

STUDY OF THE WEAR PARTICLES PRODUCED FROM COBALT-CHROMIUM-MOLYBDENUM-MANGANESE TOTAL JOINT REPLACEMENT PROSTHESES

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A device has been constructed which permits total joint replacement prostheses to be moved under load, whilst immersed in Ringer's solution at 37°C. The rate of movement, loads, and axes of movement are variable. Three prostheses all made in cobalt-chromium-molybdenum alloy have been examined to date: A Shiers Knee Replacement in "Vinertia", a Walldius' Knee Replacement in "Vitallium", and a McKee-Farrar Hip Replacement in "Vitallium".

In the experiments to be described, the rate of movement has been of the order of 40 cycles/minute, the load has been 210 lb. throughout the cycle, and the range of movement has been through 90°. Thus the prosthesis was exposed to a mechanical and chemical environment which approximately simulated that which it may be presumed to encounter in clinical practice in man.

During the test run wear particles were collected, the Ringer's solution was analysed chemically, and the frictional forces at the bearing were measured. This paper is concerned only with the features of the wear particles.

From knee prostheses particles were produced at a rate of approximately 0.1 g./100,000 cycles, the rate of production falling slightly with time during the test run. From the McKee-Farrar hip prosthesis particles were produced at the approximate rate of 0.2 g./100,000 cycles.

The particles were examined, after dispersion, by electron microscopy; they were found to be irregular in outline and to range from 0.1 to 1 μ in diameter.

The chemical composition of the individual particles is unknown and the precise composition of a collection of particles is slightly variable. In

general the particles contain proportionally rather more chromium and rather less cobalt than the parent alloy (In the Ringer's solution bathing the prosthesis, the relative proportions of these elements are reversed).

Particles were implanted into the thigh muscles of ten hooded rats* in a dose of 28 mg./rat. In four rats, killed in the first 4 months after implantation, a mild inflammatory response was observed locally which had become completely quiescent by 4 months. Metal particles were demonstrated in the para-aortic lymph nodes and were seen to be intracellular. No rats were killed in the fifth month and two rats were killed in the sixth month. Four rats are still surviving. Histologically malignant tumours (without metastases) were found in both the rats killed at 6 months: one tumour was a lymphosarcoma of a type to which this species is prone; the other was a rhabdomyosarcoma found at the site of implantation of the particles. This tumour does not occur spontaneously in the rat but was induced on a previous occasion by the implantation of larger particles of cobalt (Heath, 1954).

It is concluded that cobalt-chromium-molybdenum-manganese total joint replacement prostheses may produce wear particles in man, small enough to become intracellular and of a chemical composition different from that of the parent alloy. The biological effect of these particles is unknown but, on the basis of our observations on the rat, it is not at present possible to be certain that they are completely innocuous.

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