Deep venous thrombosis in postoperative vascular surgical patients: A frequent finding without prophylaxis

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Purpose: **The place of routine perioperative thromboprophylaxis for vascular surgical patients remains controversial, because the incidence of postoperative deep venous thrombosis (DVT) is said to be quite low. This study was designed to measure the incidence of lower limb DVT after vascular surgical procedures.**

Methods: **All consenting, consecutive patients who came to a metropolitan veterans hospital for abdominal or lower-limb arterial surgery were studied. Clinical and operative data were recorded. Lower-limb color flow duplex scans were performed before and after surgery.**

Results: **Fifty patients, age 75 ± 1 (mean ± SEM) years, were studied. Abdominal procedures were performed on 22 patients, and lower-limb procedures were performed on 28 patients. A postoperative DVT was noted in 14 patients (32%), 9 patients (41%) in the abdominal surgical group and 5 patients (18%) in the lower-limb group. Calf DVTs were four times more common than femoropopliteal DVTs.**

Conclusion: **The incidence of postoperative lower-limb DVTs in this cohort of vascular surgical patients was high. The small size of the study population precludes generalized recommendations, but the results indicate an urgent need for definitive investigation. (J Vasc Surg 2001;34:656-60.)**

Most surgical patients should receive perioperative thromboprophylaxis in accordance with published recommendations.[1] The situation is less clear for vascular patients. There have been only a few reports of the incidence of deep venous thrombosis (DVT) in patients undergoing vascular procedures. Intraoperative anticoagulation with intravenous heparin has been widely believed to provide adequate protection against thromboembolic phenomenon.[2] We hypothesized that there is a significant incidence of unrecognized DVTs among patients undergoing abdominal or peripheral vascular surgery.

METHODS

All consenting patients who came to a metropolitan veterans hospital for elective abdominal or peripheral vascular surgery from July to November 1998 were included. Patients were excluded when they had a history of DVT or pulmonary embolism (PE) or were undergoing emergency surgery or carotid or varicose vein surgery.

Clinical data, including risk factors, age, sex, impairment of mobility, carcinoma, varicose veins, thrombophilia, and usage of aspirin or anticoagulants, were recorded. Impairment of mobility was defined as the inability to walk 50 m. All patients underwent a full clinical examination. Operation details, including type, length, heparin and protamine dosage, and anesthetic method, were recorded. No patient received pharmacologic or mechanical DVT prophylaxis.

Study patients underwent bilateral lower-limb color flow duplex venous scanning on the day before surgery and on the day of discharge. Bilateral venous duplex scans were performed in the vascular laboratory at Greenslopes Private Hospital with an ATL extreme HDI 5000 system (Advanced Technology Laboratories, Bothell, Wash). The preoperative and postoperative scans were randomly performed by one of three qualified and experienced sonographers (each with more than 5 years' clinical experience in venous imaging). Each patient was placed in the reverse Trendelenburg position as a means of examining the common femoral, profunda femoris, superficial femoral, and popliteal veins. The distal popliteal, gastrocnemial, soleal, posterior tibial, anterior tibial, and peroneal veins were examined with the leg dependent on the sonographer's lap. All veins were examined in the transverse and longitudinal planes with a high-resolution 7.5-MHz linear array transducer. The scan was considered to be positive when a particular venous segment displayed intraluminal echoes and incomplete coaptation of the vein walls with transducer pressure. The absence of phasic Doppler signals with respiration, loss of brisk augmented signals, and incomplete or no filling of a vein with color or power Doppler ultrasound scanning were used as a means of supporting the diagnosis.[2,3]

Patients were examined daily for signs of DVT or PE. Patients were treated appropriately with anticoagulation

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Competition of interest: nil.
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Published online Aug 13, 2001.

0741-5214/2001/$35.00 + 0 **24/1/116803**
doi:10.1067/mva.2001.116803

Table I. Patients undergoing abdominal and peripheral vascular surgery: comparison between groups for the risk factors of postoperative DVT

	Abdominal	*Peripheral*
Total (n) = 50	22	28
Age (y)	73 ± 2	77 ± 1
Sex (M/F)	21/1	20/8
Immobility	7 (32%)	13 (46%)
OP time (min)	150 ± 9	142 ± 9
Heparin (units)	9095 ± 541	8069 ± 347
Protamine (mg)	98 ± 10	75 ± 7
Spinal anest	0	14 (50%)
Clinical suspicion of DVT/PE	0	0
LOS (d)	8 ± 1	9 ± 1

DVT/PE, Deep venous thrombosis/pulmonary embolism; *LOS,* length of stay; *M/F,* male/female ratio; *OP time,* operation time; *Spinal anest,* spinal anesthesia.

Table II. Incidence of DVT in patients undergoing vascular surgery

	Abdominal	*Peripheral*
n	22	28
Calf DVT	7 (80%)	4 (80%)
Femoropoliteal DVT	2 (20%)	1 (20%)
Total DVT	9 (41%)	5 (18%)

DVT, Deep venous thrombosis.

when the diagnosis of DVT or PE was made. The Institutional Ethics Committee of the Greenslopes Private Hospital approved the study, and informed consent was obtained in all cases. Data are presented as raw figures, percentages, and the mean ± the SEM.

RESULTS

A total of 53 patients were enrolled, and 50 patients completed the study. The age of the patients ranged from 49 to 87 years, with a mean age of 75 ± 1 years. The man-woman ratio was 41 to 9. Twenty-two patients underwent surgery to the abdominal vasculature. Twenty-eight patients underwent peripheral lower-limb vascular surgery. The abdominal group had a mean age of 73 ± 2 years. The peripheral group was slightly older (77 ± 1 years). There were more women in the peripheral group than in the abdominal group. More preoperative impairment of mobility was apparent in the peripheral group (46%) than in the abdominal group (32%). In the abdominal group, two patients had a history of carcinoma, and 10 patients were taking aspirin. In the peripheral group, 1 patient had known varicose veins, 10 patients were taking aspirin, and 1 patient was being treated with hormone replacement therapy. No patients had a stroke with preexisting paresis. No patients had a history of thrombophilia or other known coagulation abnormality. The length of hospital stay was similar for both groups. The clinical diagnosis of DVT was not made in any patient. All patients had preoperative scans, by means of which one old nonocclusive thrombus of small size limited to one calf vessel was revealed (Table I).

DVT occurred in nine patients (41%) in the abdominal group and five patients (18%) in the peripheral surgical group, producing an overall incidence of 32%. Twenty percent of all DVTs extended proximally to the femoropopliteal region (Table II). All of the patients with DVT in the abdominal group were men. Three of the patients with DVT in the peripheral group were men. There were almost equal numbers in the left (4) and right (5) legs. Five patients in the abdominal group had DVTs in both legs (56%), versus one patient in the peripheral group (20%). The operative leg was the frequent side for DVTs in the peripheral surgical patients (80%; Table III).

The one patient with a proximal DVT in the peripheral surgical group had 3 cm of clot in his long saphenous vein extending into his common femoral vein, which dislodged and embolized during scanning. However, he did not have any symptoms and was fully anticoagulated.

General anesthesia (GA) and epidural anesthesia were used for all abdominal vascular patients. The peripheral group had an equal distribution of GA/epidural anesthesia and spinal anesthesia. Of the five peripheral patients in whom DVT was detected, four had received GA/epidural anesthesia.

Three patients, all of whom were in the abdominal group, died during our study and were not included in the analysis. This represented a 5.6% overall death rate or 12% of the abdominal surgical group. An 84-year-old woman with an abdominal aortic aneurysm (AAA) died on day 11 of renal and respiratory failure, widespread multiresistant sepsis, and cerebral infarctions. An 81-year-old man with an AAA died on day 10 of congestive cardiac failure. The third patient, a 75-year-old man with an AAA, continued to smoke postoperatively and had a respiratory arrest on day 5, with a mucous plug obstructing his trachea. On day 8, he had a sudden onset of central chest pain, and ventricular tachycardia developed, rapidly progressing to asystole. His family refused a postmortem examination. The cause of death could not, therefore, be validated, but myocardial infarction or PE was a possibility. This patient did not undergo postoperative duplex scanning.

DISCUSSION

Eighty percent of the DVTs detected in our study were calf DVTs. Anticoagulation and treatment of proximal DVT are well accepted. The importance of calf DVT is not so well accepted. Postoperative calf thrombosis diagnosis and management are controversial. The clinical sequelae become increasingly more significant as the bulk of thrombus increases.[4] Lagerstedt et al[5] treated 51 patients who had venographically confirmed calf DVT either with 3 months of oral anticoagulants or with short-term therapy. No patients in the group who were treated for 3 months had a recurrence at 3 months, compared with 29% of the minimally treated group. One patient in

Table III. Comparison between patients positive for DVT and patients negative for DVT

	DVT	*No DVT*
n	14	36
Sex (M/F)	12/2	29/7
Immobility	5 (36%)	15 (42%)
OP time (min)	157 ± 13	141 ± 8
Heparin (units)	8121 ± 724	8676 ± 334
Protamine (mg)	76 ± 12	86 ± 7
Spinal anest	1 (7%)	13 (36%)
Clinical suspicion of DVT/PE	0	0
LOS (d)	9.2 ± 1	8 ± 0.5

DVT, Deep venous thrombosis; *LOS,* length of stay; *M/F,* male/female ratio; *OP time,* operation time; *PE,* pulmonary embolism; *Spinal anest,* spinal anesthesia.

the minimally treated group had a PE. Calf DVTs lead to popliteal segment dysfunction.[6] Janssen et al[7] reported on 81 patients with DVTs that were documented 7 to 13 years earlier. Clinically, 75% of the patients had symptoms of post-thrombotic syndrome, and 57% of patients had abnormal calf muscle pump function. Both the severity of clinical symptoms and the hemodynamic abnormalities were related to the location of the initial thrombus. Of the patients with distal calf thrombus, moderate clinical post-thrombotic syndrome developed in 11%, and an abnormal calf muscle pump function developed in 39%.[7] Philbrick and Becker[8] reviewed 20 studies that assessed the natural history of calf vein thrombosis. They concluded that calf vein thrombosis propagates to the proximal venous system in as many as 20% of cases. Increased volume and proximal extent of thrombus increase the risk of PE. There has been no change in the death rates from PE in the last 40 years.[9] In this study, we also found 20% of our patients had thrombosis extending proximally. Olin et al[10] found the same proportion using venograms for diagnosis. Angelides et al[11] found 33% extended proximally and used I^{125}-labeled fibrinogen for diagnosis. Farkas et al[12] found 36% DVT extended proximally using color flow duplex scanning supplemented with venograms. However, Fletcher and Batiste,[26] using color flow duplex scanning, found 54.5% extended proximally.

Different modalities for the diagnosis of DVT complicate the interpretation of all these results. I^{125}-labeled fibrinogen requires 18 to 72 hours for results to be available. It has frequent false-positive results. It requires incorporation into active thrombus, and therefore, false-negative results can occur with established thrombus. It has reduced sensitivity for detection of proximal thigh and pelvic thrombosis, because of the accumulation of radioactivity in the bladder. This is a serious disadvantage, because these DVTs represent the greatest risk of embolization. False-positive results can occur because of any condition that results in an accumulation of fibrinogen, fibrin, or fibrin-degraded products, such as surgical incision, ulcers, and areas of inflammation or hematoma.[13] All of these conditions are frequent in our vascular surgical patients.

Venograms are considered to be the gold standard, although they are invasive and can be technically difficult. Complications such as thrombophlebitis can occur, and adequate visualization of the proximal venous system may require more proximal insertion of the contrast.

Color duplex scanning is cheap, noninvasive, safe, and portable, provides immediate images, and allows assessment of venous function. It has largely replaced venograms for the diagnosis of acute DVTs.[13] Duplex scanning does, however, have its limitations. It is highly operator dependent, which contributes to decreased accuracy when compared with venography.[14] Isolated calf vein thrombosis, in particular, can be missed with color flow duplex scanning, although recent improvements in technology have increased detection rates.[15,16] The results for calf DVT diagnosis have, therefore, been slightly less satisfactory.[7] Color power Doppler ultrasound scanning and the improved resolution of B-mode ultrasound scanning offer the possibility of further improvements in detection of calf DVT.[9,27] In a meta-analysis of patients who had no symptoms after orthopedic surgery, level 1 studies demonstrated overall ultrasound scanning to have a sensitivity rate of 62% and a specificity rate of 97%.[17] Calf thrombosis has been demonstrated to be underreported when duplex scanning is the sole means of diagnosis.[17-20] Therefore, in our study, the true incidence could actually be higher than we have reported.

Studies that have evaluated the incidence of DVTs in patients undergoing abdominal vascular surgery are summarized in Table IV. A wide variation of reported incidences is evident. It is accepted that I^{125} fibrinogen tends to overestimate the incidence of DVTs.[15] Color duplex scanning tends to underestimate the true rate. In Killewich et al's study,[21] only proximal veins were assessed, and therefore, no calf DVTs were reported, explaining the reduced incidence. In the recent consensus statement on prevention of venous thromboembolism, a meta-analysis of untreated patient groups was analyzed.[4] Of the 4310 general surgical patients studied, 25% had documented DVTs. Elective orthopedic and multiple trauma patients were the surgical group at the highest risk, with a 47% to 53% incidence of DVTs.[22] In our study, vascular patients undergoing abdominal surgery had a 41% incidence of DVT, which approaches this highest risk group. The incidence of DVT in the group that received thromboprophylaxis appears to be lower, but the investigational tool used complicates this interpretation. Duplex scanning was used in all groups that received thromboprophylaxis. Unfortunately, a wide variety of modalities was used in groups that did not receive prophylaxis, making valid comparisons difficult. The 41% incidence of DVT reported here represents the highest incidence of all vascular abdominal surgical studies reported. Eighty percent of DVTs were confined to the calf, with 20% extending more proximally. Angelides et al[11] demonstrated that one third of their patients had DVTs extending beyond the knee. Farkas et al[12] did not define the extent of their DVTs. Olin et al[10] demonstrated 78% of DVTs confined

Table IV. Summary of vascular surgical studies assessing DVT risk

Study	*n*	*Prophylaxis*	*DVT (%)*	*Diagnostic method*	*Reference*
Abdominal vascular surgery					
Fletcher and Batiste	52	UFH, SCD	6 (11.5%)	Duplex	26
Farkas et al	71	UFH	3 (4.2%)	Duplex	12
	75	LMWH	8 (10.6%)	Duplex	12
Killewich et al	50	UFH, SCD	1 (2%)	Duplex	21
	48	—	1 (4%)	Duplex	21
Olin et al	50	—	9 (18%)	Venogram	10
Harstruck and Greenfield	26	—	7 (27%)	I^{125} fibrinogen	29
Angelides et al	88	—	18 (20%)	I^{125} fibrinogen	11
Peripheral vascular surgery					
Fletcher and Batiste	54	UFH, SCD	5 (9.3%)	Duplex	26
Farkas et al	40	UFH	1 (2.5%)	Duplex	12
	47	LMWH	2 (4.3%)	Duplex	12
Hamer	21	—	9 (42%)	Venogram	23
Passman et al	53	—	1 (1.8%)	Duplex	24
	18	UFH, warfarin	1 (5.6%)	Duplex	24
AbuRahma et al	72	Not reported	6 (8.3%)	IPG/duplex	25

DVT, Deep venous thrombosis; *IPG,* impedence plethysmography; *LMWH,* low molecular weight heparin; *SCD,* sequential compression devices; *UFH,* unfractionated heparin.

to the calf, with 22% extending proximally. The mortality rate in our study was substantially higher than our annual mortality rate for abdominal surgery (3.4%). It is possible that the abdominal group in our study had more complications and represented a more at-risk group. It is also possible that the incidence of DVTs in this group is higher than that normally encountered. This can only be resolved with further studies of larger numbers of patients.

The incidence of DVTs in patients undergoing peripheral vascular surgical procedures is summarized in Table IV. Hamer[23] demonstrated the highest incidence of DVTs (42%) in 21 patients, and his is the only study to use venograms. He studied patients who underwent femoropopliteal bypass grafting and found that five patients (24%) had popliteal DVT, compared with four patients (19%) who had calf thrombosis. This rate is substantially higher than our rate of 18%. However, there is a wide variation of incidences of DVTs. Passman et al[24] found two DVTs, one a calf DVT and the other a femoral DVT. AbuRahma et al[25] did not indicate the situation of their DVTs. Fletcher and Batiste[26] reported on patients receiving prophylaxis, and their distribution was the reverse of ours, with 80% of DVTs being femoropopliteal.

Immobility is known to be associated with an increased incidence of DVT.[4] However, most of these patients were actually more mobile after surgery because of revascularization. There was a greater percentage of immobile patients in the peripheral group than in the abdominal surgical group (46% vs 32%). Most of the patients in the peripheral group had immobility because of vascular claudication, which was reversed by revascularization. In the abdominal group, immobility was also primarily caused by vascular claudication (86%). This was reversed by surgery. Medical frailty was present in one of these patients and was not improved by surgery.

GA/epidural anesthesia in peripheral surgery patients was associated with four of the five DVTs. These patients experienced a more prolonged period of immobility than patients who had spinal anesthesia because of extra lines and sensory and motor impairment. In addition, perioperative limb blood flow with spinal anesthesia may well be greater because of a more complete block protecting against thrombosis.

One patient was found to have an old DVT on the preoperative scan. This was limited to the calf veins and had features of an old clot. This patient had no evidence of thrombus extension postoperatively. Libertiny and Hands[28] reported that 20% of patients with peripheral vascular disease had DVTs before intervention. However, they included all patients who underwent arteriography, angiography, or arterial reconstruction. It is possible that this represented a more severely impaired group of patients than our study.

Although the ideal prophylactic regimen remains elusive, the reported incidence appears lower in patients receiving prophylaxis. Fletcher and Batiste[26] reported on 52 patients undergoing abdominal vascular surgery. They diagnosed DVTs in 11.5% of patients who had received unfractionated heparin (UFH) and sequential compression devices. Farkas et al[12] randomized vascular patients to receive low molecular weight heparin (LMWH; enoxaparin) or UFH. Patients who underwent abdominal vascular surgery experienced a lower incidence of DVT with UFH (4.2%) than patients receiving LMWH (10.6%). Killewich et al[21] reported a higher rate of DVT in patients undergoing abdominal surgery who received prophylaxis. Farkas et al,[12] in a study of patients undergoing peripheral surgery, reported a higher rate of DVT in patients receiving LMWH (4.3%) than in patients receiving UFH (2.5%). Also, Passman et al[24] reported a higher rate in those peripheral vascular patients receiving UFH and warfarin (5.6% vs 1.8%). In 1979, Belch et al[27] performed a prospective randomized study of 50 patients undergoing elective aortic bifurcated surgery, comparing UFH with no prophylaxis. The trial was terminated prematurely because of the excessive bleeding complications in the group treated with UFH (33% vs 4%, respectively). There is no evidence in the literature regarding the best prophylactic regimen to use in patients undergoing vascular surgery; indeed, the evidence available tends to indicate a detrimental effect.

CONCLUSION

Our study has demonstrated that lower-limb DVT occurred in 32% of a small group of patients undergoing abdominal and peripheral vascular surgical procedures without perioperative thromboprophylaxis. We cannot generalize these results because of the small population studied. Nevertheless, the dramatically high incidence of DVT reported here and elsewhere makes further investigation imperative.

We thank the department of Veteran's Affairs and Queensland X-Ray for their financial support, and Dr J. Blackford, Dr A. Love, and Dr W. Foster for allowing their patients to be included in the study.

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Submitted May 2, 2000; accepted Jan 2, 2001.