(Wickes, 1952; Vining, 1952). In any case there was no more illness among the bottle-fed than among the breast-fed babies. We are therefore driven to the conclusion that, in spite of continuous medical supervision, minor degrees of underfeeding among the breast-fed babies had occurred and had been overlooked.

If there is any truth in the opinion that the high prevalence of diarrhoea among babies who were nursed until they were old enough to be spoon-fed is due to faulty technique, and if the weight records constitute evidence of "latent" underfeeding among the breast-fed babies, then the survey findings present a new challenge to the advocates of natural feeding. That breast-feeding has advantages to both mother and child which will never show on a weight chart no paediatrician will seriously deny, but artificial feeding is now so safe and easy that the slightest neglect of the special problems of nurslings could produce a sharp popular reaction against breast-feeding.

Summary

The early progress of 580 babies in the Oxford Child Health Survey has been studied in relation to feeding habits.

At the age of 1 year the babies who were bottle-fed from the beginning were appreciably heavier than the babies who were completely breast-fed for five months or longer. They also showed signs of being slightly more mature. It is suggested that these differences are due to minor degrees of under-feeding among the breast-fed babies.

For three disease groups—gastro-enteritis, bronchitis and bronchopneumonia, and otitis media and tonsillitis—there was no evidence that the duration of complete breast-feeding influenced the overall infection rates. Gastro-enteritis was comparatively rare so long as the babies were receiving nothing but breast milk, but it reached its maximum incidence in the weaning period and was especially common among babies who began to be weaned in the sixth month.

Colds, which were most frequent in large households and households with several children of school age, were almost equally common among breast- and bottle-fed babies.

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The British Legion Village at Preston Hall, near Maidstone, for tuberculous ex-Service men and women has now been in existence for 28 years, and the record of its accomplishments during that period has recently been published in the form of a souvenir brochure. Its 50 beds in 1925 had grown to 926 by 1948, when they came under the authority of the regional hospital board. The village settlement and industrial training centre includes all the amenities necessary for a self-contained community. Over 11,000 men and women have taken advantage of the services offered. The brochure is a useful guide to the facilities available at Preston Hall for the rehabilitation of tuberculous ex-Service men and women, who during their stay are enabled to live normal family lives.

FUTURE OF SURGERY IN SENILE OBLITERATIVE ARTERIAL DISEASE*

BY

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Senile obliterative arterial disease, often called arteriosclerosis, is one of the most important problems which the medical profession has to face, and as our population ages this problem is likely to increase in magnitude. All authorities agree that it is a very common disease, that it is much more frequently seen in middle and late life than in the young, that it often exists in a subclinical state before symptoms occur, and that the first clinical effect may be the patient's death from coronary or cerebral vascular occlusion.

When one thinks about the surgical treatment of senile obliterative arterial disease one fact must never be forgotten—that it is a general disease affecting the arteries of the whole body. In some patients the most abnormal vessels are in the lower limbs; they suffer from intermittent claudication or gangrene of the toes. In others the coronary arteries are affected and the patients develop either angina pectoris or coronary occlusion, while some suffer from the well-known symptoms of cerebrovascular disease or an aneurysm of the aorta. In all these patients the whole arterial system is abnormal, but one region is affected more than others, and it is against these local manifestations of a general disease that a surgeon's efforts can be directed.

An anatomical study of the changes in the arteries of these patients shows that the local manifestations are produced in a high proportion of patients by a relatively short thrombosis in a main vessel. Thus a patient with intermittent claudication usually has a thrombosis of a segment of his superficial femoral or popliteal arteries. Fig. 1 is an arteriogram from such a patient; this shows the local thrombosis and the general disease above and below the block, where plaques of atheroma can be seen in the vessel wall. Realization of this fact is changing the whole approach of surgeons to this disease, not only in the case of the superficial femoral and popliteal arteries, but also when the thrombosis is in the abdominal aorta, common or external iliac arteries, the carotid arteries, and even perhaps in the future in the coronary or cerebral vessels.

In the past, surgeons have used an indirect approach when treating the symptoms of senile obliterative arterial disease. They have employed methods designed to increase the collateral circulation such as sympathectomy (Ross, 1935), they have tried to increase the blood flow to the part by creating an arteriovenous fistula (San Martín, 1902), they have ligated the main vein in an attempt to increase the oxygen supply to the tissues by producing venous congestion (Makins, 1919), they have attempted to relieve pain due to ischaemia by interrupting the afferent nerve pathways (Jonnesco, 1920), and they have put the ischaemic muscle at rest by interrupting its motor nerve supply (Learmonth and Slessor, 1952) or by dividing its tendon (Boyd, 1950). In the case of coronary artery disease attempts have been made to increase the blood flow to

*Part of a postgraduate lecture given in New Zealand in September, 1952.

the myocardium by producing adhesions between the heart and the pectoralis major muscle (Beck, 1935), the heart and the great omentum (O'Shaughnessy, 1936), and the heart and the pericardium (Heinbecker and Barton, 1940). Other methods include ligation of the great cardiac vein (Fauteux and Palmer, 1941), the formation of an arteriovenous anastomosis between the coronary sinus and an artery (Beck *et al.*, 1948), implantations of the internal mammary artery into the myocardium (Vineberg, 1952), and various procedures designed either to decrease the activity of the heart such as thyroidectomy (Blumgart *et al.*, 1933) or to relieve cardiac pain (Swetlow, 1926). All these operations, whether on the limbs or on the heart, suffer from one great and obvious defect—the approach is indirect.

The Direct Approach

Probably the first surgeon to realize the importance of a direct attack upon the occluded segment of artery was Leriche; he performed the operation of arteriectomy in which the thrombosed portion was excised (Leriche *et al.*, 1937). Dos Santos (1947) took this step further with his operation of disobliterative endarterectomy, the first procedure designed to restore the blood flow through the blocked artery. In this operation the vessel is opened, the thrombus removed, and the vessel repaired again. The results if successful are better than with most of the indirect procedures, but the success rate is not very high; Reboul and Laubry (1950) report that of 93 disobliterations 44 (47%) remained patent, 38 clotted again, and 11 patients died. A better method is to replace the thrombosed segment of artery by an autologous vein graft or a homologous artery graft. In our experience between 50 and 60% of all patients with intermittent claudication or gangrene of the toes have a lesion in their arteries which is anatomically suitable for an artery or vein graft. In actual practice only 20% or less of these patients are suitable, the others being rendered unsuitable by such factors as age and the presence of cerebrovascular or coronary artery disease. It is obviously a waste of time to graft a patient who suffers from intermittent claudication at 100 yards for him to be stopped after a successful operation by the worse pain of angina pectoris at 150 yards. In the case of gangrene of the toes the indications for grafting are great; here, particularly if the alternative is a major amputation, a graft is justified whenever it is a practical possibility.

Vein Grafts.—The first successful vein-to-artery autograft in man was performed by Lexer in 1912. He excised a popliteal aneurysm and replaced it by a vein graft. The development of this method of replacing the thrombosed artery in senile obliterative arterial disease has been carried out almost entirely on the continent of Europe. Fontaine and Hubinont (1950) have had considerable experience of this operation, and of their first 18 grafts 8 (44%) were successful and remained patent. The advantages of vein grafts are that they are autologous; this means that they may live and an artery bank is not necessary. If the saphenous or external jugular veins are used no ill effects arise from the sacrifice of these veins. Their disadvantage is that if the host vessel is arteriosclerotic they are technically more difficult to insert than artery grafts. We therefore use vein grafts when the host's vessels are normal or nearly so; as our technique improves we hope to use them more frequently in the treatment of senile obliterative arterial disease, but to date the success rate in these patients has not been as high as with artery grafts.

Artery Grafts.—These are of necessity homologous and do not survive in the host; his tissues gradually grow in and replace the graft by a process of creeping substitution: the media and adventitia by fibrous tissue, the intima to a small extent by growth from the ends of the host vessel but mostly as cells deposited on to the surface of the graft from the blood stream; the elastic lamina, which is an extracellular structure, appears to survive. An artery

homograft therefore acts as a scaffold which maintains the blood flow whilst the tissues of the host are growing in to form a new channel. An essential requirement for efficient artery grafting is an artery bank. The first human artery bank was developed by Gross and his colleagues (1949); they preserved their vessels in nutrient saline, and the results have been excellent. An alternative method which we use is that of Eastcott and Hufnagel (1950): the grafts are frozen and stored at a temperature of -70°C . or less; these grafts are equally satisfactory, and the bank is easier to manage because the grafts can be stored for long periods and perhaps indefinitely. Artery grafts have been used to replace the thrombosed segment of artery in a number of sufferers from senile obliterative arterial disease (Rob, 1953). To date this direct attack upon the thrombosed segment of artery has been confined to the aorta, its main branches, and the major vessels of the neck and limbs. The results have been satisfactory, and Figs. 1 and 2 illustrate a typical femoral arteriogram before and after an artery graft.

FIG. 1.—Femoral arteriogram showing a thrombosed segment of superficial femoral artery. This patient suffered from severe intermittent claudication. FIG. 2.—Arteriogram from the patient shown in Fig. 1 after an artery graft. He can now walk for miles without pain.

The direct approach has reached a stage at which it is a practical everyday possibility to replace an occluded segment of a large or medium-sized artery by an autologous vein graft or a homologous artery graft, and operations of this type have been performed in many hospitals all over the world. But what of the future and, in particular, what are the possibilities of grafting such arteries as the coronaries?

Grafting the Coronary Arteries

Murray (1950) has resected a portion of a dog's coronary artery and restored continuity by using a vein graft to bridge the defect. This is a very difficult operation in the dog, but it should be easier in man, in whom the main coronary arteries are about 3 mm. in diameter. The human coronary artery is about the same size as the dog's common carotid, in which a graft succeeds in over 50% of cases (Eastcott and Hufnagel, 1950).

Senile obliterative arterial disease of the coronary arteries is often a diffuse process involving both coronary arteries, but in a minority of patients the disease is relatively localized and suitable, at least anatomically, for replacement by a vein or artery graft. Harrison and Wood (1949) found that of 15 patients who died of ischaemic heart disease eight had diffuse disease with all the major coronary arteries narrowed and irregular, but in seven the disease was limited to one artery, usually the left, or to part of an artery, the remainder of the coronary tree being relatively normal. From a study of the material presented in their paper it appears that two patients (13%) had a lesion in their coronary arteries which was anatomically suitable for a graft.

A personal study of this problem has led me to believe that this figure of about 10% is a fair picture of the proportion of sufferers from angina pectoris or perhaps early coronary occlusion who might receive benefit from such an operation. The difficulty is to select these patients. In this connexion a paper by Blumgart *et al.* (1940) is of interest. They found that the coronary arteries of 12 patients with angina pectoris were diffusely arteriosclerotic, with multiple occlusions in 10 cases, and that the two patients in whom the occlusions were limited to one artery showed diffuse and widespread disease of this vessel. On the other hand, the hearts of 12 patients who died from coronary occlusion without previous angina pectoris showed that in 10 the disease was confined to one artery only. A study of the diagrams in their article leads me to believe that three of this latter group could have been treated with an artery graft.

It is possible that clinical features such as the distribution of the pain or the findings on electrocardiography may give valuable information on this problem. The location of the infarct can be determined by these means, but to date no effort has been made to correlate these features with the suitability of coronary artery disease for an artery graft. Such a study is being carried out, but it will be several years before any worth-while conclusions can be published. An alternative and more direct approach is arteriography of the coronary tree. Radner (1945) carried out coronary arteriography by direct puncture of the ascending aorta in both man and dogs; he obtained a faint outline of the coronary arteries, but the complications were too frequent and the method had to be abandoned. Jonsson (1948) visualized the coronary arteries during catheterization and angiocardiology. The catheter was passed up the brachial artery to the aortic valve, when the contrast medium was injected. No ill effects were noted. On the other hand, Helmsworth *et al.* (1951) catheterized the left carotid artery in 10 human patients; in 5 they obtained a satisfactory coronary arteriogram, but one died—a woman of 88—after her sixth injection of 10 ml. of 70% "diodrast."

Both main trunks of the human coronary arteries are reasonably accessible to the surgeon and both move very little with the heart beat. This latter fact is important, because it is possible in animals, and should be possible in man, to graft the coronary arteries whilst the heart is beating, an extracorporeal circulation being unnecessary. It is probable that patients with complete occlusion of a main coronary artery would be made no worse by temporary interruption of the artery during the operation of grafting. In patients with only partial occlusion ventricular fibrillation might follow interruption of the blood flow; in these it would be necessary to put in the graft over a fine polythene tube and then remove the tube just before the second anastomosis had been completed; by this means the blood flow to the myocardium could be maintained during the greater part of the operation. Murray (1947) has excised the area of infarction from a dog's heart after occlusion of a main coronary artery; the results were good. It may well be that, in man, the treatment of acute occlusion of the main stem of one coronary artery when the other is normal will be an emergency operation to replace the occluded segment of coronary artery by a graft followed by excision of the myocardial infarct with repair of the cardiac defect, while patients with severe angina pectoris will be treated by a graft if the disease is confined to the main stem of one of the coronary arteries; but it is likely that suitable patients for these operations will be rarities.

Other Sites

It can be stated that in selected patients the direct treatment of senile obliterative arterial disease is now an established procedure and that this type of operation may be extended to include some sufferers from coronary occlusion, but what of the other important sites of senile arterial disease?

Intracranial Arteries.—The carotid arteries outside the skull can be replaced by a vein or artery graft, but any direct approach to intracranial obliterative arterial disease has yet to be attempted. An exception to this is provided by the surgical control of bleeding intracranial aneurysms, a proportion of which are due to senile obliterative arterial disease (Falconer, 1952). The replacement of segments of those arteries by grafts has not yet been attempted but should be possible, although the thin nature of their walls will make the operation more difficult than in other situations. The selection of patients should be relatively simple because of the highly developed state of cerebral arteriography.

Aorta.—This vessel between the left subclavian artery and the diaphragm and below the renal arteries has been replaced by a graft on many occasions (Brock, 1953). Progress will be by the extension of such an operation to include either the arch of the aorta or the upper abdominal aorta. In both these situations there are many important branches, and added to the technical difficulty of having to perform several anastomoses would be the necessity of maintaining during the operation an adequate blood flow to such essential structures as the brain, spinal cord, and kidneys. In my opinion these difficulties are not insuperable and it should be possible to replace some simple aneurysms and treat some dissecting aneurysms in these regions by a graft of the appropriate segment of aorta with its branches. The blood flow could be maintained by one or more polythene tubes, placed through the clamps but inside the graft, and removed just before the completion of the final anastomosis.

Conclusion

A direct approach to the local manifestations of a general condition—senile obliterative arterial disease—is now a practical possibility. In the future it may be possible to extend the scope for operations of this type. I feel that grafting the coronary arteries will be performed successfully during the next few years; this is not the difficult hurdle. What is much more important is to study this disease so that we can relate symptoms and signs to those features of the disease which will make a graft successful and will prevent unnecessary operations on patients unsuitable for grafting. This will be far more difficult than the technical perfection of an operation. The problem is being studied.

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