Acta orthop. Scandinav. 43, 325–334, 1972

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# ORTHOPAEDIC INFECTIONS DURING A 5-YEAR PERIOD

*Analysis of a Patient Material from an Orthopaedic Clinic 1963–1967*

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Orthopaedic infections, i.e. infections of the bones and joints, often extending to the surrounding soft tissues, have long been regarded as being a class by themselves because they often become chronic and frequently result in permanent disability. Though modern advances in medicine have not succeeded in substantially changing this situation, these infections should be carefully followed because the successive development of new antibiotics and new surgical methods are continuously changing their character.

At present most interest is concentrated on the postoperative infections and it is often forgotten that also the treatment of recent, haematogenous and traumatic infections, as well as chronic orthopaedic infections, fall within the activity of an orthopaedic department. These infections offer considerable therapeutic problems and constitute a source of infection that should be borne in mind when planning prophylactic measures.

The purpose of this article, which is the first one in a series about orthopaedic infections, is to classify all the infections seen at a Swedish department of orthopaedic surgery during a 5-year period (1963–1967) in respect of origin, age, sex distribution and site and to compare the material in certain respects with an uninfected series.

## MATERIALS AND METHODS

The investigation was carried out at the Department of Orthopaedic Surgery, Malmö General Hospital. For several reasons given in earlier publications, (Danielsson 1964, Berge & Lundberg 1970) the city of Malmö is particularly suitable for epidemiological studies of disease. The hospital is the only one in the city for somatic diseases and the orthopaedic clinic takes care of all orthopaedic diseases, including fractures and infections. The only two exceptions are lesions of the

hand and most infections in small children, which are treated at other departments. The investigation should therefore permit a representative survey of the orthopaedic infections in a Swedish city of this size (241,778 inhabitants as of January 1, 1963 and 254,338 inhabitants as of January 1, 1967).

During 1963–1967 altogether 9,948 patients were admitted to the department. Of the patients admitted during these years 357 were recorded as infected, these patients form the probands of the present investigation.

Patients with diabetic or arteriosclerotic gangrene of the lower limbs are excluded from this report, as this disease was the subject of a special investigation (Tibell, to be published).

*Statistical Analysis*

Statistical treatment of the data was performed in cooperation with Peter Vorwerk and Georg Lindgren of the Department of Mathematical Statistics, University of Lund. The statistical analysis is based on chi-square tests.

Patient data from 1965 from Malmö General Hospital were processed in a computer. From these processed data it was possible to select a normal series consisting of all non-infected patients admitted to the orthopaedic clinic in 1965–1967. Comparison between the normal series and patients infected in the same years was therefore possible regarding sex, age, site of infection and data concerning operations.

*Severity of Infection*

All cases with clinical signs of infection of the skin, subcutaneous tissues, muscles or structures belonging to the bones and joints were recorded as infections. The severity of the infections recorded therefore varied widely. In some previous investigations of postoperative infection the infections have been classified as major and minor (Tachdjiin & Compere 1957, Howe 1956, Schonholtz et al. 1962, Derian & Green 1966) or as severe, moderate and minor (Jeffrey & Sklaroff 1958, Maguire 1964, Räf 1964). Though such classification may be biased by the examiner's opinion and by how effectively the infection was treated, in investigations of this type it is desirable to distinguish between refractory infections and infections readily responding to treatment.

Here infections were classified as major when (1) they threatened or spoiled the results of operation, or (2) discharged exudate for at least 1 month, or (3) prolonged the patient's stay in hospital by at least 1 month. (4) In addition, all cases of osteomyelitis, including spondylitis) and infectious arthritis were assigned to this group. 214 infections were classified as major and 143 as minor.

## RESULTS

The patients from 1963–1967 are classified according to sex, age and major infections in Table 1. It is clear from the table that the sex distribution of the infections was largely equal and that the females were significantly older than the males ($p < 0.001$, $df = 4$, in the analysis the ages have been treated as one group). The distribution of major and minor infections did not vary significantly with sex. Distribution of infections according to origin is given in Table 2.

*Table 1. Age and sex distribution of infected patients and age distribution of patients with major infections in 1963–1967.*

| Age | No. infected males | No. infected females | Total no. of infections | Major infections |
|---|---|---|---|---|
| 0–16* | 6 | 2 | 8 | 5 |
| 17–24 | 17 | 5 | 22 | 14 |
| 25–44 | 53 | 16 | 69 | 35 |
| 45–64 | 68 | 46 | 114 | 78 |
| 65–74 | 26 | 38 | 64 | 38 |
| ≥ 75 | 14 | 66 | 80 | 44 |
| | 184 | 173 | 357 | 214 |

* 16 years has been chosen as the limit to adult age (Trueta 1959).

*Table 2. Distribution of infections according to origin 1963–1967.*

| | |
|---|---|
| Haematogenous | 44 |
| Traumatic | 44 |
| Postoperative from previous years | 26 |
| Postoperative 1963–1967 | 185 |
| After injection into joint | 8* |
| Doubtful origin | 4* |
| | 357 |

* These 12 cases will not be included in the further analysis and discussion of the results.

*Table 3. Age and sex distribution of patients with haematogenous infections in 1963–1967.*

| Age | Males | Females | Total |
|---|---|---|---|
| 0–16 | 4 | 2 | 6 |
| 17–24 | 1 | 3 | 4 |
| 25–44 | 5 | 1 | 6 |
| 45–64 | 9 | 10 | 19 |
| 65–74 | 2 | 3 | 5 |
| | 22 | 22 | 44 |

### *Haematogenous Infections*

Forty-four patients with haematogenous infections were admitted to the department in 1963–1967. Of these, the clinical onset fell within the years 1963–1967 in 29, while in 15 it dated back to 1962 or still further.

The distribution of the patients according to age, sex and number of major infections is given in Table 3. The patients' age at the onset of haematogenous infection distributed among diagnoses is given in Table 4. All haematogenous infections except 6 of the soft tissue infections were classified as major infections.

*Table 4. Distribution of haematogenous infections according to age at onset and diagnoses.*

| Age at onset | Diagnoses | | | | |
|---|---|---|---|---|---|
| | Osteomyelitis | Arthritis | Spondylitis | Soft tissue infection | Total |
| 0–16 | 9 | 3 | 0 | 2 | 14 |
| 17–65 | 8 | 7 | 6 | 4 | 25 |
| ≥ 65 | 1 | 2 | 1 | 1 | 5 |
| Total | 18 | 12 | 7 | 7 | 44 |

*Traumatic Infections*

Between 1963–1967 altogether 90 patients were admitted with infections caused by trauma other than operations. 74 of the infections occurred in 1963–1967, while the remaining 16 were recurrences or infections contracted earlier but not yet healed. The distribution of the diagnoses is given below.

*Osteomyelitis:* 7 cases, in all of which the onset dated back to 1957 or still further. All of the patients were admitted to hospital because of "spontaneous recurrences".

*Open fractures:* 18 cases, including 1 fracture of the upper limb and the remaining 17 of lower limbs. In 2 of the cases there was also an open joint wound.

*Large, recent lacerations:* 10 cases, including 2 of the upper limbs and 7 of the lower limbs. Surgical treatment consisted of amputation in 8 cases. Of the upper arm in 1, of the forearm in 1, of the lower leg in 2, of the upper femur in 2, of the foot in 1 and of a toe in 1.

*Soft tissue injuries, "clean" on admission to hospital:* 7 cases. These injuries consisted of open ruptures of the Achilles tendon in 2 cases, soft tissue injuries of the lower leg in 2, near the knee joint in 1 and hand injuries in 2.

*Soft tissue injuries, "infected" on admission to hospital:* 48 cases. This group included different soft tissue infections, mostly infected and inadequately treated wounds, 7 cases of bacterial bursitis and 14 cases of decubital ulcers that had developed during hospitalisation.

*Table 5. Number of patients with infected and with uninfected open wounds 1965–1967.*

| | 0–16 | 17–24 | 25–44 | 45–64 | 65–74 | ≥ 75 | Total |
|---|---|---|---|---|---|---|---|
| | | | | Age groups | | | |
| Non-inf. | 13 | 26 | 25 | 25 | 8 | 4 | 101 |
| Inf. | 1 | 7 | 14 | 14 | 6 | 10 | 52 |
| Fraction infected | 0.07 | 0.21 | 0.36 | 0.36 | 0.43 | 0.71 | 0.34 |

*Table 6. Age and sex distribution of patients with postoperative infections in 1965–1967.*

| Age | Males | | Females | | Total | | | |
|---|---|---|---|---|---|---|---|---|
| | No. of op. | No. infect. | No. of op. | No. infect. | No. of op. | No. infect. | Major infect. | % infect. |
| 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 | 113 | 7 | 379 | 37 | 492 | 44 | 28 | 8.9 |
| Total | 1874 | 55 | 1733 | 76 | 3617 | 131 | 75 | 3.6 |

* The age group 0–14 years had to be chosen instead of 0–16 years when processing these data in the computer.

The number of patients with infected and with uninfected open wounds 1965–1967 (page 326) and their distribution according to age groups are given in Table 5. The group of 153 open wounds accounted for in Table 5 consisted of 67 open fractures, of which 10 became infected (6 major infections), 9 open joint wounds, of which 2 became infected (both major infections), and 77 soft tissue injuries, of which 40 became infected (6 major infections).

*Postoperative Infections*

Of the 211 postoperative infections, only 185 were referable to the period covered by the present investigation. The remaining 26 cases were recurrences or infections that had started earlier and had not yet healed.

In 1963–1967 altogether 5,724 "clean operations" were performed on inpatients. Of these 185 (3.2 per cent) were infected and in 107 (1.9 per cent) of them the infections were classified as "major".

For technical reasons (page 326) the material can only be analysed and compared with uninfected operations for the years 1965–1967. During this period 3,617 "clean operations" were performed and in 131 cases (3.6 per cent) the wounds were infected, including 75 (2.1 per cent) classified as "major infections".

The distribution of the number of operations and postoperative infections according to sex and patients' ages is given in Table 6. A closer analysis of the postoperative infections in the present material will be the subject of a separate article.

*Mortality*

Of the 357 patients with infections in 1963–1967, 55 had died by January 1, 1970. The average age at death of those who were autopsied was 71.6 ± 15.3 years.

38 of the patients who died were women, which corresponds well with the large number of women in the high age groups. In 39 cases the infections were postoperative, in 11 traumatic and in 5 haematogenous. It was not possible to find out in how many of these patients the infection really was healed.

Only in 2 cases was the orthopaedic infection apparently the cause of death. In the first case a fulminant staphylococcal sepsis had originated from an abscess in the region of the trochanter after nailing of a femoral neck fracture in a 78-year-old man. The second patient was a 36-year-old man who had been paraplegic after a transverse injury of the spinal cord at the age of 17. Nine years later the patient contracted a haematogenous infection of the hip, which caused progressive amyloidosis, resulting in uraemia and death. Histologically, there was widespread amyloidosis, especially in the kidneys, but also in the liver, spleen and vessels.

In 2 other cases the infections were a contributory cause of death—in 1 with deep decubital ulcers penetrating into the sacrum in a severely deterioriated 76-year-old woman. The next case was a 71-year-old woman with a haematogenous, large abscess in the region of the right trochanter and generalised, though not very severe, amyloidosis, pronounced arteriosclerosis and chronic pyelonephritis with necrosis of the papillary tips.

In the remaining cases the infections seem not to have contributed significantly to death.

## DISCUSSION

### *Haematogenous Infections*

Of particular interest is the high frequency of infections (Tables 3 and 4) appearing in adults, i.e. in patients above 16 years (Trueta 1959). *Haematogenous osteomyelitis* has justly been regarded as being mainly a disease of childhood. Thus, as many as 85 per cent of the patients in the series published by Trueta (1959) and by Winters & Cahen (1960) were children. As a rule, the disease was also of the acute form. In recent years this classical, acute form of haematogenous osteomyelitis has become less common, whereas the more insidious primary-chronic form has become more frequent (Winters & Cahen 1960, Harris & Kirkaldy-Willis 1967, Editorials in *British Medical Journal* 1967, 1969). At the same time the onset has tended to shift towards higher ages (Bell 1968, Waldvogel et al. 1970). The observation of this shift is so recent and has apparently received such little attention that as late as 1967 it was stated in an editorial comment of the *British Medical Journal* that "osteomyelitis in the adult form from a cause other than injury" is regarded as "extremely rare".

The finding in this series of 37 cases of haematogenous bone and joint infections that 25 of the patients were adults corroborates the shift in age at onset, even though 7 such cases had been seen at the same time at the Department of Paediatrics of Malmö General Hospital.

It is sometimes stated that *haematogenous arthritis* is more common among children than among adults (Balboni 1966). But perusal of the literature failed to reveal any evidence in support of such a belief, except in newborns. Published series of haematogenous arthritis vary widely in composition with the department where they are collected, i.e. orthopaedic or paediatric. According to Kelly et al. (1965), haematogenous arthritis is becoming more common in adults.

The figures given in less recent literature for the ratio between the frequencies of *septic spondylitis* in children and adults must be regarded as uncertain, because formerly the possibilities of differentiating the condition from tuberculous spondylitis were poor. It is therefore not possible to say whether any difference in the above ratio has occurred of late. Judging from personal unpublished observations, septic spondylitis is most common in adults.

The origin of the 7 cases of soft tissue infections classified as haematogenous is somewhat obscure, but no trauma could be traced in the patients' histories. Haematogenous soft tissue infections have also been reported by Waldvogel et al. (1970).

*Traumatic Infections*

This group comprises the infections due to external trauma except the postoperative infections. The group is heterogenous and therefore less suited for closer analysis. The composition of a given series will also vary with the local conditions prevailing at a given hospital and its catering area, and this group of infections is seldom treated as a separate group in the literature (Rockwood & O'Donoghue (1962).

Of the patients with open fractures and joint injuries admitted immediately after the accident, about 15 per cent become infected. The corresponding figure for patients with soft tissue injuries was about 50 per cent. The reason why this figure was so high was due mainly to the fact that these injuries were already infected before admission and that the patients were admitted to have their infection treated.

*Postoperative Infections*

A closer analysis of the postoperative infections will be the subject of a forthcoming paper. Therefore only the age and sex distribution of the infections are given here (Table 6).

In previous papers on postoperative infections in patients who had undergone "clean orthopaedic operations" and in which all types of operation were included, the frequency of infections ranged between 0.7 per cent and 6.2 per cent (Gillqvist 1967, Jeljaszewicz & Bóbr 1968). In most investigations it varied between 2 and 5 per cent (Tachdjian & Compere 1957, Jeffrey & Sclaroff 1958, Henderson & Kornblum 1961, Schonholtz et al. 1962, Räf 1964, Maguire 1964, *Ann. Surg.* 1964, Stevens 1964, Towers 1965, Derian & Green 1966, Zifko & Vlasich 1968). About one-half of the infections were noted as "major" (Tachdjian & Compere 1957, Maguire 1964, Räf 1964, Derian & Green 1966). In the present investigation, then, the total frequency (3.2–3.8 per cent) and the frequency of "major infections" (1.9–2.2 per cent) did not vary from those seen at most other departments.

*Mortality*

Of particular interest is the low mortality claimed by the orthopaedic infections. Only one patient died from an acute infection and only one from a chronic infection. Most of the other deaths were due to advanced age and geriatric diseases. The acute infections with life-threatening systemic symptoms were controlled with the aid of antibiotics, as is reflected in the low infection mortality. On the other hand, antibiotic therapy was often unable to prevent the infections

from causing permanent disability. Those cases will be reported in forthcoming papers.

SUMMARY

All patients with "orthopaedic infections" admitted to an orthopaedic department during the period 1963–1967 were classified with respect to origin, age and sex distribution, the site of infection and in certain respects compared with the non-infected patient material from the same time. The total number of infections was 357. Thirty of the 44 haematogenous infections were found to have appeared in adults; 90 infections were caused by trauma other than operation; 185 infections were caused by "clean operations", corresponding to 3.2 per cent postoperative infections; 107 of the postoperative infections were classified as severe. Only in 2 cases was the orthopaedic infection apparently the cause of death.

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