PRIMARY OR DELAYED CLOSURE FOR OPEN TIBIAL FRACTURES

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Of 110 consecutive open tibial fractures 90 were reviewed and analysed retrospectively with particular reference to wound closure, method of stabilisation, infection rate and the incidence of non-union. There were 41% Gustilo type I, 39% type II and 20% type III injuries.

The incidence of deep infection was 20% after primary wound closure compared with 3% after delayed closure, and eight of the nine non-unions followed primary closure. We conclude that primary wound closure should be avoided in the treatment of open tibial fractures.

The primary aim in open fracture treatment is to obtain a healed fracture and a normally functioning limb, with no infection. Review of the literature shows that the prognosis is improved if strict guidelines are followed. Open fractures have been classified into three types (Gustilo and Anderson 1976) with a more recent subdivision of type III injuries (Gustilo, Mendoza and Williams 1984). This classification system not only helps to determine management, but also allows comparison of various treatments.

The incidence of infection in open tibial fractures is reported to be 10 to 20 times higher than in other open skeletal injuries (Patzakis, Wilkins and Moore 1983 a and b). It varies from 2% for type I and II injuries (Gustilo and Anderson 1976), to over 50% for type III (Veliskakis 1959; Clancey and Hansen 1978). There is no doubt that appropriate antibiotics reduce the infection rate in open tibial fractures (Patzakis, Harvey and Ivler 1974; Gustilo and Anderson 1976; Gustilo 1979; Patzakis et al 1983 a and b; Gustilo 1987; Patzakis 1987). Adequate debridement and irrigation are also essential (Trueta and Barnes 1940; Scully, Artz and Sako 1956; Gustilo and Anderson 1976; Chapman and Mahoney 1979). In view of the problem with infection, traditional orthopaedic teaching has held that the use of metallic fixation in open fractures is contra-indicated, though an

in vitro study showed that the presence of metal per se did not promote bacterial growth (Gristina and Rovere 1963). This is supported by studies in which the infection rate in open fractures treated by internal fixation is no higher than that reported for closed treatment (Chapman and Mahoney 1979; Rittmann et al 1979). Other studies have demonstrated higher infection rates when internal fixation is employed (Claffey 1960; Gustilo and Anderson 1976; Rosenthal, MacPhail and Ortiz 1977; Clancey and Hansen 1978; Behrens et al 1983). For this reason, external fixation has been recommended (Mendes, Carbal and Lima 1981; Behrens et al 1983; Edwards 1983; Etter et al 1983).

Gustilo and his colleagues made a prospective study of open fractures between 1969 and 1973. They found that if there was any doubt as to the adequacy of debridement, the wound should be left open; type III injuries should never be closed primarily (Gustilo and Anderson 1976; Gustilo 1987). This belief is shared by others (Clancey and Hansen 1978). The timing of delayed wound closure is also debatable, but it appears that delayed primary closure at five to seven days is optimal if the wound is clean (Byrd, Cierny and Tebbetts 1981; Cierny, Byrd and Jones 1983; Caudle and Stern 1987).

Our study aimed to evaluate the role of primary and delayed closure in open tibial fractures in relation to rates of infection and non-union.

MATERIALS AND METHODS

A retrospective study was undertaken of 110 consecutive patients with extra-articular open tibial fractures treated in one hospital, by one of eight orthopaedic surgeons, between January 1981 and June 1986. Five patients died of associated injuries and two had amputations within three days of their injury. A further 13 patients were

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excluded because of a delay of more than eight hours from the time of the accident to the time of initial debridement, leaving 90 patients whose results we analysed.

We reviewed records and radiographs, recording tetanus prophylaxis, antibiotic treatment, method of initial debridement and stabilisation, timing of wound closure (delayed or primary), infection, amputation, non-union, fracture classification (Gustilo), age, sex, and associated injuries. We then compared deep infection rates in the group treated by primary wound closure with those treated by delayed closure. Deep infections were defined as those involving the tibia itself, or deep to the deep fascia. They all had positive cultures and required intravenous antibiotics with or without debridement. These two groups were first compared to ensure that there were no major differences other than method of closure.

Data was analysed by chi-squared testing of two-by-two contingency tables.

RESULTS

The 90 open tibial fractures in 90 patients were studied retrospectively at a minimal follow-up of nine months, by which time the fracture had healed, non-union was apparent, or delayed amputation had been performed.

In all cases, debridement and wound irrigation were performed, and tetanus prophylaxis was given when appropriate. Intravenous antibiotics were given in all cases and are discussed below. The groups of patients having either primary or delayed wound coverage had similar mean ages, sex distribution, and percentage of associated injuries (Table I).

Fractures were classified using the system described by Gustilo. There were 37 type I, 35 type II, 4 type IIIa, 10 type IIIb, and 4 type IIIc injuries. The deep infection rate and the non-union rate for each group are shown in Table II. There was a significantly higher infection, and non-union rate in the group treated by primary wound closure ($p < 0.02$). Delayed wound closure had been performed between three and 14 days after injury, but there were insufficient numbers to suggest the optimal timing of closure.

In the group treated by primary wound closure, 22 had type I injuries, 24 type II, and 12 type III. Of the type I injuries, one patient developed non-union with no proven infection, and two patients had deep infections. In the type II injuries there were three non-unions (two infected), and four deep infections, and in the type III injuries there were six infections and four non-unions. The group treated by delayed closure fared better: there was only one case of infection which occurred in a type IIIc injury, and was associated with non-union.

Major differences in these two groups could affect these results. We therefore analysed them further in

Table I. Details of 90 patients sustaining open tibial fractures

	Mean age (years)	Male (per cent)	Associated injuries (per cent)
Primary closure	27	86	56
Delayed closure	30	78	44

Table II. Infection and non-union in relation to type of injury and wound closure

Gustilo type	Primary closure			Delayed closure		
	Total	Infected	Non-union	Total	Infected	Non-union
I	22	2	1	15	0	0
II	24	4	3	11	0	0
IIIa	3	1	1	1	0	0
IIIb	6	2	2	4	1	1
IIIc	3	3	1	1	0	0
All types	58	12*	8	32	1*	1

* significant difference $p < 0.02$

Table III. Infection related to type of fracture and antibiotic therapy in type I and II fractures

	Primary closure		Delayed closure	
	Cephalosporin	Penicillin/ cloxacillin	Cephalosporin	Penicillin/ cloxacillin
Gustilo type I Number	21	1	14	1
Infected	3	0	0	0
Gustilo type II Number	18	6	9	2
Infected	3	1	0	0

relation to the type of antibiotic used, and the method of immobilisation. All patients had received antibiotics pre-operatively and for at least 72 hours postoperatively. Type III injuries were treated by a variety of antibiotic regimes and it was therefore felt that they should be excluded when comparing infection rates with method of wound closure. All type I and II injuries received either a first or second generation cephalosporin, or a combination of penicillin and cloxacillin (Table III). There were no statistical differences in relation to infection rate and type of antibiotic used.

Table IV. Infection and non-union related to type of injury and method of immobilisation

	Primary closure			Delayed closure		
	Total	Infected	Non-union	Total	Infected	Non-union
Type I						
Plaster	18	2	1	13	0	0
Internal fixation	4	0	0	1	0	0
External fixation	0	0	0	1	0	0
Type II						
Plaster	12	2	2	9	0	0
Internal fixation	10	2	1	1	0	0
External fixation	2	0	0	1	0	0
Type III						
Plaster	8	3	2	3	0	1
Internal fixation	4	3	2	0	0	0
External fixation	0	0	0	3	1	1

The method of immobilisation used in each group is given in Table IV. A larger proportion of patients in the group treated by primary wound closure underwent internal fixation, making comparison of the two groups undesirable. Therefore, only those patients treated by plaster cast immobilisation were further studied.

Two similar groups were defined that allowed accurate comparison of primary and delayed wound closure. The age and sex ratio, and the incidence of associated injuries were similar, and each patient had been treated within eight hours of injury and given intravenous antibiotics. Within these comparable groups there were four cases of deep infection in 30 patients treated by primary wound closure (13%), and no infections in the 22 patients treated by delayed wound coverage (Table V). This difference is significant ($p < 0.05$).

Table V. Infection immobilised in plaster in two comparable groups

Gustilo type	Primary closure		Delayed closure	
	Total	Infected	Total	Infected
I	18	2	13	0
II	12	2	9	0
Total*	30	4	22	0

* statistical difference $p < 0.05$

Four late amputations were performed for sepsis. Two of these were for type IIIc injuries, one for type IIb, and one for a type II injury that had been treated by internal fixation and primary wound closure. There were 18 type III injuries in the series; 12 had primary wound closure with an infection rate of 50%, a non-union rate of

33%, and an amputation rate of 17%. In comparison six type III injuries were treated by delayed wound coverage with an infection rate of 17%, a non-union rate of 17%, and an amputation rate of 17%. Although the two groups were dissimilar, these results emphasise the poor prognosis of type III injuries.

DISCUSSION

Gustilo has shown that type III injuries should not be treated by primary wound closure (Gustilo and Anderson 1976), and also advised that type I and II wounds should be closed primarily only if the surgeon is sure that a thorough debridement has been performed. Our study has shown that the infection rate in type I and II open tibial fractures is significantly higher after primary wound closure.

The optimum treatment for open tibial fractures includes four essential steps; wound cultures before and after debridement, thorough debridement and wound irrigation as soon after the accident as possible, parenteral antibiotics as defined in the literature (Gustilo 1987; Patzakis 1987), and a suitable method of stabilisation of the fracture. From our findings we believe that there is a fifth essential step; all wounds should be left open.

The timing of wound closure is debatable; however, the authors agree with others (Byrd et al 1981; Cierny et al 1983; Caudle and Stern 1987) that delayed primary closure at five to seven days is probably optimal.

Conclusions. There is no doubt that debridement, irrigation, and antibiotic therapy reduce the incidence of infection in open tibial fractures. The role of primary and delayed closure is less well appreciated. From the results of our study we believe that there is no place for primary closure of any open tibial fracture.

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