Valve Reconstruction Procedures for Chronic Venous Insufficiency

By Seshadri Raju

THE FIRST KNOWN instance of valve reconstruction for venous insufficiency was performed by Kistner in 1968,[1] but the procedure did not receive widespread attention until much later, after presentation of his work to the vascular societies.[2] This pioneering attempt broke important ground in demonstrating that direct venous surgery could be safely undertaken without a serious risk of thromboembolic complications. In the context of unsatisfactory to disappointing results obtained in chronic venous insufficiency with previous, primarily indirect therapeutic interventions, direct valve surgery offered new hope in managing this recalcitrant problem. At the very least, the increased interest in venous diseases generated by this development, along with the advent of new diagnostic instrumentation and technology with which to investigate the venous system, has resulted in newer insights and better understanding of the pathophysiology and treatment of venous insufficiency. Nevertheless, the procedure of valve reconstruction itself remains controversial[3] and a number of aspects, including indications, selection of patients for surgery, and the best technique, remain unsettled. The following is largely a summation of the author's approach to direct venous valve surgery, but alternative approaches and viewpoints are also addressed.

VENOUS EVALUATION AND SELECTION OF PATIENTS

Patients suspected to have chronic venous insufficiency should initially have a careful clinical evaluation consisting of a detailed history and a focused physical examination. Time-honored examination techniques such as the Trendelenberg test, Perthe's test, and the three-tourniquet test, while useful to some extent, have largely been superceded by more accurate techniques available in the vascular laboratory. A thorough Doppler examination, as recommended by Barnes,[4] is a reliable technique for the detection of obstruction as well as reflux. A hand-held Doppler is more suitable for this purpose, and the examiner should always compare any findings with those in the opposite limb for detection of abnormalities. Spontaneous velocity signals should be heard over the major deep veins and be phasic with respiration. Absence of these characteristics denotes obstruction, which can be confirmed by carrying out appropriate distal compression maneuvers and noticing the absence of augmentation at the proximal monitoring sites. Reflux when present can be detected at the suspected valvular site when the patient executes the Valsalva maneuver or the examiner provides manual cephalad compression. Compression and release at a location caudad to the monitoring site can also detect valve reflux, with reversal of Doppler signals.

Photoplethysmography has become a widely used technique for detection of chronic venous insufficiency. Clear discrimination between obstruction and reflux is not possible with this instrument and it has an unacceptably high false positive rate.[5] A negative or normal examination, however, is a highly reliable indicator of normal venous hemodynamics. A positive test result usually requires further laboratory investigation and cannot by itself characterize the exact nature of the venous pathology. Ambulatory venous pressure measurements or other techniques of venous function, such as foot volumetry, are needed for selection and follow-up of patients undergoing direct valve reconstruction surgery.

In the author's laboratory, the resting arm/foot venous pressure differential is used as an index of venous obstruction. A differential of 4mmHg at rest and an elevation of more than 6mmHg during reactive hyperemia in the foot are highly reliable indicators of venous obstruction. In addition, obstruction can be graded from compensated to uncompensated depending upon the results of the latter pressure measurements.

From the University of Mississippi Medical Center, Jackson, MS.

Address reprint requests to Seshadri Raju, MD, Department of Surgery, University of Mississippi Medical Center, 2500 N State St, Jackson, MS 39216-4505.

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The reader is referred to a detailed description of these techniques published elsewhere.[6,7]

It is crucial to rule out partial or total obstruction in patients undergoing venous valve reconstruction. If reconstruction is undertaken caudad to an obstruction, the repair is bound to fail owing to the obstructive venous hypertension present. If carried out cephalad to a venous obstruction, the procedure will fail to relieve ambulatory venous hypertension distal to the obstruction. Valve reconstruction may be considered in selected instances of compensated venous obstruction, but the indications for surgery and the selection of such patients remain unclear. Ascending venography may fail to reveal venous obstruction, particularly at the upper iliac level if the technique is suboptimal. In the presence of an obstruction, the contribution of collaterals to venous outflow is poorly assessed by ascending venography. For these reasons, functional information from the described laboratory techniques is essential for proper selection of patients for venous surgery. Using the same venous needle or catheter, it is possible to carry out an entire set of pressure studies on the patient, including ambulatory venous pressure and Valsalva foot venous pressure. The latter technique has been particularly useful in the preoperative and postoperative evaluation of patients undergoing venous valve surgery.[8] An increase of less than 4mmHg in the supine position with the Valsalva maneuver indicates mild or absent reflux while higher values reflect increasing severity of reflux. Significant improvement in this parameter can be expected following valve reconstruction.[8]

SELECTION OF PATIENTS FOR SURGERY

Candidates for direct valve surgery should be chosen based on age, work status, and severity of symptoms. The presence of severe venous dysfunction should be confirmed in the laboratory. The need for chronic anticoagulation and the possibility of potential serious complications dictate that older patients, in general, be excluded. Relatively young patients with a potential for meaningful rehabilitation in the workplace or who desire a more active life style are the best candidates for direct venous surgery. Stasis dermatitis and ulceration and, to a lesser extent, limb swelling are tangible manifestations of venous dysfunction. Pain, of necessity, is a subjective manifestation. The surgeon is well advised to be sure of the emotional stability and the pain threshold of any patient in whom pain constitutes the major complaint and indication for surgery. Most patients, however, present with a combination of symptoms. Some young patients, often with a positive family history and early onset of varicosities, may be relatively asymptomatic when the varicosities are the chief complaint. Even though laboratory evaluation may reveal dysfunction in the deep system in such patients, it may be appropriate to focus surgical attention on the superficial system alone to effect the cosmetic improvement desired. In symptomatic patients in whom direct valve surgery is contemplated, further workup should consist of ascending and descending venography and even lymphangiography if swelling is the major complaint. The proper technique of descending venography has been emphasized by Kistner[9] and the details of its performance are particularly important: only reflux present at 60° tilt with Valsalva is significant.

Among 139 symptomatic patients investigated in the above fashion at the University of Mississippi Medical Center,[8] only 1% were found to have isolated or pure superficial venous insufficiency. The overwhelming majority had deep system abnormality either alone (71%) or in combination with superficial system insufficiency (28%). Likewise, isolated perforator incompetence was seen only rarely (3%). Perforator incompetence, however, was often seen (97%) as a secondary manifestation of deep venous incompetence. Based on descending venographic findings, it was possible to classify patients[8] as having reflux either at (1) single level/single system, (2) single level/multiple system, or (3) multilevel/multiple system, as shown in Fig 1. Reflux in a single system at a single level was only occasionally seen (10%) in significantly symptomatic patients (n = 189), presumably because the abnormality was limited and easily compensated for by the remaining normal segments of the venous system. Predictably, involvement of multiple systems either at a single level (24%) or more commonly at multiple levels (66%) was the predominant pathological finding in these significantly symptomatic patients.

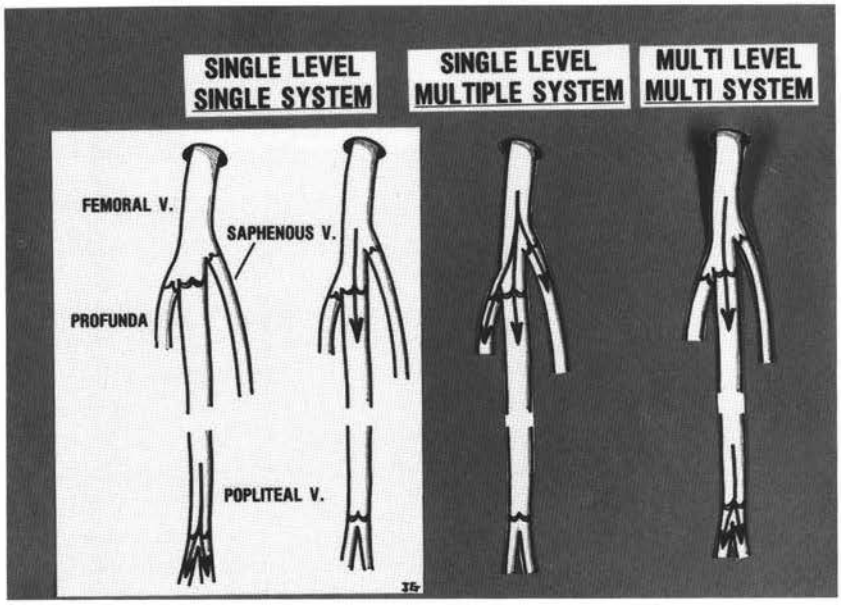

Fig 1. Types of valve reflux: single level/single system (saphenous, superficial, femoral, profunda, or popliteal); single level/multiple system; and multiple level/multisystem.

TECHNIQUE

The choice of valve location for repair in patients with multivalvular reflux remains controversial.[10] The author has generally adhered to the policy of repairing the highest valve in the superficial femoral vein, as results have been satisfactory. It is also technically easier to perform a valvuloplasty at the femoral rather than at the popliteal level. Taheri[11] and others[12] have preferred an adductor canal location lower in the thigh or the popliteal segment itself for valve reconstruction procedures. Theoretically, it may be more advantageous to do multiple repairs at multiple locations. In practical terms, however, simpler techniques of valve reconstruction than are currently used will have to be developed to pursue this approach. The technique of superficial femoral valvuloplasty through a longitudinal or a transverse venotomy has been well described and the reader is referred to the original articles[8,13-15] for technical detail. Irrespective of whether a longitudinal or transverse approach is used for valvuloplasty, the underlying principle is the same and involves gathering up or imbricating the free edges of the valve cusp at either commissural end so as to shorten the free edge and deepen the cusp, and thus cause better coaptation and prevent prolapse. After successful repair, a previously incompetent valve should clearly be demonstrated to have become competent by the "strip test." The strip test involves observing for reflux through the valve after the distal segment is stripped free of blood.[8] If the strip test reveals persistent reflux, the repair should be improved or alternatively a valved axillary vein segment should be interposed at this site to produce a competent valved segment. Occasionally, other techniques of restoring competence to the valve, such as inserting a snugging Dacron sleeve in situ (to encourage better coaptation of valve edges), on other special techniques directed towards the valve apparatus itself, may be successful. Congenital anomalies of the valve apparatus are not rare (Fig 2) and require specific modifications in the approach to achieve correction.

In the author's experience, in approximately 20% of patients operated on, the valvular apparatus is either totally or partially destroyed by a previous phlebitic process rendering a valvuloplasty procedure impossible. In this group of patients, the following technique of axillary valve transfer procedure is used: Through a transverse incision near the pectoral fold, a segment of axillary vein containing a competent valve is harvested and transposed to the superficial femoral vein just below the junction with the profunda vein. A good sized match is usually achieved, but

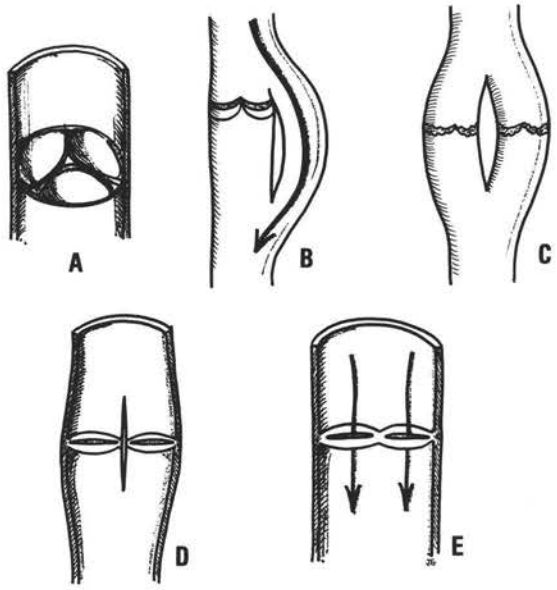

Fig 2. Congenital valve anomalies: (A) tricuspid valve, (B) valveless duplication conduit, (C) duplication with incompetent valve in each conduit, (D) double valve ring with and (E) without median septum. Absence of septum predisposes to reflux of both central cusps due to absence of a stable buttress for the valve sinuses.

care must be taken before harvesting the segment to assure that the transferred axillary valve is competent. Incompetence of the axillary valve is not infrequently present, as demonstrated by performing a strip test. Another necessary precaution in transferring an axillary valve segment is to ensheath the interposed segment in a Dacron sleeve of appropriate size.[8,13] Significant dilatation with secondary valve incompetence of the transferred segment has been observed when an enclosing Dacron sleeve was not used. Whether the Dacron sleeve will prevent this complication has not been determined with certainty at this time.

In the overwhelming majority (approximately 80%) of patients evaluated and operated upon as described, a repairable valve will be found below the profunda take-off. On examination the cusp is found to be redundant with elongated edges and shallow cusps, obviously resulting in prolapse and reflux. Usually there is no evidence of previous phlebitis inside or outside the vein. This condition of primary valve reflux will be found to be the commonest cause of chronic venous insufficiency if patients are selected as outlined. The existing view that valve reflux is predominantly due to a phlebitic process is incorrect based on the author's experience. While valve destruction and valve reflux undoubtedly occur following deep venous thrombosis, more often than not, the hemodynamic abnormalities produced in such instances are either pure obstruction or, more commonly, a combination of obstruction and reflux. Particularly proximally, the process of recanalization is often incomplete in extensive deep venous thrombosis, and residual obstruction is usually present. Pure reflux of a severe degree undoubtedly occurs in some of these patients, even though clearly not as often as is generally believed.[6] In patients presenting with a destroyed valve apparatus and reflux, it is often not possible to determine whether deep venous thrombosis was the cause or the result of a valve reflux condition. Reflux and stasis resulting from primary valve reflux can clearly precipitate deep venous thrombosis resulting in valve destruction and increased reflux. The overwhelming occurrence of primary valve reflux in symptomatic patients in the author's practice, along with a preponderance of deep system reflux (either alone or in combination with superficial system reflux), has spawned the concept that venous insufficiency is frequently the result of a basic defect[13] in the valve apparatus. Arguments that suggest this process is of nonthrombotic origin include the observed high bilaterality (>90%)[13] of reflux, the preponderant involvement of the femoral valve as opposed to the popliteal valve[13] (the popliteal valve should be more affected in the postphlebitic process), the observed reflux of the axillary valve in many instances,[8] and the absence of previous phlebitis at venography or during surgery in most cases. The fact that pure superficial system reflux occurs only occasionally in symptomatic patients and in most reflux in the deep system (either alone or in combination with the superficial system and perforator viens) is at fault requires rethinking of some traditional concepts of venous insufficiency. Classification of venous insufficiency into superficial and deep categories is probably not warranted in the light of these findings.

RESULTS

With proper selection of patients, approximately 65% to 85% have good to excellent results following valvuloplasty. Somewhat lower success

can be expected for other procedures (Table 1). Symptom relief has been durable in our[8] and Kistner's[15] series. There has been no mortality and minimal morbidity with the procedure. In the author's experience,[8,13] an 8% incidence of postoperative deep venous thrombosis (in most instances not involving the repaired valve) continues to be a vexing complication. Different perioperative anticoagulation regimens are under trial currently in an attempt to solve this problem. The author's present practice is to leave the intraoperative heparin unneutralized and continue postoperative subcutaneous heparin with conversion to Coumadin (crystalline warfarin sodium, Du Pont, Wilmington, DE) by five days after surgery. Only relatively low doses of Coumadin are used, enough to prolong the prothrombin time two to five seconds above control value.

Symptomatic relief following valve reconstruction is often dramatic. Patients frequently volunteer absence of calf pain the first time they are allowed to ambulate, the day after surgery. Swelling, even though it may be temporarily increased postoperatively, is often painless and well tolerated. More tangible evidence of improvement after surgery is seen in those patients whose stasis dermatitis wanes and whose longstanding ulcerations are healed. Characteristically there is an improvement of approximately 10 to 15 mmHg in the postexercise venous pressure following valve reconstruction. However, postexercise pressures seldom become normal. The discrepancy between the marked symptomatic improvement and the relatively modest hemodynamic improvement observed by the author and others has been the subject of some debate. A modest improvement of 10 to 15 mmHg in postexercise pressures may restore venous function below the threshold of decompensation, providing the basis for marked symptomatic improvement even though venous physiology is not entirely normalized. The ambulatory venous pressure measurement is a gross test not entirely suited for accurate assessment of the results of venous valve reconstruction. However, in our experience, the Valsalva foot venous pressure is substantially improved and often normalized after venous valve reconstruction.[8] This parameter provides a more consistent correlation with the degree of symptomatic improvement than ambulatory venous pressure measurement. A clearer understanding of venous valve reconstruction, its effect on venous pathophysiology and the complex interrelationship between symptom expression and pathology awaits further improvements in the techniques of assessing venous hemodynamics and valve function and a clarification of the many still obscure aspects of venous physiology.

Table 1. Results of Valve Reconstruction Procedures With a Minimum Follow-up of 2 Yrs

Procedure	N	Pain Relief (%)	Ulcer Healing (%)
Valvuloplasty	61	87	63
Valvuloplasty with dacron sleeve	10*	60	50
Axillary valve transfer	18	50	46
Axillary valve transfer with dacron sleeve	6	50	33
Dacron sleeve in situ	12†	83	63

*Dacron sleeve was placed to prevent further deterioration if residual incompetence was present after valvuloplasty.

†Dacron sleeve was placed without valve repair when venospasm resulted in valve competence.

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