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POSTOPERATIVE WOUND INFECTION AFTER IMPLANT AND REMOVAL OF OSTEOSYNTHETIC MATERIAL

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Osteosynthetic material was implanted and removed in 972 consecutive operations in the upper and lower extremity. Early post-operative wound infection developed significantly more often after osteosynthesis than after removal of the implant; neither sex nor age influenced significantly the frequency of wound infection. The latter was higher when insertion or removal of material was performed in the lower extremity than in the upper extremity. The hip and ankle regions were involved most often. *Staph. aureus* and *Staph. albus* predominated among the Gram-positive infections; gram-negative infections, however, occurred remarkably frequently, *E. coli* being the most common organism isolated. To decimate exogenous and endogenous contamination of the wounds during operation, aseptic and antiseptic measures should be reinforced. In operation in a region proven to carry a higher post-operative infectious risk, i.e. the hip and ankle, it is suggested that antibiotics should be administered at the time of osteosynthesis.

Key words: surgical wound infection; orthopaedic fixation devices; wound infection.

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The frequency of postoperative wound infection following orthopaedic operations ranges from 0.5 to 4.7 per cent (Tachdjian & Compere 1957, Räf 1964, Stevens 1964, Derian & Green 1966, Plaue & Hinz 1971, Charnley 1972, Lidgren & Lindberg 1974). In particular, post-operative wound infection is a serious complication following operations involving implantation of osteosynthetic material. It is a matter of controversy whether osteosynthesis in different anatomical regions implies a difference in risk of postoperative wound infection (Räf 1964, Stevens 1964, Roles 1971, Lidgren & Lindberg 1974). The present study was undertaken to determine the influence of the actual operation site following insertion and removal of osteosynthetic material.

MATERIAL AND METHODS

The investigation was retrospective and comprised 972 elective and acute operations on the extremities (703 implants and 269 removals of metallic osteosynthetic material), performed consecutively during the period 1963–1970. The distribution of patients according to age and sex

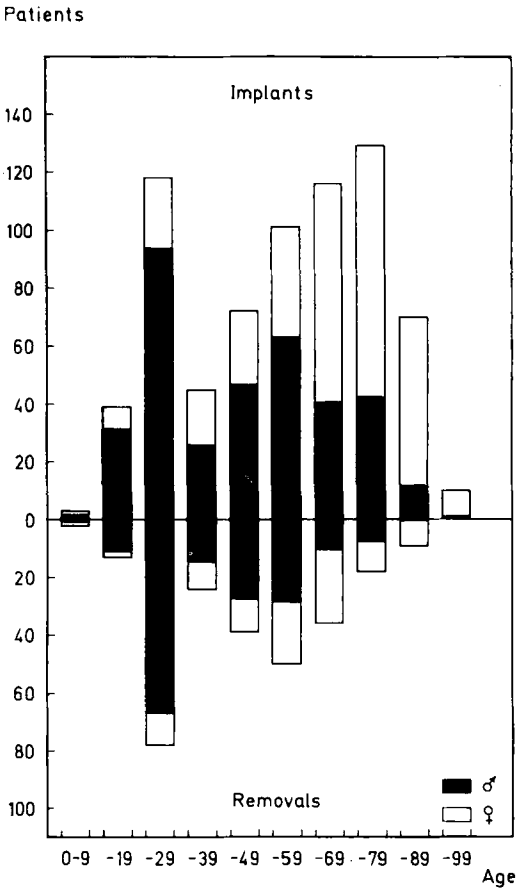

Figure 1. Age and sex of 972 patients with implant and removal of osteosynthetic material in the upper and lower extremity (1963–1970).

is shown in Figure 1. A patient was considered to have an early wound infection when clinical signs and symptoms of infection were present postoperatively before primary healing of the operation wound. There was no routine bacteriological examination of infected wounds during the first years of the investigation.

The preparation of the operation site consisted of washing with liquid soap for 3×3 min followed by propyl alcohol 35 per cent and iodine 2 per cent in ethyl alcohol 70 per cent, applied twice. The patient was draped with sterile cotton towels and there was increasing use of a transparent, adhesive skin drape of plastic (Steri-Drape®) throughout the period. The operation wounds were sutured with resorbable material, except for the use of nylon stitches in the skin. The administration of antibiotics was according to the judgment of the surgeon in question.

Statistical methods

All data were processed in a computer and clinically relevant comparisons were made by distribution-free statistical tests of significance (Siegel 1956).

RESULTS

The patient distribution (Figure1) shows maxima in the 3rd and the 8th decades for implants and in the 3rd and the 6th decades for removals. Young men had osteosynthetic material inserted and removed (for fractures of the upper ex-

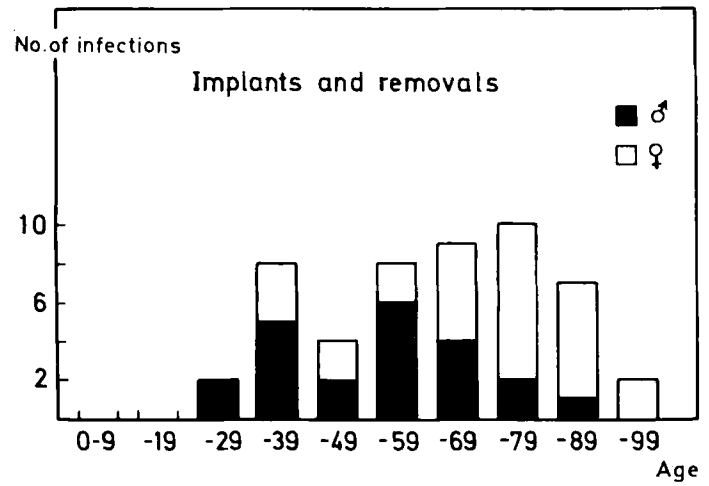

Figure 2. Fifty postoperative wound infections after implant and removal of osteosynthetic material in 972 patients.

Table 1. Postoperative wound infection after insertion and removal of osteosynthetic material for fractures of the extremities.

Osteosynthetic site	Implants	Infections		Removals	Infections	
Upper extremity	98	3	3.1 %	49	0	0.0 %
Lower extremity	605	40	6.6 %	220	7	3.2 %
Total	703	43	6.1 %	269	7	2.6 %

tremity, leg and ankle relatively more often than young women, while older women were operated on (hip operations) more often than older men; the removal of inserted material decreased rapidly with increasing age. Fifty postoperative wound infections followed 972 operations (Figure 2), and the over-all incidence of infection was 5.1 per cent. A Kolmogorov-Smirnov test between the two sample distributions (Figures 1 and 2) showed random variations ($P > 0.05$). The ratio between men and women did not differ more than accounted for by chance, the infections after implants being for men: 19 in 342 and for women 24 in 318, $P > 0.05$ (Fisher's exact method).

Topographical analysis of postoperative wound infection

The total frequency of wound infection was significantly higher after osteosynthesis than after removal of the implant ($P < 0.05$) (Table 1); this was also the case for the lower extremity. The infection rate was higher in the lower extremity than in the upper, both for implants and removals, but the differences were not significant ($P > 0.05$). Figure 3 shows the wound infection rates following insertion and removal of osteosynthetic material in 13 regions of the upper and lower extremities. The differences between the frequencies of infection in the hip, thigh, knee, leg and ankle after osteosynthesis were not significant, nor was this the case if a single region was

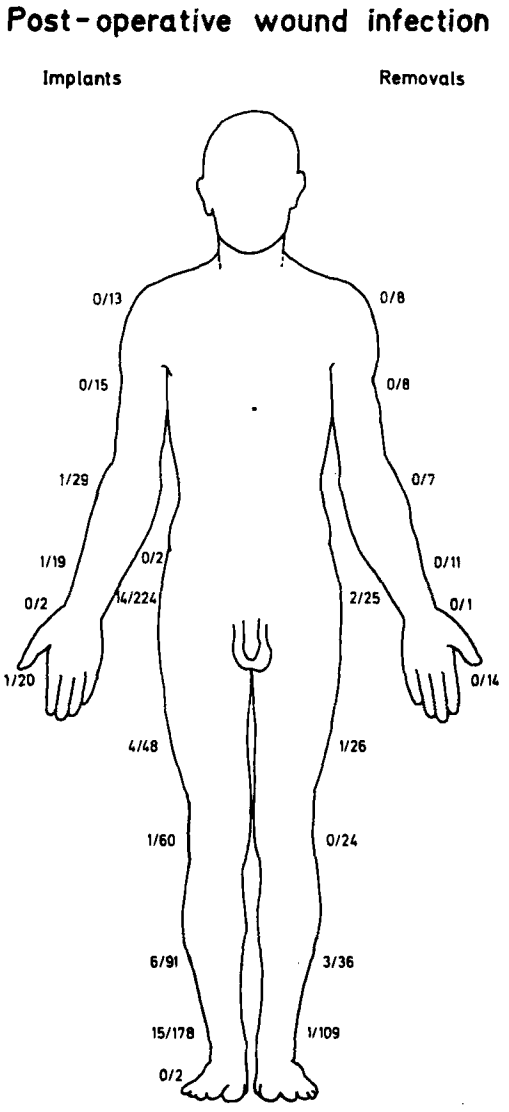

Figure 3. The frequencies of early postoperative wound infection after implants (left) and removals (right) of osteosynthetic material in 13 regions of the upper and lower extremity.

Table 2. Postoperative wound infection after osteosynthesis in the hip region.

Implant	No infection	Infection
Smith-Petersen hip nail	44	1
Moore hip prosthesis	46	9
McLaughlin plate	100	4
Total	190	14

Table 3. Postoperative wound infection after insertion of osteosynthetic material for fracture of the ankle.

Implant	No infection	Infection
Cerclage	96	10
Wiberg staple	86	9
Palmer pin	83	10
Rush pin	11	2
Agerholm staple	7	1
Screws	11	1
Others	20	5
Total	314	38

compared with the pooling of the other regions ($P > 0.05$). Osteosynthesis of the ankle was followed by infection significantly more often (12 in 45) than was the case with a pooling of the other inferior extremity sites (16 in 226), ($P < 0.01$), when sub-grouped according to the use of antibiotics.

The different techniques of osteosynthesis in relation to the occurrence of wound infection are shown in Tables 2 and 3, where in some cases two or more implants have been inserted in the same operation wound. Insertion of a Moore prosthesis was associated with postoperative wound infection significantly more often than after other treatment (chi-square analysis $P < 0.01$) (Table 2). The number of infections was notably high after insertion of metallic implants for ankle fractures (Table 3). No statistically significant differences were found (for the proportion of cases of wound infection to the total of osteosynthetic implants) between fractures of the femoral neck, the trochanter region, the femur shaft, the leg or the ankle.

Bacteriology

Gram-positive bacteria dominated, especially *Staphylococcus aureus* (coagulase-positive) (Table 4), but the Gram-negative *Escherichia coli, Proteus* spp. and *Pseudomonas aeruginosa* were also isolated from infected hip and ankle wounds. Only Gram-positive bacteria were identified from infections following

Table 4. Organisms in 50 postoperative wound infections after implant and removal of osteosynthetic material in 972 patients. Removal in brackets.

	Staph. aureus	*Staph. albus*	*α-streptococcus*	Gram-neg. organism	No growth	No report
Upper extremity						
Elbow	1					
Forearm	1			1		
Hand						1
Lower extremity						
Hip	7 (1)	(1)	2	6	1	1
Thigh	3 (1)					1
Knee						1
Leg	3	1			1 (1)	4 (2)
Ankle	2	1		5	3	6
Total	17 (2)	2 (1)	2	12	5 (1)	14 (3)

removal of osteosynthetic material. The cultures were obtained by the cotton swab method, which may explain the apparent paradox of "no growth" in association with clinical wound infection, because this sampling method does not reveal the full extent of colonization, being qualitative, not quantitative (Raahave 1975 a). One-third of the *Staph. aureus* strains identified were fully sensitive to penicillin and one-fifth were resistant.

Antibiotics

Penicillin (68.4 per cent), alone or in combination with streptomycin or other antibiotics (26.3 per cent), was administered to 37.6 per cent of the patients. The treatment was most often initiated in connection with osteosynthesis or removal from the lower extremity (Table 5), and postoperative wound infection developed significantly more often in patients treated with antibiotics than in those who were not so treated ($P < 0.05$).

DISCUSSION

Topography of postoperative wound infection

Osteosynthesis in the extremities was followed by postoperative wound infection significantly more often than was removal of the implant. The infection rate was higher when both procedures were carried out in the lower than in the upper extremity, though not significantly so. There does not appear to be any comparable study in which early postoperatively wound infection has been assessed following insertion and removal of osteosynthetic material.

Table 5. Administration of antibiotics and postoperative wound infection after insertion/removal of osteosynthetic material in the extremities.

	No infection Antibiotics		Infection Antibiotics	
	+	—	+	—
Implants				
Upper extremity	42	53	2	1
Lower extremity	271	294	28	12
Removals				
Upper extremity	1	48	0	0
Lower extremity	19	194	2	5
Total	333	589	32	18

Frequencies of 3.1 to 12.0 per cent have been reported after osteosynthesis and endoprosthetic implants (Tachdjian & Compere 1957, Räf 1964, Boyd et al. 1973, Salvati & Wilson 1973, Kavlie & Sundal 1974, Lidgren & Lindberg 1974), while a frequency of wound infection following osteosynthesis of 12.7 per cent was found in a general surgical department (Jepsen 1973). Following total hip replacements, an incidence rate as low as 0.5 to 2 per cent has been reported, including late manifestations (Charnley 1964, 1972). In the present study both sexes seemed equally prone to postoperative wound infection, a finding in line with that of Stevens (1964), and age in itself had no influence, two factors which others have stated to be of some importance (Räf 1964, Davidson et al. 1971, Lidgren & Lindberg 1974).

The frequency of wound infection in osteosynthesis and removal varied from region to region, being highest after osteosynthesis in the ankle region. A further sub-grouping according to the type of implant showed that the insertion of a Wiberg staple, a Palmer pin and a cerclage were associated with infection of wounds to a uniform degree. These implants were often used together in the same operation and the inference is that the aseptic technique may have been broken by manoeuvres necessary for reposition of the fracture and fitting the implants. Such breaks may have also occurred after osteosynthesis in the hip region, and especially when a Moore prosthesis was inserted, demanding ex-

tensive exposure and repetitive manipulations. Earlier, the hip was shown to be a region of high risk (Tachdjian & Compere 1957, Räf 1964, Salvati & Wilson 1973, Lidgren & Lindberg 1974).

Bacterial species

Staph. aureus and *Staph. albus* were responsible for most of the Gram-positive infections after osteosynthesis, and for all infections after removal. The relatively frequent isolation of Gram-negative species from hip and ankle infections was remarkable, compared to the findings of others (Tachdjian & Compere 1957, Fogelberg et al. 1970, Roles 1971, Fitzgerald et al. 1973). The presence of bacteria is one out of five major contributory factors in the development of wound sepsis (Davidson et al. 1971), and quantitative and qualitative bacteriological evidence has recently shown that wounds are contaminated during operation to various degrees from exogenous and endogenous sources (Lilly et al. 1970, Fitzgerald et al. 1973, Raahave 1974 a). In this study, the isolation of Gram-negative bacteria and the sensitivity patterns of *Staph. aureus* indicate the patients' own indigenous biota as the source, keeping in mind the nearness of urethra and anus to operation wounds of the lower extremity. Analogously, Gram-negative infections dominated in the groin after vascular operations (Shaw et al. 1973). Apart from this endogenous source, the wound may be contaminated during operation by mainly Gram-positive bacteria from the environment, with gloves, instruments and air as vectors (Raahave 1974 a).

The bacterial contamination of the operation wound should be reduced to a level which can be overcome by the natural host defences. In this study, disinfection of the operation site relied on iodine in alcohol. Chlorhexidine, however, is as powerful as iodine and is without irritant and sensitizing effects. This disinfectant is much in use at present (Lowbury & Lilly 1973), and was recently shown to eradicate aerobic and anaerobic skin flora almost completely (Raahave 1973, Lykkegaard Nielsen et al. 1975).

Aseptic barriers, including the use of a "sterile enclosure" (Charnley 1964, 1972), are established between the sterile zone and other areas which harbor bacteria in the operating room. By this means the bacteria from the skin and mucous membranes of the room personnel should be denied access to the wound. The use of plastic skin drapes has been advocated as a further aid, but these drapes neither reduced the number of bacteria (Lilly et al. 1970, Raahave 1974 b) nor the frequency of wound infection (Paskin & Lerner 1969, Jackson et al. 1971).

Antibiotics

Approximately one third of the patients in this retrospective study received antibiotics on the basis of apparent need, not on an alternate basis. The striking feature was a significantly higher frequency of wound infections after lower extremity osteosynthesis when the patients were given antibiotics postoperatively. This is in line with earlier retrospective studies (Tachdjian & Compere 1957, Derian & Green 1966), but is also seen in prospective investigations (Sanchez-Ubeda et al. 1958, Scales et al. 1972). Preventive antibiotic treatment, however, should not be abandoned, but timed correctly in relation to the operation, i.e. per- and preoperatively (Eftekhar 1973, Ruedy 1973); adequate concentrations of antibiotics could then be built up in the wound tissue (Raahave 1975 b) to combat bacterial contamination at the moment it occurs (Burke 1961). This has been confirmed in recent clinical trials of hip surgery (Fogelberg et al. 1970, Boyd et al. 1973, Ericsson et

al. 1973). When administered intravenously, antibiotics might also counteract episodes of bacteriaemia from infectious foci, thus preventing bacterial inoculation into the operation wound by the haematogenous route. In the case of bloodless osteosynthesis in the extremities, sufficient amounts of antibiotics should be given in time to ensure an adequate level in the operation wound, since no further antibiotic would be carried to the wound at the time of operation.

This study suggests a need for preventive treatment with antibiotics at the time of osteosynthesis in the lower extremity, in particular the hip and ankle, whereas this seems unnecessary for osteosynthesis or removal in the upper extremity.

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