OSTEOSARCOMA IN ASSOCIATION WITH TOTAL HIP REPLACEMENT

H. G. PENMAN, P. A. RING

From the Orthopaedic Research Unit, Redhill General Hospital, Surrey

The occurrence of an osteosarcoma at the site of a cobalt-chrome total hip replacement is described, and the possibility of the tumour arising as a result of the liberation of cobalt particles is discussed. The experimental and clinical evidence relating tumour formation to the presence of particulate metals, and to the presence of solid and particulate polyethylene, is presented. It is considered that the risk of tumour formation at the site of any total hip replacement is very small.

Total replacement of the hip has become established during the last 20 years as the procedure of choice in the treatment of severe arthritis in the elderly. There has been some caution in extending it to younger patients, partly because the durability of the implant is uncertain, and partly because the younger patient might be exposed to any possible risk for a relatively long period of time. It is known that the products of wear accumulate around the implant, and in the case of those implants in which both parts are made of cobalt-chrome, circulating metals can be detected in the blood, the urine and the hair (Coleman, Herrington and Scales 1973). The occurrence of a malignant tumour arising at the site of a total hip replacement appears to be of sufficient importance to justify reporting the present case in detail.

CASE HISTORY
A woman of 75 was admitted in October 1968 for total replacement of her right hip. She was severely disabled, with a joint which was continuously painful, and she was able to walk only with the aid of an elbow crutch. She had a severe adduction and flexion deformity of the hip with only a small range of movement; radiographs showed severe degenerative changes (Fig. 1).

Her general condition was fair. She had a longstanding scoliosis with degenerative changes throughout the spine and a valgus deformity of the right knee with osteoarthritic changes. In addition she had early Parkinson's disease and a hiatus hernia. There was no evidence of Paget's disease either in the region of the right hip or elsewhere, and she had not previously had radiotherapy to the pelvic region.

An uncemented cobalt-chrome implant of the Ring type was inserted. At operation the bone was noted to be osteoporotic, but no other abnormality was found. Her recovery from the operation was uneventful but her progress was slow, partly because of her knee deformity and partly because of the Parkinson's disease. She was discharged from hospital in December 1968.

She was seen monthly at first and thereafter annually. The hip remained painless with a free range of movement, though she preferred to use a tripod when walking. The radiographs, taken at annual intervals, showed that the prosthesis remained soundly embedded although the bone was still osteoporotic (Fig. 2). Her last attendance for annual review was in October 1972, and because of her other disabilities at that time no arrangements were made for further routine supervision. She remained reasonably active during the following year, but in the summer of 1973 her right leg started to swell and she experienced some discomfort in the hip region. She was however able to walk indoors until December 1973, when she fell, injuring her right hip, and was admitted as an emergency.

She was noted to have gross oedema in the region of the right hip, and moderate restriction of movement at the joint. Radiographs showed gross destruction of bone around the femoral component of the prosthesis, with an undisplaced fracture of the femur near its tip (Fig. 3). A skeletal survey showed no other bony abnormality and radiographs of her chest were normal. The results of haematological investigations were within normal limits apart from an ESR of 16 mm in the first hour. The serum calcium was 11.8 mg/dl, the phosphate 3.8 mg/dl, and the alkaline phosphatase 8.8 King–Armstrong units.

A biopsy was performed on January 9, 1974. The outer side of the right femur was found to be invaded by a large white tumour mass, parts of which were removed for section. Her general condition slowly deteriorated and she died 19 days later.

H. G. Penman, MD, MRCP, MRCPath, Consultant Pathologist (Histopathology) Crawley Hospital, West Green Drive, Crawley, West Sussex RH11 7DH, England
P. A. Ring, MS, FRCS, Consultant Orthopaedic Surgeon East Surrey (New) Hospital, Three Arches Road, Redhill, Surrey RH1 5RH, England.

Requests for reprints should be sent to Mr P. A. Ring.

© 1984 British Editorial Society of Bone and Joint Surgery 0301–620X/84/5149 $2.00
Postmortem findings. Apart from bilateral basal pneumonia the most important finding was a masssive firm, white tumour surrounding the right hip region. It extended upwards into the groin to just beneath the peritoneum of the right iliac fossa, and downwards to about mid-thigh level. The tumour measured about 28 cm vertically and had caused extensive destruction of the upper part of the femoral shaft, but not of the acetabulum. The lining of the acetabulum and the surface of the tissues surrounding the femoral component showed obvious greyish pigmentation. A white nodule, 0.5 cm in diameter, in the right renal cortex, was the only evidence of distant metastasis.

Histology. The biopsy (Fig. 4) showed a cellular pleomorphic malignant tumour with quite frequent mitotic figures. The tumour cells were haphazardly arranged and there was an intercellular background of irregularly disposed eosinophilic material containing variable amounts of stainable and birefringent collagen. Nowhere was this material seen to be calcified; in several places it looked like poorly formed osteoid. The tumour was considered to be an osteogenic sarcoma.

Postmortem sections taken from both superficial and deep parts of the tumour and from the renal nodule all showed similar appearances. Between the tumour and the femoral component there was a zone of poorly cellular fibrin, fibrous tissue and amorphous debris with many small fragments of bone. Close to the inner surface much grey-brown granular pigment (Perl's negative) was present, both extracellularly and intracellularly. Intact bone from the acetabulum and from the femoral shaft below the tumour showed no evidence of Paget's disease.

DISCUSSION

Between 1964 and 1978, a total of 1888 total hip replacements, using metal-on-metal prostheses made of cobalt-chrome, were performed at Redhill and Dorking hospitals. These patients were reviewed annually and every effort was made to trace those who did not attend. By the end of 1983, 682 patients had died or had been lost to review. None of the 1206 survivors has shown any evidence of reactive changes in association with the implant. Over this period of study 151 patients have
come to revisional surgery, mainly for loosening of the implant; in each patient biopsies have been taken from the peri-articular tissues. In no case has there been evidence of any malignant or premalignant change in the connective tissue around the articulation.

Osteosarcoma in the elderly may be associated with Paget’s disease and occasionally follows radiotherapy. The development of a sarcoma at the site of a total hip replacement, in the absence of either of these predisposing causes, must raise the possibility that the tumour has been induced by the presence of the implant. The laboratory tests described by Swanson, Freeman and Heath (1973) and the observations of Coleman et al. (1973) show that total joint replacements in which both parts are made of cobalt-chrome liberate particles of cobalt, chromium, molybdenum and manganese. Heath, Freeman and Swanson (1971) demonstrated that the debris which accumulates around this type of joint in the hip simulator can, on injection into rats, produce sarcomatous tumours. It seems likely that it is the cobalt element, which passes into the cells, which is responsible for the production of these malignant tumours, although cadmium, nickel and chromium have all been shown to produce malignant tumours in animals (Sunderman 1971).

The development of a sarcoma at the site of a total hip replacement must raise the possibility that this tumour has been induced by the presence of metallic debris, particularly when such debris has been shown in the experimental animal to be capable of inducing tumour formation. All-metal implants have, however, been used for many years in considerable numbers, so that any risk of tumour formation in patients must be very small.

The advantage of polyethylene, with its low frictional resistance, as one component of a total hip replacement, has been stressed by Swanson et al. (1973) and the liberation of metal from this type of replacement is undoubtedly small. However, the work of Carter and Roe (1969) suggests that even the use of polyethylene may be associated with some risk of tumour formation. It is generally accepted that fragmented plastics are not carcinogenic, but these authors were able to induce sarcomata in rats using shredded polyethylene. The occurrence of sarcomata however was more common in those animals in whom solid polyethylene implants had been used and Thompson and Entin (1969) have reported the formation of a chondrosarcoma around polyethylene balls used for extrapleural plombage. Cleland (personal communication 1974) has noted two other similar cases. Bagó-Granell et al. (1984) have recently reported a malignant fibrous histiocytoma occurring at the site of a Charnley-Müller total hip replacement.

It is possible therefore that patients in whom metal-on-plastic articulations have been implanted are exposed to long-term risks of tumour formation similar to those in whom both parts of the implant are made of cobalt-chrome. This risk, however, with any total hip replacement, must on the present evidence be regarded as very small indeed.

REFERENCES


