BLOOD VESSEL GRAFTING

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The first successful blood vessel graft in a patient was performed by Lexer, of Jena, in 1912. He resected an aneurysm of the popliteal artery and then restored continuity by a 13-cm. length of saphenous vein taken from the opposite leg. By 1913 he was able to report that he had resected three aneurysms of the vessels of the lower limb and restored continuity in each case with an autogenous vein graft. Two patients were alive with patent grafts and one had died, possibly of cardiac failure, but with a patent graft. After Lexer's pioneer work with autogenous vein grafts sporadic reports of successful cases have occurred in the literature, notable examples being those of Coenen, of Breslau, who in 1913 was the first to use a free vein graft as a method of reconstructing the artery after the resection of an arteriovenous aneurysm, and Murray, of Toronto, who in 1939 used heparin for the first time after reconstructing the popliteal artery with an autogenous vein graft.

The alternative to vein grafting is artery grafting. An artery graft may be autogenous, homologous or heterologous. The obvious limitations of supply render an arterial autograft rarely possible; heterografts of all types seldom succeed and so one is left with the homograft as the most useful type of artery graft. Carrel in 1908 performed on a dog the first successful arterial homograft and he also realised that an artery bank was essential for artery grafting to be a practical proposition in clinical practice. He devised a method of storing arteries in saline at 0° to 4°C. and used the method successfully in experimental animals, but it was many years before stored arteries were used in man. Gross, Bill and Peirce in 1949 developed the first human artery bank; their method of preservation in nutrient saline was a modification of Carrel's method of storage. The results have been very good, but the method has one great disadvantage—the arteries cannot be kept for more than six weeks. This means much wastage and Peirce reports a utilisation rate of only 6 per cent. from such a bank. At St. Mary's Hospital we used to bank our arteries by freezing. The method which was worked out by Hufnagel and Eastcott was simple, satisfactory

and had the advantage that the arteries could be stored for long periods or almost indefinitely. But recently we have been using freeze-dried arteries; these are even more satisfactory, because they can be stored for an indefinite period at room temperatures and the surgeon can carry them in his instrument bag with as much ease as a tube of distilled water (Fig. 1).

Now that arteries can be banked satisfactorily the surgeon can use either an autogenous vein graft or a homologous artery graft to reconstruct the arteries of his patients. The vein graft has many advantages; it is autogenous and therefore survives after transplantation, an artery bank is unnecessary and, if the saphenous or external jugular veins are used, their loss causes little inconvenience to the patient. On the other hand, vein grafts are unsatisfactory for the aorta and its main branches because they dilate and they are technically more difficult to insert than artery grafts. We use artery grafts for the aorta and its major branches and prefer them for reconstruction of the peripheral arteries because they have less tendency to thrombose and, in spite of the fact that they do not survive transplantation, the results appear to be better.

The Fate of a Blood Vessel Graft

As already stated, autogenous vein grafts survive transplantation but homologous artery grafts do not. The vein hypertrophies and to some extent becomes arterialized; the end result of such a graft is a satisfactory channel for the conduction of blood. A homologous artery graft survives for a limited period only, but long enough to act as a scaffold whilst the tissues of the host are growing in to form a new blood vessel. What probably happens is that the media and adventitia are replaced by fibrous tissue and a new intima is formed largely from cells deposited on to the surface of the graft from the blood-stream and to a lesser extent by outgrowth from the endothelium of the host vessels. The elastic fibres persist, appearing to be unchanged several years after grafting.

FIG. 1 (a and b).—Arteriograms from a patient before and after a freeze-dried arterial homograft had been inserted. Before operation this patient developed intermittent claudication after walking for 50 yds.; after operation he could walk for miles.

Indications for Blood Vessel Grafting

(1) *Congenital abnormalities of the great vessels such as a long coarctation of the aorta.*

(2) *Aneurysms or arteriovenous aneurysms of major vessels.*

(3) *Wounds of major vessels and past ligations which have caused symptoms.*

(4) *Intermittent claudication when severe and due to:*

(a) *Primary thrombosis of a main vessel, e.g. the popliteal artery.*

(b) *An injury or an aneurysm.*

(c) *Very occasionally and only after careful selection in patients with senile obliterative arterial disease.*

(5) *Gangrene and threatened gangrene when associated with a graftable block.*

Most of these indications need no further elaboration, but those which refer to senile obliterative arterial disease will be discussed. The usual symptoms produced by senile obliterative arterial disease of the limbs are intermittent claudication, rest pain, and gangrene. Approximately 60 per cent. of patients with intermittent claudication and a fair proportion of those with rest pain and gangrene have a lesion in the arteries of the limb which is anatomically suitable for an artery graft. And on anatomical grounds alone, replacing the thrombosed segment of main vessel should produce dramatic results. In actual practice this is not so, and other factors have to be considered when selecting patients with senile obliterative arterial disease for artery grafting. This general disease affects the arteries of the whole

body and it is obviously a mistake to cure a patient of intermittent claudication developing at 100 yds. for him to be stopped by the worse pain of angina pectoris at 150 yds. In addition, the life expectancy of these patients is reduced and it is probable that more than one-third of all patients with intermittent claudication due to arteriosclerosis will have died within three years of their first consultation with their doctor. Another factor is that these patients tend to thrombose their arteries and a successful graft may be followed by occlusion of the vessels of the other lower limb, the same limb usually proximal to the graft, the heart or the brain.

This means that the strictest criteria are necessary before one treats a sufferer from senile obliterative arterial disease causing intermittent claudication by the operation of blood vessel grafting. In the case of rest pain or early gangrene, the criteria of selection may be less severe, because the alternative is for many patients a major amputation and under these circumstances a blood vessel graft is justified whenever the anatomical situation permits.

In Conclusion

Blood vessel grafting is now a practical everyday possibility; either an autogenous vein or a homologous artery can be used. The results are satisfactory in patients without evidence of senile obliterative arterial disease. In patients with this disease the immediate results are good, but the late results are governed by the general disease and here the most careful selection of patients for operation should be practised.

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