

PREVENTION OF POSTOPERATIVE DEEP VEIN THROMBOSIS

Low-dose Heparin versus Graded Pressure Stockings

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Abstract. In a prospective, controlled clinical study prevention of postoperative deep vein thrombosis by low-dose heparin (Heparin Leo 5000 I.U. subcutaneously twice daily) was compared with graded compression stockings (TED stockings, Kendall Co.). One hundred and twelve patients, admitted during a period of one year for elective major surgery, were allocated to one of the two treatment groups. In order to detect deep vein thrombosis the ^{99m}Tc -plasmin test was performed before the operative procedure and again 5 days later. Ninety-seven patients completed the study (45 patients in the heparin group and 52 patients in the stocking group). Venous thromboembolism was detected in 4 patients (8.9%) in the heparin group and in 3 patients (5.8%) in the stocking group ($p>0.05$). In 6 patients the plasmin test was positive and one patient in the heparin group died following pulmonary embolism. It is concluded that graded compression stockings can be used as an alternative to low-dose heparin for prophylaxis against deep vein thrombosis in elective general surgery.

Stasis of the blood in the veins is probably the most important factor predisposing to thrombosis and it is of particular significance in surgical patients (22). The increased risk of venous pooling and activated coagulation factors is considered responsible for the high incidence of postoperative deep vein thrombosis (DVT). Reduction in the frequency of postoperative DVT can be achieved either by preventing the hypercoagulable state or by eliminating the venous stasis (16). Reduced preoperative venous pooling can be achieved by physical methods such as graded compression stockings or intermittent pneumatic compression, which prevents stasis by increasing the mean femoral venous blood flow velocity by 38% (19).

The aim of this study was to compare the efficacy of low-dose heparin versus graded compression

stockings in the prevention of postoperative DVT in a prospective, clinical trial.

PATIENTS AND METHODS

Included in the study were 112 patients above 40 years of age, admitted to the County Hospital of Aarhus for elective general surgery, involving general anesthesia of more than one hour's duration. Patients already treated with anticoagulants, patients with severe heart failure or hemorrhagic diathesis were not included in this study. All participants gave informed consent, and the trial protocol was approved by the Ethical Committee. Patients were randomly allocated to a stocking group (Thrombosis Embolic Deterrent stockings (TED stockings, Kendall Co.)) or a low-dose heparin group by instructions in sealed envelopes. Prophylaxis was started the evening before operation. The heparin group received sodium heparin (Heparin Leo®), 5000 I.U. subcutaneously every 12 h, and a heparin dose was always given 2-3 h before operation. The patients in the stocking group wore graded compression stockings of thigh length. Stocking size was determined according to the recommendations of the manufacturer. Both treatments were continued for at least 5 days after operation and were only stopped when patients were mobile. A ^{99m}Tc -plasmin test was performed to detect DVT before operation and 5 days later. The ^{99m}Tc -plasmin test for DVT detection has recently been described (9), and a good correlation between the ^{125}I -fibrinogen test and the ^{99m}Tc -plasmin test has been demonstrated (17).

Fifteen of the 112 allocated patients (9 in the stocking group and 6 in the heparin group) had to be excluded, for various reasons. Four patients were discharged before follow-up and 2 patients refused to participate in the follow-up scintigraphy. Two patients were excluded because of a poor postoperative condition, which was not related to thromboembolic complications, and 1 patient, already receiving anticoagulant treatment, was included by mistake. Finally, 6 patients were excluded for technical reasons due to lack of ^{99m}Tc -plasmin and trouble with the counter. The patients, who were excluded, did not

Table I. Age, weight, sex and duration of operation (mean and range)

Prophylaxis	No. of patients	Age (years)	Weight (kg)	Sex (% female)	Duration of operation (min)
Heparin	45	60 (39-80)	72 (47-95)	56	213 (105-540)
Stockings	52	60 (39-87)	73 (40-115)	44	203 (105-450)

differ from the trial patients regarding sex, age, type of operation, or treatment received, and none of them developed clinical signs of DVT or pulmonary embolism.

χ^2 -test, Student *t*-test for both paired and unpaired data, and the Mann-Whitney test were used for statistical analysis.

RESULTS

Forty-five (25 females and 20 males) of the 97 patients, who completed the study, were allocated to the heparin group and 52 patients (23 females and 29 males) to the stocking group. The groups were comparable according to age, weight, sex and duration of operation (Table I), and Table II shows the types of operation and the distribution of malignant and benign cases. No difference regarding risk factors such as obesity, previous thromboembolic diseases, varicose veins, malignancy, cardiopulmonary disorders or estrogen intake was found (Table III). There was no significant difference between the number of smokers in the groups. Venous thromboembolism was detected in 7 patients (7.2%), 4 (8.9%) (95% confidence limits 2.5-21.2%) in the respasin group and 3 (5.8%) (95% confidence limits 1.2-16.0%) in the stocking group. Although the difference between the groups was 3.1% in favour of the use of stockings the difference is insignificant ($p > 0.05$) (95% confidence limits—7.4-13.6%). Six patients had a positive plasmin test and one patient in the heparin

group died on the 2nd postoperative day from pulmonary embolism verified at autopsy. In the heparin groups we found a slightly, but insignificantly higher perioperative bleeding and total number of blood transfusions, as compared with the stocking group. There was no difference in the pre- and postoperative hemoglobin concentration between the two groups (Table IV). In none of the groups were any major postoperative hemorrhagic complications registered. In the heparin group a few patients complained of discomfort from the injections. In the stocking group a few patients complained about the stockings, which slipped down or felt hot.

DISCUSSION

Static compression by stockings has been used for many years in the prevention as well as in the treatment of DVT. Wilkins et al. (21) showed that elastic stockings reduced the incidence of pulmonary embolism, but more recent studies have failed to confirm this finding (6). More recently still a graded static compression stocking has been developed, which increases the velocity of femoral venous blood flow (12), thus reducing the pooling of blood in the soleal sinuses and valve cusps. The efficacy of graded compression stockings in the prevention of postoperative DVT has been documented in several controlled clinical studies, with a significant reduction in DVT frequency as com-

Table II. Type of operation and presence of malignancy related to the type of antithrombotic prophylaxis

	Malignant cases, <i>n</i> =31		Benign cases, <i>n</i> =66	
	Stockings	Heparin	Stockings	Heparin
Gastro-duodenal	2	1	7	4
Large intestine	3	4	1	1
Rectal	6	8	0	0
Biliary	0	0	20	15
Urological	6	1	5	7
Others	0	0	2	4
Total	17	14	35	31

Table III. Risk factors

Prophylaxis	No. of patients	Obesity (>1.25) (Natvig's index)	Previous DVT or varices	Malignancy	Cardio-pulmonary disorders	Estrogen intake
Heparin	45	10	6	14	6	3
Stockings	52	10	10	17	8	1

pared with no treatment (1, 2, 8, 10, 18). Törngren (20) has shown that graded compression stockings combined with low-dose heparin were more effective than heparin alone, and Bergqvist & Lindblad (3) found an additive effect of graded compression stockings during treatment with dextran. In the present study the efficacy of graded compression stockings was compared with low-dose heparin for the prevention of DVT in relation to elective, general major surgery. No significant difference was detected. The frequency of DVT was found to be about 10%. A similar frequency has been registered in other studies using low-dose heparin (11).

The ^{99m}Tc -plasmin test is easy to perform and has a high diagnostic sensitivity (9). One disadvantage of the ^{99m}Tc -plasmin test as compared with the ^{125}J -fibrinogen test is that it does not allow for daily DVT screening and therefore some transient cases of DVT may elude detection. We have chosen the 5th postoperative day for DVT screening because most patients will be fully ambulated and at least 90% of all DVT are developed at this time (4, 7). In addition, the changes in the pattern of venous blood flow induced by the TED stockings may introduce a potential source of error, but we feel this is of little significance owing to the symmetric application of the stockings, and because the patients did not wear the stockings during the last hour before investigations.

Borrow & Goldson (5) compared the efficacy of low-dose heparin, aspirin, dextran, graded compression stockings and intermittent pneumatic

stockings versus an untreated control group in 562 patients undergoing major surgery. All modalities with the exception of low-dose heparin significantly reduced the incidence of DVT postoperatively, with the anti-stasis devices being more effective than the pharmacological methods. However, five different surgical specialties participated in the study, as about 20% underwent orthopedic procedures, 60% general surgery and 20% gynecological, urological or vascular surgery. Nevertheless, the results in the groups with 332 patients undergoing general surgery were comparable to those obtained for all patients included (4). Nicolaidis et al. (16) compared intermittent sequential compression of the legs followed by application of TED stockings, versus low-dose heparin in 150 patients undergoing major surgical operations using electrical calf stimulation as a control group. A significant reduction in DVT frequency was found by low-dose heparin and an even further though insignificant reduction was obtained with the physical device. In a similar study including 227 patients undergoing general surgery, Moser et al. (15) found intermittent pneumatic compression alone to be just as effective as low-dose heparin alone or low-dose heparin combined with dihydroergotamine.

The efficacy of low-dose heparin in the prevention of postoperative DVT has been most convincingly demonstrated in general surgery (11), whereas in hip surgery a less convincing effect has been obtained (14). There is a small, but definite risk of bleeding—such as wound hematomas—during he-

Table IV. Perioperative bleeding, transfusions (mean and range) and hemoglobin concentration (Hb) before and after operation (mean and SD)

Prophylaxis	No. of patients	Peroperative bleeding (ml)	Patients transfused	No. of transfusions	Hb before (mmol/l)	Hb after (mmol/l)
Heparin	45	554 (50–3 500)	29	2.3 (0–11)	8.6±0.75	7.5±0.88
Stockings	52	505 (50–3 250)	26	1.5 (0–9)	8.6±0.87	7.6±0.86

parin therapy and, furthermore, it is expensive and the administration form may be unpleasant for the patients. The ultimate purpose of antithrombotic prophylaxis is to prevent fatal pulmonary embolism, but until now no study has shown a convincing effect of low-dose heparin in this respect (13).

Therefore, we conclude that graded compression stockings are an alternative to heparin for the prevention of postoperative DVT following elective, general surgery, and have the advantage of being simple, with a low incidence of side effects.

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