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Review Article

SCORING SYSTEMS FOR GRADING DEEP LEG VEIN THROMBOSIS

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Abstract

A scoring system could be used in all situations where grading of deep leg vein thrombosis (DVT), including mapping of its distribution, is needed. It should also be used in epidemiological studies of DVT in further analysis of different risk groups suffering from DVT. Several scoring systems have been developed during the last three decades but have resulted in various complex and impractical systems. A scoring system should be easy to follow without any risk of misunderstanding and misinterpretation. All vein segments of importance should be defined and be possible to be included. This review describes and compares the scoring systems according to Marder et al., Arnesen et al., a subcommittee of venous disease and Björgell et al.

Key words: Deep vein thrombosis, pulmonary embolism; scoring system, comparative investigation; phlebography; colour Doppler ultrasonography.

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Scoring of deep leg vein thrombosis

In clinical practice, deep vein thrombosis (DVT) is usually described as distal when occurring below the knee, involving the whole leg, or even more extensive, involving the pelvic veins. The pioneers describing the thrombotic burden were Robertson, Nilsson and Nylander from Malmö, Sweden, who measured the length of thrombus displayed on phlebograms in 1970 (35). Scoring systems for grading DVT are mostly used in anticoagulant trials, but have the potential to be used in every patient, and can perhaps be used to calculate the risk of other events such as pulmonary embolism (PE) or venous insufficiency. A scoring system can also be used to compare different diagnostic methods with each other and thus also elucidate the importance of visualizing of all vein segments as well as the extent of the thrombus in each segment. A scoring system that can be used by different modalities will increase the possibilities of comparing different studies and populations in a standardized concept. The scoring system should be easy to follow without any risk of misunderstandings and misinterpretations. All vein segments of importance should be defined and be possible to be included (Table 1).

Inclusion of important vein segments

The deep muscle veins of the calf (soleal and gastrocnemial veins) are the most common sites of origin of a thrombus that may propagate and result in PE or venous dysfunction (2, 10, 12, 13, 18–23, 27–30, 36). The DVT distribution in 105 patients with phlebographically proven DVT referred for phlebography from the Department of Internal Medicine at Malmö University Hospital, Malmö, Sweden, has been described previously. In 70% (73/105) of the patients, a DVT in the soleal vein was seen, and in 51% (54/105) a DVT in the gastrocnemial vein was observed (7). The result

Table 1

Comparison between four different scoring systems

	The new system of Björgell et al.	Marder et al.	Arnesen et al.	Subcommittee of venous disease
Number of vein segments	14	7	6	6 (not completely described)
Maximal score	42	40	30	24 (not completely described)
Segmental score	0–3	0–10	0–5	0–3 (not completely described)
Possibility to interpret the most common locations of DVT	Yes	No	No	No
Inclusion of deep muscle veins	Yes	No	No	No
Inclusion of the planta pedis veins	Yes	No	No	No
Inclusion of the deep femoral veins	Yes	No	No	No
Inclusion of the internal iliac veins	Yes	No	No	No
Description of how to score a double venous segment	Yes	No	No	No
Interpretation of non-filling of vein segments	Independent and possible to score	Judged as DVT	Judged as DVT	Occlusion interpreted as DVT
Interpretation of non-filling of vein segments	Independent and possible to score	Given the maximum score	Given the maximum score	Occlusion given the maximum score
Scoring by the eye	Yes	No	No	Occlusion not defined
Scientifically compared to other scoring systems	Yes	No	No	No
Segmental code system for analysis of the distribution of DVT and correlation to risk factors	Yes	No	No	No

supports the opinion that the calf veins are the primary sites of a thrombus, since the majority of the patients had a DVT in these vein segments. Consequently, it should be mandatory to include calf vein segments in a scoring system (Fig. 1). The veins of the gastrocnemial and soleal muscles can differ greatly in size and shape and can be difficult to visualize (10, 17). However, their inclusion is possible if the correct phlebographic technique is used (3–7). Even with colour Doppler ultrasonography (CDU) it is possible to visualize many, but not all, of these deep muscle veins (4, 5). The veins of the planta pedis, the deep femoral vein, the internal iliac vein and the distal vena cava can to various degrees be displayed on phlebography or CDU. An ideal score protocol is one that includes these segments, which are more difficult to visualize (Fig. 2). Most of the deep femoral veins may be visualized on CDU despite extensive oedema being present in the legs (5). The deep femoral vein may be difficult to visualize on an ascending phlebography and the real number of DVTs in this segment could thus be underestimated. A description of how to score a double venous segment is also necessary. In various degrees, most scoring systems lack the above-mentioned criteria. Furthermore, they sometimes prove to be rather complicated to use (1, 24, 26, 32–34).

The aim of this review was to compare the most commonly described scoring systems, focusing on each system's possibility to give an objective and complete description of the thrombotic burden.

The scoring systems

The scoring system of Marder et al. (Table 2): In 1977 Marder et al. described a venographic scoring system (26) developed to evaluate streptokinase and heparin therapy. Since then it has been the most commonly used method. The methodology was based on the relative volume of the venous segment, but in reality it was the area (width × length) of each segment that was being used (25). Thus, the score setting is based on the calculated, relative area and degree of occlusion in the various venous segments. Total occlusion or non-filling (non-filling of contrast medium) of a given vein is assigned the maximum score, while segmental occlusion or filling defects are given lower scores. The maximum score differs between the various vein segments from 4 to 10 points. A maximum score of 40 points can be obtained if all scored, deep leg vein segments are completely filled with a thrombosis. The Marder scoring system excludes the deep muscle veins of the thigh (deep femoral vein) and calf (soleal and gastrocnemial muscle veins) as well as the inferior caval vein and does not distinguish the different iliacal vein segments. The soleal veins were excluded from scoring in the Marder system due to marked variation in size and number. The double anterior and posterior tibial veins and the fibular veins are scored separately but the MARDER system lacks a description of how to score a double venous segment, when present, in the rest of the venous system of the lower leg.

The scoring system of ARNESEN (Table 3): In 1978 ARNESEN et al. (1) presented a scoring system with the inclusion of 6 deep vein segments (the anterior tibial veins, posterior tibial veins, fibular veins, popliteal vein, femoral vein and iliac vein). The scoring system was designed for a study of streptokinase and heparin in the treatment of DVT. A vein not involved by a thrombus is given the score 0. A DVT in a segment of vein is scored from 1 to 5 depending on the involvement of the vein and whether occlusion is present or not. Non-visualization of the vein, interpreted as complete occlusion, is given the score 5. Thus, the scoring system of ARNESEN et al. includes only 6 deep vein segments. There is no definition of how an occlusion should be judged. Furthermore, the system lacks a description of how to score a double venous segment.

Table 2

Venographic quantification of thrombosis according to MARDER et al.

Region	Deep veins	Score
Pelvis + groin	Iliacs	6
	Common femoral	4
Thigh + knee	Superficial femoral	10
	Popliteal vein	4
	Anterior tibials	4 (2 each)
	Posterior tibials	6 (3 each)
	Peroneals	6 (3 each)
Total		40

The scoring system of a subcommittee of venous dis-

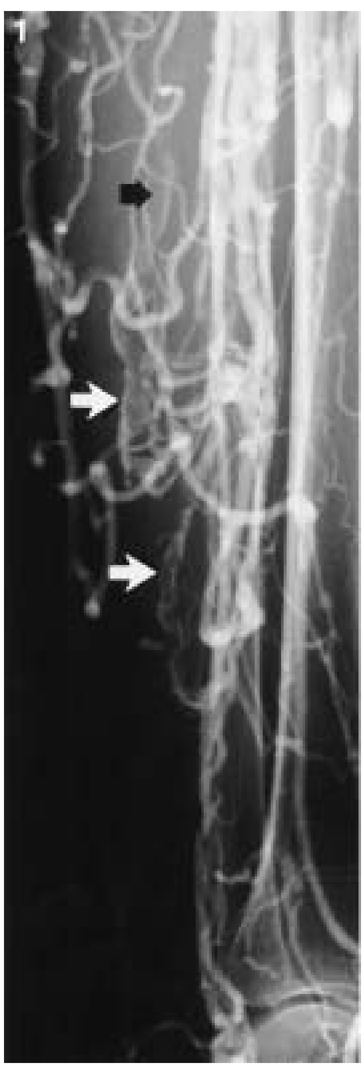

Fig. 1. A DVT in the soleal veins (→).

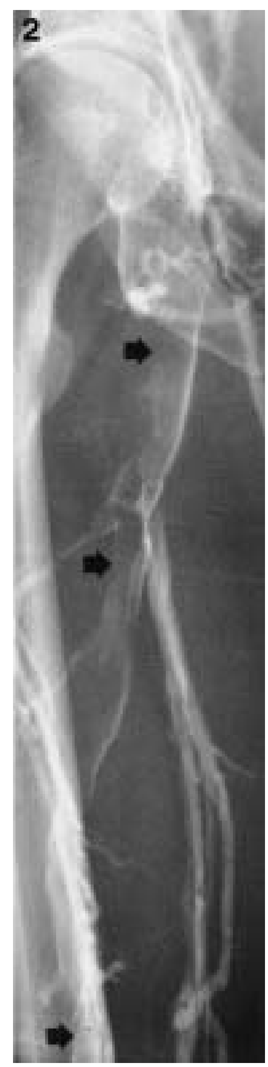

Fig. 2. A DVT in the deep femoral vein (→).

Table 3

Assigned grade in the Arnesen et al. *system*

Grade	
0	A vein not involved by the thrombus
1	Involvement up to 1/3 of the vein without occlusion
2	Involvement up to 2/3 of the vein without occlusion, or involvement up to 1/3 of the vein with occlusion
3	Involvement up to 3/3 of the vein without occlusion, or involvement up to 2/3 of the vein with occlusion
4	Involvement up to 3/3 of the vein with occlusion
5	No visualization of the vein due to complete occlusion

Table 4

Assigned grade according to a subcommittee on reporting standards in venous disease

Grade	
0	Patent
1	Subsegmental, non-occlusive thrombus
2	Subsegmental, occlusive thrombus
3	Occlusive thrombus throughout length of segment

ease (Table 4): In 1988, a subcommittee from some scientific societies on reporting standards in venous disease suggested a scoring system for DVT (33). Six deep vein areas are included in this scoring system (tibial-soleal veins, popliteal vein, common femoral or superficial femoral vein, deep femoral vein, iliac vein and inferior caval vein). The maximal thrombotic score for a limb is 18 or, if the saphenous vein is included, 24. The tibial and soleal veins are regarded as one segment and the common or superficial femoral vein is recommended to be scored. Thus, vein segments are mixed together and it is difficult to know how to interpret the different femoral vein segments. No description is given of how to score a double venous segment or distinguish between occlusive and non-occlusive thrombus.

The scoring system of Björgell et al. (Table 5): In 1999, a new scoring system for the detailed description of the distribution and thrombotic burden in DVT was developed (7). The outcome of the new scoring system was compared with that of Marder et al., applied to a group of patients undergoing acute ascending phlebography. The aim was to develop a more detailed and easily handled scoring system with the possibility to describe the origin and extension of DVT in each patient, applicable both with phlebography and ultrasonography or other diagnostic modalities such as CT and MR imaging. The first study (7) showed that in 72% (76/105) of the patients, the DVT distribution was not completely described and the thrombotic burden was significantly underestimated by the Marder system. Of these, 12% (13/105) were not scored at all, thus representing false-negative investigations. It was possible to score all DVTs and important vein segments of these patients with the new system.

The new scoring system divides the deep veins into 14 separate segments. The deep femoral vein is included in the new scoring system, although not always visualized on an ascending phlebogram. A DVT in a segment of vein is scored from 1 to 3, depending on the extension of DVT (0 = no DVT, 1 = less than one-third, 2 = one-third or more but less than two-thirds, 3 = two-thirds or more of the length of the vein segment). A maximum score of 42 (= 14 × 3) can be reached when there is a complete leg and pelvic thrombosis of the 14 segments. A paired or double vein is scored as one segment regardless of position. By using the coefficient in Table 5 it is possible to transform the scores into an approximately corresponding value in the Marder system, for example, in order to compare earlier studies with those done later, based on the new system. The new system can be utilized by all major diagnostic methods and regardless of the criteria used to define a DVT because it is based on the extension in length of the DVT in each segment. Thus, it could be used irrespective of whether non-filling on phlebography is classified as DVT or not.

Discussion

Scoring and non-filling: The use of both phlebography and CDU in scoring DVT may give a more reliable indication of the incidence of DVT in some patients. The most difficult aspect of phlebography is how to score a vein segment not filled with contrast medium (non-filling). Some authors accept non-filling as an indirect sign of DVT, but others reject this criterion (8, 9, 11, 15, 16, 31, 33, 38). Non-filling of vein segments without concomitant, direct signs of DVT in other vein segments is a true diagnostic dilemma. It has previously been shown that in only about one-third of patients with isolated non-filling this is caused by a DVT and that other pathological conditions such as oedema, Baker cysts, haematoma/bleeding, muscle ruptures, rupture of the Achilles tendon, or superficial thrombophlebitis may be present instead (4). Thus, a scoring system should not accept non-filling as evidence of DVT (Table 1).

The volume, area or length of the thrombus? If a correct calculation of the volume is to be made, two projections of each vein segment are needed when performing the phlebography or CDU. Frontal and lateral projections of the entire venous system of the leg and pelvis are hardly ever used in any department and thus the volume cannot be calculated routinely. Consequently, a scoring system, easy to follow and without any risk of misunderstanding and misinterpretation, should not be calculated upon measurements of the volume.

In a study of sonographic estimates of vein size in the lower extremity, mean vein diameters in 975 legs showed that the width of the vein varies a lot between patients (14). It is well known that the width of the veins varies among patients, ages and different levels within the same vein segment, and also depends upon which modality is used to make the measurement. The width of the veins also depends on the venous pressure, which changes on altering position, time of investigation and the present venous function. A Valsalva manoeuvre will increase, and a post-thrombotic lesion decrease, the width of the veins. Thus, the area or width is not suitable for interpreting the thrombotic burden.

The length! Instead of measuring the area or volume, a scoring system could be based entirely upon the length of the thrombus in each segment and thereby reduce the risk of miscalculations when the scoring is done, irrespective of the diagnostic method used. By dividing a vein into three parts, most of the segments can be visually assessed, giving an instant score value.

When different score values are assigned according to whether the thrombus occludes part of the vein segment or not, this implies that an occlusive DVT is regarded as more complex. Actually, just the opposite could be the case. Most probably, a free-floating thrombus would cause fewer symptoms and a higher risk of PE. This is a problem in ARNESEN'S scoring system as well as in the scoring system of the subcommittee of venous disease. An extensive non-occlusive DVT that involves slightly less than the whole length of a venous system, could be given the score 1 in the subcommittee scoring system, as could a tiny DVT involving only the cusp area, for example. On CDU, almost all DVTs have, in parts, non-adherent surfaces. Consequently, non-occlusive parts are often seen, and are not possible to score as 3 in the system suggested by the subcommittee. Such a miscalculation is avoided in the new system of BJÖRGELL et al. (7). A minor DVT will always be given the score value 1 regardless of the total length of the venous segment, and an extensive thrombus of the segment will always be given the score of 3. A complete DVT in a vein segment will have the same impact on the thrombotic burden regardless of the length of the venous segment in the new system and the signed distribution protocol will further show the extent in every single vein segment. Thus, this type of scoring system is a semi-quantitative method that also topographically shows the vein segments involved.

Clinical relevance of scoring DVT: The new scoring system of BJÖRGELL et al. has now been used in several studies and has resulted in the first description of a specific phlebographic pattern related to the most common inherited molecular defect (FV:R 506Q

Table 5

Score protocol of the new system of BJÖRGELL et al. *and that of* MARDER et al.

Vein segments		Segmental vessel code New system 0–3[1]		Transformation coefficient into the Marder system[2]	Marder system 0–10[3]
Inf. caval vein	=	A1 _		0	ni
Com. iliac vein	=	A2 _	x	1 }	
Ext. iliac vein	=	A3 _	x	1 }	_ (6)
Int. iliac vein	=	A4 _		0	ni
Com. femoral vein	=	B5 _	x	1.33	_ (4)
Deep femoral vein	=	B6 _		0	ni
Sup. femoral vein	=	B7 _	x	3.33	_(10)
Popliteal vein	=	B8 _	x	1.33	_ (4)
Ant. tibial veins	=	C9 _	x	1.33	_ (4)
Post. tibial veins	=	C10_	x	2	_ (6)
Fibular veins	=	C11_	x	2	_ (6)
Soleus	=	D12_		0	ni
Gastrocnemius	=	D13_		0	ni
Planta pedis	=	E14_		0	ni
Total	=	_(42)			_(40)

ni = not included. [1]Interpretation of the new system: 0 = negative. A DVT is scored from 1 to 3 depending on the extension. 1 = less than one-third, 2 = one-third or more but less than two-thirds, 3 = two-thirds or more of the length of the vein segment. A paired/double vein is defined as one segment. [2]When this coefficient is multiplied by the new 0–3 score, the approximate value in the Marder system is obtained. [3]Depending on the area of each segment.

mutation) (6). Furthermore, the new scoring system has changed the diagnostic criteria of DVT when phlebography is performed (4, 5). It has also described in detail the different phlebographic patterns of asymptomatic and symptomatic patients suffering from DVT after total hip replacement (3). Most recently, it has been used to compare the thrombotic burden with a newly devised immunofluorometric assay for measuring of plasma concentrations of activated protein C (APC) in complex with protein C inhibitor (PCI) in order to develop additional diagnostic tools in the investigation of DVT (37). The method was compared with testing for other markers of hypercoagulability, and significant correlations were found between score and assay results for D-dimer, thrombin antithrombin complex (TAT), prothrombin fragment 1 + 2 (F1 + 2) and soluble fibrin monomer (SFM). Thus, objective tests confirm the clinical relevance of the new scoring system. APC-PCI and D-dimer makes the most significant contribution to the prediction of DVT and patients with DVT have highly significant increase in concentrations of the APC-PCI complex compared to non-DVT patients.

Conclusion: Several scoring systems have previously been developed, as reviewed above, indicating that there is a need of such systems. The innovation of Robertson, Nilsson and Nylander in the 1970s, who developed the first method for measurements of thrombus size, has resulted in various complex and impractical scoring systems that have been used during the last three decades. This review emphasizes the importance of using an easy method for grading DVT.

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