Is the vascular laboratory necessary in the management of venous disease?


The author sets forth an assessment of the practical usefulness of the currently available noninvasive laboratory tests in the diagnosis and management of peripheral deep vein thrombosis and chronic venous insufficiency. His standards of evaluation are defined in terms of his personal experience and suggest that these tests, in the setting under discussion, have a value largely limited to patient screening. (J VASC SURG 1986; 3:481-5.)

I have been asked to address the question: "Is the vascular laboratory necessary in the management of venous disease?" If we take a literal interpretation of the word "necessary," the answer to the question must be "no" because it is possible to treat venous disease solely on the evidence given by clinical examination. Indeed many consider that venous disease needs no more than a prescription for an elastic stocking. Therefore, I am going to change the question to "Is the vascular laboratory helpful in the management of venous disease?" Two other words in this question also deserve attention. To me the word "management" covers all that I do between the time the patient first comes to the office or hospital and is finally discharged—diagnosis, treatment, and follow-up. The majority of articles in this area have discussed diagnosis. But diagnosis is only the first step of management and, if one can use a diagnostic technique that helps with management, it may be more cost-effective and a better method of diagnosis than a method that simply gives a "yes or no" answer, a common fault of many of the noninvasive techniques. The question also asks me to discuss "venous disease." The majority of venous problems fall into two categories, acute thrombosis and chronic post-thrombotic problems. Most publications on this subject have discussed acute thrombosis; they rarely address post-thrombotic problems, possibly an indication of the relative role of the vascular laboratory in these two areas.

DEEP VEIN THROMBOSIS

What does the clinician want to know about deep vein thrombosis? He wants information that will help him make the diagnosis, decide about the correct form of treatment, and assess the effect of treatment. Let us discuss the value of the laboratory in each of these categories.

Diagnosis

The laboratory's diagnostic techniques fall into three categories—methods of flow detection determined on the basis of the Doppler shift of ultrasound, methods determined by changes of leg volume (plethysmography), and venous imaging. The fibrinogen uptake test will not be considered here because it is more useful as a research tool than a diagnostic test.

Flow detection (Doppler ultrasonography). If the rate of venous blood flow is changed by squeezing the calf, the change can be detected because the frequency of the reflected ultrasound also changes. It is important to remember the deficiencies of this method (Fig. 1.)

1. Small calf thrombi are not detectable. Most authors have accepted this fact but then discounted it by claiming that it does not matter. I think that is an overstated and unjustifiable claim. Fifty percent of patients with venous thrombosis in the calf detected by radioactive fibrinogen also have a pulmonary embolus detectable by lung scan; thus thrombus in the calf does embolize. These thrombi can also extend into the axial veins. When these patients are examined 3 years later, they have no leg symptoms,
Calf Thrombus  Non-Occlusive Thrombus  Large Collaterals

Fig. 1. The deficiencies of Doppler ultrasound flow detection in diagnosis of deep vein thrombosis. Neither small calf thrombi, nonocclusive thrombi, nor large collaterals will prevent calf squeezing altering the rate of blood flow in the femoral vein. There are, therefore, three causes of false negative tests.

but that does not mean that the thrombosis has not damaged the calf pump in a way that will cause clinical problems 5 or 10 years later. To disregard all the thrombi that develop in the calf after an operation as clinically irrelevant is too presumptuous.

2. The nonocclusive thrombus may be missed. Supporters of the noninvasive test argue that if you repeat the test you will ultimately find the thrombus when it becomes occlusive. I would suggest that you may not find it the next day, when the test is repeated because the thrombus may be in the lungs. I think that the inability to detect this type of thrombus is a serious deficiency of this test.

3. Large collateral veins will also hide an occluded vein from the ultrasound flow detector. This observation is important because patients with large varicose veins, which can act as collateral pathways, are more likely to have deep vein thrombosis.

The overall accuracy rate of Doppler flow detection in the diagnosis of thrombus in the main axial veins is between 85% and 90% and less than 80% when applied to the calf veins.4 This means that it gives the wrong answer in at least one of five patients.

Plethysmography. The plethysmographic diagnosis of deep vein thrombosis is based on the rate and degree of filling and emptying of the calf veins when congested by a pneumatic tourniquet placed above the knee. Plethysmography misses the same type of thrombi missed by ultrasonography, the small calf vein thrombosis and the nonadherent thrombus (Fig. 2).

Thrombus detection is also related to the volume of the blood within the calf veins and the volume of the thrombus. Thus capacious, subcutaneous, varicose veins may mask the presence of thrombi that would have been detected had the superficial veins been normal. In fact all the deficiencies of ultrasonography apply to plethysmography. Therefore, although plethysmography provides a fairly good diagnostic test, approaching 90% to 95% accuracy in the femoral and the popliteal veins, it becomes less accurate with thrombus in the iliac veins because of the large pelvic collateral branches and is inadequate in the calf.5-7 Some authors discuss ways of improving the accuracy of impedance photoplethysmography,8 but when one remembers that 80% of the patients who develop a deep vein thrombosis have a calf vein thrombosis and only a small proportion have occlusive iliac or femoral vein thrombosis, one must accept that plethysmography is the source of many false negative diagnoses.

Management decisions

I do not only want to know whether a patient has a deep vein thrombosis. I want help when deciding on treatment. There are many ways of treating deep vein thrombosis—thrombolysis, thrombectomy, vein ligation or partial occlusion, anticoagulation, repeated observation, or masterly inactivity. All are acceptable approaches in the right circum-
Table I. Value of vascular laboratory investigations in management of deep vein thrombosis

<table>
<thead>
<tr>
<th>Type of noninvasive test</th>
<th>Information desired</th>
<th>Flow detection</th>
<th>Plethysmography</th>
<th>Imaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site</td>
<td>Good &amp; bad</td>
<td>Good &amp; bad</td>
<td>? Good</td>
<td></td>
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<tr>
<td>Extent</td>
<td>Poor</td>
<td>Poor</td>
<td>? Good</td>
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</tr>
<tr>
<td>Adherence</td>
<td>Nil</td>
<td>Nil</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>Nil</td>
<td>Nil</td>
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stances. I need additional information to be able to choose the correct treatment. I want to know where the thrombus is, how big it is, and something about its nature, is it young or old, and is it adherent or nonadherent? Can the tests we have discussed give us such information? (Table I.)

The flow detection techniques achieve some success with regard to site because they are quite good at detecting iliac and femoral vein thrombus although unable to detect calf vein thrombus. But they cannot provide a precise definition of the upper and lower limits of a thrombus and none of the flow detection techniques gives any information about the age and adherence of a thrombus.

Plethysmography has the same limitations. It can provide some information about the site of a thrombus but cannot define its anatomic extent, age, or adherence. My knowledge of venous B-mode imaging is limited but we all hope that it may be able to supply the information we seek. Its accuracy will have to be compared and corroborated with phlebography.

Treatment assessment

Once we know the features of a venous thrombus and have decided on treatment, we need to assess the effect of the treatment. Has the thrombosis extended or regressed, or has it fractured and become a pulmonary embolus? What has the thrombus done to the valves? Can the noninvasive tests designed to assess extension answer these questions? (Table II.) A test that cannot define extent cannot define extension and regression. Thus, neither flow detection or plethysmography can answer the first two questions. The fact that the calf empties faster after 5 days of treatment with heparin does not mean that the thrombus has gone. It is just as likely, probably more likely, to be related to the development of collateral vessels. Neither of these tests provides helpful information about valve damage. B-mode imaging may be helpful once it is fully developed and tested.

COMMENT: The only technique that gives both diagnostic and management information about deep vein thrombosis is phlebography. However, not all patients with suspected venous thrombosis are subjected to phlebography. The vascular laboratory's sole but important role is to screen out patients with no or minimal thrombosis. It may be necessary to repeat the tests daily to be certain that is the case. When a noninvasive test is positive, you must proceed to make an objective anatomical diagnosis. In my opinion, no treatment, especially dangerous drugs such as heparin and streptokinase, should be administered without a positive phlebographic diagnosis. From this point onward, the vascular laboratory currently has no place in the treatment decisions or the treatment control.

CHRONIC VENOUS INSUFFICIENCY (CVI)

The problem of CVI may be approached in the same way that we have discussed deep vein thrombosis. What does the clinician want to know about a patient with CVI?

CVI presents four problems-incompetence of the superficial veins, of the communicating veins, of the deep calf veins, of the deep axial veins, and obstruction of the deep axial veins.

The laboratory techniques that are used to examine these aspects of calf pump physiology are similar to those used for the detection of thrombosis. The measurement of the direction of blood flow, the many methods of plethysmography (pneumatic, strain-gauge, impedance, photo-, isotope, and foot volumetry) and imaging. Foot vein pressures are not commonly used for routine investigations and are, strictly speaking, invasive.

Superficial vein incompetence

Of all patients with venous disease who see a vascular surgeon, 80% to 95% have simple incom-
petent superficial varicose veins. The varicosities are diagnosed at inspection and incompetence is confirmed with the time-honored Trendelenburg test modified by the use of a tourniquet placed at different levels around the thigh or leg. If the direction of blood flow is unclear, the directional Doppler flow detector will help.

Plethysmography during and after exercise and passive calf compression, with and without tourniquets, will also detect and to some extent quantify the degree of superficial vein incompetence, but in nine patients out of 10, inspection and a tourniquet test will tell us all that we need to know. Thus the diagnosis, treatment, and follow-up of most patients with simple primary varicose veins rarely needs laboratory backup.

Communicating veins

Clinical examination only detects 50% of incompetent communicating veins (ICVs). The addition of a multiple tourniquet test improves our ability to define the presence or absence of these veins but does not help define the site.

Many assessments of the value of the directional Doppler flow detector have been published with varied results. In my own department we have only been able to detect 60% of the ICVs found at operation, but others have claimed much better detection rates. The average accuracy rate is probably 60% to 70%. Unless the surgeon wishes to look for individual ICVs through separate incisions, it does not help to know the precise site of each abnormal vein because the standard operation is to explore all the common sites through a single long incision.

The plethysmographic techniques aided by tourniquets may also reveal reflux through ICVs but cannot define their exact anatomic location.

Thus the vascular laboratory does not have an accurate technique for the detection of ICVs. Some workers claim that phlebography is much better than the noninvasive tests; others find it inadequate. Whatever method we use we must admit that our detection rate is poor (I consider 70% accuracy to be poor), and no method measures either the pressure gradient or the volume of the reflux.

Deep vein reflux

Both the directional Doppler flow detector and plethysmography, with the assistance of tourniquets, can identify and quantify deep and superficial vein reflux. I have found the directional Doppler method difficult to use and misleading when examining the popliteal vein compared with the examination of the superficial femoral and common femoral veins in the thigh and groin.

Because reflux is often present in patients with the postthrombotic syndrome, we assume that it is significant. Yet it is interesting that those surgeons who are attempting valve transplantation and valve transposition techniques are commenting that, although they have successfully implanted a competent valve into the deep system, the noninvasive tests of reflux do not always show improvement even when there is definite clinical improvement. This finding may mean that their operation has not altered reflux but it may mean that we are misinterpreting our tests and not really measuring reflux at all.

This raises an important point. The tests for deep vein thrombosis have all had phlebography as their "gold standard." None of the tests of calf pump insufficiency, including foot vein pressures, has a "gold standard" against which it has been compared. They have all been compared against each other, or against symptoms and signs, or interpreted on the basis of our theoretical conception of the mechanism of the test. All our tests need a better evaluation, ideally against (i.e., before and after) the surgical correction of the physiologic abnormality they are supposed to define.

Deep vein obstruction

The directional Doppler flow detector obviously cannot define obstruction. Plethysmography is insensitive. Most studies show calf vein emptying rates that overlap into the normal range in patients with clinically and phlebographically demonstrable obstruction. The problem is not that the test cannot detect obstruction but that we are doing the test in the wrong circumstances. There is not much obstruction to the minor increase of venous outflow from the leg caused by raising the venous pressure with a tourniquet and then deflating it. We should be doing our tests when the obstruction becomes significant (i.e., during exercise). This can be done with iliac vein occlusion by measurement of femoral vein pressure while the leg is exercised. The equivalent test of femoral vein occlusion would be to measure popliteal vein pressure during exercise. This is not practicable. We need better stress tests for outflow obstruction similar to our exercise tests for claudication.

COMMENT: My overall view of the value of the vascular laboratory in the management of chronic venous insufficiency is as follows. Laboratory tests of superficial vein insufficiency are usually unnecessary.
The detection of CVI in the laboratory is sometimes helpful and deep vein reflux can be measured accurately, but our tests for deep vein obstruction are insensitive.

SUMMARY

The question I set out to answer was “Is the vascular laboratory necessary in the management of venous disease?” For the visiting professor who has spent the day pontificating, lecturing, and talking to energetic doctors, the vascular laboratory is a haven of peace where one can sit down and talk with interested technicians about the practical problems of diagnosis. But may I remind you of this definition of a drug—“a drug is a substance that when injected into a guinea pig produces a scientific paper.” I am concerned that the vascular laboratory has, over the past years, too often been a room that, when put into a hospital, has produced not one but many papers, some of which have not been as scientific as they should have been.

The vascular laboratory can play an important role in screening patients for deep vein thrombosis. Thereafter the laboratory’s tests are inadequate for objective anatomic diagnosis, management, and control of treatment. For these reasons I use the simplest screening test available, the portable Doppler flow detector in my pocket, and then proceed directly to phlebography. I do not use the vascular laboratory for the management of venous thrombosis. I prefer to have one test that tells me all I want to know rather than use a battery of inadequate tests.

The majority of patients with venous insufficiency have simple superficial venous problems that need no investigation, but the laboratory tests are helpful in the patient with recurrent disease and deep vein disease. They would be even more helpful if they were more specific. At present our tests are so inaccurate that we frequently do not know what we are testing. The tests must be refined and validated by use before and after the surgical correction of known and specifically defined abnormalities, a different approach to the one we normally use, which is forced on us by our lack of a “gold standard.”

You may well think that this article comes from the devil’s advocate; I think it comes from the patients’ advocate. The vascular laboratory has a long road ahead of it before it becomes an established part of the management of venous disease. We need better tests, not more laboratories.

REFERENCES