The surgical treatment of coronary artery disease has a long history. The earliest efforts were directed to relief of angina by cervical sympathectomy which did not increase myocardial blood flow and to various indirect means such as pericardial poudrage to facilitate vascular adhesions from adjacent structures.

Although postmortem injection studies with radiopaque material such as Schlesinger mass gave important information as to the extent of coronary atherosclerosis in autopsy cases, objective preoperative delineation of coronary artery disease was not adequate until Sones and colleagues developed the technique of selective coronary arteriography. This technique demonstrated that coronary atherosclerosis is not greatly different from atherosclerosis in other areas of the body, i.e., the major involvement is in proximal vessels and at bifurcations. The distal vessels are usually patent and either uninvolved with atherosclerotic changes or minimally involved. Surgeons could now plan and develop operations to increase the blood supply to areas of demonstrated insufficiency. They also have an effective tool to document results.

**Indirect Approaches**

Sones' demonstration of long-term patency of internal mammary implants...
with effective revascularization via collateralized coronary vessels stimulated Effler and others to re-evaluate and establish on a firm objective basis the effectiveness of internal mammary artery implantation. This was accomplished for single anterior implants and later for bilateral anterior and posterior internal mammary artery implants.

Although these indirect approaches were shown to increase total myocardial blood flow, the maximum effect is not obtained for from nine to twelve months following operation. It takes considerable time for the implant to form effective anastomotic channels with the pre-existing coronary system. In addition indirect methods of revascularization may not be effective in carrying a large amount of extra coronary blood to the myocardium.

Direct Approaches

Further efforts were made to improve direct surgical procedures. Longmire et al. had begun such direct coronary procedures before the advent of selective coronary arteriography and during the early phases of cardiopulmonary bypass. Effler's group with their vast experience in coronary arteriography and coronary surgery made two significant contributions to direct coronary artery surgery. One was the clarification of the balance of coronary circulation in patients with intractable angina. They demonstrated that in the living human with symptomatic coronary insufficiency, the right coronary artery is dominant, that it supplies a very significant amount of blood to the posterior left ventricle in 60% of the patients. They also developed a concept of endarterotomy and patch grafting as opposed to endarterectomy. In the former technique the intima is not disturbed and a stenotic vessel is opened by a longitudinal incision in the artery and widened by closing the artery with a gusset of vein or pericardium. This technique avoids the “snow plow” effect on collateral vessels, an effect which at times follows endarterectomy due to shearing off the intima of the small branches in the endarterectomized segment leading to their subsequent thrombosis. The endarterotomy technique, however, is limited in application to stenotic vessels only, not occluded ones, and to arteries where only a short segment is involved.

This endarterotomy and patch graft procedure was performed in a sizable
number of patients with lesions of a
dominant right coronary. The early
mortality was in the range of five per­
cent and the results encouraging. How­
ever, coronary arteriography performed
in the late postoperative period showed
that approximately 40% of cases had
restenosis or occlusion of the vessel.
This was thought to be due to platelet
and fibrin deposition in the roughened
sclerotic wall of the reconstructed ves­
sel and perhaps also to a contraction of
the pericardial onlay graft.

Our group 7, 8 had a similar inci­
dence of late stenosis and occlusion in
a much smaller series of right coronary
endarterotomy and patch graft proce­
dures. We also saw a larger number of
patients with complete obstruction of
the right coronary artery and subse­
sequently devised another procedure—
aortocoronary bypass. See Figure 1.

This technique has several advan­
tages over the endarterectomy alone,
and endarterotomy and patch grafting.
These are:

1) It can be used for occlusive as
well as stenotic lesions.

2) Long areas of stenosis are no
more difficult to manage than short
areas of stenosis.

3) Only a short segment of distal
right coronary artery need be isolated.

4) The distal anastomosis of the re­
versed saphenous vein bypass can be
made quickly on total cardiopulmonary
bypass.

5) The proximal anastomosis is es­
sentially a large vessel anastomosis to
a segment of the ascending aorta iso­
lated by a side-biting vascular clamp
and can be made after bypass has been
discontinued.

Patient Selection

Patients with significant intractable
angina usually of more than a year's
duration are candidates for a complete
evaluation of the coronary circulation.
In our unit, in addition to the routine
cardiac roentgenograms, electrocardio­
grams and blood studies, this involves
an exercise treadmill electrocardiogram
to demonstrate or document ischemic
changes during exercise, selective coro­
nary arteriography to confirm and docu­
mament the coronary pathology and coro­
nary anatomy, and a left ventriculogram
and right heart catheterization to study
cardiac hemodynamics.

Patients with severe stenosis (more
than 80% narrowing) or occlusion of
a dominant right coronary artery are
then candidates for a right aortocoro­
nary bypass. In most instances there is
an additional significant stenosis of the
left main, left anterior descending cor­
onary artery or the left circumflex cor­
onary artery. In these instances an in­
ternal mammary artery implantation is
frequently done at the same operation.

Operative Technique

As a median sternotomy incision is
being made to expose the heart, one of
the saphenous veins, usually the left, is
exposed and removed. Cannulation for
 cardiopulmonary bypass with two caval
cannulas and an aortic perfusion can­
 nula is accomplished. A left atrial or
left ventricular vent is inserted.

Mild hypothermia is employed to
quiet the heart action and to protect
the myocardium from ischemic dam­
age. The right coronary artery is iso­
lated and encircled with two heavy
braided silk sutures which are tightened
to occlude blood flow. A short longi­
tudinal arteriotomy is then made distal
to the obstruction and the reversed
saphenous vein draft sutured with an
oblique end-to-side technique. The oc­
cluding sutures around the coronary
artery are then removed and flow is re­
established through the right coronary
vessel.

A side-biting aortic clamp is then ap­
piled to the ascending aorta and the
proximal anastomosis is made during
the short period of rewarming, or fol­
lowing termination of cardiopulmonary
bypass if heart action is strong. See
Figure 2.

In cases where a concurrent internal
mammary implantation is planned the
artery is dissected from the chest wall
from its origin to the sixth intercostal
space and then detached and implanted
while the patient is still on the cardio­
pulmonary bypass.

Comments

Direct coronary artery surgery is com­ing of age. Early efforts of Long­
mire and others carried a high risk due
to the lack of precise pathological diag­
nosis and the early state of the art of
cardiopulmonary bypass.

Selective coronary arteriography per­
mits accurate pathological diagnosis
and a better understanding of anatomical
considerations. These factors permit
direct coronary artery surgery at a low
risk. The vessel most frequently ap­
proached by direct surgical techniques
now is a dominant right coronary ar­
tery. By opening this vessel, or prefer­
ably bypassing the obstructing lesion,
the posterior left ventricle can be effec­
tively revascularized. Also via collateral­
ars, coronary perfusion of the anterior
left ventricle may be improved by this
 technique.

We have now performed seven such
aortocoronary bypasses with no opera­
tive deaths. The clinical course has
been good in most patients. One pa­
tient with a postoperative coronary
arteriogram showed not only excellent
filling of the entire dominant right cor­
nary but also a significant contribution
of flow to the distal branches of the
anterior descending and left circumflex
coronary vessels. See Figure 3.

Aortocoronary bypass appears to be
an improvement over other forms of
direct coronary artery surgery. It is
probable that this procedure can be
extended to the left coronary as well.

References

coronary arteriography. Mod. Concepts.
2. Effler, D. B.; Sones, F. M.; Groves, L.
K.; and Suarez, E.: Myocardial re­
vascularization by Vineberg's internal
mammary artery implant. J. Thorac.
MacGregor, D.: Internal mammary im­
plantation (Vineberg operation) for cor­
onary heart disease: cineangiography
and long-term follow-up. Ann. Surg.,
and Kallius, A. A., Jr: Direct vision
endarterectomy for angina pectoris.
5. Effler, D. B.; Groves, L. K.; Suarez,
E. L.; and Favalaro, R. G.: Direct cor­
onary artery surgery with endarterec­
tomy and patch-graft reconstruction.
6. Favalaro, R. G.: Saphenous vein auto­
graft replacement of severe segmental
7. Kerth, W. J.: Discussion Dodenemo­
ico, M.; Suhmoh, A. A.; Berger, K. E.;
Wood, S. J.; and Sauvage, L. R.: Ex­
perimental coronary artery surgery: long­term follow-up bypass venous auto­
grafts, longitudinal arteriotomies, and
end-to-end anastomoses. J. Thorac.