INFECTION AFTER INTRAMEDULLARY NAILING OF THE TIBIA

INCIDENCE AND PROTOCOL FOR MANAGEMENT

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There is concern about the incidence and serious nature of infection after intramedullary nailing of the tibia, especially for open injuries. We have reviewed 459 patients with tibial fractures treated by primary reamed nailing. The incidence of infection was 1.8% in closed and Gustilo type I open fractures, 3.8% in type II, and 9.5% in type III fractures (5.5% in type IIIa, 12.5% in type IIIb). These incidences appear to be acceptable in comparison with other published results.

We describe the different modes of presentation of infection in these cases, and suggest a protocol for its management, which has been generally successful in our series.

The treatment of diaphyseal fractures of the tibia by intramedullary nailing is gaining in popularity mainly because of the introduction of locking nails. Good results have been reported for both closed and Gustilo type I open fractures (Gustilo and Anderson 1976; Gustilo, Mendoza and Williams 1984; Klemm and Börner 1986; Court-Brown, Christie and McQueen 1990; Hooper, Keddell and Penny 1991), and there is some evidence that the technique is also successful in Gustilo type II and III open fractures (Court-Brown et al 1991).

Intramedullary nailing of the tibia is associated with a number of complications. The combination of open operation and instrumentation of the whole diaphysis raises concern about the risk and consequences of infection: Chapman (1986) stated that reamed nailing of open tibial fractures is contra-indicated because of the incidence of sepsis.

Few papers have dealt with the incidence of infection after intramedullary nailing, and there are no guidelines on the management of an infected intramedullary tibial nail. We have reviewed our experience and developed a protocol for treatment.

PATIENTS AND METHODS

We treated 459 tibial fractures by primary reamed nailing with the Grosse-Kempf locking nail from August 1986 to April 1991. Of these, 391 were closed or Gustilo type I in severity, 26 were type II, 18 were type IIIa and 24 were type IIIb.

All the closed fractures were treated by the nailing technique described by Court-Brown (1991), with antibiotic cover by a three-dose regime. Cefuroxime 1.5 g was given at the induction of anaesthesia and 750 mg six and 12 hours after operation. This regime was modified only in patients with impaired renal function, or with other injuries which indicated the use of other antibiotics.

The open fractures were treated according to a definite protocol. Thorough wound toilet removed all devitalised soft tissue and bone before primary nailing. The wound was left open. Gustilo type I wounds were either allowed to granulate, secondarily sutured or

Table I. The incidence of infection after nailing of tibial fractures related to Gustilo type

Fracture Type	Number	Infected	
		Number	Per cent
Closed or I	391	7	1.8
II	26	1	3.8
III	42	4	9.5
IIIa	18	1	5.6
IIIb	24	3	12.5

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occasionally closed by split-skin grafts. Most type II wounds were treated similarly, although some were closed by local flaps. Most type III wounds were closed by flaps, with an effort to provide definitive skin cover within three days of injury. All type III wounds were re-examined under anaesthesia within 36 hours of admission and a further re-examination was performed if the wound was seen to be contaminated. Patients with type III fractures were given penicillin, and occasionally ceftazidime in addition to the three doses of cefuroxime.

We defined infection of a wound as the presence of a purulent discharge from which organisms could be cultured. Infection in a closed fracture was diagnosed by the presence of increased local pain, swelling, and erythema associated with pyrexia.

RESULTS

The incidence of infection in the different Gustilo types and subtypes is given in Table I.

Closed and type I open fractures. In the closed and type I open fractures all seven infections were in young male patients with an average age of 24 years (17 to 35). Five fractures were due to soccer injuries and two followed road-traffic accidents. Six infections presented between two and ten weeks after nailing, and the seventh at 16 weeks. There were three distinct modes of presentation: *Group I.* Three patients developed pyrexia associated with local pain, erythema and generalised swelling at the fracture site, but there was no clinical evidence of an abscess. All three patients were treated with high-dose intravenous antibiotics followed by oral antibiotics for six to eight weeks. The fractures united in a time appropriate for their Tscherne grading (Oestern and Tscherne 1984; Court-Brown et al 1990a). After union, the nails were removed, and the intramedullary canal was reamed to remove the pyogenic membrane. In two of the three patients, *Staphylococcus aureus* was cultured from the medullary reamings, but none of the three has shown evidence of continued infection after follow-up from one year to 3.5 years.

Group II. Two patients presented early with evidence of pus at the site of the fracture.

One developed a fluctuant swelling at the fracture site at three weeks, with systemic symptoms of infection. The abscess was incised, *Staphylococcus aureus* cultured from the discharge, and antibiotics started. The infection resolved in a few days, the nail was left in situ, and the course of antibiotics was continued. The fracture healed in 13 weeks and the nail was removed after 17 weeks with reaming of the endosteal surface of the intramedullary canal. There has been no further evidence of sepsis after one year.

The second patient had a type I open proximal shaft fracture of the tibia. Two weeks after nailing, pus became evident at the site of the open wound and at the proximal skin incision. *Staphylococcus aureus* was cultured. Initial

treatment by local wound toilet and high-dose antibiotics failed to reduce the pyogenic discharge and one week later exchange nailing was performed, with reaming of the intramedullary pyogenic membrane. Infection was controlled, but union was delayed until 36 weeks.

Group III. Two patients presented later, and in both cases a Gram-negative bacillus was cultured. One developed a purulent discharge from the proximal and the distal screw incisions at 16 weeks after injury. The fracture appeared to have united; the nail was removed and the endosteal surface was reamed.

The second patient (Fig. 1) developed a pyogenic discharge from the fracture site nine weeks postoperatively, but was not referred for treatment for a further eight weeks. By then, there was an established sinus over the subcutaneous border of the tibia, surrounded by unstable skin (Fig. 1a). Exploration revealed avascular bone; resection of bone and soft tissue was undertaken, and at a later date flap cover and bone grafting were performed (Fig. 1b). Union was apparent at 36 weeks and there has been no evidence of recurrent infection (Fig. 1c).

Table II. Reported incidence of infection (*per cent*) after nailing of closed and type I open fractures of the tibia

Author	Nail	Fracture	
		Closed	Type I
Velazco et al (1983)	Lottes	–	0
Puno et al (1986)	AO	2.3	–
Klemm and Börner (1986)	Klemm-Schellmann	0.9	6.4
Bone and Johnson (1986)	AO Grosse-Kempf	4.4	4.7
Hooper et al (1991)	?	0	0
Court-Brown et al (1991)	Grosse-Kempf	1.8	

Type II and III open fractures. The incidence of infection in Gustilo type II and III open fractures is shown in Table I: five infections in 68 fractures over a three-year period. In all five cases there had been a departure from the accepted protocol. In one type IIb fracture, wound toilet was inadequate; avascular bone was left in the wound. The other four cases demonstrated errors in soft-tissue management: one type II wound was closed primarily, and one type IIIa wound was closed secondarily by a split-skin graft over the subcutaneous border of the tibia. Two type IIb wounds were closed by technically poor soft-tissue flaps, which partially failed. The defects had been left to granulate, instead of using further flaps to close them.

All five infected type II and type III fractures were treated by nail removal and resection of avascular bone and unstable overlying skin when necessary. The fractures were then renailed. Further flap cover was required later in three patients after the eradication of infection.

Fig. 1a

Fig. 1b

Fig. 1c

Figure 1a – A closed tibial fracture treated primarily by Grosse-Kempf nailing. A distal screw should have been used but the position was, nevertheless, maintained. A purulent discharge started at nine weeks but active treatment was delayed until 17 weeks postoperatively. Figure 1b – After soft-tissue and bone resection, a fasciocutaneous flap was used to cover the defect. Bone grafting was performed after the flap had healed. Figure 1c – Bone grafting was successful; the fracture had apparently united at 36 weeks, by which time the patient was asymptomatic. The radiographs show a satisfactory posteromedial bone bridge.

When the soft tissues had healed, corticocancellous bone grafting was performed.

The type IIIa fracture united at 38 weeks and the three type IIIb fractures at an average time of 71 weeks. The patient with an infected type II fracture had recurrence of local infection after bone resection and corticocancellous grafting. Further bone resection was performed using a vascularised fibular graft, but the proximal end of the graft became avascular and infection continued. The patient opted for amputation after two years of treatment.

DISCUSSION

There are three widely held beliefs regarding infection after intramedullary nailing of open tibial fractures. These are that there is a high incidence, particularly after severe injuries; that infection presents as a panosseous osteomyelitis which may lead to diaphyseal sequestration; and that it is very difficult to eradicate.

We believe that our incidences of infection in the various Gustilo fracture types are acceptable, and comparable with those of other methods of managing these fractures. Few reports make an adequate separation of the different types, but Table II shows the available figures for Gustilo closed and type I open fractures. The rates of infection vary between 0% and 6.4%, but the average infection rate for nailing of closed and type I open fractures was 4.1%. This figure may be slightly skewed because Bone and Johnson (1986) included some patients whose tibiae had been nailed secondarily after

failure of the original treatment method, but we believe that 4% is the current world-wide figure. Sequential analysis of our results has shown our incidence of infection to be consistently below 2% (Court-Brown et al 1990a). An overall incidence of 4% is comparable with that reported for the plating of closed fractures (Batten, Donaldson and Aldridge 1978; Christensen, Greiff and Rosendahl 1982), but is greater than the reported figures for external skeletal fixation in closed and type I open fractures (De Bastiani, Aldegheri and Brivio 1984; Court-Brown and Hughes 1985; Keating et al 1991).

Table III gives the published infection rates for type II and III open fractures. Analysis is more difficult, because the incidence of infection appears to depend on the handling of the soft-tissue injuries: infection rates are related to the adequacy of the initial wound excision and the timing and expertise of closure of the soft-tissue defect by a plastic surgeon. They will also vary between nailing as a primary or as a secondary procedure. Our incidence of 3.8% infection after type II fractures and

Table III. Reported incidence of infection (*per cent*) after nailing of type II and III open fractures of the tibia

Author	Nail	Fracture	
		Type II	Type III
Velazco et al (1983)	Lottes	0	9.4
Bone and Johnson (1986)	AO	10.5	25
	Grosse-Kempf		
Court-Brown et al (1991)	Grosse-Kempf	3.8	9.5

Fig. 2

Protocol for the management of infection after intramedullary nailing of the tibia.

9.5% after type III fractures (5.6% for type IIIa, 12.5% for type IIIb) compares well with the published results for external skeletal fixation (Edwards et al 1984; Blick et al 1989; Court-Brown et al 1990b).

We have never seen a case of panosseous tibial osteomyelitis. All our infections were localised to the fracture site, and behaved in a manner similar to post-traumatic osteomyelitis after other treatment methods. The volume of bone involved varied mainly with the length of time that had elapsed before diagnosis and treatment. The two patients in whom treatment was delayed required extensive bone grafting (see Figs 1b and 1c). Osteomyelitis may involve a considerable amount of cortical bone, but this is probable only if the patient has been neglected for a long period. The presence of an intramedullary nail in an infected fracture does not ensure widespread cortical osteomyelitis even if pus tracks along the nail.

Treatment of infected nailing has not been difficult, but basic surgical principles must be followed. Twelve of our 13 infected cases were successfully treated with no evidence of recurrence. In the single case of persistent infection this remained localised to the fracture site; it probably followed inadequate bone resection at the first procedure.

We present our protocol for the management of bone infection associated with intramedullary nailing in Figure 2. The initial treatment is similar to that for other types of osteomyelitis. Bone stability is essential and the nail should be retained in all cases. If there is no evidence of a pyogenic collection normal bone union can be expected without altering the treatment of the fracture. Intravenous antibiotics should be given, and the patient rested in bed until symptoms resolve. If a pyogenic collection is identified, this should be drained. If drainage then ceases, the fracture may subsequently be treated as if there had been no initial collection. If drainage persists then we advise exchange nailing with reaming of the intramedullary canal.

If there is a discharge when infection is first diagnosed, bone resection may be required. If, at operation, there is no evidence of avascular bone, then an exchange nailing should be performed. If there is avascular bone, it must be resected before exchange nailing. A purulent discharging sinus is usually on the subcutaneous border of the tibia; any unstable skin around it should be resected and a flap used to cover the defect. Bone grafting is postponed until the flap has healed. We believe that infection after intramedullary nailing can be successfully treated in most cases.

It appears that the problems of infection after intramedullary nailing of the tibia have been overstated. The incidence of infection in closed and type I open fractures is similar to that of plating, but in experienced hands should be below 2%. The results in more severe open fractures compare well with those of similar injuries treated by external skeletal fixation. We believe that the

incidence of infection is related more to the handling of the soft tissues than to the method of stabilising the fracture.

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