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ORIGINAL STUDY

TREATMENT OF OPEN SHAFT FRACTURE OF THE TIBIA

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ABSTRACT

A prospective study of 78 open fractures of the tibial shaft, treated with plate fixation, unreamead intramedullary nails, POP casts and external fixators, followed for minimum 3 years for the rate of infection, malunion, nonunion and reoperation. The fractures were type I, type II and type III A,B,C (Gustilio's–Anderson classification). Superficial infection occurred in 2 fractures (2.59%), deep infection in 2 fractures (2.5%) and reoperation due to malunion occurred in 2 fractures (2.5%).

KEYWORDS*: open fractures, plate fixation, unreamed intramedullary fixation, external fixation, rate of complication.*

1. Introduction

The tibial shaft is prone to open fractures more than any other long bone. Epidemiological studies have shown that open fractures comprise 23.5% of all tibial shaft fractures [1].

The lack of muscular protection along the antero-medial aspect of the tibia and the poor blood supply predispose open tibia fractures to certain complications [2]. They present a 10-20 times higher risk of developing infection than open fractures in other anatomical areas and a nonunion rate as high as 28% has been reported in the literature [3,4].

Early stabilization of open fractures provides many benefits to the injured patient. It protects the soft tissues around the zone of injury by preventing further damage from mobile fracture fragments. It also restores length, alignment and rotation. This restoration of length also helps decrease soft tissue dead spaces and has been shown in studies to decrease the rate of infection in open fractures [5-7]. Lastly, early fixation allows improved access to soft tissues surrounding the injury and facilitates the patient's early return to normal function8. The surgeon has many choices when deciding on fixation constructs, POP casts, intramedullary nails, plates and external fixators.

Higher infections rates have been reported with plate fixation of open fractures [9,10] so that diligence is needed when the decision is made to use plates. Current plating technology and less invasive techniques are lowering these rates and providing the patient with good to excellent results [11,12].

Intramedullary nail fixation remains the mainstay of treatment for most open tibial shaft

fractures. There has been a considerable debate in the literature regarding reamed and unreamed intramedullary nails, with proponents of both methods.

2. Material and Methods

Between January 2007 and January 2010, 78 patients with open fracture of the tibia shaft were admitted and treated in Athoura Generalized Hospital in Taiz – Yemen. All the patients were studied prospectively to evaluate the type of treatment and the rate of infection, nonunion, malunion and reoperation. The average age was 30, within a range of 14 to 55 years-old patients. The mechanism of injury is shown in table one. Males were 62 (79.5%) and females were 16 (20.5%).

The open fractures were classified according to the Gustilo-Anderson classification of open fractures. Fourteen open fractures were type I, twenty-two fractures were type II, twenty-four open fractures were type IIIA, fourteen open fractures were type IIIB and four open fractures were type IIIC.

Twenty-two open fractures were fixed with plates and screws (28.20%), eight open fractures were fixed with unreamed intramedullary nails (10.25%), six open fractures were fixed with POP casts (7.70%) and fourty-two open fractures were fixed with external fixators (53.85%).

Before fixation, the wounds were thoroughly debrided. Prophylaxis anti-tetanus was administered. If the wound could be converted to a clean wound and no soft tissue procedure was needed, immediate fixation of the fracture and primary closure of the wound was performed. If soft tissue procedure (skin graft or flap) was needed, a delayed closure of the wound (within 3-5 days) was performed.

The antibiotics we used were ceftriaxone & gentamicin for type I and type II fractures and intravenous metronidazole added for type III fractures. The duration of antibiotic administration was for 7-10 days, according to the severity of the wound.

3. Results

Two superficial infections (pin tract), occurred in two patients with open fracture type IIIB, treated with external fixators. The infection in the first patient was treated successfully with cephalexin, administered orally for one week and in the second patient, it was treated with dicloxacillin administered orally for two weeks.

Two patients with open fractures of the tibia and fibula type IIIC, caused by industrial accidents and treated with external fixator shifted to intramedullary nailing after 3 months, developed deep infection, solved by administering cephalexin orally for 2weeks.

The average time of bone healing (union) was 9.44 months, within a range of 6-18 months, with a standard deviation of 3.2.

Bone healing was defined as bridging callus on antero-posterior and lateral radiographs, with no pain on palpation or on weight bearing. In plate fixation with rigid internal fixation, since motion at the fracture site is abolished and no callus is produced to be seen on radiograph, we consider bony union as the time to full weight bearing without support, with the consent of the attending surgeon and in the absence of any radiological or clinical signs of motion at the fracture site. Malunion was defined as a residual angulations' of more than 10 degrees in any plane [13-15].

Non-union was defined as no progression of clinical and radiographic healing after 6 months of immobilization [16-18].

We had two malunion of the tibial shaft fractures after external fixation. Two reoperations were necessary for the correction of the malunion. No

cases of non-union are noted in our series.

4. Discussions

We had 78 open tibial shaft fractures, out of which 22 fractures (28.20%) were fixed with plates – six fractures were type I (27.3%), fourteen fractures were type II, (63.6%) and two fractures were type IIIA (9.1%) (table I). No infection, no union failure, no malunion and no reoperation were registered in this series. Our series with no infection, nonunion rate 0% and reoperation rate 0%, may be due to the low percentage of severe cases (table II).

Figure 1 a. *Open fracture of the tibia, type IIIB, after debridement and external fixation*

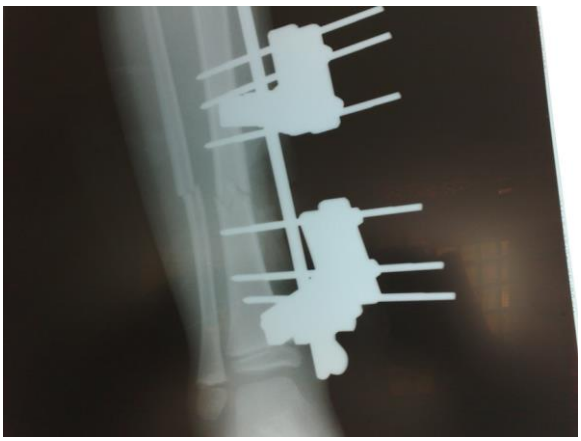

Figure 1b. *Antero-posterior X-ray after external fixation*

We had 8 open fractures of the tibial shaft treated with a unreamed intramedullary nail (10.25%), six type I fractures (75%) and 2 type II fractures (25%). No infection, no malunion or nonunion occurred. No reoperation was registered.

Figure 1c. *Lateral X-ray after external fixation*

Figure 1d. *Aspect of the shank after the bone healing and the removal of the external fixator*

It is clear from the above comparison that our series is small in terms of the sample size and that the type of fracture is not severe, so this could explain the more favorable results as compared to those in literature (tables III and IV).

We had 42 fractures of open tibial shaft,

treated with external fixation (53.85%). Four fractures were type II (9.5%), twenty fractures were type IIIA (47.6%), sixteen fractures were type IIIB (38.2%) (Figure 1a,b,c,d,e,f) and two fractures were type IIIC (4.7%).

Figure 1 e. *Detail of the clinical aspect of the shank.*

Figure 1f. *X-rays after consolidation*

Comparing our results (table V), they are within the same average range as those in literature, although a little better and this may be due to the thorough debridement, the early closure of the wound and the long duration of antibiotic usage.

Table I. Mechanism of injury

Mechanism of injury	Number
Motorcycle accident	8
Car accident	42
Occupational injury	4
Falling from a height	14
Struck by stone	4
Gunshot	6
Total	78

Table II. *Comparison of our series with plate fixation with some ones in literature*

Author	No	% of severe cases	Infectiom as CI rate	Union rate 95CI	Re-op CI
Ruedi[19]	95	60%	12% (6-20)	87% (79-93)	23% (15-33)
Kristensen[20]	23	30%	11% (2-9)	91% (72-99)	15% (4-34)
Clifford	97	62%	10% (6-18)	87% (78-93)	13% (7-22)
Bach [21]	30	100%	35% (17-65)	62% (41-80)	69% (48-86)
Gopal[22]	30	100%	17% (6-35)	90% (70-98)	43% (25-36)
Our series	22	9.1%	0%	0%	0%

Legend: CI = confidence interval

Table III. *Comparison of patients' number of our series, with unreamed nail fixation, with the literature*

Author	No. of fractures	Type I	Type II	Type IIIA	Type IIIB	Type IIIC
Keting [23]	44	5	16	19	4	0
Henley [24]	103	0	52	40	12	0
Tornetta [25]	15	0	0	0	15	0
Whittle [26]	50	3	13	22	13	0
Our series	8	6	2	0	0	0

Table IV. *Unreamed nailing in open tibial fracture - comparison with the literature*

Author	Infection	Malunion	Non-union	Implant failure	Re-operation
Keting	4.4%	4.4%	12%	29%	
Henley	13%	8%			1.7%
Tornetta	6.6%				
Whittle	84%	0%	8%	0%	0%
Our series	0%	0%	0%		0%

Table V. *Comparison of our results with external fixation with those of the literature*

Author	Number of cases	Severity of cases	Infection	Malunion	Non-union	Re-operation
Bach	30	Type II Type III	Pin tract – 10% Deep infection – 3%	10%	0%	0%
Henley	70	Type II Type IIIA Type IIIB	21%	31%	0%	2.7%
Tornetta	14	Type IIIB	Pin tract – 21% Superficial – 14.2% Deep infection – 7.14%	0%	0%	0%
Halbroock [27]	28		Pin tract – 25% Deep infection – 14%	36%	11%	
Our series	42	Type II Type IIIA Type IIIB Type IIIC	Pin tract – 4,7% Deep infection – 4.7%	4.7%	0%	4.7%

5.Conclusions

In the treatment of open fractures, through intensive debridement of the wound and immediate fixation, primary closure of the wound, with prolonged use of antibiotics from seven to ten days, the rate of infection dramatically decreased.

The tibial open shaft fractures type I, II, IIIA could be treated with plating or unreamed intramedullary nailing with favourable results.

The treatment of choice for the type IIIB and IIIC open tibial shaft fracture is the external fixation.

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