A comparison between descending phlebography and duplex Doppler investigation in the evaluation of reflux in chronic venous insufficiency: A challenge to phlebography as the "gold standard"

Peter Neglen, MD, PhD,* and Seshadri Raju, MD, *Al-Ain, United Arab Emirates, and Jackson, Miss.*

To evaluate venous reflux in 56 lower limbs of 32 consecutive patients, hemodynamic tests, ascending and descending phlebography, and supine and erect quantitative duplex scanning were performed and the clinical severity was classified (class 0 = 15, class 1 = 19, class 2 = 8, and class 3 = 14). Of the 56 lower limbs, 22 (40%) had severe swelling and hyperpigmentation with or without ulcer (classes 2 and 3). Adequacy of the clinical severity classification was supported by the hemodynamic results. Radiologic and ultrasound findings were described by axial grading, multilevel/multisystem point, and multisegment scoring systems. Applying these evaluation systems, the phlebographic and scan results correlated poorly. There was no relationship between the radiologically obtained average reflux grade or points and the clinical severity. An erect quantitative duplex Doppler test assessed by the multisegment scoring system correlated best with the severity classification. The predictive value of this test to diagnose severe reflux leading to severe symptoms (classes 2 and 3) was 77% compared with 35% to 44% for descending phlebography. The study suggests that erect quantitative segmental duplex Doppler reflects the degree and distribution of venous reflux more accurately than does descending venography. (J VASC SURG 1992;16:687-93.)

Phlebography is considered the "gold standard" in the evaluation of venous disease. The role of ascending phlebography in the diagnosis of deep vein thrombosis is now being replaced by duplex Doppler investigation.[1] The Doppler technique not only appears to be more comprehensive and specific but is also noninvasive and thus patient friendly and easily repeated if necessary.

Descending phlebography is the time-honored method of choice for assessing the reflux component in chronic venous insufficiency. Surgical treatment of valvular insufficiency is usually based on phlebographic findings. Different techniques and gradings of severity have been described. The most common method is that of performing a transfemoral injection of contrast medium with the patient in a semierect position while simultaneously performing a Valsalva maneuver.[2] The objective is to mimic the physiologic situation as closely as possible. However, there are still centers that advocate that the study should be performed with the patient supine.[3]

The classic reflux classification was introduced by Kistner[4] and modified by Herman et al.[5] This is an axial grading system that gives higher points the farther distal the contrast medium is pushed in the deep system. A multilevel and multisystem ranking has been suggested by Raju.[6] This classification includes the deep and long saphenous veins.

In 1989 van Bemmelen et al.[7] described a quantitative segmental evaluation of venous reflux with duplex ultrasound scanning. This investigation is performed in the erect position with standardized compression by cuffs positioned at different levels on

From the Departments of Surgery, United Emirates University, Al-Ain, and the University of Mississippi Medical Center, Jackson.

Presented at the Fourth Annual Meeting of the American Venous Forum, Coronado, Calif., Feb. 26-28, 1992.

Reprint requests: Seshadri Raju, MD, Department of Surgery, University of Mississippi Medical Center, 2500 N. State St., Jackson, MS 39216-3404.

*At the time of the study Dr. Neglen was a Visiting Professor at the Department of Surgery, University of Mississippi Medical Center.

24/1/40884

Table I. Frequency of involvement of the superficial veins (on ultrasonography), perforator incompetence (ascending venogram), and deep vein reflux (descending venography) and hemodynamic tests in 56 lower limbs according to clinical severity staging

Clinical severity class	*n*	*AVP (% drop)**	*VFT (sec)**	*Superficial incompetence (%)*	*Perforator incompetence (%)*	*Deep vein reflux (%)*
0	15	58 ± 7	39 ± 21	20	20	20
1	19	57 ± 5	33 ± 16	58	69	26
2	8	49 ± 12	16 ± 12	63	88	63
3	14	41 ± 11	9 ± 7	71	100	86

See text for definitions of classes. Class 0/1 is significantly different from class 2/3 for AVP ($p < 0.001$) and VFT ($p < 0.001$).
AVP, Ambulatory venous pressure; *VFT,* venous filling time.
*Mean ± SD.

the leg, which appears to be more physiologic than applying manual compression in the supine position.

This study attempts to compare the findings of semierect 60-degree descending phlebography with the erect and supine duplex ultrasound scanning and to evaluate any discrepancies. To determine which technique best describes the extent of reflux, the radiologic findings and the scan results are compared with the clinical severity stage of the patient. A new multisegment reflux classification of the findings obtained by ultrasonography is proposed.

MATERIAL AND METHOD

Fifty-six lower limbs in 32 consecutive patients were studied. Based on hemodynamic and phlebographic data, 38 of the 56 limbs were classified as cryptogenic reflux and 18 of 56 as postthrombotic reflux. Among the latter group, eight limbs had hemodynamic evidence of obstruction. Investigation included ambulatory venous pressure,[8] venous filling time, arm/foot pressure difference and hyperemia pressure measurements,[9] ascending and descending phlebography, and supine and erect duplex scanning. In addition, a full history was taken and each lower limb was examined and graded by one of the authors (P.N.).

Clinical classification. Clinical severity was graded according to the *Reporting Standards in Venous Disease* by the Ad Hoc Committee[10]: class 0 = asymptomatic, 1 = mild chronic venous insufficiency with chief complaints of swelling and aching, 2 = moderate chronic venous insufficiency with significant hyperpigmentation and other skin changes but no ulcer, and 3 = severe chronic venous insufficiency with skin changes and an active or recently active venous ulcer. For practical purposes, the main division is between clinical severity grades 0/1 and 2/3. Therefore these two major groups are compared below.

Ascending phlebography. Ascending phlebography was performed with the patient in a 60-degree partially erect position with a tourniquet above the ankle.

Descending venography. Descending venography was performed according to the technique described by Kistner et al.[2] The patient was placed in a 60-degree partially erect position and asked to perform a Valsalva maneuver by blowing against a mercury manometer at 30 to 40 mm Hg. Reflux was observed on an image intensifier and recorded on video. Interpretation of the same was carried out immediately by an experienced vascular radiologist who performed the procedure. He was blinded to the results of duplex and other studies on the patient. Maximal observed reflux during the procedure was classified according to Kistner's classification[4,5] (i.e., 0 = no reflux, 1 = reflux of the upper thigh, 2 = reflux in the lower thigh to the popliteal level, 3 = reflux below the popliteal level into the upper calf, or 4 = reflux to the ankle). A different classification[6] based on the number and level of the venous system involved was also used. One point each was given to reflux into the long saphenous, superficial femoral, deep, and below the popliteal veins. The maximal number of points is 4, more than one indicating significant reflux. For example, a lower limb with reflux into the long saphenous, deep, and superficial femoral veins will be classified as grade 2 according to the Kistner classification but would be awarded 3 points according to the latter method.[6]

Duplex Doppler scanning. Erect duplex ultrasound scanning (Acuson 128, PV, probe 531 linear; Acuson, Inc., Irving, Texas) was performed according to the technique described by van Bemmelen et al.[7] by an experienced technologist blinded to the venographic findings. An automatic cuff inflator (Hokanson, Bellevue, Wash.) was used for rapid inflation and deflation of cuffs placed on the thigh

Table IIA. Comparison of the results obtained in 56 lower limbs with Kistner's classification for reflux on descending phlebography versus duplex Doppler scanning in the erect position with the same axial classification

	Kistner's classification (phlebography) (n)			
	0/1	*2*	*3*	*4*
Erect duplex Doppler (axial)				
0/1	14	9	2	7
2	2	2	–	–
3	1	1	4	–
4	5	1	1	–
Isolated popliteal	2	1	1	2

See text for definitions of grades and scoring.

Table IIB. Comparison of the results obtained in 56 lower limbs with multilevel/multisystem scoring in descending phlebography versus multisegment scoring of erect ultrasound investigation

	Multilevel/multisystem scoring (phlebography) (n)				
	0	*1*	*2*	*3*	*4*
Erect duplex Doppler (score)					
0	1	5	11	2	1
1	–	8	5	1	–
2	1	4	1	1	–
3	–	2	4	3	–
4	2	2	–	–	–
5	–	–	1	1	–

See text for definitions of grades and scoring.

Table IIC. Comparison of the results obtained in 56 lower limbs with the axial classification of ultrasound findings in the supine versus erect position

	Supine duplex Doppler (axial) (n)				*Isolated popliteal*
	0/1	*2*	*3*	*4*	
Erect duplex Doppler (axial)					
0/1	24	4	3	–	1
2	–	3	1	–	–
3	1	–	5	1	–
4	1	1	1	4	–
Isolated popliteal	–	1	2	1	2

See text for definitions of grades and scoring.

Table IID. Comparison of the results obtained in 56 lower limbs with multisegment scoring of ultrasound findings in the supine versus erect position

	Supine duplex Doppler (score) (n)					
	0	*1*	*2*	*3*	*4*	*5*
Erect duplex Doppler (score)						
0	12	3	5	–	–	–
1	3	7	3	–	1	–
2	1	2	2	1	1	–
3	–	1	2	3	2	–
4	1	–	–	–	3	–
5	–	–	1	–	1	1

See text for definitions of grades and scoring.

(inflation pressure 80 mm Hg; width 24 cm), calf (100 mm Hg; 12 cm), and foot (120 mm Hg; 7 cm). The cuffs were inflated for approximately 3 seconds. Reflux was considered significant if the duration of retrograde flow exceeded 0.5 second and was measured in the common femoral, superficial femoral, long saphenous, popliteal, and proximal and distal posterior tibial veins. Unfortunately, the deep femoral vein could not be visualized consistently. The duplex Doppler scan was also performed with the patient supine, slightly tilted to the 10-degree reverse Trendelenburg position. Reflux was induced by the Valsalva maneuver and proximal manual compression.

Reflux grading was carried out by the technologist performing the procedure and confirmed by one of the authors (P.N.) supervising the study. Because duplex examination was carried out ahead of phlebography for the most part, interpretational bias was minimized. Reflux severity was graded in an axial fashion mimicking Kistner's classification, giving one to four points as the reflux involved common femoral, superficial femoral, popliteal, and distal posterior tibial veins consecutively. Similar to the descending phlebography, another scoring system was assessed, taking into account the superficial incompetence. In this multisegment score, one point each was awarded to observed reflux in superficial femoral, long saphenous, popliteal, short saphenous, and distal posterior tibial veins (maximum score = 5).

Wilcoxon rank unpaired and paired nonparametric tests were used for statistical analysis in the appropriate situations. A $p < 0.05$ was considered significant. All numbers are given as mean ± SD unless otherwise noted.

RESULTS

The clinical severity grading for the 56 lower limbs is shown in Table I. With increasing clinical

Table III. Average reflux grade and score of the different modes of phlebographic and ultrasound investigations in each clinical severity class

	Class 0 (n = 15)	*Class 1 (n = 19)*	*Class 2 (n = 8)*	*Class 3 (n = 14)*
Erect duplex Doppler scan (axial)	0.3 ± 0.6	0.4 ± 1.2	1.6 ± 1.4*	3.0 ± 1.4**
Erect duplex Doppler scan (multisegment scoring)	0.3 ± 0.5	1.1 ± 1.4	2.3 ± 1.0**	2.8 ± 1.3***
Supine duplex Doppler scan (axial)	1.6 ± 1.2	1.1 ± 1.1	1.3 ± 1.5	2.6 ± 1.4**
Supine duplex Doppler scan (multisegment scoring)	1.5 ± 1.1	0.9 ± 0.8	1.8 ± 2.0	2.4 ± 1.5**
Descending phlebography (Kistner's classification)	2.1 ± 1.2	1.9 ± 1.5	2.5 ± 1.2	1.6 ± 1.3
Descending phlebography (multilevel/multisystem scoring)	1.8 ± 0.7	1.6 ± 0.8	1.9 ± 1.0	1.5 ± 1.2

Data are mean ± SD. Class 1-3 values were compared statistically with class 0 values. If significantly higher, $*p < 0.05$, $**p < 0.01$, and $***p < 0.001$.

severity, progressive deterioration of ambulatory hemodynamics is noted, suggesting that the clinical staging was appropriate. With increasing clinical severity, increasing incidence of superficial, deep, and perforator incompetence is also seen.

Comparison between the radiologic and scanning classifications is shown in Tables IIA to IID. It is obvious that the erect and supine positions of the patient produced different results. Axial reflux classification by duplex ultrasonography (supine or erect) did not correspond to the status found on descending phlebography. Use of multilevel/multisystem score versus multisegment score did not improve the correlation. It is obvious that there are major discrepancies between the different methods.

To determine which system best reflected the degree of reflux, comparison was done with the clinical severity grading. Regardless of the reflux grading classification used, duplex ultrasound scanning better reflected the clinical severity (Table III). Descending phlebography did not separate the clinical severity of class 0/1 and class 2/3. Both erect and supine duplex Doppler investigation, however, readily distinguished these two groups (Fig. 1).

The sensitivity, specificity, and predictive value of the different investigations to differentiate between clinical severity of class 0/1 and class 2/3 are listed in Table IV. Erect scanning was superior to that of the supine position, with better positive and negative predictive values. The multisegment score classification had better sensitivity value than the axial classification. This was probably the result of the inclusion of the superficial vein system and isolated popliteal vein incompetence of this classification. Both descending phlebography classifications had very poor sensitivity and predictive values.

The discrepancies between the investigations were scrutinized further. In 19 limbs, findings on x-ray films and ultrasonography were completely discordant. Eight limbs had grade 3-4 axial reflux with ultrasonography, but no reflux was found below the popliteal level on descending phlebography. Hemodynamic test results (ambulatory venous pressure and venous filling test) were positive and venous ulcer disease (class 3) was present in all limbs. Chronic postthrombotic changes were found in seven of eight limbs, with varying degrees of obstruction. We speculate that the Valsalva method used in descending venography may be less effective in delineating reflux in postthrombotic limbs than the cuff compression method used with ultrasonography.

In nine limbs the opposite situation prevailed. No reflux was observed with ultrasonography, but descending phlebography delineated venous incompetence well below the knee. These patients had fewer clinical symptoms and signs of venous disease (seven in class 0/1 and two in class 2/3). Hemodynamic test results were negative in all patients. In only one patient, the only patient with venous ulcer disease, were postthrombotic findings demonstrated on x-ray films. The explanation for the discrepancy is not known.

DISCUSSION

With the advent of surgical techniques to restore valvular competence, it is increasingly essential to delineate correctly the patency of the deep veins and specify precisely the level of the venous reflux before surgery. The time-honored tool for determining the degree of retrograde flow is descending phlebography. Since its introduction in the 1940s, debate has continued with regard to technical details that might influence the results. The issue of breathing (normal respiration versus the Valsalva maneuver) has been discussed in several studies.[2,3,11] Recognition of the importance of sufficiently high reflux velocity to enable closure of the valve[12] has lead to the general

acceptance that a standardized Valsalva maneuver should be used. More controversial is the issue of proper positioning of the patient (supine vs semierect). Many investigators have recommended the supine position so as to minimize overdiagnosis from trickling down of the contrast medium, which has a higher specific gravity than blood.[3,13] To the contrary, Morano and Raju[11] feared an underdiagnosis of reflux unless the 60-degree semierect position was used. Undoubtedly both the Valsalva maneuver and increasing tilt from supine to semierect augmented the reflux. In this study the frequency of observed reflux was only 42% in the supine position compared with approximately 80% with the semierect tilt position. The problem is to define the true pathophysiologic reflux. According to Kistner et al.,[2] results can be physiologic and reproducible only if the Valsalva maneuver is combined with a semierect (60-degree) positioning of the patient. With this technique, they found abnormal reflux in 72% of patients with venous ulcer disease and no or mild reflux in 92% of asymptomatic legs. No detailed description was provided as to primary disease or hemodynamic status of the patients.

The potential disadvantages of the descending venogram include: (1) A competent proximal valve will prevent the evaluation of reflux of the distal veins; (2) the result is influenced by the heavy contrast medium; (3) all valves are opened in the relaxed horizontal and vertical leg; and (4) proximal obstruction may catch the push of the Valsalva maneuver, thus giving a false-negative finding. Descending venography, however, is superior to duplex scanning in providing greater anatomic detail of valve stations and valve structure, as well as in delineating deep femoral vein incompetence.

Continuous-wave Doppler is an inexpensive, commonly used screening method to evaluate reflux. The major disadvantage is the inability to prove which vein is being detected with ultrasonography. With the introduction of duplex Doppler scanning, this obstacle was overcome. The technique described by van Bemmelen et al.[7] overrides many of the disadvantages of descending phlebography. Used in this study, this technique allows quantification of reflux and evaluation of shorter valve-carrying segments regardless of proximal valve status and patency and seems to be more physiologic in that it mimics the muscle pump.

To our knowledge, no study comparing descending phlebography and this duplex ultrasound scanning technique has previously been reported. One report compared the two methods, but only in the

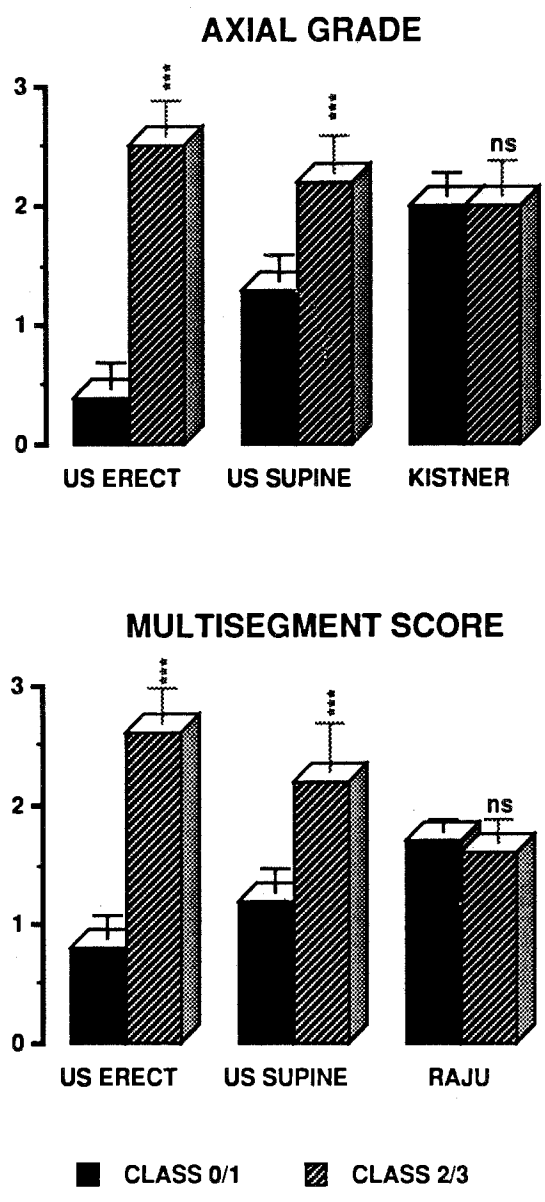

Fig. 1. Average grade and score of different modes of phlebographic and ultrasound investigations of lower limbs with clinical severity class 0/1 (n = 34) compared with results in class 2/3 (n = 22) (mean ± SEM; *ns*, not significant). $***p < 0.001$.

supine position.[14] A good correlation between the investigations was found. However, the material is limited (23 lower limbs), with only 5 of 23 with reflux below the popliteal level and 1 of 23 with a previous deep vein thrombosis. Probably this population does not reflect the true distribution of patients, who will certainly have a higher frequency of postthrombotic complaints.

This study revealed a vast discrepancy of the degree and distribution of reflux between the results

Table IV. Sensitivity, specificity, and predictive value of different phlebographic and ultrasound investigations applying axial, multilevel/multisystem, and multisegment scoring to diagnose severe reflux resulting in clinical severity class 2/3

	Sensitivity (%)	*Specificity (%)*	*Positive predictive value (%)*	*Negative predictive value (%)*
Erect duplex Doppler scan (axial), ≥ class 3	60	93	86	78
Erect duplex Doppler scan (multisegment scoring), ≥ class 2	77	85	77	85
Supine duplex Doppler scan (axial), ≥ class 3	53	81	64	73
Supine duplex Doppler scan (multisegment scoring), ≥ class 2	61	60	48	72
Descending phlebography (Kistner's classification), ≥ class 3	36	71	44	63
Descending phlebography (multilevel/multisystem scoring), ≥ class 2	50	41	35	56

obtained by descending phlebography and erect, quantitative ultrasound scanning. The ultrasound finding was correlated directly to the clinical severity stage of the limb. The noninvasive scan had significantly higher specificity and predictive values of the ability to distinguish severe chronic venous insufficiency regardless of which of the two classifications for descending phlebography was used. It is always difficult to challenge a gold standard, because being the accepted reference for the investigation, it has to be replaced. Although outflow obstruction may be important, in the majority of patients the amount of reflux flow is believed to be the major factor in determining the severity of signs and symptoms. Therefore clinical findings remain the most important single consideration in the evaluation of venous reflux in untreated patients. The validity of the clinical staging was supported by the results of the hemodynamic investigations. Lacking other modalities to assess the retrograde flow at the present time, it appears that quantitative ultrasound scanning more accurately delineates the pattern of venous reflux of the lower limbs than descending venography. However, the sensitivity of a positive multisegment ultrasound scan alone is not adequate for the identification of severe reflux. It must be combined with an additional test indicating the global hemodynamic impact by the reflux.

The results suggest that the erect position is superior to the supine position regardless of which type of classification is used. The axial reflux grading does not include superficial venous incompetence, which may contribute significantly to chronic venous insufficiency.[15] It also does not allow grading of isolated distal incompetence in the presence of a proximal competent valve. The multisegment scoring is more comprehensive but will need further assessment. The contribution of the deep femoral vein, incompetent perforators, or additional leg veins must be evaluated.

Descending venography failed to identify any significant reflux in eight limbs in which ultrasonography indicated grade 3-4 axial reflux. Hemodynamic data suggested severe reflux, as did the clinical examination. Ascending venography showed seven of these limbs to be postthrombotic. Ackroyd et al.[16] identified significant (grade 3-4) reflux with descending phlebography in only 31% (6/19) of patients with proved postthrombotic damage to the deep veins and in 19% (7/37) of patients with liposclerosis or ulceration. Herman et al.[5] reported higher rates of 36% (4/11) and 38% (12/32), respectively. In this study the frequencies differed significantly between the radiologic and ultrasound investigations. Descending phlebography showed significant reflux in only 17% (3/18) of limbs with previous deep vein thrombosis and 21% (3/14) of limbs in clinical class 2/3. The corresponding numbers were markedly higher with duplex Doppler: 56% (10/18) and 79% (11/14), respectively. Only two limbs had intact superficial femoral vein valves on ultrasound scanning in which the lack of distal contrast flow despite distal incompetence could be explained. False-negative x-ray findings appear to occur in postthrombotic limbs with severe insufficiency, especially with hemodynamically significant proximal obstruction.

In nine limbs descending venography identified axial reflux into the calf, which could not be detected with ultrasonography. The overwhelming majority of these limbs had normal hemodynamic test results and slight or no signs and symptoms of venous disease. This supports the validity of the ultrasound scanning. However, these "normal" limbs, although asymptomatic, were contralateral to symptomatic legs (five with previous thrombosis and four with superficial venous reflux). We have previously shown

a high bilaterality of venous reflux on descending phlebography.[8] The possibility exists that descending venography is a more sensitive technique for detecting even minimal reflux through a valve site even though duplex ultrasonography correlates better with functional reflux. Descending venography correlates well with reflux noted on strip testing during surgery in patients with significant symptoms.[8] Because patients without symptoms are not operated on, the question remains unanswered.

This study suggests that erect quantitative segmental duplex Doppler scanning reflects the degree and distribution of reflux more accurately than descending phlebography performed in the semierect 60-degree position in combination with the standardized Valsalva maneuver. The test is noninvasive and patient friendly and can easily be repeated if necessary. The proposed multisegment scoring identifies clinically significant severe reflux with high specificity. For accurate diagnosis of severe reflux, the scan must be combined with a hemodynamic test. Identification of deep femoral reflux may be important in patients undergoing valve reconstruction surgery.[17] Descending venography is superior to duplex scanning in this regard. For this reason and because of the greater anatomic detail of valve stations and valve structure obtained with descending venography, this technique will continue to be used in patients undergoing valve reconstruction surgery.

REFERENCES

1. White RH, McGahan JP, Daschbach MM, Hartling RP. Diagnosis of deep-vein thrombosis using duplex ultrasound. Ann Intern Med 1989;111:297-304.
2. Kistner RL, Ferris EB, Randhawa G, Kamida C. A method of performing descending venography. J VASC SURG 1986;4: 464-8.
3. Lea Thomas M, Keeling FP, Ackroyd JS. Descending phlebography: a comparison of three methods and an assessment of the normal range of deep vein reflux. J Cardiovasc Surg 1986;27:27-30.
4. Kistner RL. Transvenous repair of the incompetent femoral vein valve. In: Bergan JJ, Yao JST, eds. Venous problems. London: Year Book Medical Publishers, 1978.
5. Herman RJ, Neiman HL, Yao JST, Egan TJ, Bergan JJ, Malave SR. Descending venography: a method of evaluating lower extremity venous valvular function. Radiology 1980; 137:63-9.
6. Raju S. Valve reconstruction procedures for chronic venous insufficiency. Semin Vasc Surg 1986;27:27-30.
7. van Bemmelen PS, Bedford G, Beach K, Strandness DE. Quantitative segmental evaluation of venous valvular reflux with duplex ultrasound scanning. J VASC SURG 1989;10:424-31.
8. Raju S, Fredericks R. Evaluation of methods for detecting venous reflux. Arch Surg 1990;125:1463-7.
9. Raju S. New approaches to the diagnosis and treatment of venous obstruction. J VASC SURG 1986;4:42-54.
10. Porter JM, Rutherford RB, Clagett GP, et al. Ad Hoc Committee. Reporting standards in venous disease. J VASC SURG 1988;8:172-81.
11. Morano JU, Raju S. Chronic venous insufficiency: assessment with descending venography. Radiology 1990;174: 441-4.
12. van Bemmelen PS, Beach K, Bedford G, Strandness DE Jr. The mechanism of venous valve closure. Arch Surg 1990; 125:617-9.
13. Gullmo AL. The phlebographic Trendelenburg test. Br J Radiol 1963;24:375-9.
14. Rosfors S, Bygdeman S, Nordstrom E. Assessment of deep venous incompetence: a prospective study comparing duplex scanning with descending phlebography. Angiology 1990; 41:463-8.
15. Gooley NA, Sumner DS. Relationship of venous reflux to the size of venous valvular incompetence: implications for venous reconstructive surgery. J VASC SURG 1988;7:50-9.
16. Ackroyd JS, Lea Thomas M, Browse NL. Deep vein reflux: an assessment by descending phlebography. Br J Surg 1986;73: 31-3.
17. Eriksson I, Almgren B. Influence of the profunda femoris vein on venous hemodynamics of the limb. J VASC SURG 1986; 4:390-5.

Submitted April 14, 1992; accepted July 7, 1992.