EDITORIALS AND ANNOTATIONS

SKELETAL ALLOGRAFTS FOR SYNOVIAL JOINT RECONSTRUCTION

A principle of reconstructive surgery is to replace lost tissue with similar tissue. This principle is applicable particularly to traumatic and orthopaedic surgery in which autografts are now used widely to replace bone, tendon, nerve and skin.

Articular cartilage, as a component of a synovial joint, is rarely transplanted as an autograft in man. When used as an autograft articular cartilage is employed in one of three ways: as a shell or plaque composed of cartilage and a thin layer of subchondral bone (Lagrange Rigault and Guyonvarch 1969); as a half-joint transplant attached to the shaft of a long bone; or as a whole-joint transplant (Lexer 1925 vide Burwell 1969).

The use of skeletal allografts (homografts) for the reconstruction of synovial joints in man was explored first by Lexer (1925), who performed eleven half-joint and twenty-three whole-joint transplantations, using as donor tissue fresh material procured from amputation specimens or from the fresh cadaver. Apparently the results of these procedures were not impressive enough to justify their popularisation (Chase and Herndon 1955), although sporadic reports of the clinical method continued to be published (May 1942, Capurro and Pedemonte 1953). It is only in the last few years and with increasing knowledge in several fields, namely the immunology of tissue transplantation, the preservation and sterilisation of tissues, the internal fixation of the skeleton and the control of infection, that interest in joint allotransplantation has reawakened.

The fresh skeletal allograft for synovial joint replacement, like the autograft, may be employed in one of three ways: as a shell or plaque of cartilage and subchondral bone; as a partial or half-joint transplant; or as a whole-joint transplant. In man, at the present time, only the chondro-osseous shell is worthy of study as a fresh skeletal allograft to replace a joint surface, for encouraging experimental results have been gained recently in using such chondro-osseous shell allografts in the hip and knee joints of animals (Gibson 1965, 1969; Chesterman 1965, 1968; Laurence 1969a, Smith 1969); and preliminary reports of the clinical application have been published (Störig 1968, Laurence 1969b). However, many problems, mainly mechanical and immunological, await solution in the laboratory before the method is applied more fully to man.

Fresh half-joint and whole-joint skeletal allografts continue to be studied in the laboratory (Herndon and Chase 1954, Curtiss and Herndon 1956), but rejection occurs, due presumably to the development of an actively acquired immunity in the host against the transplantation antigens of the graft. Preliminary attempts to use immunosuppressive therapy have enabled vascularised knee joint allografts in dogs to survive for as long as eighteen months (Reeves 1968, 1969). A clinical application of fresh joint allotransplantation (which would involve vascular anastomoses) seems remote at present (vide Imamaliev 1969); this is because the currently available immunosuppressive therapy is not justified for clinical allotransplantation performed to replace an organ whose loss is not obligatory for the life of the patient. However, the improved clinical results after kidney allotrafting due to tissue-typing and immunosuppression (Terasaki, Michey, Mittal, Singal and Patel 1968; van Rood, van Leeuwen, Pearce and van der Does 1969; Joysey and Calne 1969; Calne 1967) indicate the need to explore synovial joint allografting more fully in the laboratory.

The preservation of skeletal tissues by freezing or freeze-drying is known to impair the antigenicity of the material as a graft (Burwell and Gowland 1962). It is perhaps mainly because
of this effect that encouraging clinical results have been reported in recent years from frozen half-joint replacements. In this connection fairly consistent findings have been published from several countries of the world including Russia (Moscow and Leningrad), Yugoslavia, Czechoslovakia, France, Sweden, the United States of America and South America (Jaros 1964; Kovalenko and Vereschagin 1966; Krupko, Tkachenko and Malevsky 1966; Merle d’Aubigné, Märy and Thomine 1966; Ottolenghi 1966; Parrish 1966; Volkov and Imamaliev 1967; Petrokov, Vukići and Schenk 1967; Nilsonne 1969; vide Afanassieff 1967). In one patient a whole femur, resected for hydatid disease, was replaced successfully by a frozen allograft of femur (Ottolenghi 1966). In other patients, rather than attempt articular reconstruction, some surgeons have used massive skeletal allografts or autografts to create an arthrodesis (Merle d’Aubigné and Dejouany 1958, Wilson and Lance 1965, Merle d’Aubigné et al. 1966).

The clinical indications for half-joint reconstruction by frozen skeletal allografts have included resections performed for tumours, chronic infections (tuberculous and pyogenic), hydatid disease, traumatic arthritis and intractable juxta-articular non-union. The method has been applied to all the major limb joints: the hip, knee, ankle, shoulder, elbow, radiocarpal and metacarpo-phalangeal joints.

At the Central Institute for Traumatology and Orthopaedics (C.I.T.O.) in Moscow, research has been proceeding now for several years into the use of half-joint and whole-joint allografts to replace parts of the skeleton excised principally for tumour and chronic infection. The problem has been approached as a basic scientific study examined in both the laboratory and the clinic. In the laboratory, Imamaliev, who heads the Department for the Preparation and Preservation of Organs and Tissues in C.I.T.O., has made an extensive study of half-joint allografts preserved at — 60 to — 70 degrees Centigrade for different periods of time and implanted into the lower femora of dogs (Volkov and Imamaliev 1967, Imamaliev 1969). This laboratory research has shown that the best material was that preserved for periods from twenty-five days to six months. Grafts preserved for shorter periods showed after implantation a tendency to partial or complete resorption.

In this issue of the Journal Professor Volkov, who directs the C.I.T.O. in Moscow, reports his clinical experience of using frozen joint allografts at the hip, knee, shoulder and elbow. The allografts have been used in one of four ways, namely to replace: 1) a part of one articular surface; 2) the whole of one articular surface; 3) the whole of two articular surfaces; 4) a whole-joint complex. Each of these skeletal allografts is not simply a tissue graft but an organ (or composite tissue) graft, being composed of articular cartilage, cancellous bone, cortical bone, marrow and fat. The smaller grafts were inserted without internal fixation, whereas the larger (or massive) replacements were stabilised by intramedullary, plate or compression fixation. The joints were mobilised within one or two months of operation but weight-bearing was generally avoided for one year.

The clinical results, Volkov states, are related at least in part to the size of the replacement. The results were good and the movement was well preserved when grafts were used to replace a part of one joint surface. In the larger skeletal allografts used to replace the whole of one articular surface, avascular necrosis and degeneration occurred in some of the replacements; while in the whole-joint replacements partial destruction of the joint had occurred in 70 per cent by eighteen months after operation. Although the incidence of infection is not given, Volkov states that the grafts had to be removed in 12 per cent of his patients. Professor Volkov concludes that skeletal allografts have a place in the treatment of joints destroyed by operation or disease. He attributed the failures to several causes, including tissue incompatibility, impaired incorporation of the graft, imperfect fixation and inadequate immobilisation.

In Leningrad, Kovalenko and Vereschagin (1966) have used frozen joint replacements in 136 patients after excision, principally at the knee for tuberculosis. In a follow-up over four years they state that aggravation of disease occurred in six patients, but that in general the functional results have been satisfactory. In contrast, Krupko et al. (1966), also in Leningrad,
with an experience of forty-three frozen half-joint replacements involving the upper femur and reviewed after three months to four years, reported good results in only sixteen patients. They concluded that a wide application of the method is not yet warranted. Parrish (1966), working in Houston, Texas, summarises his findings as follows: "Neither the number of patients treated nor the consistency of the surgical technique will permit any definite conclusions at this time. The eventual fate of massive homografts is undetermined. However, it seems likely that gradual resorption or degeneration or both may take place."

The apparent success of some frozen half-joint allografts should encourage research in this field; but the present results do not justify a ubiquitous application of the method. The problems for critical analysis concern the preparation, the internal fixation and the fate of the bone (and articular cartilage) of the allograft. In preparation, should the implant be preserved by freezing, freeze-drying or in solid paraffin or plastic (Tkachenko 1967)?: and should they be sterilised by high-energy radiation, antibiotics or chemicals such as ethylene dioxide? For internal fixation, how does compression fixation compare with other available methods? As regards the fate of the allograft, does it immunologically sensitise the host?: is remodelling facilitated by removing soft tissues and by multiple perforations of the shaft?: and what happens to its articular cartilage?

Clearly the need is for a continued and extensive laboratory study using animals, and a simultaneous but more limited exploration in man. Then, and only then, will the task arise of comparing the results of skeletal allograft replacement with the best that prosthetic replacement can offer (Scales, Duff-Barclay and Burrows 1965; Wilson and Lance 1965; Burrows 1968); and perhaps defining for each the clinical indications.

Finally, it should be added that it would be unfortunate if the current pragmatic attempts to reconstruct articular surfaces by prosthetic and biological replacements were to distract us from gaining a clearer understanding of the disease processes which are commonly responsible for joint destruction; for it is hoped that from such understanding will emerge new methods enabling us to prevent such diseases and avoid the need for radical surgery.

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REFERENCES


