

Michigan group, two reached proportions which prompted resection of the vein graft and creation of a second aortorenal vein graft. Both of the original vein grafts revealed degenerative changes of a rather non-specific nature. These aneurysmal changes in the saphenous vein implanted in the renal artery are cause for great concern. However most of the aortorenal vein grafts have held up quite well. It is likely that they should *not* be used in children. The saphenous vein in the child is structurally an anatomically different than in the adult.⁹ The arterial blood supply of the saphenous vein in the child and in the adult are apparently different. The frequency of aneurysmal dilatation of vein grafts in children has been attributed to these differences. Information concerning the long term performance of the hypogastric artery implanted in the renal system is not yet available. Early in our experience we felt that the dacron prosthesis, implanted in the renal artery was more likely to thrombose. What we were actually comparing was our first three or four year experience with our second three to four year experience with renal arterial revascularization. In actual fact, in our experience, if the Dacron graft was initially patent, it has remained patent on subsequent examinations. If the renal artery beyond the stenosis is large (6–8 mm in diameter) and the saphenous vein is less than 4 mm in diameter, we do not hesitate to use a Dacron prosthesis, especially in a child. The ultimate fate of these grafts remains to be determined. We have never seen or heard of a false aneurysm developing in an anastomosis between the saphenous vein and an artery. False aneurysm formation in a Dacron prosthesis-renal artery anastomosis has been observed.⁸

We have rarely encountered a functionally significant stenosis in an aorto renal vein graft (e.g. a stenosis causing recurrent RVH). Stanley *et al.* reported a 9% incidence of such stenoses.⁹ The etiology of these stenoses is also obscure. Once again vein graft handling has been incriminated as has the retrocaval course of a right aortorenal graft. In the latter type of stenosis retrocaval hematoma and subsequent cicatrix formation has been cited as the inciting factor in causing a stenosis in the mid-portion of a right aortorenal vein graft. We have not observed a stenosis other than at the suture lines in any of our patients. Conkle, et al have reported experimental canine studies which indicate that both arteries and veins when transplanted in an arterial system develop proliferative intimal lesions which might produce significant stenoses—these studies were done in the femoral arteries

of the dog.³ The one vein graft that we have recovered following thrombosis showed similar fibrotic intimal proliferation.

Another observation encountered in this study was the frequency of development of new or progressive stenotic lesions in the contralateral renal artery. The importance of this observation relates to avoiding nephrectomy in patients with RVH. In many of the early reports on treating patients with RVH, nephrectomy was the mode of treatment in over 50% of the patients. It is now apparent that nephrectomy should not be done except in the case of a destroyed kidney or in patients who are uncontrollable and whose renal artery can not be reconstructed.

The most satisfying observation in the study was the sharp decline in graft thrombosis in 1973 as compared to 1972. This improvement is attributed to modifications in operative technique.

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DISCUSSION

DR. GEORGE COOPER MORRIS, JR. (Houston): Our experience in the long-term state of the vein in the renal artery position has

been exactly similar to Dr. Foster's and his group. True aneurysms developing in adults have been extremely rare in our experience.

(Slide) Here is an example of a patient who has been followed

through the years, who had a preoperative study in 1962, and then the immediate postoperative study. It has the appearance of a vein, without uniform conformity, but most of these veins arteria-
lize, as it were, to a certain extent and get a more uniform appearance, which you can see in 1969.

This same patient returned last year with iliac occlusive disease, and again his vein graft in the left renal artery appears normal.

However, in children the story is a little different. Renal artery problems in children are infrequent, and yet I have had three aneurysms develop after saphenous vein autograft repairs. This is an example of one, a young boy of eight who had a high grade stenosis distally in his right renal artery which might have been of traumatic origin.

An early followup study shows a normal appearance after patch angioplasty bridging over the branching complex on the right, much as Dr. Foster has done. The boy remained normotensive, but I did get him back for a followup study, having had this experience previously in two other children, and again I saw this development of an aneurysm after six years.

I do not know whether the saphenous vein is infantile, or lacks elastic tissue, or whatever, but it does not seem to work well in children. The hypogastric artery in the child is a better substitute.

The hypogastric artery is not a good graft in the adult because it is usually the first artery to develop atherosclerosis. Here is an example of a congenital occlusion of the right renal artery in a child, and you can see the early and late phases in the arteriogram with total occlusion, but a good kidney.

(Slide) After operation, you see the missing right hypogastric artery and its appearance as a right renal artery. It is probably important to use interrupted sutures in children.

DR. WILLIAM J. FRY (Ann Arbor, Michigan): A year ago we presented our results with 100 consecutive vein grafts; and as pointed out by Dr. Foster, we were concerned principally with aneurysmal change, stenosis, and thrombosis. I think expansion is probably not something to be worried about, as these patients have continued to do well. Their grafts have not enlarged after their immediate expansion, and continue to function extremely well. With the technique of a widely spatulated end-to-end anastomosis we have seen no stenosis at the suture line.

Of our six graft aneurysms, four occurred in children. Only one of those four had to be replaced, and the others have leveled off, have not dilated any more beyond a two-year period and continue to function well. Obviously, we are worried about them.

One of the aneurysms we replaced in the adult group was a poststenotic dilatation, and I would like to emphasize that we believe the stenoses that occurred were secondary to rough handling of the vein at the time of operation, where a large occluding clamp was placed on the vein graft prior to the distal anastomosis. This provoked us to stop using crushing clamps. If the vein graft must be clamped during the course of the procedure, we should prefer to use microvascular clamps that will not injure the graft.

We agree with Dr. Foster that thrombosis is a factor of technical failure. One has a high-flow system, and there is no reason for immediate thrombosis of the graft. Thrombosis is secondary to lack of systematic anticoagulation, poor technique or improper selection of patients.

We have continued to use vein grafts in our children. We now have a group of 32. They have done well, and we have had no further aneurysms since we have procured our vein grafts with more care. I do believe, however, that veins are not perfect. These grafts must last a long period of time, and it is important to continue to watch them closely.

(Slide) This is a vein graft that was preserved in normal saline at room temperature for 15 minutes, and you can already see the amount of separation of the intima from the vein graft wall.

(Slide) This represents a vein graft preserved in room temperature Hartmann's solution for 15 minutes. Notice the discoloration and puffy appearance of the vein graft.

(Slide) This is a vein graft preserved and cooled in heparinized blood for one hour. You can see the integrity of the vein graft has been maintained with a relatively normal appearance. Certainly, preservation of the vein graft at the time of operation is an important consideration and one that we had not paid attention

to until we did our survey. This is particularly important in young people. The majority of our patients are young ladies with fibrodysplastic disease. They have many years ahead of them, and these grafts must serve them over a long period of time.

PROFESSOR LARS-ERIK GELIN (Goteborg, Sweden): The patency in Dr. Foster's series of patients was impressive. Two of 28 cases with fibromuscular stenosis occluded, however, which stresses the risk of failure at reconstruction of this otherwise benign lesion.

Patency will depend on the efficiency and smoothness in detailed reconstruction of small arterial branches.

I advocate an extracorporeal approach for repair of such distal renal artery stenosis. It will allow a very detailed and proper reconstruction at the workbench in a totally bloodless state, as a safer procedure than *in situ* repair.

(Slide) Let me illustrate this with a case of distal renal artery stenosis in a 40-year-old woman with a single kidney. She had a progressive hypertension with a blood pressure of 240/120 with maximal doses of antihypertensive drugs, permanent headache, serum creatinine 1.2; inulin clearance was 66 ml per minute.

(Slide) At excision you can see the branching off, and two stenotic areas. After resection of this region, reconstruction was done using saphenous veins, and reimplantation. The followup angiogram shows a good perfusion, excellent renographic phase.

After reconstruction, her serum creatinine decreased to 0.6. Inulin clearance increased to 80 ml per minute, blood pressure was 130/80, without any drugs.

Our experience from 23 extracorporeal kidney reconstructions has convinced us that the procedure is safe and permits ideal conditions for detailed surgical repair without the pressure of time. I believe that the ischemia time with *in situ* repair contributes to an increased renal vascular resistance, and thereby decreases flow through the reconstructed region and thrombotic occlusions. Failure of arterial reconstructions to correct hypertension may be due to arterial occlusion to ischemia injury to the renal parenchyma and to extrarenal causes. The first two might be more readily controlled with the extracorporeal method.

DR. RICHARD H. DEAN (Closing discussion): As Dr. Foster has stated, we have also had concern regarding long term results in regard to dilatation and aneurysmal formation of the vein graft, and also feel that this is much more common in children (slide).

This child, for example, had a severe, bizarre form of juvenile fibromuscular dysplastic disease. He has multiple arteries involved, including his left renal artery and his superior mesenteric artery.

Immediate postoperative arteriograms following an iliac vein anastomosis to the superior mesenteric artery and a hypogastric artery to the left renal artery showed patent grafts.

Within three years following this, both of these had undergone severe dilatation; approximately 300% in the iliac vein, and 100% dilatation in the hypogastric artery.

Although we do know that it occurs from saphenous veins, the dilatatory phenomenon late in followup in these patients is not limited to veins, but can also be seen in arterial reconstructions.

Another point brought out by all the discussants that we feel is extremely important is that of technique. Obviously, if the vein thromboses a week following operation, the opportunity for even dilatation or aneurysmal formation is lost, and the importance of operative technique cannot be minimized.

In regard to Dr. Gelin's comments concerning extracorporeal circulation, we have now done this in six patients also. In the first patients we used a modification of the Belzer pump, leaving the ureter intact. To date all six of these patients' grafts have remained open and have not shown any dilation or thrombosis.

Finally, in the childhood age group we have not used the hypogastric artery, but have usually preferred to use Dacron grafts. Although in our earlier experience with Dacron grafts we felt there was an increased thrombosis rate, we now feel this probably simply reflected our early experience, and in our later followup of these patients in which the Dacron graft was used, the patency rate has been very similar to that of saphenous vein grafts. Dacron works quite well in children in which there is aneurysmal dilatation distal to the stenosis, at which point the Dacron graft can be easily anastomosed.