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OSTEOMYELITIS AFTER OPERATIVE FRACTURE TREATMENT

A Report of 62 Cases Treated with Radical Surgery and Lincomycin (Lincocin®)

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During the years 1967–1975 a total of 62 patients were treated for postoperative osteomyelitis. The lower extremities had been fractured in 89 per cent of the cases and 54 per cent were closed injuries. The fractures, mostly caused by traffic accidents and falls, had been immobilized by plates in 30 and by intramedullary nails or pins in 25 patients.

Staphylococcus aureus was cultured in 80 per cent, 68 per cent of them were resistant to penicillin, but in 84 per cent the organisms were highly lincomycin sensitive and only three patients with four osteomyelitic lesions presented lincomycin resistance.

The treatment consisted chiefly of sequestrectomies and saucerizations supported by 3–12 months of lincomycin treatment. In 30 operations a closed irrigation-suction technique was used, perfusing the wound with lincomycin solution. Stable implants should be left in place until the fracture is clinically solid whereas unstable osteosyntheses should be replaced by rigid internal or extraskeletal fixation.

At follow-up, the results were judged as good in 74 per cent, fair 8 per cent and poor 18 per cent. The amputation rate was 13 per cent.

Plates should not be used in the treatment of comminuted tibial fractures with considerable soft tissue damage.

Key words: post-traumatic osteomyelitis; operative procedures; closed irrigation suction drainage; lincomycin treatment; osteosynthesis of fractures; osteomyelitis, predisposing factors

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Osteomyelitis following fracture surgery implies a serious complication which prolongs the treatment and considerably increases the disability of the patient.

This report concerns the results and some essential points in the treatment of chronic osteomyelitis after fracture surgery. It also reflects some of the features of the primary treatment which favour the development of osteomyelitis. Eighteen patients included in the present series have been reported earlier (Paus 1971).

MATERIAL AND METHODS

During the period 1967–1975, a total of 62 patients, 51 men and 11 women, with 63 surgically treated fractures were treated for postoperative osteomyelitis at Martina Hansens Hospital. Hip infections after osteosynthesis for

femoral neck and pertrochanteric fractures were excluded from the material.

There was a preponderance of men between 20 and 50 years of age (mean age 38 years) with traffic and occupational accidents while the women (mean age 48 years) usually sustained their fractures at an older age as the result of a fall.

The accidents could be classified as 28 road accidents, 21 falls, 7 occupational accidents, 4 sports injuries and 2 shooting injuries.

In agreement with other publications the osteomyelitis was located in the femur and the tibia in 80 per cent of the cases (Table 1).

The records and X-rays from the hospitals where the primary treatment was given were reviewed with particular attention being paid to the type of osteosynthesis (Table 2) and the postoperative occurrence of osteomyelitis (Table 3). Half of the operations were performed as emergencies within 24 hours of the accident; the rest were delayed from 2–30 days. Table 3 reveals that half of the infections developed within 2 weeks and 40 per cent were delayed more than 2 months.

Seventy-five per cent of the fractures were associated with extensive damage to skin and soft tissues, and 33 per cent of the operations involved peroperative technical difficulties. Half of the fractures were stable postoperatively, 70 per cent of the closed and 32 per cent of the open fractures, respectively.

Table 1. Localization and type of fracture in 63 fractures with osteomyelitis after osteosynthesis

	Closed	Open		
Femur	14	10		
Tibia	11	15		
Malleolus	3	1	89	per cent
Calcaneus	1			
Forefoot		1		
Humeral neck	3			
Humeral shaft		1		
Antebrachium		1	11	per cent
Radius	2			
	34 (54 per cent)	29 (46 per cent)		

Follow-up examination

All the 62 patients were examined clinically and roentgenologically 3 months – 10 years after the last operation, the average observation period being 6.5 years. Two patients with mainly ischaemic crural problems were followed for only 9 months whereas the remaining 60 patients were observed for a period of more than 2 years.

One patient with a previously infected malleolar fracture died from cardiac failure in 1970; the postmortem examination revealed a poorly healed osteomyelitis. This patient is included in the material.

At follow-up, the state of the patients was classified according to the following criteria:

Good: No clinical or roentgenological signs of osteomyelitis over the previous 2 years, $\leqslant 10$ per cent anatomical invalidity, normal sedimentation rate, normal or slightly reduced function, normal working ability.

Table 2. Primary fracture treatment in 63 fractures (62 patients) complicated by osteomyelitis

		Number	Per cent
Plate		30	48
Intramedullary nail	8		
+ Cerclage	4		
+ Parham's band	2	14	22
Rushpin	7		
+ Cerclage	2		
+ Parham's band	1		
+ Screws	1	11	17
Screws	3		
+ Cerclage	2	5	8
Cerclage or Parham's band		2	3
Palmer's pin + bone transpl.		1	2

Table 3. Time of manifestation of osteomyelitis in 63 fractures treated with osteosynthesis

	Number	Per cent
< 2 Weeks	33	52
3rd Week–1st Month	5	8
2nd Month–6th Month	19	30
> 1/2 Year	6	10

Table 4. Duration of lincomycin treatment in 47 patients with osteomyelitis after osteosynthesis

		Number	Per cent
< 3	Months	6	11
3–6	"	15	32
6–12	"	22	51
> 12	"	4	6

Fair: Recurrence of osteomyelitis with or without minimal drainage, 10–25 per cent anatomical invalidity, reduced function.

Poor: Persistent drainage, pseudarthrosis, amputation of femur or tibia, > 25 per cent anatomical invalidity, considerably reduced function, disability insurance only owing to sequelae following osteomyelitis.

The groups "Good" and "Fair" constituted satisfactory results. All the criteria for a classification of "Good" needed to be fulfilled before the patient was placed in this group while only one was necessary in the groups "Fair" and "Poor".

TREATMENT OF OSTEOMYELITIS

The mean duration of osteomyelitis was 2 years (range 1 month – 23 years), and on admission to our department 90 per cent of the infections presented discharging fistulas whereas the remaining were temporarily dry. After discontinuation of any antibiotic drug and no medication for about 1 week, new specimens for bacteriological growth were taken and sensitivity tests were carried out in all patients with fistulas and repeated later at regular intervals.

Staphylococcus aureus was cultured in 80 per cent (50/62), 68 per cent (34/50) of them were penicillin resistant, but in 84 per cent (42/50) the organisms were highly lincomycin (Lincocin®) sensitive and only three patients with four osteomyelitic lesions (8 per cent) presented lincomycin resistance. Lincomycin sensitivity tests were not performed in the remaining four patients (8 per cent). Phage typing was done only in about one-third of the cases.

Thus, the lincomycin-treated group comprised the 42 patients with high lincomycin sensitivity, three patients with no bacterial growth in spite of several cultures, and two patients with highly lincomycin-sensitive strains of bacillus and Gram-positive anaerobic rods, respectively.

Table 4 demonstrates that more than half of the lincomycin-treated cases were given this drug for more than 6 months. The drug was usually instituted a few days before operation in doses of 500 mg four times a day and continued until about 4–5 weeks after healing and then reduced to 500 mg two or three times a day.

The only side effect was a mild transient looseness of the stools which occurred in two patients and did not necessitate discontinuation of the drug. The three patients with lincomycin resistance and the four who were not given lincomycin sensitivity tests, and four other patients with non-staphylococcal infections, were given different antibiotic drugs according to the results of repeated bacteriological sensitivity tests while the remaining four received no antibiotic therapy.

The surgical procedures used in our 62 patients are summarized in Table 5. In 30 operations with stable mechanical conditions, mostly in the lower extremities, a closed irrigation-suction technique was used with polyethylene tubes of 6–8 mm in diameter, perfusing the wound with 0.4 per cent lincomycin solution. An irrigation of 1000 ml Ringer's or physiological saline solution with 600 mg (4 ml) lincomycin lasted from 4–7 days, and the amount of liquid used was 1000–1500 ml per 24 hours.

The mean period of stay at the primary hospitals was 60 days and in our department 120 days, i.e., a total mean hospitalization period of 6 months.

RESULTS

The results were recorded as follows:

Good – 74 per cent (46/62)
Fair – 8 per cent (5/62)
Poor – 18 per cent (11/62)

At the time of follow-up, there were no cases of pus secretion or pseudarthrosis, and none of the patients were receiving any form of antibiotic therapy. The 47 patients treated with lincomycin did not complain of side effects after its withdrawal. The results were significantly better among the 33 cases with

Table 5. Operative treatment of osteomyelitis after osteosynthesis in 62 patients with 63 fractures

		Number
Sequestrectomy/saucerization	50	
+ Hoffmann's apparatus	2	
+ bone transpl.	1	 53
Sequestrectomy/removal of metal implant	3	
+ Osteosynthesis	2	 5
Sequestrectomy/osteosynthesis		2
Removal of metal implant	19	
+ Hoffmann's apparatus	1	 20
Saucerization	12	
+ bone transplantation	6	
+ cross-leg/Hoffmann's app.	1	 19
Pseudarthrosis operation /bone transpl.	10	
+ Osteosynthesis	2	 12
Pseudart. op./inlay of elec. stimulator		1
Amputation		8
Plastic procedure (split-skin graft, cross-leg with delay, skin tube)		22
		142

Table 6. Working capacity at follow-up of 62 patients with osteomyelitis after osteosynthesis*

	Number	Per cent
Normal working capacity	41	66
Age pension (normal daily activity)	5	8
Disability pension owing to osteomyelitis alone	9	15
Disability pension owing to osteomyelitis and other diseases	3	5
Disability pension prior to injury	3	5

* One patient had died

pure cultures of *staphylococcus aureus* (31 good/1 fair/6 poor) as compared with 9 cases with lincomycin resistant mixed infections (2 good/1 fair/6 poor).

However, amputations had to be performed in eight cases (13 per cent), three poorly healed infections with hip, shoulder and ankle joint damage respectively needed secondary arthrodeses and two angular deformities required corrective osteotomies. The osteomyelitis healed without removal of metal implants in only four patients.

Pathological fractures occurred in six cases (10 per cent) and two of them belonged to the amputation group. In the initial osteosyntheses three open transverse tibial shaft and two closed transverse femoral shaft fractures were fixed with plates and one open transverse humeral shaft fracture was nailed by one Rushpin.

Before and after the treatment at our hospital the mean sedimentation rate was 32 mm/hour (range 25–115) and 9 mm/hour (range 2– 40), respectively.

Table 6 shows the working capacity at the follow-up examination and it is pointed out that two-thirds of the patients are doing full-time work, seven of them after having been through a rehabilitation programme.

DISCUSSION

Pathophysiologically, post-traumatic or exogenous osteomyelitis is a primary local

affection characterized by avascularity (Burri 1975, Popkirov 1971, Waldvogel et al. 1971). The transition to a chronic stage begins in the first days after the injury because this type of osteomyelitis represents both an ischaemic and an infectious problem. A sequestrum is frequently present initially. Table 3 shows that the symptoms of post-traumatic osteomyelitis could be diagnosed within 1 month of the injury in 60 per cent of the material.

Sequestrectomies and saucerizations, eventually combined with removal of implants and renewed internal or external fixations were the chief methods of treatment used in our cases, but other methods such as bone transplantation and skin reconstruction have proved valuable in healing the infection (Table 5).

The surgical treatment is difficult, time-consuming and full of disappointments because of recurrent flare-ups, fistulas and pathological fractures. The orthopaedic surgeon should try to plan a schedule of treatment for each individual case; this may eventually mean several interventions per patient. Taking into consideration that about 100 operations were performed at the primary general surgical departments this means a mean total of four operations per patient.

An integration of radical surgery and antibiotic therapy is essential in the management of most cases of post-traumatic osteomyelitis (Rowling 1970). The group of 47 patients treated with surgery and lincomycin achieved a satisfactory result in 85 per cent and the difference between the results in pure *staphylococcal* infections and in mixed ones is significant. The lincomycin-sensitive organisms usually disappeared, but the mixed infections continued in three patients and necessitated amputations.

The three patients with four lincomycin-resistant lesions also deserve a few comments. Two patients with pure cultures of *staphylococci aurei* showed resistance at the first test and in the subsequent 6 and 9 cultures, respectively, and ultimately amputation was performed. The last patient with two osteomyelitic foci with mixed infections showed lincomycin sensitivity in the first test and subsequently several cultures showed resistant *staphylococci aurei.*

In our opinion, the advantages of a closed irrigation-suction technique are that it provides mechanical rinsing of the wound, it penetrates necrotic tissue not yet removed with a radical procedure and it prepares a profuse purulent focus for an immediate or later acceptance of a cancellous graft.

Such a perfusion with lincomycin was used in about half the cases, and was perhaps most successful in the various infected leg pseudarthroses in connection with rigid extraskeletal fixation. The irrigation was largely applied as described in the literature (Compere et al. 1967, Dombrowski & Dunn 1966, Michelinakis 1972, Taylor & Maudsley 1970, Willenegger et al. 1970), but the technique must be carefully adapted to the individual case. The importance of inserting the tubes through oblique cortical burr-holes a good distance from the focus to avoid kinking and blocking of the inlet and outlet drains is emphasized. Moreover, the efficiency of the irrigation system with the overlapping tube ends must be tested with 250–500 ml of the solution during and after wound closure and frequently checked during the first 24 hours.

From a therapeutic point of view it is first of all of great importance to establish whether the osteomyelitic process is combined with a pseudarthrosis or not. On admission, 44 per cent of the infected fractures in this material also revealed a pseudarthrosis which created great therapeutic problems. In most cases the bridging of a purulent pseudarthrosis with autologous cancellous bone grafts should be postponed until the infection has subsided. It is safer to saucerize and remove sequestrums and unstable metal implants, combined with irrigation and renewal of rigid internal or extraskeletal fixation as a first procedure and to perform bone grafting as a secondary measure on a freshened pseudarthrotic bed in a quiet period a few weeks later. The analysis of our series also supports the observation made by others (Alho et al. 1972, Macausland & Eaton

1963, McNeur 1970) that it is an advantage to maintain a rigid osteosynthesis even during an aggressive form of osteomyelitis until the fracture has clinically consolidated. The tendency to heal is determined as much by the consolidation of the fracture as by the reversal and restitution of the infectious process.

In a few cases the ischaemic component of the tibial osteomyelitis with pronounced cicatrization is undoubtedly so evident that skin grafting reconstructions are necessary to promote healing and prevent recurrence. It seems unsuccessful to perform split-skin grafting primarily upon saucerized cavitites packed with cancellous bone. In this respect our experience corresponds with that of Burri (1975) who states that it is more profitable not to close the skin but to wait for spontaneous epithelialization or put split-skin grafts on the granulation tissue as a secondary measure.

A question which sooner or later always arises in this field of surgery concerns the magnitude of the saucerization because a radical bone excision inevitably means a skeletal weakness and the danger of a pathological fracture. In a given case a little more than half of the shaft might be removed to obtain an adequate blood circulation on all cut surfaces. Our series indicates that a pathological fracture is a complication that may lead to subsequent amputation. Autologous cancellous bone transplantation constitutes the best prophylactic measure.

The results in our series are encouraging although the amputation rate was 13 per cent. In the pre-antibiotic era the rate of amputation was over 50 per cent, while the rate today according to the literature varies between 2.2 and 15 per cent (Burri 1975). Five of our eight amputated patients with three open and two closed tibial fractures were primarily fixed with plates using the anteromedial approach.

The use of metal for internal fixation has not led to an increased incidence of infection if the osteosynthesis provides stability and the osteosynthesis material is covered by sufficient live tissue (McNeur 1970, Hagen 1971). Hagen (1969) reported six cases of osteomyelitis among 129 non-operated open leg and femur fractures (4.5 per cent) against none (0 per cent) after osteosynthesis in 40 corresponding fractures.

However, the increasing number of high-velocity road traffic accidents with extensive soft tissue damage and comminuted tibial fragments require special consideration. The injury is already comprehensive and any additional approach to the medial surface of the tibia entails a potential risk of subsequent osteomyelitis (Bauer et al. 1962, Edwards 1965).

The lateral approach to the tibia for plate osteosynthesis seems to be a better choice from an infectious as well as a biomechanical point of view. If there is extensive damage to soft tissue both pretibially and laterally, the possibility still exists of using the little known posteromedial approach to the tibia which is seldom used. Lastly, a transfixation procedure with Hoffmann's apparatus may also be a very valuable form of treatment for these fractures with severe soft tissue damage (Olerud 1973).

In conclusion, it now often seems possible to heal bone infections of this type if the surgical procedure is sufficiently radical and combined with appropriate antibiotic therapy. In addition, in certain cases plastic reconstructive methods and extraskeletal fixation are necessary to avoid disappointments in this challenging field of orthopaedic surgery.

REFERENCES

Alho, A., Koskinen, E. V. S. & Malmberg, H. (1972) Osteomyelitis in nonoperative and operative fracture treatment. A survey of 49 adult patients. *Clin. Orthop.* **82,** 123–133.

Bauer, G., Edwards, P. & Widmark, P. H. (1962) Shaft fractures of the tibia. *Acta chir. scand.* **124,** 386–395.

Burri, C. (1975) *Post-traumatic osteomyelitis.* Hans Huber Publishers, Bern-Stuttgart-Vienna.

Compere, E. L., Metzger, W. I. & Mitra, R. N. (1967) The treatment of pyogenic bone and joint infections by closed irrigation (circulation) with a non-toxic detergent and one or more antibiotics. *J. Bone Jt Surg.* **49**-A, 614–624.

Dombrowski, E. T. & Dunn, A. W. (1966) Treatment of osteomyelitis by débridement and closed wound irrigation-suction. *Clin. Orthop.* **43,** 215–231.

Edwards, P. (1965) Fractures of the shaft of the tibia: 492 consecutive cases in adults. Importance of soft tissue injury. *Acta orthop. scand.*, Suppl. 76.

Hagen, R. (1969) Osteomyelitis in a general surgical department. *Acta orthop. scand.* **40,** 673–674.

Hagen, R. (1971) Osteosynthesis of multiple open fractures. *Nord. Med.* **85,** 383.

Macausland, W. R. & Eaton, R. G. (1963) The management of sepsis following intramedullary fixation for fractures of the femur. *J. Bone Jt Surg.* **45**-A, 1643–1653.

McNeur, J. C. (1970) The management of open skeletal trauma with particular reference to internal fixation. *J. Bone Jt Surg.* **52**-B, 54–60.

Michelinakis, E. (1972) Treatment of chronic osteomyelitis with the continuous irrigation-suction method. *Acta orthop. scand.* **43,** 25–31.

Olerud, S. (1973) Treatment of fractures by the Vidal-Adrey method. *Acta orthop. scand.* **44,** 516–531.

Paus, B. (1971) Chronic osteomyelitis. A report of fifty cases treated with lincomycin (Lincocin®). *Acta orthop. scand.* **42,** 320–327.

Popkirov, S. (1971) *Die Behandlung der hämatogenen und der traumatischen Osteomyelitis.* V E B Verlag Volk und Gesundheit, Berlin.

Rowling, D. E. (1970) Further experience in the management of chronic osteomyelitis. *J. Bone Jt Surg.* **52**-B, 302–307.

Taylor, A. R. & Maudsley, R. H. (1970) Instillation-suction technique in chronic osteomyelitis. *J. Bone Jt Surg.* **52**-B, 88–92.

Waldvogel. F. A., Medoff, G. & Swartz, M. N. (1971) *Osteomyelitis. Clinical features, therapeutic considerations, and unusual aspects.* Charles C Thomas, Springfield, Illinois.

Willenegger, H., Ledermann, M., Wahl, H. G. & Plaass, U. (1970) Über das Wesen der Spüldrainage. *Die posttraumatische Osteomyelitis*, ed. Hierholzer, G. & Rehn, J., p.79. Schattauer, Stuttgart-New York.

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