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#### DISCUSSION

DR. JONATHAN TOWNE (Milwaukee, Wisconsin): To my knowledge, this is the largest series of surgically treated patients with occlusive disease of the lower extremities. The operability rate of 99% in previously unoperated patients is outstanding. We agree with the desirability of autogenous repair and the good results of grafts originating from the distal superficial femoral artery, popliteal, and in our experience, occasionally tibial vessels. We do not share the author's enthusiasm for sequential bypasses. In our experience it is rarely needed to maintain graft patency or necessary to supply sufficient arterial flow to heal foot lesions. I would ask Dr. Veith to explain his indications for doing sequential bypasses. Also, I was curious, in this series what is the incidence of diabetes and its relatively changing incidence through the years?

As one reads Dr. Veith's manuscript, I wonder if it is possible to identify a group in whom it is technically possible to do a bypass but because short-term results are not as good, primary amputation may be more desirable.

Finally, when is enough, enough? When is the reoperative vascular repair not likely to be successful, and it is better to proceed to primary amputation?

In looking at these patients, some of whom had seven operations, as listed in the manuscript, what is the deterioration of patency and limb salvage curves as one adds additional operative procedures?

DR. ROBERT P. LEATHER (Albany, New York): As you know, Dr. Veith has been an enthusiastic advocate of arterial reconstruction for the prevention of amputation, a concept that originally was popularized in the late 1950s by the late Alfred Humphreys of this society. Dr. Veith's commitment can be best characterized as aggressive, persistent, and cre-

ative based on and encouraged by the constantly improving results about which we have just heard.

However I feel compelled to suggest that the title should be changed to 'Changing Management Patterns and Strategies in the Treatment of Limb-threatening Ischemia, Due to Atherosclerosis.'

I say that because I don't believe the occlusive patterns have changed, but our perception of them has, and our confidence in carrying bypasses to evermore distal arteries has steadily increased.

Our own experience in Albany, reported to this society more than 2 years ago, supports this aggressive confidence and is reflected in an even greater proportion of bypasses to the tibial level, representing more than 50% of the 2000-plus arterial reconstructions for limb salvage in the last 10 years, or in the context of infrainguinal bypasses, two tibials for each femoral-popliteal, as in contrast to the one-to-one ratio in this report.

Although we may disagree on methodology, there is complete agreement that the commitment of the surgical team is one of the most important factors in producing optimum results, for it is a tedious, time-consuming, and often frustrating effort.

I have several questions that have already been addressed, but one that struck me was the high incidence or number of revisions, constituting more than one third of the patients operated on, with 85% of these reoperations in the infrainguinal group. Does this reflect the frequent use of prosthetic material? That is, 40% in the femoral-popliteal and 16% in the femoral-tibial level.

DR. NORMAN HERTZER (Cleveland, Ohio): Lower extremity revascularization undoubtedly is the most common type of vascular surgery performed throughout the world, and many of the technical innovations that we now take almost for granted were introduced in the Bronx by

these same authors. The fact that their manuscript does not contain any late patency rates will be disappointing to some and perhaps refreshing to others, but there may be many lessons learned from a review of nearly 4500 procedures in more than 2800 patients.

I would like to focus on just two of them.

Since 1974 some form of extra-anatomic bypass was used for 515 (71%) of the 724 patients who required inflow operations for aortoiliac occlusive disease in this series. Only 209 (29%) received direct aortic reconstruction, a figure that would seem rather low in my own center and perhaps elsewhere as well.

We generally restrict the use of subcutaneous grafts to patients who have compelling risk factors or surgically hostile abdomens and, for whatever reason, who are also inappropriate candidates for the retroperitoneal approach to the aorta through the left flank.

What are the indications used by the authors for extra-anatomic bypasses in the treatment of aortoiliac occlusive disease?

My second question addresses what I consider to be one of the most important issues concerning lower-extremity revascularization today. In the presence of usable saphenous vein, can below-knee prosthetic grafting finally be considered unacceptable?

Although the content of their manuscript is otherwise encyclopedic, the Montefiore group has not touched on this critical topic. It is too important, however, to ignore.

The surgeon who, as a thoughtless matter of expediency, constructs a prosthetic graft to the distal popliteal or tibial arteries is *wrong*. Do the authors agree?

**DR. ANTHONY WHITEMORE (Boston, Massachusetts):** The resurrection of some 2500 limbs is a significant achievement and it testifies to the ongoing very aggressive commitment to the management of peripheral vascular disease.

I use the 'management' advisedly because our armamentarium has become extraordinarily complex. We routinely perform more distal and innovative procedures amid a burgeoning array of endovascular instruments that are being aggressively marketed, partially developed, and less intelligently applied.

I am concerned, however, that the truly important principles that underlie the favorable trends that Dr. Veith has expressed in the manuscript may be obscured in the descriptive rhetoric presented in the absence of hard data, which really testifies to the efficacy of specific interventions that he has addressed.

Two such principles deserve emphasis, and prompt my two questions. First it is clear that we can reconstruct distal tibial peroneal vessels with a variety of techniques. Autogenous vein, whether it is reversed or *in situ*, provides a 75% to 80% 5-year patency rate when carried to the inframalleolar level. Such is not the case with PTFE, however, as Dr. Hertzner noted, which both in Dr. Veith's experience and in ours, provides a quite unacceptable 12% 5-year patency rate. I'll concede, however, that there may be circumstances in which PTFE carried to the infrapopliteal level might be appropriate; I have difficulty bringing them to mind, however. I would ask the authors to clarify those circumstances in which an infrapopliteal graft is indicated.

The second important principle that finally emerged from some data we produced in 1981 demonstrated the fact that secondary intervention is worthwhile for failed vein grafts inasmuch as we can achieve sustained a 50% patency rate in limb salvage following secondary or even tertiary intervention.

An unexpected observation at that time, however, was the dramatic discrepancy that appeared between grafts that were identified as failing to thrombosis and those that were intervened after thrombosis. Grafts identified before total occlusion yield an 80% 5-year patency rate in stark contrast to the thrombosed grafts, which required initial catheter thrombectomy. The same secondary procedure yielded a miserable 20% patency rate.

Despite the adoption of several graft surveillance techniques, patients still arrive at our doorstep with occlusive grafts, and how best to manage them remains highly controversial. Would the authors reveal their thoughts regarding the optimal management of totally thrombosed primary reconstruction?

**PROFESSOR ROGER GREENHALGH (London, England):** This paper represents the struggle during the last 15 years of a development of the methods that are now being taught by vascular surgeons. I pick on just one part of this.

Using contemporary methods, the total amputation rate has decreased in these authors' records from 49% to 14%, and during that period of time other authors without vascular subspecialty training have reported a 77% midhigh amputation rate for similar patients with critical ischemia. Dr. Veith and his colleagues did not note whether their amputation was below knee or above knee.

These excellent limb salvage results reported here have occurred despite the increasing and aging population nationally and they are reproducible in other centers; for example President Mannick's and our laboratory in London have had limb salvage rates in this range, so they can be reproduced.

But a word of caution is surely appropriate. I note the need to determine a well-defined place for primary amputation. Because of this decrease in amputation rate from 49% to 14% during the years described by the authors, does this mean that expert vascular training today leads to a lower amputation rate in some parts of the community where these surgeons are found and higher amputation rate where nonspecialists manage the patient. The definitive prospective trial has not yet taken place, and we must regard the story as only partially told.

**DR. JAMES A. DEWEESE (Rochester, New York):** I do note that in the last 5 years Dr. Veith found that PTA alone had increased his ability to manage many of these patients. I also know that more recently he has been involved with laser and laser-assisted balloon angioplasty as well as the other types, and I wondered whether he has found that laser technology has been helpful in his balloon angioplasty experience.

**DR. FRANK J. VEITH (Closing discussion):** With regard to Dr. Towne's question on sequential bypasses, we use them primarily in patients who have isolated popliteal artery segments and some defect in their vein—a not uncommon finding. The lower half of the vein and the part around the knee is frequently of poor quality in our experience, and in those cases we do a sequential bypass to the popliteal artery using a prosthetic and a vein bypass to the distal artery, particularly when the foot is extremely gangrenous and ischemic. We think that patients with severe ischemia need the straight-line blood flow to the foot for it to heal. Sometimes the distal vein will close; sometimes the proximal prosthetic will close. Some of these patients then need a secondary procedure to maintain their circulation and save the foot.

Diabetics comprise from 60% to 65% of our patients. We did not analyze it specifically in this paper, although we have in the past.

We have tried very hard over the years, using measurements of outflow resistance and other criteria, to identify a group of patients in whom we can do a primary amputation because it is not worth trying to save the foot. However we failed rather miserably in this effort. Every time we come up with a possible criterion, we find that there are exceptions to it and the patient will persuade us to try to save the leg, and we find that our procedure works. Even with high outflow resistance measurements, which we described several years ago, some patients have had very short bypass grafts to very high resistance outflow tracts and have had long-term patency. Some of the examples I showed were in this category.

When is enough, enough? That is difficult to determine. Many of the patients with multiple operations have had as many as 15 operations during a period of 18 years. However these patients do not have all the operations at one time. They will come back several times with a problem during 8 to 15 years, and each time they will have another procedure to fix the problem. Many of these patients maintain both of their limbs in a functional state. One has to see some of these patients to believe how well they do. We, therefore, think we have not been able to define what *enough* is, but we do continue to look at this question.

With regard to Dr. Leather's kind comments, we agree completely that the disease is not changing. It is merely our perception and recognition of the disease that is changing. I think we just did not know what the disease was in the early years, and certainly better arteriography which

you and we have, has allowed us to recognize the very distal disease, which is quite common and also quite treatable.

There is one point I did not mention. We believe the *in situ* graft may be better in certain circumstances, particularly when the vein is long and has a small diameter. However, we are performing a randomized study to prove this.

The next question concerned revision operations during many years. Again it gets to the same point that Dr. Towne mentioned: When is enough, enough? Many of these multiple operations have been used over periods of a decade or more and in those situations we believe that they are very worthwhile.

We also think that, although in the beginning some of our reoperations were due to usage of the PTFE grafts, more and more we are seeing that reoperations are required because of progressive atherosclerosis. The latter failures in particular are not due to graft failures, but to atherosclerotic disease progression.

Dr. Hertzler, there certainly are late patency statistics that we did not put in this paper. We have most of these figures, but enough is enough, and time and space constraints kept us from including some of them. We think that the bottom line from the patient's perspective was limb salvage and that was what we were trying to take a hard look at to determine if our efforts were worthwhile.

What are the indications for extra-anatomic bypass? We don't like axillofemoral bypasses either. We think they are poor operations, and we use them probably in the same situations that you do when patients are so sick that they could not tolerate a hair cut, or when they have a previously violated or infected abdomen. Even though the axillofemoral bypass is not a good procedure, it does get us out of certain very difficult situations, and a fair percentage of them remain patent for more than 5 years.

With regard to the many points about the PTFE grafts below the knee and to small vessels, that is infrapopliteal bypasses, we still think that in patients who do not have veins that can be used as a bypass graft, PTFE grafts to the popliteal artery below the knee are worthwhile. When one has to do a PTFE graft to an infrapopliteal artery, the mid-term and late

patency and limb salvage rates are worse, but, in our opinion, they are often still worthwhile.

Dr. Whittemore, you also mentioned the question of small-vessel (infrapopliteal) PTFE grafts. We do not do them in patients with available vein, but we do have a fair number of patients who we characterize as 'What would they do in Portland, Oregon, or what would they do in Boston' patients. These patients truly do not have any usable veins. In such patients we still perform PTFE infrapopliteal grafts. Limb salvage has been achieved in many of these patients for several years, and some have patent PTFE bypasses to crural arteries 4 to 5 years after operation.

We agree completely with the point made about failing grafts. It is much better to detect them before they thrombose. If one reintervenes before thrombosis occurs, much higher extended patency intervals are obtained. We still use PTA for short vein graft stenoses, although there is some difference of opinion about the value of this reintervention.

What do we do for a totally thrombosed graft? We now believe the best thing to do is a totally new graft using virgin arteries. Sometimes in a patient with a groin that has been dissected many times, we will thrombectomize an old PTFE graft from below and use its proximal portion for the origin of a new distal bypass. However that is not our preferred procedure. A new graft in a new field is our preference if a patient with a failed graft requires a secondary procedure to save his or her limb.

Professor Greenhalgh, I thank you for your remarks. We certainly try to do below-knee amputations even after multiple failed bypasses. Between 80% and 90% of these attempts succeed.

With regard to Dr. DeWeese's comments, the laser has not made a major impact in our practice pattern. When we analyzed the last 600 cases that presented with limb-threatening ischemia, there were only 11 suitable for the laser. That is, they had a short (<10 cm) occlusion and we could not do a standard balloon angioplasty. Thus I believe that the laser is useful in dealing with a different disease pattern or stage than that which produces threatened limbs. The laser procedures deal mainly with patients with simple lesions, and such lesions rarely produce a threat to the limb.