femoral system, would be anticipated to remain patent. In addition, the probability of a good long-term result should be enhanced by the use of a vein graft. The superior intimal characteristics, the lack of problems associated with kinking, and the lesser tendency to infection and extrusion from inguino-femoral sites, make its use preferable to a vascular prosthesis.

We believe there is justification for more frequent use of the femoro-femoral bypass in patients who have a good iliac and common femoral inflow. In such patients, it would seem reasonable to employ this bypass and avoid the usual stressing operation, the blood transfusions, and the increased risk of complications associated with aorto-femoral reconstruction.

Conclusions

1. The femoro-femoral bypass graft is a well-tolerated operative procedure which can be performed on patients in poor physical condition.
2. Two of eight patients undergoing bypass procedure developed femoro-femoral steal syndromes which produced intolerable rest pain in the donor limbs.
3. A review of factors associated with the steal syndromes and studies with a hemodynamic model have shown that iliac stenosis is the most important factor predisposing to a steal syndrome. The adverse effects of iliac stenosis may be aggravated by a greater peripheral resistance in the vasculature of the donor limb than is present in the recipient limb.
4. We believe a wider use of the femoro-femoral bypass is justified.

References


Discussion

Dr. Jesse E. Thompson (Dallas) discussing Paper No. 38: I have enjoyed Dr. Edwards’ paper very much, and I am in agreement with the principles which he has enunciated, especially that the use of the simpler cervical, extrathoracic operation should be preferred whenever possible to the more extensive intrathoracic maneuvers.

I would like to show you a single case to indicate how one can manage fairly simply a rather complex situation in a poor-risk individual. A 63-year-old man with a history of myocardial infarction complained of blackouts and dizzy spells and recurrent blindness in the right eye. He also became lightheaded upon extension of his neck. He was unable to walk more than half a block because of claudication.

He was found to have harsh bruits over his subclavian, carotid and innominate arteries. Retrograde x-rays showed a very tight stenosis in the innominate artery, 85 per cent stenosis at the right carotid bifurcation and total occlusion of the left internal carotid. Both vertebrals were patent. The left subclavian artery was patent, and on serial x-rays he had a left-to-right vertebral-subclavian steal.

(Slide) It was decided to do nothing to the left total carotid, but to revascularize the innominate, with a bypass graft from the left subclavian. The slide shows the type of procedure which was carried out. An 8 mm. Dacron tube was anastomosed to the left subclavian, brought across the neck, and anastomosed to the right subclavian artery.

Following this, at the same operation, a right carotid endarterectomy was done.

(Slide) Thus all of the procedures were done in the neck, and provided revascularization of the right carotid, right vertebral, and right subclavian. He obtained immediate relief of all his cerebrovascular symptoms, with no untoward effects or steal syndromes.

At a later date he returned for an aorto-femoral bypass to allow him to walk and to work.

There are many different variations of this bypass procedure, depending upon the lesions in the individual patient. I have no experience with the side-to-side carotid-subclavian anastomosis which Dr. Edwards has described, but this may
well be simpler than a graft. We have done, however, vertebral-subclavian side-to-side anastomosis when the vertebral has been stenosed and has been tortuous, and allowed this procedure to be done.

In closing, I would like to ask Dr. Edwards a question: How many patients with vertebro-basilar symptoms has he been so relieved of their symptoms by carotid endarterectomy alone, without the necessity of a vertebral or subclavian operation?

**Dr. Daniel Munn (Jacksonville)** discussing Paper No. 38: First of all I would like to congratulate the authors on their fine presentation. And secondly, I would like to share with you my experience with an unusual case of subclavian steal syndrome which I think point out some of the problems that one may encounter in the treatment of this particular condition.

In the interest of time, I want to show only one slide. (Slide) This slide depicts, with the exception of the subclavian steal, the arteriographic findings on a 55-year-old woman who had the clinical symptoms of right subclavian steal syndrome.

The patient complained of periodic attacks of vertigo and syncope and a tired sensation in the right upper extremity associated with physical exertion. Carotid pulses were present bilaterally, though the right carotid pulse, as you can imagine, was markedly diminished. There was a systolic bruit over the left bifurcation, the left supraclavicular area, and the base of the right neck. A faint right radial pulse was present, while the left radial pulse seemed to be of quite good quality.

Blood pressure was recorded as 104 diastolic in the right arm and 160/98 in the left arm.

The arteriograms in this patient was aortic arch study performed by the Sedlinger technic, using the right femoral artery. In addition to that, a right carotid puncture was performed in order to permit better visualization of the right carotid bifurcation. Fortunately, this was possible, since there was a faint pulse present in this particular vessel.

The findings from the arteriograms, as you see on the slide, are those of complete occlusion of the innominate artery, significant narrowing of the proximal right internal carotid artery, complete occlusion of the left external carotid artery, slight narrowing of the left proximal internal carotid artery, and narrowing of the left subclavian artery proximal to the vertebral artery.

The patient was treated by operation approximately four years ago. An 8 mm. Dacron graft was inserted, end to side to the ascending aorta, and the other end of the graft attached end to end to the distal innominate artery. It was necessary to perform an endarterectomy on the distal innominate artery in order to carry out this procedure. A right carotid endarterectomy was also performed at the same time.

I did not appreciate the significance of the narrowing in the left subclavian artery, since following the corrective procedure on the right side, blood pressures were measured at the time of operation and appeared to be essentially the same.

Following operation, the patient was asymptomatic, and the blood pressures were again essentially the same approximately one month after operation. However, about 6 months after operation the patient developed recurrent symptoms consisting of periodic attacks of vertigo, syncope, and this time a tying sensation in the left arm associated with exercise.

She was rehospitalized, and an aortic apex study performed which showed a less subclavian steal. She was subsequently treated by left thoracotomy, with correction of the subclavian artery stenosis by an endarterectomy.

The patient is now approximately 4 years postoperative, and has had no further symptoms. Her last blood pressure determinations were as follows: 120/70 in the right arm, 104/70 in the left arm.

**Dr. Garland D. Perdue (Atlanta)** discussing Paper No. 38: I think the excessive cuteness of the term "subclavian steal" has directed, perhaps, too much attention to it as an isolated lesion. I would like to reemphasize what he has said about considering it in the context of its effect on the total cerebral flow.

When it exists as an isolated lesion, it may be in the totally asymptomatic patient. The patient may be symptomatic: distressed, annoyed, or even disabled. He does not, however, develop cerebral infarction as a result of this isolated lesion, and to borrow from Gilbert and Sullivan, let the punishment fit the crime. An operation which involves significant risk of mortality would be unacceptable in correction of this lesion.

**Dr. Jere W. Lord, Jr. (New York)** discussing Paper No. 39: Just a word about Dr. Trimble—I would like to pay tribute to him. For those of you who may not remember, 25 years ago he was the first to publish the usefulness of a surgical attack on atherosclerotic lesions of the lower extremity.

I have had the opportunity of reading Dr. Trimble's and associates' paper, and would like first to compliment them on the excellent clinical results of 100 per cent patency, and also to comment upon the fact that their model is a most useful one and is one that will be applicable to other areas.

There are two or three points about which I would like to comment. The inflow from the iliac artery should be determined as being excellent not only by palpating a strong pulse. We have seen several instances where the iliac, the femoral, and the popliteal arteries may be severely stenotic causing partial interference with blood flow, but still have a good pulse beyond. All of these
patients should have careful angiographic studies to demonstrate a widely patent iliac artery.

In our experience with nineteen patients, there were five with prostheses for the femoro-femoral bypass and three closed after 18 and 20 months. We think it is much better, as the authors pointed out, to use the saphenous vein. In the last 2 years we have had the opportunity to use the cephalic vein, and have found this to be very helpful, and we would use the cephalic vein as a good substitute for the saphenous vein when the latter is not available.

Twelve vein grafts worked well and have been functioning satisfactorily. Two have closed, one because of progression of an atherosclerotic lesion of the opposite iliac artery, which had been the source of inflow. The other one closed and I would like to offer a word of warning. The patient was operated upon for marked ischemia of the left foot. A femoro-femoral bypass was functioning well 4 months later. Eight months later it had closed with recurrence of the ischemic process. He had entered another hospital and a hemorrhoidectomy had been performed under spinal anesthesia in the lithotomy position.

This is a point about which I think all patients must be warned strongly who have a femoro-femoral bypass. They must not have their thighs flexed when they are having a cystoscopic examination or a hemorrhoidectomy as it may shut off the vein graft permanently.

There is another word of warning. All people who have had this operation must let their gynecologist and urologist know, and future incisions in that area should be planned carefully.

DR. ROBERT B. SMITH (Atlanta) discussing Paper No. 39: I compliment Dr. Trimble and his coauthors on their contribution to our understanding of the steal syndrome as it relates to the lower extremities by this ingenious hemodynamic model.

Our experience is approximately the same in number of patients. We feel we have been able to salvage some limbs in otherwise very poor risk patients by femoro-femoral bypass. We have not recognized any steal syndrome in these patients, and I suppose this is due to the fact that we have only chosen patients for this operation if they had a strong femoral pulse on the donor side.

Dr. Trimble suggested that there might be wider application of the femoro-femoral bypass. I think we would prefer to reserve that operation for poor risk patients, until we see the long-term patency.

I too have a word of caution, in addition to the two experiences described by Dr. Lord. I am aware of one patient who fell asleep on the beach face down who had had a femoro-femoral bypass, and suffered occlusion of his graft by pressure against the firm sand. It is important to warn these patients not only about lithotomy position and subsequent operations, but also to sleep face up.

DR. ROBERT MASON (Baltimore) discussing Paper No. 39: I'd like to comment briefly on the paper by Dr. Trimble and his associates.

I think that the findings that they showed to you in the two cases that had steal were also well illustrated a number of years ago by another member of this Association, Dr. Dean Warren, in a fine study of arteriograms. The points that he made at that time were that, first of all, atherosclerosis is a generalized disease, and secondly, that if you have a proximal stenosis, it tends to protect the distal runoff somewhat from further ravages of the disease.

The direct point of this, then, is that if you have a patient that you are intending to do a femor-femoral bypass on for one occluded iliac artery, it would probably be an error to assume that the other iliac artery is entirely normal. Similarly if the one occluded iliac artery is stenosed, the runoff from that side is probably better than that from the unoccluded side.

I had the privilege of reading this paper, and I would like to compliment Dr. Stonesifer on his very ingenious hydraulic arrangement. I think it's a compliment to our times that this was done as nicely as it was. Ten years ago this probably would have taken 30 dogs and two flowmeters.

DR. HUGH BEEBE (Baltimore) discussing Paper No. 39: I had the privilege of reviewing Dr. Trimble's and Dr. Stonesifer's excellent paper, and would like to add a word of caution that has been mentioned before by Dr. Szilyagi on a number of occasions.

The translumbar arteriogram is frequently misleading, in that it does not show us that the aortoiliac segment is as severely diseased, as we find it to be at operation. For some time now we have routinely been measuring mean pressures in the aorta and the common femoral arteries at the time of operation in patients undergoing aortofemoral bypass graft, and have frequently noted that the pressure gradient was far greater than the disease appeared to be by arteriography.

So I think the point that Dr. Trimble has made, that feeling the femoral pulse, feeling the quality of the pulse, listening carefully for a bruit, and perhaps even measuring pressures with a small Moss Manometer that can be gas autoclaved and kept sterile for use on the operating table, is an important adjunct to the treatment of this type of patient. Thank you.

DR. WILLIAM H. EDWARDS (Closing discussion of Paper No. 38): I would also like to compliment Dr. Stonesifer on his excellent experimental setup.

In answer to Dr. Thompson's question, I will have to come at it backwards. I cannot specifically say how many patients we have evaluated with vertebro-basilar symptoms were relieved by carotid operation alone. I think through the years we have all tended to approach the carotid artery as
our primary operation because of both ease of
diagnosis and because of ease of operation.

(Slide) I would like to show two slides of a
right lateral carotid arteriogram in a 58-year-old
man who complained of weakness of the left arm,
dizziness and ataxia. The carotid endarterectomy
was performed. The patient did well. However,
one year later he was reevaluated for persistent
ataxia and dizziness. At that time we had
bilateral retrograde brachial arteriograms, which
were not performed at the first hospitalization.
There is minimal stenosis in the right vertebral
artery. There is rather marked stenosis in the left
vertebral artery.

A vertebral endarterectomy was performed,
and this patient was relieved of his vertebro-
basilar symptoms. We had eight additional pa-
tients who had carotid involvement and in whom
carotid endarterectomy was performed.

The comments that Dr. Perdue made, I think,
reiterate our feeling. I do not think we see
asymptomatic patients with proximal subclavian
disease. I think we see the symptomatic patients.
This is the reason that it is our feeling that the
demonstration of a steal in the vertebral artery is
not the essential point.

DR. GEARY L. STONESIFER, JR. (Closing dis-
cussion of Paper No. 39): First I would like to
reply to Dr. Lord and Dr. Beebe, in saying that
we do use arteriographic studies routinely in these
patients. They are all studied at least with an
anteroposterior view, and many with a lateral
view also. Occult stenotic disease of the iliac
artery we regard as very important, obviously,
particularly after our studies. Blood pressure
measurements in the extremities are also important,
and the ultrasonic flowmeter has made this easier
in certain cases.

We are aware, Dr. Mason, of Dr. Warren's
work on this, and this is included in our references.

I would like to close by showing a brief
movie of our hemodynamic model. you might call
it—the "low-grant" hemodynamic model, done
with very few funds.

(Film) Here you see the aorta. Blood was used
for this. Analogs have been made with electrical
models, but we understand the flow of blood better.

This is polyethylene tubing and rubber tubing.
Now, you will be seeing the two needles at the
very bottom, and this is flow with no iliac
stenosis above. The lower limbs are widely patent.
These are 18 needles, which allow 58 ml. of flow
per minute. You see the flow here. It was quite
rapid flow.

Now we open the graft, and you will see the
consequences of opening the graft. The two flows
now, from the recipient limb and from the donor
limb, are equal.

Now we introduce a high peripheral resistance,
which would correspond to occlusive vascular
disease in the donor limb. Here you see the flow.
When the graft is opened, and a large flow comes
down the recipient side, the donor flow continues
the same. If there is enough inflow, it seems to
perfuse both limbs adequately. The relative per-
ipheral resistance of the two does not matter.

We now add the most important factor, the
iliac stenosis. Again we will measure the donor
side and the recipient side.

First we will see the stenosis alone. This
produced approximately a 40 per cent reduction
in flow, just from the stenosis above. When you
open the graft, you can see what happens to both
limbs. Neither is perfused nearly so well as before.
Forty-three per cent of the blood that was going
here is now being shifted to the recipient side
(indicating) and neither side is perfused well.

The final and worst situation is a combination
of an iliac stenosis and increased peripheral
resistance on the donor side. The control flow is
16 ml. per minute. We will now open the graft,
and look what happens to this. The donor flow
is reduced by 71 per cent.