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TREATMENT OF CHRONIC OSTEOMYELITIS

A Prospective Study of 55 Cases Treated with Radical Surgery and Primary Wound Closure

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A prospective and consecutive series of 55 patients were treated for chronic osteomyelitis occurring mainly in the lower extremity and after fractures treated with internal fixation. The mean duration of osteomyelitis was 27 months. Sixty-five per cent had previously undergone operations and had been hospitalized for an average of 131 days. Staphylococcus aureus was cultured in 72 per cent of the cases as the solitary agent. In 6 cases no bacteria were found. The remaining cases had more than one species. The treatment consisted of radical operation, removal of all internal fixation, sequestrectomy, partial decortication and primary wound closure with suction drainage. External fixation was used for bone stabilization. In 13 cases plastic procedures were carried out. Antibiotics appropriate for the sensitivity patterns were given for a maximum of 3 months. Primary wound healing was obtained in 98 per cent of the cases. In practically all cases the sedimentation rate normalized within 4 weeks after the operation. The results in the available literature indicate that radical operation is effective in the treatment of osteomyelitis and this treatment seems economical as regards hospitalization time and quantity of antibiotics required

Key words: chronic osteomyelitis; closed suction drainage; hospitalization time; primary wound closure; radical operation; short-term antibiotics

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Today osteomyelitis is one of the most serious problems confronting orthopaedic surgery because of the increasing number of open fractures, open osteosyntheses and joint prostheses inserted. It also involves a high level of social expenditure, as it entails long periods of confinement in hospital and costly antibiotics.

The purpose of this study is to report a 3-year prospective and consecutive survey of examinations and principles of treatment for chronic osteomyelitis carried out at the Department of Orthopaedic Surgery, Odense University Hospital.

In 1976 we drew up the following treatment protocol.

1. Preliminary treatment of the patient. This was to include informing the patient and increasing motivation for the possible long duration of treatment. All possible foci of infection elsewhere in the patient were to be eliminated. Concomitant diseases such as heart and lung insufficiency, diabetes, etc., which could adversely affect the course of healing were to be dealt with prior to the operation. For several days before operation regional skin treatment with Hibitane® ointment was to be given.

2. Topographical and microbiological diagnosis. Adequate X-ray examination was to be performed, including tomography, fistulography

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and, if necessary, scintigraphy. The microbiological diagnosis was to be derived from cultures from fistula, and aspirations from bone sinuses and venous blood were also to be tested. If the responsible microbe was known, appropriate antibiotics were to be given 24 hours before the operation. If the microbe was unknown, samples from the infected area including bone samples sufficient for culture were to be taken during the operation, and antibiotics administered peroperatively.

3. Radical operation. Methylene blue was to be instilled in fistula and cavities colouring all devitalized tissue blue. A radical excision of all devitalized soft tissue was to be carried out. Implants were to be removed as well as any sequestra and all devitalized bone tissue, until spot bleeding from the cortical vessels was seen from the edges of the resection. In the case of bone defects, or when osteogeneous stimulation was required, cancellous bone or periosteum transplantation was to be carried out as part of the same procedure and covered with transposed muscle to reinforce blood circulation in the area. In cases of bone instability external fixation was to be performed. The wound was to be covered with skin primarily by suturing, or by some type of plastic procedure.

4. Postoperative treatment. An adequate number of closed suction drains were to be applied and removed successively by retracting them a distance of 1 cm per day, beginning when there was less than 2 ml of secretion per 24 hours. Samples for bacteriological sensitivity tests were to be taken from the suction drains every 3 days. As a rule the wound was not to be dressed, but cleaned with Iodophorm® once a day. The patient was to be confined to bed for 1 or 2 weeks and then be mobilized, with the aid of supporting devices if necessary. Appropriate antibiotics were to be given for a maximum of 3 months only.

PATIENTS

A series of 58 patients were admitted to our department suffering from chronic osteomyelitis during the 3-year period from 1976 to 1979. Three patients were not operated on because the presence of severe concomitant diseases. Of the remaining 55 consecutive patients, 42 were males, and 13 females, the youngest being 15 years, the oldest 91 years. The average age was 41 years. Eight patients were over 70 years of age. From an aetiological point of view the infection was endogenous in 5 patients (Table 1), and exogenous, i.e. due to bone fractures, in 50 patients. In 21 patients (42.0 per cent) the infection was connected with open fractures. Five of the fractures, all of them open, had been treated conservatively with plaster of Paris, and another 5 patients had an external fixation *ad modum* Hoffmann. Forty patients, among them 11 with open fractures, had some type of internal fixation.

Prior to the radical operation, the patients had suffered from the bone infection for a minimum of 3 months and for a maximum of 540 months, an average of 27 months (Table 2). Forty-nine patients (89.1 per cent) had previously spent an average of 134 days in hospital because of the bone infection. Thirty-five (63.6 per cent) of the patients had previously undergone from one to six operations for the osteomyelitis.

Table 1. Localization and type of infection in 55 patients with chronic osteomyelitis (Figures in bracket = after open fractures)

	Endogenous/ (haematogenous)	Exogenous/ (following fractures)	
Femoral neck		9	
Femoral shaft	2	19	(2)
Tibia	1	16	(14)
Foot		2	(2)
Humerus	2	2	(2)
Ulna		1	(1)
	5	50	(21)

Table 2. Duration of infection, previous stay in hospital and number of previous operations for chronic osteomyelitis before radical operation in a consecutive series of 55 patients

	No. of patients	Mean	Range
Duration of infection	55	27 months	3–540 months
Previous stay in hospital	49	134 days	10–695 days
No. of previous operations	35	2.5	1–6

RESULTS

Twenty-nine patients had metal implants after primary fracture treatment. In 34 (61.8 per cent) of the infected bones sequestra were demonstrated. Preoperative and peroperative samples showed positive bacteria cultures in 49 patients (89.1 per cent). In 26 of the patients (47.3 per cent) only one type of bacteria was cultured from the infected bone, and in 24 (43.6 per cent) more than one type was cultured. In 5 patients (9.1 per cent) no bacteria could be cultured even from postoperative suction drains in spite of repeat cultivations. The bacteria cultured are listed in Table 3.

Antibiotics were given, in accordance with the pattern of the sensitivity test, for a maximum of 3 months. In 42 cases (76.4 per cent) the strains of bacteria were sensitive to methicillin or penicillin. Streptomycin was added in another 8 cases because of mixed infection. The same combination of antibiotics was given to 3 out of the 5 cases with negative cultures. A total of 47 patients (85.5 per cent) were treated in this way with conventional antibiotics. The remaining 8 patients (14.5 per cent) were given some other antibiotics. In this series there were no serious side-effects requiring discontinuation of the prescribed drug.

There were no patients in which one single surgical technique proved to be satisfactory. Various operative procedures had to be used in combination (Table 4). Metal implants and obvious sequestra were removed as part of all radical operations as planned. In 48 cases (87.3 per cent) various degrees of decortication were carried out. In two cases with diffuse infection of the femur antero-lateral decortication was performed for the full length of the bone, and the medullary canal was cleaned and filled with the sartorius muscle. In 10 cases (18.1 per cent) cancellous bone transplantation was performed to reinforce osteogenesis, not for the sake of stabilization.

Table 3. Bacteria cultured from 50 out of 55 infected bones. In 5 cases no bacteria were cultured

	No. of pts.
Staphylococcus aureus	42
Micrococcus not aureus	16
Streptococcus	3
Escherichia coli	3
Proteus vulgaris	2
Pseudomonas aeruginosa	4
Miscellaneous	5

Table 4. Operative procedures during radical operation in 55 patients with chronic osteomyelitis

	No. of pts.
Removal of implant	29
Removal of sequestra	34
Decortication	48
Bone transplant	10
Periost transplant	3
Muscle transposition	10
Primary skin suture	45
Skin transplant	8
Cross-leg graft	2
Amputation	1

Primary skin suture was possible in 45 cases (81.8 per cent), in some cases after skin incision to relieve tension. In 8 cases the wounds were covered with split-skin grafts and in another 2 cases with cross-leg grafts.

One patient, a 72-year-old man, had to be amputated. He developed osteomyelitis following internal fixation after supracondylar fracture of the right femur. On admission to our department his right knee had a 30-degree flexion contracture, and there were signs of arteriosclerotic gangrene on the toes. The initial choice of treatment was an above-knee amputation.

Closed suction drainage for 5 to 28 days (average 8 days) was used in all cases. Suction drainage used in this way did not cause any complications.

In 33 patients (60.0 per cent) the bone operated on was stable. External fixation *ad modum.* Hoffmann was applied in 11 cases, including 2 with cross-leg grafts. In 4 patients with bone instability and osteomyelitis of the femoral shaft, closed medullary nailing was performed 4 weeks after the radical operation, when there were no signs of infection. In 7 patients various forms of external support had to be applied for a certain period of time.

The follow-up period was 38 months on average (range 28–52). At that time there were no

signs of infection or bone instability. There was primary wound healing within 2 weeks in 49 patients and within 4 weeks in another 5 patients, equalling 98.1 per cent. In one patient the wound did not heal until 13 months after the radical operation because of universal furuncolosis, in spite of primary healing of the osteomyelitis. In 53 patients (96.4 per cent) the osteomyelitis healed after only one operation, but 2 patients needed more than one operation.

Before the operation 20 patients (36.4 per cent) had a sedimentation rate within the normal range, and 35 patients (63.6 per cent) had an elevated sedimentation rate. Three months after the operation 49 patients (89.1 per cent) had a sedimentation rate within the normal range. Of the 6 patients with an elevated sedimentation rate, one had a gastric ulcer, one collagenosis, and another 2 patients had an infection of the urinary tracts. In the remaining 2 patients no explanation could be found, not even signs of osteomyelitis. The length of stay in hospital because of the radical operation was 11 to 130 days (average 39 days). The one patient with universal furuncolosis had a hospitalization time of 13 months and has for this reason not been included in the calculations.

The "social status" after radical operation is shown in Table 5. Fifteen patients received a pension before the accident. Out of the 40 patients who received a disablement benefit at the time of the radical operation, 35 patients (87.5 per cent) regained normal working capacity. Three patients still received disablement benefit, and another two patients had been transferred to old age pension.

One of the 22 patients who needed some type of bone fixation after the operation still wore a splint at the follow-up.

Table 5. "Social status" of 55 patients after radical operation (RA) for chronic osteomyelitis after a mean follow-up period of 38 months

	Before accident	Before RA	After RA
Normal working capacity	40	0	35
Disablement benefit		40	3
Disability/old age pension	15	15	17

DISCUSSION

The principles of radical operation are now well accepted, and many different surgical techniques have been reported (Willenegger et al. 1970, Papineau 1973, Shannon et al. 1973, Horwitz 1973, Burri 1975, Hagen 1978). The purpose of this paper is to demonstrate the efficiency of combining the most successful treatment methods recommended by earlier authors into one single procedure.

The importing of information to the patient about the treatment, after-treatment and the expected results is important in order to increase motivation. All concomitant conditions should be corrected as far as possible, prior to the operation. All orthopaedic surgeons agree that radical excision of all devitalized soft tissue and bone is essential. The difficulty lies in defining the border between dead and live tissue. Intravital dye has been recommended (Hedström et al. 1980). This technique was not used in this material, as spot bleeding from cut surfaces, including bone, was considered to be the most obvious sign of vascularized and live tissue. There has been a longstanding discussion as to whether metal implants should be left *in situ* or removed at the radical operation (Burri 1975, Hagen 1978). Microscopy revealed a stratum of devitalized tissue of varying thickness around metal implants which could hinder cleaning of the infected area. In our opinion, therefore, removal of implants is imperative. External fixation some distance from the infected area has proved to be a good alternative to internal fixation and provides a rigid fixation of the bone (Vidal et al. 1979). External fixation also permits electrical stimulation of the bone (Jørgensen 1972) and this was used in 4 cases in this material without complications.

In cases of bone defects Shannon et al. (1973) used immediate skin grafting and secondary bone grafting as a reconstructive procedure, and in the method of Papineau (1973), primary cancellous bone grafting and secondary skin grafting were

performed. Lortat-Jacob et al. (1981) reviewed a series of 82 non-unions treated by the Papineau method. Infections recurred in several instances, and 18 patients (22 per cent) required further operations. In the present series cancellous bone transplant and primary wound closure was used in 10 cases without recurrence of the bone infection. Also periost transplant may successfully regenerate new bone (Mulholland & Pritchard 1959) and was used in 3 cases.

In order to cover and fill in bone defects and, in addition, to reinforce vascularization, muscle transposition has proved to be effective (Rowe & Sakellarides 1961). In all cases the aim was to cover the bone with muscle tissue, which could often be accomplished by using the muscles *in situ*. In 10 cases muscle transposition was carried out, and in 2 cases the medullary canal of the femur was completely filled with the sartorius muscle. Treatment with the closed irrigation-suction technique with or without antibiotics has been fully described and recommended in the literature (Willenegger et al. 1970, Clawson et al. 1973, Hagen 1978), and some authors emphasize this method as imperative. We do not agree with this statement. If the surgical procedure has been adequate as regards removal of all devitalized and infected tissue this method should not be necessary. Moreover, it is not always easy to perform, and it takes up a lot of the nursing staff's time. Also there is a theoretical risk of inflow of hospital strains of bacteria causing super-infection. In this series an adequate number of closed suction drains were used in all cases and proved to be effective, and without complications.

Intelligent use of antibiotics requires not only a good drug (Ruedy 1973), but also a good preoperative and postoperative microbiologic diagnosis and specific and effective administration of the antibiotics. In this series there has been close co-operation between the microbiologists and the orthopaedic surgeons in the decision regarding the administration of all antibiotics, as recommended in previous reports (Hierholzer et al. 1974, Hedström 1975). In this way conventional antibiotics, methicillin and streptomycin, proved to be effective in 85.5 per cent of the cases with a minimum of expense and side-effects.

The amputation rate seems fortunately to be decreasing in the treatment of osteomyelitis. According to the literature Burri (1975) found the rate to be between 2.2 and 15 per cent. In the present material one patient (1.8 per cent) had to be amputated, and the basic reason was not the osteomyelitis itself, but an advancing arteriosclerotic gangrene of the foot.

The sedimentation rate seems to be a good indicator of a healed osteomyelitis. In the present series 49 patients (89.1 per cent) had a normal sedimentation rate within 3 months after radical operation, and in a further 4 patients there were various other explanations for a raised sedimentation rate, equalling 96.4 per cent. In accordance with this, antibiotics were given for a maximum of 3 months, and there was no recurrence of osteomyelitis at the time of the follow-up.

CONCLUSION

Radical operation, removal of metal implants, primary wound closure and closed suction drainage is effective in the treatment of chronic osteomyelitis and seems economical as regards hospitalization time and quantity of antibiotics administered.

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