

DISCUSSION

DR. DONALD BRIAN EFFLER (Cleveland): We have taken a little different philosophy and attitude about the need for revascularization surgery than the one expressed by Dr. Spencer and his colleagues. We believe that the man with the normal ventricle and with severe angina and threatening disease is probably more deserving of surgery than the man who has already had multiple insults to his ventricle. In other words, the normal ventricle that is now threatened has more at stake than does the one that has already had multiple infarcts with attendant impairment of function.

Since 1967, Dr. Sones and his colleagues have made a retrospective study of people who were considered ideal candidates for revascularization surgery; these patients had good ventricles, but had coronary disease described as single, double, and triple vessel in type. Their retrospective analysis of life expectancy follows this pattern: if they had single vessel disease, within five years 20% of them had died, within the same period of time those with double vessel disease suffered a 40–45% expected mortality, and the triple vessel disease patients faced a dismal 70% death expectancy within five years. All as a result of their coronary artery disease. This is certainly an unimpressive testimony for medical therapy because all of these patients were private patients and all were given the benefit of the best we had to offer from the standpoint of modern medical treatment.

Beginning in 1967, when René Favaloro did our first interposed saphenous vein graft, 4600 patients were operated upon with bypass graft techniques by the end of 1972. In the past year, there has been an additional group of 1573 patients—this is the 1973 record—and as mentioned by Dr. Spencer, the mortality rate with experience gets lower and lower. There were exactly 15 deaths in this 1973 group, giving us a mortality rate of slightly less than 1% overall. We believe this is important and necessary. In other words, the surgical treatment of coronary artery disease requires a “cheap operation,” cheap from the standpoint of risk to the patient.

It was already mentioned that the mammary-coronary anastomoses seemed to have tremendous promise, perhaps more than the saphenous vein grafts; and this appears to be correct. During 1973 there were 464 patients in the Cleveland Clinic series who were operated upon with mammary-coronary techniques; either mammary-to-coronary anastomosis alone or mammary-coronary anastomosis combined with a single vein graft. By good fortune, no patient died during this particular period, giving us a zero mortality rate. Another factor of importance is the low postoperative myocardial infarction rate which runs less than 4%.

Postoperative angiographic studies, as Frank Spencer has already pointed out, suggest a graft patency rate in the neighborhood of 80%. If you will look at our experience between 1967 and 1972, there were 1152 grafts restudied. In the year 1972, 1100 grafts were assessed by postoperative angiography. The overall patency rate is approximately 80% throughout both series. Actually, this is not a precisely correct figure, and it is probably conservative for two reasons. First of all, the patient most likely to be studied after surgery is the one who is not doing well; this will be the man who has had abrupt recurrence of his angina caused by primary-graft thrombosis. Secondly, many patients receive more grafts than they actually need for relief of symptoms; when a patient with triple vessel disease receives three grafts and obtains the desired result, even though one graft may have closed, it seems a bit silly to classify him as an “incomplete result” because of his postoperative arteriography. Arithmetically this individual has a 66.6% angiographic result even though he enjoys 100% clinical rehabilitation. If we look at the results in patients who undergo single vein graft surgery, the patency rate here is between 92–94%. Therefore, it will be statistically more significant to classify grafts as “primary” or “supporting” since the individual patency will have considerable variation in significance.

From the standpoint of relief of symptoms, as has already been alluded to, there is no question that revascularization surgery

by the bypass techniques is extremely successful. The retrospective study done by Shirey shows that the preoperative patients, the great majority of them, were Class II, III and IV. After surgery these patients were predominantly angina-free (Class I). The majority of them had no angina of any kind, nor could angina be induced on stress test; we think this is very significant.

After our initial experience, as results improved and enthusiasm escalated, there was a natural tendency to put in more grafts with individual operations; nevertheless, it would appear that we have tended to level off since 1970, and the graph shows 65% of patients receive double or triple grafts. It was suggested by Dr. Spencer that more people probably need more grafts; triple, quadruple, and so forth. We're not entirely sure that this is correct. Whereas the majority of patients operated upon by the Cleveland Clinic team have multiple grafts, the larger segment will have two; quadruple grafts, quintuple, and the like, seem to be less and less frequent.

Perhaps the most important factor relative to revascularization surgery is longevity. If we compare the Webster-Moberg series that describes the fate of patients with single, double, and triple vessel disease treated medically, it would appear that the patients who undergo revascularization surgery do appreciably better. Sheldon's analysis of postoperative survival rate in over one thousand patients in the Cleveland Clinic series suggests that the life expectancy curve parallels that of patients who suffer from single vessel disease. This has been interpreted by some cardiologists as an indication that there is no need for surgery in single vessel disease, but I do not think this is correct conclusion. In Sheldon's series of postoperative patients there was no correlation between success and failure of the operative result—only survival. It is reasonable to assume that somewhere in the neighborhood of 15% of these postoperative patients have primary graft occlusions. Therefore, it would be far more significant to contrast successful postoperative cases with the Webster-Moberg curves.

When the surgical team has been established and the operative procedure has been standardized and when all concerned arrive at a sensible system for selection and rejection of the candidate for revascularization surgery, then revascularization surgery will be performed with a hospital mortality rate of in the neighborhood of 1–2%. This standard of surgical performance has been achieved already in many community hospitals throughout the United States as well as major surgical centers. Dr. Spencer and his colleagues deserve commendation for this excellent report; as various teams gain experience, there seems to be less and less major differences of opinion. There seems little doubt today that the surgeon will continue to play a dominant role in the treatment of the patient who suffers from ischemic heart disease.

DR. DAVID C. SABISTON, JR. (Durham): It is remarkable to observe the consistency with which Dr. Spencer makes presentations of excellence, and I would like to commend him and his associates for this fine study. Moreover, when one reads the complete manuscript, it is impressive to note the additional data which further support the points which he has just made.

Most of those interested in myocardial revascularization agree that there are numerous problems which remain, and I should like to comment briefly about computer analysis and interpretation of some of the major points which Dr. Spencer raised this evening.

Recently, Dr. McNeer, working with the computer group, has completed a study of 781 consecutive patients seen at Duke with angina pectoris. In each instance, the diagnosis was confirmed by coronary arteriography and an obstructing lesion of 70% or more of one of the major coronary arteries was demonstrated. All patients were classified with the entry of some 89 different parameters into the computer. These entries varied from clinical manifestations at one end of the spectrum to specific figures of cardiac performance at the other.

Of the 781 patients studied, 402 were treated medically and 379 by surgery. At the end of the second year, the survival rate for all patients in the study was slightly higher in the surgically treated group, but it is impressive that twice as many of the

survivors in the surgical group are now completely free of pain.

Moreover, in a group of 169 equally matched patients with three vessel disease and evidence of angiocardigraphic abnormality of left ventricular contraction, approximately half of these patients were managed medically and half surgically. At the end of the first two years, 76% of the medically treated group had survived, whereas in the surgically managed group the survival was 90%.

With the passage of more time, it is likely that the surgical group will show an increasingly favorable survival, although this yet remains to be seen. However, it is already apparent that in certain groups these computerized data can be identified preoperatively and aid in the selection of patients in whom surgery is apt to be the most beneficial. In addition, this approach will identify those in whom it can be statistically predicted that life expectancy will be increased.

DR. JOHN L. OCHSNER (New Orleans): I rise to give some support to the internal mammary as the principal conduit today.

(Slide) With proper preparation of the internal mammary, one can achieve as much as 300 cc of free flow per minute. These are our postoperative angiograms, all of these over a year. As you can see, in the vein bypass 29% either occluded or narrowed postoperatively.

By contrast, of the 88 patients who had an internal mammary and have been followed and studied, only one is occluded, and it was occluded during the study by a catheter that dissected the internal mammary, and two are narrowed; both technical errors.

The internal mammary can be used, as Dr. Spencer showed, not only to the anterior descending (slide), but it can be used to the right; (slide) it can be used to the circumflex; (slide) and it can be used as a free graft to any vessel on the myocardial surface.

I think in this day and time, with our present-day knowledge, the principal graft should be the internal mammary.

DR. GEORGE COOPER MORRIS, JR. (Houston): Our experience has been essentially similar in most respects (slide) to Dr. Spencer's. These particular statistics are my own, and you will see that some 94% of patients have at least one open graft and graft occlusion rate was 12%. However, I think the overall patency rate is probably better than these statistics would reveal. In the last three years only those patients who are essentially squeaky wheels, as it were, were studied, together with some of the patients who fall into interesting groups such as congestive heart failure.

(Slide) Frank Spencer has been interested in the bad ventricle, and has talked about this problem for several years. Our experience has been somewhat different in terms of the operability and the long-term results. The reduction in end diastolic pressure has not been remarkable. In some it has been good; in others it has been minimal. But clinical results have been outstanding.

Here you see some improvement in the ventriculogram postoperatively, but the fall in diastolic pressure has been modest.

(Slide) Here is a patient who was essentially bedfast before operation, and his end diastolic pressure has not fallen after operation; and yet for three years he has never missed a day's work. This man's congestive heart failure was documented at Dr. Effler's clinic.

(Slide) Here is another example of single vessel disease with what appears to be an aneurysm, but was simply a poor apex. Even without resection of any myocardium, you can see the improvement with a single bypass.

Formulas and computers have been of little help to me in trying to ascertain which patients with very bad ventricles will come off pump. The best guideline to me has been somewhat simplistic, but has worked very well. That is visualization of total occlusions, particularly of a major left coronary artery, which will accept a distal bypass. Patients with diffuse disease, with a bad ventricle, without total occlusion of main coronary arteries, will very likely do poorly.

(Slide) One of the most striking findings has been work status in patients with bad ventricles and preoperative congestive failure compared to the overall group of bypass patients. It is difficult

to argue with return to work status, and you can see that there is not a great deal of difference between the two groups.

Similar to Frank Spencer's experience, the attrition rate yearly in terms of death has been essentially the same in these patients with the bad ventricles and patients with angina alone; and that has been 2% per year, exactly the same.

The hospital mortality in those with congestive failure preoperatively has been 8%, compared to 3% for the usual group, and 0.7% for those with single vessel disease and good ventricles.

DR. JACK A. CANNON (Phoenix): In the last few years, the surgical potential in the direct arterial surgical attack on obliterative atherosclerosis of the coronary arteries has been "suddenly" discovered. Dr. Spencer has mentioned in his paper that he envisions the "curative" surgical correction of these atherosclerotic lesions of the coronary arteries may be attainable. I note that after *palliative* surgery to the arterial tree at *any* level, subsequent atherosclerotic involvement has been recorded in *any* type of reconstructive endeavor. This involvement includes endarterectomy, homologous arterial bypass, Dacron bypass, and autologous vein bypass. I ask Dr. Spencer, how does he envision the possibility of a curative result from a palliative surgical endeavor?

It has been my experience in the attempted palliation of coronary obliterative atherosclerosis that lesions of the left coronary tree are likely to be diffuse and to involve vessels of smaller caliber than when the right main coronary is involved. I note also that reconstructive direct surgical endeavor directed to the left anterior descending coronary and branches of the left circumflex coronaries involve vessels which are smaller in diameter and more diffusely involved. I note that the re-occlusion rate of reconstructions of the left anterior descending coronary and the left circumflex artery seem to be higher than such reconstructions to the right main coronary. I note also that long-term results seem to be more affected by the excellence of intercoronary collateral in the individual case than by the nature of the technical intervention. I am unable, in evaluating any data so far—especially that presented by Dr. Spencer—to recognize *any* advantage of the use of internal mammary artery versus the autologous saphenous vein as implied by Dr. Spencer in his analysis of his series.

I suggest that his improved results may be more related to the improved technique afforded by the use of the operating microscope and even the steady-handed, near-sighted young surgeon in performing these meticulous anastomoses, rather than some mysterious quality of the difficulty harvested, tenuously and uncertainly prepared, frequently damaged internal mammary artery. I ask Professor Spencer to speak of these considerations.

I note that in this excellent paper, Dr. Spencer makes no mention of electromagnetic flow meter measurements of the results of reconstructive coronary arterial surgery. It is true that measurements of flow through the internal mammary artery are difficult since the diameter of the vessel to be measured is usually less than the 2–3 mm minimal diameter of the smallest flow probe accurately available. I note that I am extremely unhappy with a post-reconstruction flow rate of less than 50 cc/min. This rate is rarely obtained, even when measurable, with internal mammary artery reconstruction. Left-sided autologous vein reconstructions are not surviving the test of time. Time has not yet proven the superiority of internal mammary artery reconstructions. Would Dr. Spencer please speak of these considerations?

Finally, since there can really be no question that coronary reconstruction for atherosclerosis is palliative in nature, I ask: Should we seriously be considering surgical attack against the cause of the disease. Earlier in this program, Dr. Varco and his group reported on the effective, obligatory, non-escape lowering of serum cholesterol and serum triglycerides in patients with symptomatic atherosclerotic lesions. His series involved patients with abnormally elevated serum cholesterol and triglycerides. Human races with no incidence of atherosclerotic disease show serum cholesterol levels in the 100–150 range with serum triglycerides of a correspondingly reduced level. Lethal atherosclerosis is epidemic in western "civilized" man whose "normal" serum cholesterol is considered to be 180–300 mgm%. I ask Dr. Spencer:

Should ileal shunt for the prevention of this disease in patients with potentially lethal coronary atherosclerosis be considered as implied by the results of Dr. Varco and his group?

DR. FRANK C. SPENCER (Closing discussion): I think the many contributions by Dr. Effler and his group at the Cleveland Clinic should be emphasized. They have clearly demonstrated the wide applicability of the operation and the very low mortality. Before 1966 any operation on the left coronary artery had a mortality exceeding 50%. That was only eight years ago; so the progress in achieving the present low mortality is great.

Dr. Effler's concept of a double bypass for triple vessel disease is certainly plausible. Theoretically, after two grafts have been inserted for triple vessel disease, the patient may have the subsequent prognosis of someone with single vessel disease, provided both grafts remain patent. It seems reasonable that it would be unwise to prolong an operation unduly to insert an additional graft, though in the majority of our patients all diseased arteries have been bypassed.

I feel certain that much is yet to be learned about the cardiac physiology and intercoronary blood flow during bypass, while the heart is decompressed, the ventricle fibrillating, and intramural tension considerably altered. All of these factors may influence collateral blood flow. One reason for the very low mortality reported by Dr. Effler's group may be the relatively short bypass time with most patients.

Regarding Dr. Sabiston's comments, I would like to emphasize the great value of computer analysis for this disease with so many variables. In their recent publications, a computer analysis of over 80 variables clearly defined a sub-group of patients with vessel disease and an abnormal ventricle, with a two-year mortality near 25-30% with nonoperative treatment. The analysis clearly demonstrated that unless sub-groups were separated, the overall influence of a method of therapy was difficult to determine.

I agree completely with Dr. Ochsner's enthusiasm and emphasis on the use of arterial grafts, especially the internal mammary artery. I consider the mammary probably an ideal graft, except it is difficult and tedious to mobilize in some patients because of its size and friability. However, all considerations about the ideal graft remain hypothetical until data demonstrate at least 80% patency after five years, comparable to data obtained with bypass grafts for femoral-popliteal disease.

The internal mammary artery is of particular interest for the question of bypass grafting for isolated occlusion of the anterior descending coronary artery, a group often not operated upon because of the favorable prognosis. From the surgical standpoint, however, the operative risk approaches zero, the relief of symp-

toms is dramatic, and the patency shown by several groups over a year after operation with the internal mammary artery is over 95%. Hence, the operation very closely approaches "a cure." We have had no failures with single bypass grafts in our patients with disease limited to the anterior descending coronary in the past four years.

Dr. Morris emphasizes the difficult problem of the patient with substantial injury of the left ventricle before operation. It seems that the normal human heart has a reserve of about 30% of the left ventricular muscle mass. Cardiac function remains fairly good until this limit is exceeded, but when loss of muscle mass approaches 30-40%, congestive failure appears, becoming intractable with more extensive injury. Hence, both the hazard of operation and the likelihood of benefit in patients with extensive injury of the left ventricle is increased. On the other hand, the patient has a very small safety margin; even one additional small infarct may precipitate chronic congestive failure. Bypass grafting in such instances, if successful, may possibly avoid further injury and protect from the end-stage disease of intractable failure, currently treatable only by cardiac transplantation.

I cannot answer most of Dr. Cannon's question. We always use a flow meter at operation, though there is considerable uncertainty about its reliability. Flow varies, of course, with blood pressure, vasomotor tone, and other factors. It is a valuable guide, however, in demonstrating the capacity of the vascular bed beyond the graft, and is especially useful if re-operation is considered for an occluded graft months later. He correctly emphasized the important basic problem of the underlying atherosclerosis. One of the dividends of the bypass operation is that a base line is clearly defined, from which future efforts to control the atherosclerotic process can be measured. The grim fact at present is that nothing in medical therapy has yet strongly influenced the course of atherosclerosis when evaluated in randomized studies over a period of five years.

In conclusion, I want to emphasize again that answers will come not from debate, but from careful accumulation of significant data over a long period of time. This is a major and awesome responsibility of all investigators in this area. The present frequency of disease indicates that there are probably at least five million American males with significant occlusive disease of the coronary arteries, who would be theoretical candidates for a prophylactic bypass graft. This five million far exceeds the frequency of any other major disease in the American population. The logistics, the expense, the training, the facilities all inherent in a decision of this magnitude are enormous. Hence, the great responsibility for careful accumulation of data in reaching a clear decision is evident.