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Patients admitted to in-patient rehabilitation programs have an increased risk for developing deep venous thrombosis (DVT). However, the utility of screening for lower extremity DVT using duplex ultrasound in this high-risk population is not well characterized. The purpose of this study is to identify whether or not screening lower-extremity duplex exams are indicated in this high-risk population. Screening lower extremity duplex exams were performed on all patients admitted to the rehabilitation center at Mt. Sinai Hospital over a 3-year period. Charts were reviewed for patient age, gender, diagnosis, date of screening and follow-up duplex exams, presence and location of venous thrombosis at each duplex exam, history of anticoagulation, and medical DVT prophylaxis. The presence of DVT at screening, the location of DVT along the lower extremity, and the outcome of calf DVT were analyzed in terms of gender, underlying diagnosis, and history of DVT prophylaxis. Lower extremity DVT was detected in 34% of patients. Twenty-three percent of patients had isolated calf vein thrombosis. Men were more likely than women to have DVT. Calf DVTs progressed in 3% of patients over an average follow-up of 2 weeks. The presence of DVT, its location along the lower extremity, and the outcome of calf vein DVT had no significant relationship to underlying diagnosis or history of prophylaxis. Screening duplex exams to detect lower extremity DVT in rehabilitation patients is useful. Screening altered management in 26% of patients, prompting either anticoagulation or repeat duplex exam.

Introduction

Patients admitted to in-patient rehabilitation programs are at an increased risk for developing deep venous thrombosis (DVT), not only because of relative immobilization, but also because their admitting diagnoses, including bony injuries, joint-replacement surgery, and cancer, predispose to thrombus formation. In addition, studies indicate that individual clinical features may not be reliable in diagnosing lower extremity DVT.[1] However, the utility of screening for lower extremity DVT using duplex ultrasound in

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this high-risk population is not well characterized. Recent literature suggests that early mobilization and compression treatment may yield better long-term resolution of DVT than bed-rest, without increasing the risk of pulmonary embolism (PE),[2,3] suggesting that even patients with lower extremity DVT should be offered the mobilization regimen associated with acute rehabilitation programs. Other investigators propose that patients entering brain-injury rehabilitation programs in particular should have screening lower extremity duplex exams in order to identify patients at risk of embolizing from a lower extremity thrombus when mobilized, and to make recommendations for prophylactic therapy.[4,5]

The management of calf vein DVT has also been controversial. While it is well established that calf vein DVT rarely causes pulmonary embolism, some argue that their propensity to propagate into proximal veins, and become both symptomatic and a potential source of embolus, warrants formal anticoagulation.[6-8] Proximal extension of thrombosis from a source in a calf vein is thought to be greatest during the first week.[6] Formal anticoagulation has been found to decrease this risk from 29% to 0 in 1 study.[8]

The purpose of this study is to identify whether or not screening lower extremity duplex exams are indicated in this high-risk population. We describe the incidence and distribution of lower extremity DVT in an in-patient rehabilitation program, in which all patients over the course of 3 years underwent duplex exams on admission to the program. In particular, the incidence and short-term outcome of calf DVTs is discussed, to better understand the significance of their detection.

Materials and Methods

All patients admitted to the rehabilitation program at Mount Sinai Medical Center in New York between December 1997 and December 2000 underwent screening, bilateral duplex examination of both the deep and superficial veins of the leg and thigh. Patients suspected of having DVT by physical exam or symptoms underwent diagnostic duplex exams, and were not included in this database. Duplex exams were performed using pulsed-wave and color flow Doppler with spectral analysis; thrombosis was identified on the basis of both direct visualization as well as the lack of venous compressibility. Patients who had recent duplex exams showing lower extremity DVT before admission were not included.

The charts of patients who had screening duplex exams were reviewed for patient age, gender, diagnosis, date of screening and follow-up duplex exams, presence and location of venous thrombosis at each duplex exam, and history of anticoagulation, DVT prophylaxis therapy, and/or antiplatelet medication. Diagnosis was categorized as lower extremity orthopedic surgery or injury ("Ortho"), spine surgery or injury ("Spine"), brain surgery or injury, including stroke ("Neuro"), cancer, sepsis, other, or unknown. Thrombus identified in the common femoral, superficial femoral, deep femoral, popliteal, posterior tibial, peroneal, gastrocnemius, soleal, and perforator veins were considered deep vein thrombosis. Formal anticoagulation was considered to be treatment with warfarin, IV heparin, or low-molecular-weight heparin administered in therapeutic doses. Treatment with prophylactic doses of subcutaneous heparin or low-molecular-weight heparin, and treatment with antiplatelet medication was also recorded. Patients who were receiving anticoagulation at the time of the study were excluded from further analysis in order to limit our investigation to those patients whose management would be significantly changed by screening.

The time between first and last duplex exam in those patients who had more than 1 exam was calculated. For each exam, thrombi identified in the common, deep and superficial femoral veins, as well as those found in the popliteal vein, were classified as thigh DVTs. Calf DVTs included those involving the tibial, peroneal, soleal, gastrocnemius, and perforator veins. Patients were categorized as having calf, thigh, both calf and thigh, or no DVT in either leg. Detection of thigh DVT on follow-up exam, in a patient who had calf DVT of the same leg on screening, was categorized as proximal progression of the calf DVT.

The presence of DVT at screening, the location of DVT along the lower extremity, and the outcome of calf DVT, were analyzed in terms of gender, underlying diagnosis, and history of DVT prophylaxis. Statistical analysis was performed using t test, X^2 analysis, and multivariate, logistic regression, with $p < 0.05$ indicating statistical significance.

Results

Five hundred and seventy-nine patients underwent bilateral, lower extremity duplex exams between December 1997 and December 2000 as a screening exam for admission to rehabilitation. In 118 patients, medication history was unknown, and 81 patients were receiving anticoagulation at the time of the study. These patients were excluded from further analysis. Of the remaining 380 patients, 191 (50%) were male. One hundred and twenty-eight (34%) patients were found to have lower extremity DVT. Men were significantly more likely to have lower extremity DVT (Table I). The mean age in patients with DVT was 64.7 years, which was significantly older than the mean age of patients without DVT (55.8, $p<0.001$). In 25 patients (7%), DVT was found in both the thigh and calf veins; in 87 patients (23%), DVT was limited to the calf veins; and in 16 patients (4%), DVT was limited to the thigh veins. Screening prompted treatment with warfarin in a total of 29 patients (8%), 5 of whom had calf DVT only, 10 of whom had thigh DVT only, and 14 of whom had both thigh and calf DVT.

The presence or absence of DVT in relation to underlying diagnosis and history of medical DVT prophylaxis is shown in Table II. Only 16 patients were not receiving prophylactic therapy with subcutaneous heparin or low-molecular-weight heparin at the time of the screening duplex exam. There were no significant differences in incidence of DVT when patients were com-

Table I. Men were significantly more likely to have lower extremity DVT than women ($p<0.01$). In both men and women, patients with lower extremity DVT were likely to have calf vein involvement (86% in men, 88% in women).

	DVT	No DVT	Calf	Thigh
Men	76	115	66	25
Women	52	137	46	16

Table II. Patient history regarding DVT prophylaxis with either subcutaneous fractionated or unfractionated heparin is demonstrated in regard to diagnosis, as well as presence or absence of DVT. The presence of DVT at screening did not correlate significantly with history of prophylaxis ($p=0.60$), or diagnosis ($p=0.50$).

(n)	Prophylaxis		No Prophylaxis	
(380)	DVT (121)	No DVT (243)	DVT (7)	No DVT (9)
Ortho	12	36	1	1
Spine	24	47	1	2
Neuro	68	125	4	4
Cancer	6	6	0	1
Sepsis	1	3	0	0
Other	10	22	1	0
Unknown	0	4	0	1

pared in regard to underlying diagnosis and history of DVT prophylaxis. Similarly, when the location of DVT along the lower extremity was evaluated in terms of diagnosis and history of prophylaxis (Table III), no significant differences were found.

Seventy-three patients with DVT on screening exam had follow-up duplex exams. In 71 of these patients, follow-up duplex was performed within 6 weeks of the initial exam. The mean follow-up period in these patients was 14 days. The other 2 patients, 1 of whom had isolated thigh vein DVT, and the other of whom had isolated calf vein DVT, had follow-up at 45 and 365 days, respectively. The results of the follow-up exams for all patients in whom they were performed within a 6-week period are demonstrated in Table IV. Patients with isolated calf DVT at screening represented the majority of patients who underwent follow-up examination (94%). Outcome of DVT is expressed as progression to proximal veins for calf DVT, or progression to distal veins for thigh DVT, or resolution, or no change.

Thirty percent of patients screened had calf vein DVT, and in 23% of patients, DVT was isolated to calf veins. Sixty-seven of 87 patients

Table III. Distribution of lower extremity DVT is shown in relation to underlying diagnosis and history of DVT prophylaxis. Underlying diagnosis was not significantly related to presence of DVT in the thigh ($p = 0.26$) or calf ($p = 0.46$).

(n)	+ DVT/Prophylaxis (121)			+DVT/No Prophylaxis (7)		
	Calf (84)	Thigh (15)	Both (22)	Calf (3)	Thigh (1)	Both (3)
Ortho	10	1	1	0	0	1
Spine	16	4	4	1	0	0
Neuro	47	7	14	2	1	1
Cancer	6	0	0	0	0	0
Sepsis	1	0	0	0	0	0
Other	4	3	3	0	0	1

Table IV. The results of follow-up duplex exams within 6 weeks of initial screening are shown for patients who had isolated calf DVT, isolated thigh DVT, and DVT of the calf and thigh in either the same or opposite legs at screening. The mean time for follow-up was 13 days.

	No Change	Resolution	Proximal Progression
Isolated calf DVT, n = 67	56*	11	2
Isolated thigh DVT, n = 2	2	0	0
Calf and thigh DVT; same leg, n = 1	1	0	0
Calf and thigh DVT; different leg, n = 1	1	0	0

*Includes the 2 patients with isolated calf DVT who were anticoagulated.

(77%) with isolated calf DVT had follow-up exams within 6 weeks. The mean time to follow-up in patients with isolated calf vein DVT was 14 days (range 1–38; median 12) All of these patients were receiving medical DVT prophylaxis at the time of the screening, and 65 patients were maintained on subcutaneous heparin in the time between screening and follow-up. Whereas 5 patients with isolated calf vein DVT were started on anticoagulation as a result of screening, only 2 patients had follow-up exams. Outcome of calf vein DVT in relation to diagnosis and gender is shown in Table V. Neither underlying diagnosis nor gender was significantly associated with calf DVT progression or resolution. Because only 2 patients with calf vein DVT who had follow-up were treated with formal anticoagulation, outcome of calf DVT was not analyzed in terms of medical treatment.

Discussion

While rehabilitation patients represent a high-risk population for the development of deep venous thrombosis, the performance of screening lower extremity duplex exams to identify DVTs in this population is controversial. A number of studies indicate that screening is warranted in high-risk patients.[4,9,10] Ultrasonography was reported to be a cost-effective means of demonstrating proximal lower extremity venous thrombosis in brain-injured patients.[4] In that study, none of the patients were receiving DVT prophylaxis in the form of either prophylactic heparin or sequential compression devices, and 8% of patients were found to have proximal lower extremity DVTs.[4] Screening duplex exams performed in a prospective study of medical ICU patients demonstrated higher rates of venous thrombosis in both upper and lower extremities.[9] Proximal veins of the lower extremity were thrombosed in 16% of patients screened.[9] Recent studies investigating the use of screening venous duplex ultrasonography, again in neurorehabilitation programs, have shown an 11% incidence of lower extremity DVT in proximal veins,[11] confirming earlier findings that DVTs affect 8–18% of brain-injured patients in rehabilitation programs.[11]

The trauma literature does not consistently support the use of screening duplex exams in high-risk trauma patients, but rather suggests that DVT prophylaxis with subcutaneous heparin or low-molecular-weight heparin obviates the need for screening exams.[12-14] One study suggests that strict protocols of DVT prophylaxis helped keep rates of pulmonary embolism low in trauma patients, despite decreasing the number of screening exams performed.[14] DVT prophylaxis in both brain-injured patients and in those patients with orthopedic trauma or surgery have also been demonstrated to be cost effective.[15]

In this study, one third of a diverse group of rehabilitation patients were found to have DVT by a lower extremity duplex exam which was performed at the time of admission. Older age and male gender positively correlated with the presence of DVT. Proximal DVT was present in 11% of patients studied, suggesting that screening duplex exams can detect clinically relevant DVT in a significant percentage of rehabilitation patients. Furthermore, the majority of these patients were receiving prophylaxis at the time of the study, suggesting that the incidence of proximal DVT in rehabilitation patients is significant despite prophylactic therapy.

Eighty-eight percent of patients with DVT in this study had thrombus in the calf veins. Isolated calf vein DVT were found in 23% of all patients

Table V. Outcome of calf vein DVT within 6 weeks of screening is shown in regard to gender and underlying diagnosis. No significant association between outcome and either gender ($p = 0.08$) or underlying diagnosis ($p = 0.45$) was found.

	Male	Female	Cancer	Neuro	Ortho	SCI	Other
Resolution	3	6	0	8	0	1	0
Progression	0	2	0	1	1	0	0
No change	36	20	4	32	4	13	3

studied. Therefore, the utility of screening duplex exams in this population depends largely on the natural history and treatment options for calf vein DVT. The clinical significance of calf vein DVT is debated. Previous studies have demonstrated a higher incidence of calf DVT than thigh DVT in symptomatic and high-risk patients.[16] These findings have led to routine imaging of calf veins by ultrasound in many centers.[16,17] Proponents of treating asymptomatic calf vein DVT with anticoagulation suggest that untreated patients have higher risks of thrombus recurrence, propagation, and pulmonary embolism, and that patients on anticoagulation can resolve calf DVT faster than those with proximal DVT.[7,8,18] Recent studies indicate that a 6-week course of anticoagulation reduces recurrent thromboembolic events in patients with calf vein DVT.[19]

Thrombus propagation from a source in the calf has a variable incidence in the literature. One study examining the natural history of isolated gastrocnemius and soleal vein thrombosis found that only 3% propagated to tibial veins, with rare propagation to the popliteal vein, and that 90% of propagation occurred within 2 weeks.[20] Yet another study found a 13% rate of ascending progression within a 10-day follow-up period.[21] In both papers, a history of anticoagulation did not demonstrate any significant correlation with progression of calf vein DVT, although these studies were not controlled.

The incidence of calf vein DVT in our study population was high, compared with other studies that report incidences closer to 5%, and occasionally as high as 16% in large samples of patients undergoing lower extremity duplex.[17,20,22,23] However, only 3% of patients with follow-up demonstrated proximal progression within an average of 14 days. While this study cannot make strong recommendations regarding definitive treatment of calf vein DVT, our data suggest that the risk of early propagation from a source in the calf is small within a 2-week period of follow-up, in patients receiving subcutaneous heparin. Current treatment recommendations for calf vein DVT support repeat duplex ultrasonography in those patients in whom anticoagulation is not started.[24]

Our study is limited by its retrospective design. Furthermore, our follow-up for patients with calf vein DVT is short, limiting our ability to make conclusions regarding the long-term natural history of DVT in this location. We also did not look at the incidence of pulmonary embolism in this population, which would help determine whether screening and treatment affect its rate. Finally, follow-up was not available for all patients with calf vein DVT, suggesting that the true incidence of clot propagation may be underestimated.

In conclusion, screening duplex exams to detect lower extremity DVT is useful in this population of patients, in whom physical examination, or dependence on symptoms alone, may be unreliable because of neurologic deficits, recent surgery, or paralysis. In our study, screening altered management in 26% of patients by prompting either anticoagulation (29/380) or repeat duplex exam within 6 weeks (71/380), as was the case for the majority of the patients with calf vein DVT. Since nearly one quarter of patients screened had evidence of isolated calf DVT which requires either anticoagulation or follow-up duplex exam, screening is warranted.

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