Venous duplex imaging follow-up of acute symptomatic deep vein thrombosis of the leg

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Purpose: **The purpose of this study was to evaluate the rate of resolution of deep vein thrombosis (DVT) in the leg, by means of duplex imaging, in patients with symptoms during a 6-month period after initial diagnosis.**
Methods: **Seventy-three limbs in 69 patients with acute DVT diagnosed by duplex imaging received conventional heparin and warfarin treatment and underwent subsequent duplex studies 1, 4, 12, and 24 weeks after the initial diagnosis. The objectives of the study were to document (1) the rate or complete resolution of DVT, (2) the proportion of unstable, floating thrombi, and (3) the development of chronic damage as a result of vessel wall scarring.**
Results: **The rate of normalization of DVT 6 months after diagnosis was 78% in the common femoral vein, 70% in the superficial femoral vein, 75% in the popliteal vein, and 70% in the calf veins examined at the scheduled intervals. Twenty-six percent of thrombi were considered unstable on the baseline examination. The average number of days necessary for these thrombi to become stable was 10.7 days. Damage to the vessel wall or valves was documented in 44% of the patients.**
Conclusions: **Rates of resolution of DVT were similar for the different veins of the leg studied. There was a high proportion of unstable thrombi, which present a high potential risk of embolization. Serial duplex scanning after DVT renders important information with regard to thrombus resolution, propagation, and attachment to the vein wall. (J VASC SURG 1995;21:472-6.)**

During the past few years, real-time B-Mode ultrasonography combined with pulsed Doppler echocardiography (duplex imaging) has become one of the most reliable diagnostic techniques for the evaluation of deep vein thrombosis (DVT) of the legs.[1-5] Because of its noninvasive nature, venous duplex imaging is repeatable, allowing for continued follow-up after DVT is diagnosed, at no risk to the patient. In addition, duplex imaging can assess the echogenic characteristics of the thrombus and its degree of adherence to the vein wall.[5] This test also provides important information regarding valve motion and reflux in the superficial and deep venous systems.[3,6]

Initial therapy of acute DVT is based primarily on objective diagnosis, usually ascending venography or, more recently, duplex imaging, whereas secondary prevention of recurrences relies on protocols recommending at least 3 months of treatment with oral anticoagulants.[7,8] The recent European Consensus Statement on the prevention of venous thromboembolism recognizes that the optimal duration of secondary prophylaxis is not known.[9]

Only a small number of studies have prospectively assessed the outcome of acute DVT by means of serial duplex scanning.[7-10] This study was undertaken to assess the rate of normalization of duplex imaging within 6 months after the diagnosis of acute DVT in various vein segments and to estimate prospectively the frequency of presentation of unstable, floating thrombi.

METHODS

During a 3-year period, 69 patients (42 men and 27 women) aged 35 to 85 years (mean 67.6 years),

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diagnosed with acute DVT of the legs by duplex scanning, were scheduled to repeat duplex scanning 1, 4, 12, and 24 weeks after the initial diagnosis. All patients had been referred by their attending physicians to the vascular laboratory of the Glenbrook Hospital, Glenview, Ill. There were four patients with bilateral DVT; accordingly, 73 limbs were evaluated prospectively.

Duplex imaging studies were performed with an Ultrasonix 750 SDX scanner, with a 7.5 MHz linear transducer and, later on, an Ultramark 9 HDI color scanner (Advanced Technology Laboratories, Bothell, Wash.). Pulsed Doppler signals were obtained with a 5 MHz probe. All veins were examined in the transverse and longitudinal views. For every leg, four vein segments were evaluated prospectively: common femoral, superficial femoral, popliteal, and calf. All tests were performed by vascular technologists, recorded on videotape, and interpreted by one senior attending physician.

Abnormal examination criteria diagnostic of DVT included absence of Doppler signal noted with respiration or augmentation maneuvers, echogenic-filled vein lumen occluding the vessel partially or completely, inability to compress the vein with gentle pressure of the probe, and the presence of an area of dilation of the vein, usually distal to the level of the thrombus. Often vein compression will reveal intraluminal echogenicity when a thrombus is present. The outcome of DVT, according to duplex scan follow-up findings, was divided into four categories: no change, worsening, improvement, or complete resolution.

No change was reported when the thrombus remained confined to the same vein segment, without recanalization, and appeared to be the same size. Worsening was reported if the clot extended to other previously unaffected vein segments. A thrombus was considered to improve if the clot inside the vein lumen had undergone evidence of recanalization, with persistence of incomplete compression of the vein segment with the probe. An overall decrease in size or volume of the clot was also a criterion indicating improvement.

Criteria to consider that resolution of the DVT process had occurred included return of phasic Doppler signals with respiration and augmentation maneuvers, disappearance of the echogenic filling defect, and ability to compress the vein fully in the transverse position by gentle pressure of the probe. If all these criteria were met but there were findings such as abnormal thickening and increased echogenicity of the vessel wall, abnormal valve motion, or reflux, the DVT process was considered resolved but the patient was considered at high risk for postphlebitic syndrome and elastic compression therapy was encouraged.

Chronic damage included thickening of the vein wall, reflux, and abnormal valves. A vein wall was considered thickened when it was twice the thickness of a normal venous wall segment, with increased echogenicity brighter than the normal vessel wall. Reflux was assessed in the supine and reverse Trendelenburg position with the transducer placed over the vein segment. The patient was asked to perform the Valsalva maneuver, and reflux was present if retrograde flow lasted for more than 2 seconds. Proximal or distal hand compression of the leg was done when the Valsalva maneuver was inadequate or could not be performed. Valves were considered abnormal if they were grossly distorted or immobile or the cusps failed to oppose with the Valsalva maneuver. Under the above circumstances, although the DVT process was considered resolved, the patient was encouraged to wear therapeutic compression hose to decrease the risk of postphlebitic syndrome. Recurrence of the DVT process was diagnosed when the aforementioned criteria for DVT reappeared in a vein segment that had previously been considered resolved.

A thrombus was considered floating at presentation if at least one third of the clot was not adhered to the vein wall. These clots were examined every 24 to 48 hours until there was not any remaining "floating" component. These patients were kept in bed until the clot was completely attached to the vessel wall, and warfarin and compression hose were also withheld until the clot was fully attached to the vein wall.

Data were analyzed by use of the SPSS-PC program run on a 486 DX2 IBM-compatible computer (Packard-Bell, Kenoga Park, Calif.). Comparisons between groups were made by means of Fisher's exact test. Statistical significance was defined as $p < 0.05$.

RESULTS

Apart from the initial 73 examinations, there were another 214 follow-up studies. This represents an average of 2.93 follow-up examinations per patient (range 2 to 5). There were 198 segments with DVT on the baseline examinations, which represents 67% of the 292 vein segments studied (four per leg). The distribution of thrombi among the different vein segments at diagnosis was as follows: 46 in the common femoral, 48 in the superficial femoral, 50 in the popliteal, and 54 in at least one of the calf veins.

Table I. Outcome of DVT in the common femoral vein (n = 46)

Time (wk)	*n*	*No change (%)*	*Worse (%)*	*Improved (%)*	*Resolved (%)*
1	36	39	3	53	6
4	34	23	0	56	20
12	26	0	4	42	54
24	27	4	4	15	78

Table II. Outcome of DVT in the superficial femoral vein (n = 48)

Time (wk)	*n*	*No change (%)*	*Worse (%)*	*Improved (%)*	*Resolved (%)*
1	35	15	0	49	8
4	40	27	3	45	25
12	28	0	4	50	38
24	27	4	4	22	70

Table III. Outcome of DVT in the popliteal vein (n = 50)

Time (wk)	*n*	*No change (%)*	*Worse (%)*	*Improved (%)*	*Resolved (%)*
1	43	39	5	54	2
4	42	22	0	52	26
12	44	7	2	41	50
24	32	3	3	19	75

Table IV. Outcome of DVT in the calf veins (n = 54)

Time (wk)	*n*	*No change (%)*	*Worse (%)*	*Improved (%)*	*Resolved (%)*
1	48	40	2	50	8
4	54	18	0	52	30
12	40	5	5	42	48
24	37	3	3	24	70

The percentage of thrombi completely occluding the vein lumen among the different vein segments was 70% (32/46) in the common femoral, 81% (39/48) in the superficial femoral, 59% (29/50) in the popliteal, and 69% (37/54) in the calf veins.

The results of the follow-up duplex examinations regarding the normalization of the examination in the four vein segments evaluated are detailed in Tables I to IV. The percentages shown in the tables indicate the number of segments with resolution, improvement, worsening, or no change of the DVT process divided by the number of segments with thrombosis at presentation examined at that specific interval. There were no statistical differences in the rates of resolution among the four vein segments at the four intervals.

There were 18 vein segments with floating thrombi at diagnosis, as defined above, which represents 24.5% of all thrombi. Most of these thrombi were located in the common femoral vein segment (n = 13), whereas there were three and two in the superficial femoral and popliteal veins, respectively. The average number of days for clot stabilization was 10.7, with a range between 2 and 33 days. One thrombus showed dramatic reduction in size in the follow-up study performed 48 hours after diagnosis, suggesting that a part of the clot had embolized. This was confirmed by a ventilation/perfusion lung scan. There were no other cases of suspected pulmonary embolism in this group.

Chronic damage, as defined by alteration of valve motion, reflux of venous flow, and thickened vein wall, developed in 31 (44%) of the 69 limbs during the study. Throughout the 6-month study period, there were six cases (8.2%) of recurrence of DVT in previously normalized segments.

DISCUSSION

The natural history of DVT is not well understood. A significant number of patients have clinical evidence of chronic venous insufficiency months or years after an acute DVT, which is sometimes

difficult to differentiate from a recurrent DVT. With experimental models, several authors have documented that organization and recanalization of venous thrombi proceed at a constant yet variable rate.[11-14] The organization of the thrombus appears to depend initially on circulatory cells, and later on there is cellular proliferation and migration from the vessel wall.[11]

A few studies have prospectively assessed the evolution of DVT for several weeks after diagnosis, according to noninvasive objective diagnostic methods such as duplex ultrasound scanning[8-10] or impedance plethysmography.[15] Another study has retrospectively reviewed the normalization rates of duplex scans within 6 months after DVT diagnosis and compared the results obtained in patients with symptoms versus those without.[16] The results of this study revealed that the total normalization rate at 6 months was 77% in symptom-free patients and 53% in patients with symptoms.

Our results are similar to those of Jay et al.,[15] who found normalization of impedance plethysmography in 60% of the patients 3 months after diagnosis of DVT. At that time, we found that 54% of common femoral and 38% of superficial femoral thrombi had resolved. On the other hand, Krupski et al.[9] reported improved duplex scans in 62% of cases within 1 week. Our results reveal that approximately 60% of cases of DVT had improved or resolved 1 week after diagnosis, irrespective of the vein segment in which they were located (Tables I to IV).

Whereas some studies have reported that thrombi located distal to the knee undergo faster resolution than those above the knee,[17] others have shown better recanalization in proximal veins.[18] There were no statistically significant differences in the outcome among the different vein segments examined in our study. This is coincident with another recent prospective study, in which the rate of regression of thrombus was similar over time among the deep vein segments.[8]

Of particular interest was the high proportion of "floating" thrombi (25%), which is above the 16% reported by Berry et al.[19] in a retrospective review of 400 cases of DVT diagnosed by duplex scanning. The mean time to stabilization of thrombus and attachment to the vein wall in our series is similar to that of Berry et al., who reported 9.2 days. We had only one documented pulmonary embolism in this group (6%), whereas they reported 17 cases (26%). We do agree with Berry et al. when they recommend serial duplex scanning every second or third day to monitor the floating thrombus for attachment, propagation, or embolization. It is our routine clinical practice to avoid patient ambulation until the thrombus is attached to the vessel wall.

Although most patients in our study showed dramatic improvement of the DVT process within the 6-month follow-up period, it is important to notice that 44% had ultrasound findings suggesting a high risk for the development of postphlebitic syndrome. Similar results have been reported by Markel et al.,[20] who found that 52% and 69% of limbs with venous thrombosis had reflux 3 and 6 months after diagnosis, respectively. Another similar study has documented the development of valvular incompetence in 62% of patients during a 9-month follow-up period.[10] A major contribution of that study is their finding that vein valves became incompetent both above and below the segment where the clot was located.

Lindner et al.[21] have reported that 80% of patients had documented postphlebitic syndrome 5 to 10 years after leg DVT. A long-term follow-up of patients diagnosed with DVT is required to correlate the development of clinically evident postphlebitic syndrome with the duplex scan findings over time.

In conclusion, duplex scanning represents a valid clinical tool, not only for the initial diagnosis of DVT but also to assess long-term outcome of thrombus. This test can guide initial patient management, providing information about clot attachment to the vein wall and resolution. In addition, duplex scanning can identify those patients with a potential high risk for postphlebitic syndrome. Finally, duplex scans may be used to compare and evaluate the results of different regimens of anticoagulant and fibrinolytic drug therapy on the long-term outcome of venous thrombi in the lower extremity.

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