Acta orthop. scand. 45, 161–169, 1974

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POST-OPERATIVE WOUND INFECTIONS IN CLEAN ORTHOPAEDIC SURGERY

Review of a 5-year material

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Accepted 16.viii.73

In the analysis of postoperative infections it is important to compare not only the overall infection rate but also the incidence of infections after each type of operation. Kocher (1899) reported a postoperative wound infection rate of 2.3 per cent. This figure is remarkably similar to the postoperative wound infection rates today. However, this similarity is misleading because it does not take into account the different types of surgical patients involved, together with the more extensive surgical procedures and the introduction of new osteosynthetic materials today. The development of new antibiotics continually changes the bacterial spectra and also the nature of infection. Therefore, in order for it to be possible to prevent and to treat these infections they must be thoroughly followed and analysed.

This paper reporting postoperative infections is one of a series (Lidgren & Lindberg 1972 a, b, 1973, Lidgren 1973 a, b) based on a 5-year material of orthopaedic infections encountered in a population of a quarter of a million.

MATERIAL AND METHODS

During the 5-year period 1963 through 1967 all patients with orthopaedic infections at the Department of Orthopaedic Surgery, Malmö General Hospital, were subjected to analysis. This 1,500 bed hospital is the only hospital for somatic diseases for the population of Malmö (241,778 inhabitants Dec. 31, 1963 and 254,338 inhabitants Dec. 31, 1967) and is therefore suitable for an epidemiologic study (Lidgren & Lindberg 1972 a). The Department of Orthopaedic Surgery has 150 beds and is responsible for both classic orthopaedics and fracture surgery.

During the entire 5-year period of investigation 5,724 clean operations were performed on inpatients. The postoperative infections were recorded as major or minor (Lidgren & Lindberg 1972 a). Starting in 1965 data on all patients were stored in a computer. During the 3-year period 1965–1967, 3,617 clean operations were performed. All patients during that latter period could therefore be compared as regards sex, age, diagnosis, anatomic location, type of operation and duration of stay in hospital.

Material from infected wounds or joints was obtained for culture. In those cases where bacterial cultures were negative or not performed the postoperative infection was diagnosed on the basis of local inflammation, the clinical course, elevated E.S.R., positive serological findings, prompt response to antibiotics etc. The courses of the infections were analysed and notes were made as to whether the bacteria had been susceptible to the antibiotic given initially.

Toward the end of 1972 all of the hospital records were studied to find out whether the infections had had any demonstrable effect on the late results of the operations. Patients with bacterial arthritis (Lidgren & Lindberg 1973) and chronic osteitis (Lidgren & Lindberg, to be published) were reviewed during 1971–1972 clinically and radiographically.

The results of the operations were regarded as having been spoiled by the infection if;

1. an endoprosthesis had to be removed, 2. osteosynthetic material had to be removed before a fracture or osteotomy had healed, 3. chronic osteitis had developed, 4. bacterial arthritis had resulted in destruction of a joint, 5. deformity had occurred as a late consequence of infection and/or because of disturbed growth, 6. function was impaired as a direct consequence of the infection.

Statistical methods

The statistical analysis was performed in co-qperation with Peter Vorwerk of the Department of Mathematic Statistics at the University of Lund. The methods used were chi-squared tests. When comparing anatomic locations, each of eleven subset groups were compared with the remaining material by single chi-square tests, and high risk and low risk groups, respectively, were determined. The tests were made simultaneously by multiplying the individual significance levels by eleven. When comparing different types of operations, high and low risk groups, respectively, were determined by simultaneous tests for seven groups of operations.

RESULTS

In 1963 through 1967 a total of 5,724 clean operations were performed on inpatients. Of these, 185 (3.2 per cent) became infected and in 107 (1.9 per cent) the infection was classified as major. During the last three years of this eriod 3,617 clean operations were performed and infection occurred in 131 (3.6 per cent) including 75 (2.1 per cent) in whom the infections were classified as major. The incidence of infections in relation to sex and age is shown in Table 1.

The frequency of postoperative infections increased significantly with age ($X^2 = 69$, df $= 4$) ($P < 0.001$) from less than 0.5 per cent below age 25 to close to 9 per cent above age 75. However, within the group of 219 cases of trochanteric femoral fracture operated with nail and plate with 32 (15 per cent) postoperative infections, no increase in the infection rate with age was found; only 40 patients were below age 65. The age corrected incidence of infection was the same in males and females ($X^2 = 5.3$, 4, $P > 0.05$).

Table 1. Age and sex distribution of patients with postoperative infections in Malmö 1965–1967.

Age	Males		Females		Total			
	Number of operations	Number infections	Number of operations	Number infections	Number of operations	Number infections	Major infections	% infections
0–14	122	0	66	0	188	0	0	0
15–24	250	2	95	1	345	3	1	0.9
25–44	552	10	250	6	802	16	7	2.0
45–64	679	24	630	13	1309	37	24	2.8
65–74	158	12	323	19	481	31	15	6.4
75 and older	113	7	379	37	492	44	28	8.9
Total	1874	55	1743	76	3617	131	75	3.6

The difference in figures between the tables is because of data-technical faults which have not been possible to correct.

In Table 2 the distribution of postoperative infections among anatomic locations during 1965 through 1967 in our investigation is compared with three earlier reports. The hip region ($P < 0.001$) was found to be a high-risk location, the spine ($P < 0.05$) and the knee joint ($P < 0.01$) were low-risk locations. The correlation of postoperative infection with different types of operation showed that the use of osteosynthetic material ($P < 0.001$) carried a higher risk (Table 3). Of the 72 arthroplasties performed, 62 were Moore prostheses with 7 infections (5 major). The remaining 10 were Smith-Petersen arthroplasties with 2 minor infections.

Bacterial cultures were available in 160 of the 185 cases; in seven cases no culture was performed. In 107 (67 per cent) Staph. aureus was the only pathogenic bacterium and in 23 others it was associated

with other bacteria. In 84 (65 per cent) of these 130 cases the bacteria were found to be resistant to penicillin already at the first culture. Twelve patients received no antibiotics because the infection had healed before the bacteriologists report had been received. In 57 (32 per cent) of the remaining 148 cases the pathogenic bacterium was not sensitive to the primary antibiotic given. A closer analysis of the bacteriology will be published separately (Ericson & Lidgren, to be published).

Table 2. Anatomical distribution of operations and infections.

Region	Tachdjian & Compere 1952–1957		Räf 1959–1962		Stevens 1960		Own investigation 1965–1967		
	Number of operations	Number of infections	Number of operations	Number of infections	Number of operations	Number of infections	Number of operations	Number of infections	Major infections
Spine	566	7	288	15	173	8	510	6	0
Hip	401	14	528	31	321	14	1010	76	18
Thigh	160	1	241	11	68	4	123	6	4
Knee	316	3			181	4	667	8	2
Leg	178	4	183	5	63	4	278	7	4
Ankle	120	2			67	1	292	3	2
Foot	551	7	481	13	131	7	163	6	4
Neck	48	0	–	–	8	0	–	–	–
Shoulder: clac. scapula	108	2	124	0	28	1	62	2	1
Arm	91	0			24	1	31	2	2
Elbow	118	1			54	2	50	1	1
Forearm	128	1			72	6	110	1	1
Wrist	55	1			30	0	2	0	0
Hand	161	1			59	4			
Thorax	–	–	–	–	2	0	–	–	–
Pelvis	–	–	–	–	7	0	11	1	1
Miscellaneous	–	–	80	0	–	–	518	12	5

In 48 cases (26 per cent of all infections), the infection was considered to have spoiled the results of the operation, and in 32 of these osteosynthetic material had been used. In 42 of the 48 cases with spoiled results the location was in the lower extremities. Twenty-four

of these were in the hip region. Eight were cervical (all subjected to open reposition) and 11 trochanteric femoral fractures. In seven cases the condition of the patient was so severe before the operation, however, that the effect, if any, of the infection could not be assessed with certainty. In 130 cases the infection had not affected the late result. In only one case was the infection the direct cause of death.

Table 3. Distribution of postoperative infections in different types of operations, Malmö 1965–1967.

	Number of operations	With post-operative infections	Major infections
Amputations	155	5	1
Arthrodesis with osteosynthetic material	46	1	1
Arthrodesis without osteosynthetic material	38	1	1
Arthroplasties with endoprosthesis	72	9	5
Arthrotomy	665	16	6
Open reduction of fracture with osteosynthetic material	1143	61	43
Open reduction of fracture without osteosynthetic material	42	3	3
Osteotomy with osteosynthetic material	64	8	4
Osteotomy without osteosynthetic material	91	0	0
Removal of osteosynthetic material	178	4	3
Spine operations including disc herniation	487	6	0
Miscellaneous	665	17	8
Total	3787	131	75

DISCUSSION

The widening of the indications for operations to include patients classified as poor surgical risks and the introduction of new osteosynthetic material is apt to give a false impression that the frequency of post-operative infections is unchanged. In the beginning of the era of so called aseptic surgery, poor risk patients were operated upon only exceptionally because of the risks involved with anaesthesia and inadequate knowledge of the fluid electrolyte balance, heart and renal function. We can now carry almost all poor surgical risks through an operation but we still have difficulties in keeping the risk of infection down to a reasonable level.

Infection rate

The overall postoperative wound infection rate in clean orthopaedic surgery varies between 0.7 per cent (Jeljaszewicz & Bobr 1968) and 8.8 per cent (O'Riordan et al. 1972). In most investigations it is between 2–5 per cent (Henderson & Kornblum 1961, Schonholtz et al. 1962, Maguire 1964, Räf 1964, Stevens 1964, Towers 1965, Dencker 1965, Derian & Green 1966, Annals of Surgery 1964, Jeffrey & Sklaroff 1968, Zifko & Vlasich 1968, Bruun 1970). About half of the infections have been recorded as major (Tachdjian & Compere 1957, Maguire 1964, Räf 1964, Derian & Green 1966, O'Riordan et al. 1972). In our material the overall infection rate was 3.2 per cent and in 1.9 per cent the infection was classified as major. This does not differ from what has been reported by other authors.

Anatomic location

In three earlier series (Table 2) the frequency of postoperative infection was reported with respect to anatomic locations. Tachdjian & Compere (1957) found a significantly higher infection rate after operation in the hip region and Räf (1965) a significantly higher frequency after operation in the spine, hip and thigh region. Stevens (1964) compared different regions but found no difference. In our material the frequency of infection was particularly high in the hip region and low in the spine.

Type of operation

Stevens (1964) found a clear increase in the frequency of infection in association with the insertion of osteosynthetic material and doubling of the frequency when two or more operations were performed at the same time. The use of osteosynthetic material was also associated in our material with a significantly increased frequency of infection. Insertion of osteosynthetic material in the often more complicated cases with a foreign body effect may possibly explain the increase of infections in these patients. However, this does not imply that there would have been a lower infection rate if osteosynthetic material had not been used.

Late result of the infection

In 26 per cent of our cases the infection spoiled the operation. In two-thirds of these osteosynthetic material was used. In one previous

report (Räf 1964) the final result of the postoperative infection in orthopaedic surgery has been analysed; in 37 per cent of his cases with postoperative infection the result was spoiled. In our material only one patient died as a direct cause of the postoperative infection.

A large number of factors believed to increase the frequency of postoperative infection have been analysed by several investigators. In a few investigations attempts have been made statistically to correct for possible interfering background factors. An increase of postoperative infections has thus been shown with age, duration of preoperative hospitalisation, co-existing infection elsewhere (e.g. of the nose, skin, urinary tract), type of preoperative washing, duration of operation, length of incision, drainage, the number of persons present in the operating theatre, the time of the day the operations are performed. (Lancet 1960, Hendersen & Kornblum 1961, Annals of Surgery 1964, Räf 1964, Stevens 1964, Gillquist 1967, Jeljaszewicz & Bobr 1968, Bruun 1970). Annals of Surgery (1964) reported a significant increase of postoperative infections in patients with malnutrition, overweight, diabetes and patients undergoing steroid treatment while Stevens (1964) and Bruun (1970) found no increase for these. We have previously reported that the incidence of postoperative infections in patients with diabetes (Lidgren 1973 a) or rheumatoid arthritis (Lidgren 1973 b) was not increased.

In this material the following parameters have been analysed; age, anatomical locations and type of operation. Within a group of trochanteric femoral fractures no increase in the incidence of postoperative infections with increasing age could be found. It is clear, however, that operations in the hip region together with insertion of osteosynthetic material not only significantly increase the incidence of postoperative infection but also account for no less than 60 per cent of all postoperative infections and half of the spoiled results after operation. Strictly aseptic routine in major hip operations seems highly necessary. In these operations special procedures such as steril enclosure (Charnley 1972) or even limited antibiotic prophylactic treatment (Ericson et al. 1973, Lidgren & Lindberg 1973 b) are clearly indicated.

SUMMARY

A prospective study of 185 (3.2 per cent) postoperative infections in 5,724 clean orthopaedic operations during a 5-year period is reported.

107 of the infections were classified as major. Analysis of the anatomic location and the type of operation showed that the incidence of infection was highest for operations in hip regions. Staphylococcus aureus was the only pathogenic bacteria in 107 cases (67 per cent). In 57 (32 per cent) the pathogenic bacteria was not susceptible to the primary antibiotic given. Only one patient died of the infection but the late result of the operation was spoiled by infection in one-fourth of the cases. Various factors affecting the frequency of postoperative infections are discussed.

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