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INFLUENCE OF HIP ARTHROPLASTY UPON CHEMOTACTIC BEHAVIOUR OF LEUCOCYTES

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Fourteen patients treated with total hip endoprosthesis were investigated for leucocyte defects. A chemotactic assay was used as an indicator of leucocyte function. Tests were carried out preoperatively and on postoperative days 1, 3 and 6. The chemotactic index started to decline on the first postoperative day, reached a peak on the third day after surgery and returned to almost preoperative values on the sixth day. The results might provide a clinical explanation for the data showing a high postoperative infection rate in total hip surgery.

Key words: hip arthroplasty; leucotaxis

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Surgical and anaesthetic procedures are known to influence the immunological system. Clinical experience (Cotta & Schulitz 1973) and experimental studies have demonstrated that the patient runs the greatest risk of developing a wound infection during the operation and in the immediate postoperative period. Several authors (Wilson et al. 1973, Krizel & Robson 1975, Burke 1961) have demonstrated that bacterial inoculation of experimental wounds in rabbits within the first and second postoperative day resulted in more infections than later contamination. Since granulocytes represent a main body defence against bacterial infections, we have investigated the chemotactic behaviour of leucocytes in a standardized orthopaedic operation in order to detect possible cellular defects which might influence resistance to early postoperative infections.

PATIENTS AND METHODS

Fourteen patients operated on and fitted with a total hip prosthesis were investigated. Thirteen had osteoarthritis and one rheumatoid arthritis. Six were female and eight male. The mean age was 70 years (range 52–76 years). Three patients had diabetes. Twelve patients received a general anaesthesia (Thiopental N_2O) and two a lumbar anaesthesia according to the principles of conductive anaesthesia (bupivacain).

All patients had infection prophylaxis with 4 g of cephalosporines on the day of operation and 3 g on the day after surgery (Wewalka & Endler 1978) and all patients except one received a blood transfusion and at least 500 ml plasma expander (dextran 70) preoperatively. Postoperative complications occurred in two patients: the first developed haematemesis from a duodenal ulcer 2 days after surgery and the second thrombophlebitis on the eighth postoperative day.

As a control group, 25 patients matched for age and sex who had non-inflammatory and non-malignant orthopaedic diseases were selected from the same hospital.

Blood was drawn by venal puncture into sterile syringes, containing 50 IU of preservative free heparin per ml blood, on the day before operation and on postoperative days 1, 3 and 6. Controls were investigated on two consecutive days.

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Leucocytes were gained by sedimentation of the whole blood in 2 per cent Dextran 500 (Pharmacia, Sweden) at 37°C for 45 minutes. Afterwards cells were washed three times in phosphate buffered saline (PBS) at 40°C.

The leucocytes were adjusted to a concentration of 2.5×10^6/ml in RPMI 1640 (Flow Lab.) containing 100 IU penicillin and 100 μg streptomycin per ml. The chemotaxis assay was performed in modified Boyden chambers as described previously (Frei et al. 1974). Two compartments were separated by a filter with a pore size of 3 μm (Millipore Corp.). The upper compartment contained 0.5 ml of leucocyte suspension and the lower compartment was filled with 1.5 ml of either PBS or 0.1 per cent Casein (Merck). All assays were performed in triplicate. After incubation at 37°C for 150 minutes filters were detached and stained with haemalaun and tap water and cleared in xylol. The chemotactic response was expressed as mean total leucocyte count per 200 oil immersion fields (chemotactic index, CI) ± standard error of the mean (S.E.M.) for triplicate filters.

RESULTS

The course of the chemotactic indices is shown in Figure 1. The mean CI declined from the preoperative value 5.36 ± 2.95 to 3.56 ± 2.69 on the first postoperative day ($P < 0.05$). On the third day the mean CI was 9.45 ± 3.72 which was significantly higher ($P < 0.005$) than on all the other days of the investigation. The mean CI on the sixth postoperative day was 4.55 ± 3.02 ($P > 0.05$) and did not differ from the values before surgery. The CIs on postoperative days 1 and 6 demonstrated a significant difference ($P < 0.05$). The significance of differences was determined by multiple paired Student's *t*-tests.

The decrease on postoperative day 3 could be found in 12 out of 14 patients. One patient who did not show this pattern was a diabetic; the other patient was inconspicuous. The sharp decrease of the CI from postoperative day 3 to day 6 could be observed in all patients except one who showed only a slight decrease.

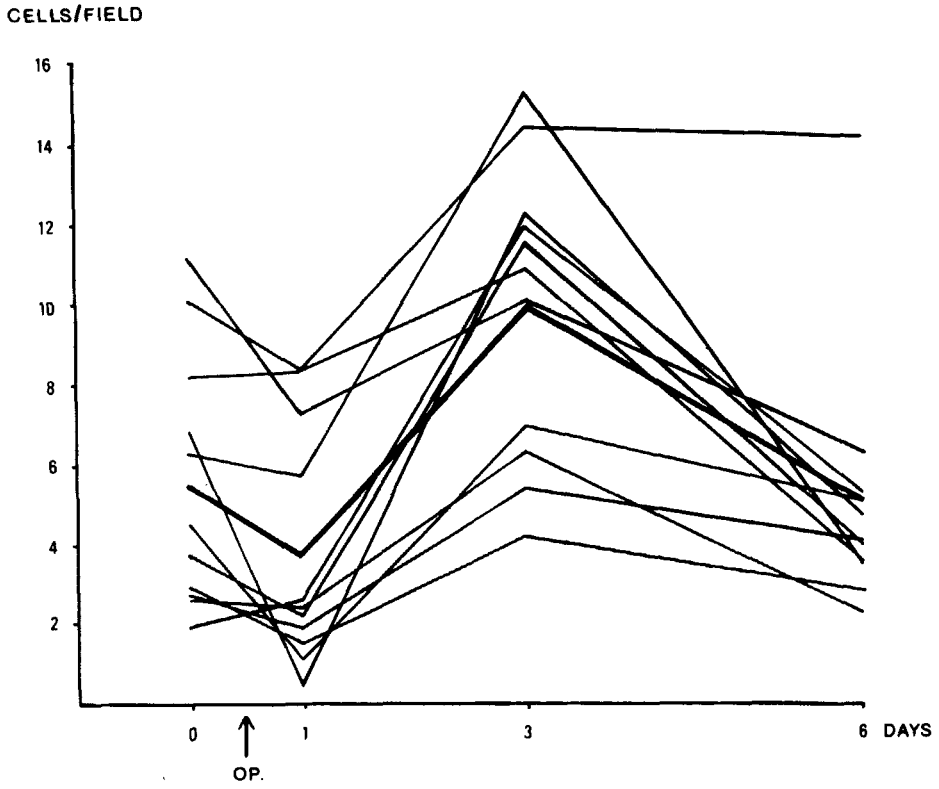

Figure 1. Course of chemotactic indices (CI) in patients operated with total hip prosthesis.

One patient did not receive blood transfusions during surgery because of religious reasons. The chemotactic behaviour of his leucocytes was similar to the other investigated patients. No difference was found in the chemotactic behaviour of patients operated on under general or lumbar anaesthesia.

The 25 control patients investigated in a similar way to the patients undergoing total hip joint replacement showed a mean CI of 5.62 on the first day and 4.96 on the second day. No significant differences could be found in these two groups by paired Student's t-test ($P > 0.1$).

The index of the random mobility of the tested leucocytes was never higher than 0.5. Casein did not show any cytotoxicity in trypan exclusion tests.

DISCUSSION

The ability of leucocytes to respond to chemotactic stimuli is a prerequisite for phagocytosis and subsequent intracellular killing. Therefore the CI can be regarded as an indicator of the function and activity of these cells.

Changes in phagocytosis in connection with surgery have been described previously (Bröte & Stendahl 1975, Alexander et al. 1968).

For the study of the postoperative chemotactic behaviour of leucocytes total hip replacement is especially suitable because neither the respiratory nor the digestive systems, which possess special immunological defence mechanisms, are manipulated during this intervention.

On the first postoperative day the chemotactic activity of the leucocytes was diminished. This was in accordance with the observation that the greatest hazard of bacterial infection occurs during the first 24 postoperative hours (Krizek & Robson 1975), which coincides with a decreased ability of leucocytes to respond to a chemotactic stimulus. Moudgil et al. (1977) described an immediate decrease of chemotactic activity of leucocytes following an *in vitro* exposure to anaesthetizing agents. The leucocyte function was assessed at least 24 hours after anaesthesia, so that the concentration of the anaesthetizing agent was low and a direct effect on leucocyte activity before testing could be almost excluded. In this connection, the similarity of the results from 12 patients anaesthetized by general anaesthesia and two patients anaesthetized by lumbar anaesthesia should be considered. Moreover, Alexander et al. (1968) and Nathenson et al. (1978) described abnormalities of leucocyte function following physical and thermal injuries.

The increase in chemotactic activity of leucocytes on day 3 after surgery could be in accordance with Bröte & Stendahl (1975) who suggest an increase of leucocyte activation on the fourth postoperative day.

In conclusion, a surgical intervention which includes tissue lesion and implantation of a foreign body with bone cement causes an impairment of the chemotactic function of leucocytes. This might lead to an increased infection rate (Edelson et al. 1973, Krizek & Robson 1975) within the first 24 hours after surgery. After an increase in chemotactic activity on the third postoperative day leucocyte function normalizes on day 6 and the patient's susceptibility to infection is no longer due to the operative intervention.

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