler studies after the discharge of the patient. (1) Mobility (whether the patient was confined to bed, mobile with toilet privileges, or unrestrictedly mobile). (2) Temperature. (3) Calf pain (present or absent). (4) Calf tenderness (present or absent). (5) Ankle oedema (present or absent; unilateral or bilateral). (6) Homan's sign (positive or negative).

PATIENTS

Altogether, 75 patients admitted for elective surgery were studied. It was necessary to exclude patients undergoing thyroid operations or surgery of the lower limbs, and patients whose stay in hospital was likely to be less than a week. The nature of the investigation was fully explained to all patients, including a discussion of the possible hazards. There were 59 men and 16 women in the group. All but four were over 50 years of age, the oldest being 82 and the youngest 30, with a mean age of 63 years (fig. 1). Most patients had general surgical procedures, ranging from hernia repair to major abdominal surgery. Five orthopaedic procedures and five gynaecological operations were performed. Eight patients had operations for malignancy. The trial included patients treated by 12 different surgeons. Only one patient did not have a general anaesthetic and he had a low spinal anaesthetic for a haemorrhoidectomy. Sixteen patients had varicose veins and in five there was a previous (but not confirmed) history of venous thrombosis or suspected pulmonary embolism.

FIG. 1—Age distribution of the 75 patients included in survey.

Results

Nine patients (12%) showed evidence of unilateral deep vein thrombosis on the ^{125}I -fibrinogen study. Of these, four had localized areas of calf thrombosis and five had thrombi involving the femoral vein. There were no instances of bilateral venous

thrombosis, and of the nine patients with positive results eight were men and one was a woman. Three patients had had a cholecystectomy, two an inguinal hernia repair, and the other four a partial gastrectomy, a Nissen's procedure, a sigmoid colectomy, and an internal fixation of a fractured femoral neck respectively. Positive results obtained by the radioiodinated fibrinogen uptake method were well defined as shown by figs. 2 and 3. The Doppler flow meter failed to detect the four thrombi shown by the ^{125}I -fibrinogen method to be small and localized in the calf vein. The remaining five patients with axial venous thrombi were detected by the Doppler technique. A previous unreported study by us comparing Doppler ultrasound with venography in 50 patients produced similar results, and our continuing experience since the completion of this trial confirms our belief that the Doppler method is quick, safe, reasonably simple, and accurate in the detection of thrombi above the knee.

Only two of the patients in whom deep vein thromboses were diagnosed developed clinical signs or symptoms; the remainder showing no clinical evidence of thrombosis.

FIG. 2— ^{125}I -Fibrinogen percentage uptake. Preoperative and postoperative readings on days 3 and 7 were plotted. The left leg in this patient showed no abnormality.

FIG. 3— ^{125}I -Fibrinogen percentage uptake. The right leg in this patient showed an increased uptake of isotope on the third and seventh postoperative days, indicating presence of a localized deep vein thrombosis in right calf.

Discussion

There have been many reports in the literature of studies carried out in various parts of the world using iodinated fibrinogen to detect deep vein thrombosis and the incidence in almost all of

these series has been more than 30% (Flanc *et al.*, 1968; Negus *et al.*, 1968, Flanc *et al.*, 1969; Tsapogas *et al.*, 1970; *Lancet*, 1971; Rosengarten, 1971). Kakkar (1969) stated that there is a postoperative deep vein thrombosis rate of 35% in patients over the age of 40 years. Similar results have been found in Australia. In Melbourne, Renney and O'Sullivan (1972) reported an incidence of 47% in a group of 38 patients. Nearly half of these had surgery for malignant disease, and their average age was 59 years. Little (1971), using a Doppler ultrasonic method of detection in a series of 121 patients in Sydney, found a thrombotic rate of nearly 31%. This study was not confined to patients having surgery, and because radioiodinated fibrinogen was not used the figures are not truly comparable to other series.

The incidence we have found in Brisbane (12%) is significantly lower than those reported in both Melbourne (47%) and Sydney (31%).

It is obvious that the incidence of deep vein thrombosis will be influenced by differences in the patient samples involved. After the work of Kakkar and his co-workers (1970) it appears that patients having major operations, those suffering from malignant diseases, those with previous episodes of deep vein thrombosis or pulmonary embolism, those who have varicose veins, and those patients over the age of 60 years constitute a high risk group. In such a group the incidence of deep vein thrombosis may be more than 45%.

In the present series 57 of the patients (76%) were in this high risk group. Most were included because of their age but several of the patients could be classified into this group for more than one reason. The incidence of deep vein thrombosis in this group was 14%, which is again significantly lower than that reported in similar high risk groups by Renney and O'Sullivan (1972) in Melbourne and Kakkar (1969) in London.

Statistics compiled by the Australian Commonwealth Bureau of Census and Statistics tend to support the suggestion that there may be a low incidence of deep vein thrombosis in Queensland. We considered that death rates from pulmonary embolism might well mirror the incidence of deep vein thrombosis, although the difficulty in establishing the diagnosis of pulmonary embolism in those patients not having necropsies is well known. However, it was hoped to eliminate such error by taking figures over the last six years. Accordingly, all deaths attributed to pulmonary embolism from the beginning of 1965 through to the end of 1970 were recorded and the numbers were expressed as rates per 100,000 population for each of the eastern seaboard Australian States and for South Australia. In Queensland there were 6.1 deaths per 100,000 during this period, while in South Australia and Victoria the rates were 8.6 and 9.2 per 100,000 respectively. In New South Wales the death rate was 6.8 per 100,000 and for the whole of Australia 7.6 per 100,000.

It is tempting to conclude that climate and other related factors may influence the incidence of postoperative deep vein

thrombosis. Evidence is incomplete as few studies have been performed in tropical and subtropical areas. Trowell (1971) commented on the rarity of deep vein thrombosis in Africans and stated that the death rate from pulmonary embolism was low in Uganda; it was suggested that dietary factors were responsible here.

It is of interest that a low incidence of deep vein thrombosis has been reported from two district general hospitals in Essex (Billericay Hospital 16%, Chelmsford Hospital 18%) (Sripad *et al.*, 1971). In this study radioiodinated fibrinogen was used, but monitoring of the legs was done for only four days, except those patients who showed evidence of deep vein thrombosis at this time when the monitoring was continued till their discharge. It is possible that thrombi developing on the fifth or later days were missed in this way.

Investigations are being continued in our unit directed towards establishing the cause of this apparent low incidence of deep vein thrombosis. There is some evidence already that there is a general failure of platelet numbers to rise and of platelets to become more adhesive in postoperative patients in Brisbane.

We are grateful to the chairman of the Repatriation Commission for permission to perform and report this investigation, and to the visiting specialist surgeons at the Repatriation General Hospital, Greenslopes, for their co-operation in making patients under their care available for inclusion in the survey.

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