THE JOURNAL OF BONE AND JOINT SURGERY

Metallosis

With the number of total joint replacements performed worldwide estimated at about a million a year (*US News and World Report*, 30 April 1990), it is remarkable that so little effort has been made to investigate the long-term biological effects of this procedure, especially by routine necropsy and tissue examination. The apologist would say that the patients mostly die many years after the operation, usually in another place, and cannot be followed; the realist would point out that nowadays very few necropsies are done anyway, because of 'cost containment' efforts and because morbid anatomy is widely regarded as an outmoded science. In many parts of the world, routine examination by a trained pathologist of tissue removed at surgery simply does not happen. This is a pity since the examination of tissues both at autopsy and after surgical procedures should be regarded today, as it was in the past, as the cornerstone of medical science and of continuing improvement in medical practice. The *Journal* is therefore to be congratulated for publishing in this issue the autopsy study by Case et al (p 701) which describes the widespread dissemination of metal debris from implants and discusses its possible effects. This report, unfortunately, is limited in scope (13 subjects) and conveys little that the student of the problem does not already know. However, it should bring to a much wider audience the realisation that orthopaedic implants can have effects far beyond local tissue adaptation.

In the bulk forms in which they are used, the materials of modern artificial joints are all well tolerated by the host tissues. However, when we speak of a material as being biologically inert, we need to remember that the term is only relative, inertness depending on the use to which the material is put, as has been shown by the recent verdicts against some manufacturers of breast implants.

All moving parts wear and some corrode with time, use and abuse. A cubic millimetre of implant material in one piece has a surface area, at which chemical reactions may take place, of 6.0 mm^2. Broken down into 1 μm fragments, the surface area increases to 6×10^6 mm^2. When these fragments are intracellular and disseminated throughout the body tissues, it is difficult to imagine that they do not eventually have some effect, but we have no studies with large enough population samples to demonstrate possible correlations with coexistent disease.

It has been said that there are at least three consequences of the shedding of wear particles from articulating implants (Rae 1975). First, the total surface area of the contact between the implanted material and the biological environment is enormously increased, facilitating both the exchange of potentially toxic elements at the interface and their wider dissemination. Second, wear particles of a suitable size can be phagocytosed and exposed to intracellular processes which they may alter. Third, such ingested particles may be transported to sites remote from the implant, such as the regional lymph nodes, lungs and spleen, and interfere with their functions.

Recently, the focus has been on potential harm from metal debris, especially since the discovery of large amounts of metal in tissues surrounding failed prostheses made of titanium (Agins et al 1988). Metal debris is, however, generally rare except in cases of a loose or broken prosthesis. Metal levels in the blood and urine have also been found to be low except in some patients with loose prostheses (Sunderam et al 1989). Concern has been expressed about the effects of particulate metal debris on the immune system, with the possible development of late infection or hypersensitivity reactions to the metal prosthesis itself, and the increased incidence of tumours of the lymphoreticular system in patients with joint implants followed for periods up to ten years (Gillespie et al 1988).

Perhaps the most dramatic complication of the use of orthopaedic implants is the possible induction of adjacent neoplasia. This is regarded by some as a major concern although only 24 such cases have been reported in the literature (Goodfellow 1992) despite the huge number of implants in place worldwide. On the other hand, in dogs, there is a significant incidence of neoplasia adjacent to intramedullary metal rods (Sinibaldi et al 1976).

In the paper in this issue of the *Journal*, Case et al report the presence of only a few polyethylene fragments in the synovium of the subjects they examined and none in remote sites. This finding is surprising since, in our experience and that of others, tissue obtained at revision of aseptically failed hip prostheses has always contained copious amounts of polyethylene, an observation that has

P. G. Bullough, Director of Laboratory Medicine
The Hospital for Special Surgery, 535 East 70 Street, New York, NY 10021, USA.

0301-620X/94/5900 $2.00
J Bone Joint Surg [Br] 1994; 76-B:687–8.

led increasingly to the belief that it is the reaction to polyethylene debris which is the major factor in late loosening (DiCarlo and Bullough 1992). Since the linear wear of polyethylene in well-fixed prosthetic hips can be more than 0.1 mm per year, the number of debris particles generated must be very large; surely some of these particles accumulate in remote organs.

Polyethylene fragments, which are usually engulfed by macrophages, can be seen by polarising microscopy but are easily overlooked by transmitted light microscopy. The very small particles of cement which may be generated by movement at a loose bone-cement interface are dissolved during routine processing of the tissue for histology; generally, only the barium sulphate remains behind and it may be overlooked. The limit of resolution of the light microscope precludes seeing particles smaller than about 0.5 μm, but electron-microscopic studies have shown metal fragments in tissue which are much smaller than this.

Investigations of long-term effects of prosthetic wear debris are becoming more important as more prostheses are implanted in younger patients. We need to develop reliable and standardised methods for the detection of metal, polyethylene and other polymeric debris and to establish a worldwide registry of the possibly harmful effects of metal and plastic implants. Has not the time now come to expend a small proportion of the money and energies devoted to the development and modification of implants to the establishment of a multicentre study of their long-term biological effects?

P. G. BULLOUGH

REFERENCES

Agins HJ, Alcock NW, Bansal M, et al. Metallic wear in failed titanium-alloy total hip replacements: a histological and quantitative analysis. *J Bone Joint Surg [Am]* 1988; 70-A:347-56.

DiCarlo EF, Bullough PG. The biological responses to orthopedic implants and their wear debris. *Clin. Mat* 1992; 9: 235–60.

Gillespie WJ, Frampton CMA, Henderson RJ, Ryan PM. The incidence of cancer following total hip replacement. *J Bone Joint Surg [Br]* 1988; 70-B:539-42.

Goodfellow J. Editorial. Malignancy and joint replacement. *J Bone Joint Surg [Br]* 1992; 74-B:645.

Rae T. A study on the effects of particular metals of orthopaedic interest on murine macrophages *in vitro*. *J Bone Joint Surg [Br]* 1975; 57-B:444-50.

Sinibaldi K, Rosen H, Liu S-K, DeAngelis M. Tumours associated with metallic implants in animals. *Clin Orthop* 1976; 118:257-66.

Sunderman FW Jr, Hopfer SM, Swift T, et al. Cobalt, chromium and nickel concentrations in body fluids of patients with porous-coated knee or hip prostheses. *J Orthop Res* 1989; 7:307-15.

Ultrasound imaging of soft-tissue masses in the extremities

Radiographs are of little use in the assessment of most soft-tissue lesions in the extremities and other imaging techniques are required. Those available are ultrasound, CT and MRI. The last two are considerably more expensive than ultrasound and not available in many parts of the world. Ultrasound, like MRI, does not expose the patient to ionising radiation and, unlike MRI, is safe to use in patients who have ferromagnetic implants, such as those with cardiac valve prostheses or cerebral aneurysm clips.

There is little information in the orthopaedic literature about the role of ultrasound in identifying and assessing soft-tissue lesions in the extremities although with the development of high-resolution real-time equipment, it has become a versatile and accurate first-line investigation. Ultrasound can demonstrate the internal architecture of muscles and fascial compartments in detail and can detect very small lesions (Harcke, Grissom and Finkelstein 1988; Kaplan, Matamoros and Anderson 1990). In comparison, CT can show the presence of abnormal soft-tissue lesions only if they have a significantly different radiodensity from neighbouring tissues or are large enough to disrupt normal tissue planes (Bernardino et al 1981; Yeh and Rabinowitz 1982). In the extremities CT can miss soft-tissue lesions either because they are too small or because of poor contrast resolution due to the lack of fat. Several studies have confirmed that ultrasound is more accurate than CT in estimating the size, shape, and anatomical relations of such lesions (Bernardino et al 1981; Yeh and Rabinowitz 1982; Harcke et al 1988; Kaplan et al 1990), information which is essential in making a diagnosis and planning treatment (Bernardino et al 1981; De Flaviis et al 1987).

We have used ultrasound for over five years to investigate patients with suspected soft-tissue lesions and have found it to be an accurate method for detecting the presence of such a lesion. We have examined the upper arm, elbow, forearm, back, groin, thigh, knee, popliteal fossa, calf, anterior lower leg, ankle and foot and the

A. J. Johnstone, FRCS, Senior Orthopaedic Registrar
Department of Orthopaedic Surgery, University of Aberdeen, Polwarth Building, Foresterhill, Aberdeen AB9 2ZD, UK.

I. Beggs, FRCR, Consultant Radiologist
Princess Margaret Rose Orthopaedic Hospital, Frogston Road West, Fairmilehead, Edinburgh EH10 7AD, UK.

0301-620X/94/5876 $2.00
J Bone Joint Surg [Br] 1994; 76-B:688–9.