At the workshop several investigators recommended an alternate approach, which is to measure the rate of protein escape from plasma into the lung tissue. Such dynamic measurements are possible and offer substantial gains in sensitivity, especially when the permeability of the alveolar-capillary barrier is increased. The methods are relatively noninvasive, since they rely on external detection over the chest of gamma-emitting protein tracers that have been injected intravascularly. This approach has been validated in experimental animals, and preliminary studies on human subjects are promising. For the present, however, clinical judgment, the chest x-ray examination, and one or more of the water content methods are what the physician must rely upon.

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Continuous Murmur following Bypass Surgery

In this issue, Starling and colleagues (see page 64) describe the inadvertent placement of a saphenous vein graft from the aorta to a coronary vein. In addition to the four cases previously reported in the literature\(^1\)\(^-\)\(^4\) and the two present cases, I am aware of three additional cases that have occurred in institutions throughout this country. All nine cases involved the great cardiac vein adjacent to the left anterior descending artery. There are no cases involving a coronary vein in the distribution of the marginal branches of the left circumflex artery or the distal branches of the right coronary artery. There is almost inevitably considerable fat overlying the proximal left anterior descending artery and, occasionally, the more distal portion of this vessel is intramyocardial. When the proximal left anterior descending artery is covered with fat and its distal portion is intramyocardial, the only visible vessel on the anterior surface of the heart may be the great cardiac vein. If cardioplegia is used and the great cardiac vein is at all sclerotic, this vessel can readily be mistaken for the left anterior descending artery. In the first case reported by Starling et al, the actual left anterior descending artery was never identified at reoperation and the distal anastomosis was connected to a diagonal branch. The left anterior descending artery may well have been intramyocardial. In at least one other case of which I am aware, a definitely intramyocardial left anterior descending artery was found at reoperation and this vessel was used for the distal anastomosis.

If one hears a murmur at all, a short systolic murmur along the upper left sternal border is heard when a vein graft is placed to the left anterior descending artery.\(^5\) Therefore, the discovery of a continuous murmur along the upper left sternal border postoperatively in the patient who has undergone bypass surgery is an indication to submit the patient to cardiac catheterization looking for the improper placement of a saphenous vein (or other graft material) into a coronary vein. Since coronary arterial blood flow is only 5 percent of cardiac output, it is not surprising that oxygen saturation determinations and green dye curves will be normal in this setting. Even though hydrogen inhalation studies are sufficiently sensitive to recognize the small left-to-right shunt produced by grafting from the aorta to a coronary vein, angiography is the method of choice to recognize this entity.

Bhayana et al\(^6\) and Park et al\(^7\) have described a modification of the Beck procedure in which the great cardiac vein is ligated proximally and a graft placed distally into that coronary vein in an effort to arterialize the coronary venous system. The utility of this technique has been challenged recently by Klinke et al\(^8\) who performed an elegant study in a patient who had undergone inadvertent placement of a saphenous vein graft from the aorta to the great cardiac vein. These authors occluded the coronary sinus with a balloon catheter and then selectively injected contrast material into the saphenous vein graft. Neither arterial visualization nor evidence of myocardial perfusion was found.

When inadvertent placement of a graft from the aorta to the great cardiac vein is discovered, what is the proper course of action? The size of the left-to-right shunt in this situation is sufficiently small so that the presence of the shunt itself is not an indication for surgical intervention. When the patient is clearly symptomatic as in the first case of Starling et al, there is no choice but to reoperate. In the case of Treistman et al\(^9\) and in the second case of Starling et al, it was elected to simply follow the patient rather than reoperate since exercise performance was good and symptoms were absent. It seems reasonable to consider such patients as similar to those individuals with single vessel disease and base consideration for reoperation principally on symptoms.

Almost certainly this surgical error occurs with
much greater frequency than one would conclude from a review of the literature. Therefore, it is most important that both cardiologists and cardiac surgeons be aware of this entity. Cardiologists must be alert to the recognition of the continuous murmur which seems virtually pathognomonic of this complication. Surgeons should take precautions to avoid this complication such as identifying and, perhaps, tagging the left anterior descending artery prior to the institution of cardiopulmonary bypass when possible. It is also noteworthy that neither prompt flow of cardioplegic solution from the supposed arteriotomy nor the absence of a murmur immediately following an anastomosis is proof that one is not grafting to a coronary vein.

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