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Treatment of 78 type II and type IIIa open fractures by primary closure on suction drain: a prospective study

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Abstract The purpose of this study was to assess if primary closure of wounds on a suction drain can be performed in open fractures after debridement and to determine the risk of infection and nonunion. A total of 78 type II and type IIIa open fractures were managed with primary closure on a suction drain. They were followed until union. Rates of infection, delayed union and nonunion were determined and compared with rates reported in the literature. Overall, 16 fractures (20.5%) were complicated with superficial infections and 8 fractures (10.2%) had deep infections. Delayed union was observed in 11 fractures (14.1%) and nonunion in 12 fractures (15.3%). Primary closure of a wound on a suction drain seems to cause no significant increase in rates of infection, nonunion or delayed union.

Key words Open fractures • Primary closure • Suction drain

Introduction

Primary closure of a wound after copious irrigation and debridement is controversial. Ideally, a wound is closed or covered shortly after its infliction and so proceeds smoothly to healing by primary intention [1]. Advances in antibiotics, local antibiotic bead pouches, debridement methods and surgical techniques including the advent of pulse lavage have provided ground for an aggressive approach to open fracture management [2]. In the words of the late Dr. Charles Gregory, primary closure is a judgment: reason plus willingness to take a chance [1]. The purpose of this study was to prospectively analyze the results of open fractures closed with a suction drain in terms of infection rate and union.

Material and methods

Between January 2004 and January 2006, 80 patients with 88 type II and type IIIa open fractures were admitted to our level I trauma centre. Ten patients were lost to follow-up and the remaining 70 patients (78 fractures) were followed until bony union.

These 78 fractures were categorized by clinical findings according to the classification system developed by Gustilo and Anderson [3]. There were 30 open fractures of type II with wound size more than 1 cm and a moderate degree of contamination, as well as 48 open fractures of type IIIa with wound size more than 10 cm with moderate to severe contamination.

Open fractures caused by animal bites or gunshots were not included in the study. Open fractures with extensive degloving of subcutaneous tissue, with compartment syndrome or with crush

syndrome were also excluded. Closure on drain was not done in any open fracture of the pelvis. Open fractures of the hand and feet were also not included.

Of the 78 fractures, 36 were of the tibia, 18 of the femur, 12 of the radius-ulna, 5 of the humerus, 4 of the patella and 3 of the malleolus. On radiographs, 37 fractures were linear, 18 fractures were with comminution less than 50%, 14 were with comminution more than 50%, 3 were segmental and 5 had bone loss but less than 50% of the circumference. 55 patients were brought to the trauma centre within twelve hours and 15 patients were brought after twelve hours of injury. Ten patients were diabetic with controlled blood sugar. No patient in the study was on steroids or had a diagnosis of immunodeficiency. Smoking history was positive in 35 patients before trauma. Patients included in study were of all ages and of both sexes. Ten were below the age of 15 years, 46 were between 15 and 50 years, and 14 were above the age of 50 years.

After assessment and resustication of the patient, attention was turned to the management of the open fracture. Radiographs were taken in the emergency unit. A pre-debridement culture was taken. Antibiotics (cefotaxim and gentamycin) were started and tetanus prophylaxis was updated. Open fracture wounds were irrigated with 6-10 liters of normal saline. Pulse lavage was used to irrigate the wound and remove the contamination. Hydrogen peroxide was not used. Gross superficial contaminants were removed.

A tourniquet was not used routinely. Debridement of the wound was done in layers. A first skin incision was made to provide effective debridement and to visualize the deep tissues. Incision in the fascia was extended to release pressure. The muscle was debrided to a level that provided contractile, firm and beefy red muscle. Any small bone fragment becoming denuded of soft tissues during debridement was removed but the articular surfaces were always saved.

Wound closure on a negative suction drain was done in two management techniques. In one technique (immediate primary closure), immediate approximation of wound edges was done including both surgical and traumatic portions, without excessive tension, alone or by giving a relieving incision. This technique was used in relatively clean wounds, with limited skin loss, good initial debridement and no vascular insufficiency. In the second technique (delayed primary closure), wounds were packed open after initial debridement. Approximation of wound edges was done later but within five days of injury, after daily serial debridements of the wound. This was done in highly contaminated wound such as farmyard injuries, with skin loss or extensive tissue necrosis found during initial debridement, requiring second-look debridements. Suction drains were usually kept for 3 days (range, 3–5 days) in both the techniques.

Of the 30 grade II open fractures, 28 had immediate primary closure and 2 had delayed primary closure. Of the 48 grade IIIa open fractures, 12 had immediate primary closure and 36 had delayed primary closure. Regarding the 40 fractures that had immediate primary closure, 34 were fixed by unreamed nailing (10 in tibia, 8 in femur, 6 in radius-ulna); 7 were fixed with K-wires and 3 by external fixation.

Traction was the usual mode of immobilization of fractures which could not be taken up for immediate fracture fixation due to various reasons. Of 6 such fractures, two were fixed by reamed nailing, two by plate and screws, one by plaster and one was kept on traction.

All 38 fractures with delayed primary closure were kept initially on traction. Of these, 26 were later fixed by reamed nailing, 6 by plate and screws, 3 were managed on plaster and 3 had to be kept on traction. Bone grafting was not done as a primary procedure.

Five fractures required a releasing incision for primary closure. Pie crusting was not used. The limb was elevated to avoid distal edema, and active finger and toe movements were advised.

Antibiotics were continued until the seventh day after closure. Antibiotics were changed depending upon the sensitivity, only if infection appeared or predebridement culture showed resistance to given antibiotics.

Results

We treated 30 type II and 48 type IIIa open fractures with immediate (n=40) or delayed (n=38) primary closure (Table 1). Overall, there were 12 cases of nonunion (15.4%). Delayed union was observed in 11 cases (14.1%). The total incidence of superficial infection was 20.5% (16 of 78 open fractures). The total incidence of deep infection was 10.2% (8 of 78 open fractures).

In 5 open fractures requiring releasing incision, skin grafting was done at the site of releasing incision. Flap coverage was not required in any case. Patients who developed superficial infection were managed by stitches removal and dressings, and were allowed to heal by secondary intention. No patient developed gas gangrene or compartment syndrome. There was no death related to this management of open fractures. Use of suction drain with

Table 1 Outcome and complications of primary closure of 78 open fractures, by Gustilo type of fracture and type of primary closure (immediate or delayed)

	Type II (n=30)		Type IIIa (n=48)	
	Immediate	Delayed	Immediate	Delayed
Fractures, n	28	2	12	36
Outcome				
Union	23	2	7	23
Delayed union	2	0	2	7
Nonunion	3	0	3	6
Complications, n				
Superficial infection	4	0	4	8
Deep infection	2	0	3	3

primary closure in open fractures and its removal on days 3–5 did not lead to any infection at the drain site. The drain site wound healed well in all cases.

Discussion

Few studies support the use of primary closure of the wound from open fractures. Because of the danger of wound infection and osteitis with primary closure, open treatment of open fractures has been used by many universities. However, one study that compared treatment approaches for open fractures found a higher success rate for primary closure with suction irrigation than for open treatment [4].

Type I wounds often meet criteria for closure. Types II and IIIa wounds require careful judgement while types IIIb and IIIc should never be closed [3]. Primary closure is beneficial because it primarily covers the tendons without peritenon and bone which is not covered with periosteum [5].

Nuzumlali et al. [6] treated 60 gunshot wounds caused by high velocity rifles by primary closure and found that primary closure following extensive debridement and suction drainage was effective. The infection rate ranged from 2.5% to 20% depending on wound grades [6]. Benson et al. [7] prospectively studied 82 open fractures and found that the timing of wound closure did not affect the infection rate. DeLong et al. [8] reported a 7% deep wound infection rate in open fractures which were managed aggressively; they found no significant difference in infection rate between immediate and delayed closure. Henley and Chapman reported a deep infection rate of 4% in 52 type II open fractures and 10% in 40 type IIIa open fractures which were fixed with an unreamed solid interlocking nail [9]. Gustilo and Anderson reported no infection in type I, a 1.8% infection rate in type II, 18.4% in type III and an overall 8.9% infection rate after primary closure of the wound [3]. Merritt [10] reviewed 70 cases of open fractures and reported an infection rate from 5% to 26%. The 10.2% deep infection rate in the present series is comparable to these studies reported in the literature. We agree with Benson et al. [7] and DeLong et al. [8] that the timing of wound closure does not affect the infection rate.

DeLong et al. [8] reported a 16% rate of delayed or nonunion in open fractures managed conservatively. Henley and Chapman reported nonunion in 35% and delayed union in 14% of 103 open fractures fixed with an unreamed solid interlocking nail [9]. In our study, the delayed union rate of 14.1% and the nonunion rate of 15.3% are similar to those reported in these studies. Higher rates of nonunion and delayed union can be due to lack of bone grafting, as bone grafting is not prescribed early for open fractures. Fischer and Gustillo demonstrated a decreased infection incidence when bone grafting was performed on a delayed basis for type IIIa open fractures [11].

Regarding the time of closure of open fractures, current evidence indicates that infections after treatment of open fractures frequently are not caused by the initial contaminating organisms but often are acquired in the hospital. Recent studies that compared immediate with delayed primary closure did not demonstrate an increased rate of complications. Delayed primary closure is preferred to immediate primary closure as long as closure is achieved before day 5. Wound strength on day 14 is equal. Risk of anaerobic infection is low, host defence becomes better, and second look debridement is possible [5].

Vacuum sealing procedure decreases the infection rate and stimulates proliferation of granulation tissue. Combined treatment with vacuum sealing and emergency internal fixation is a simple and effective method for open fractures [12]. Application of subatmospheric pressure alters the cytoskelton of cells in the wound bed, and triggers intracellular signals that increase the rate of cell division and subsequent formation of granulation tissue [13]. Standard suction drainage to eliminate the dead space and prevent the accumulation of hematoma is used regularly. The drain decreases the tension in the wound, by decreasing edema and removing excessive fluid [5].

In conclusion, primary closure of wounds on a suction drain seems to cause no significant increase in rates of infection, nonunion and delayed union. Rather, it aids in early fixation of fractures and early healing of wounds, with good outcome. Aggressive but judicious management of compound fractures using suction drain for wound closure has shown a favorable outcome in our series.

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