

Primary Wound Closure in the Treatment of Open Fractures of Lower Limb in Al-Sawfwa Hospital, Taiz City-Yemen

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Abstract

Background: The management of open fractures continues to provide challenges for the orthopedic surgeon. Despite the improvements in technology and surgical techniques, rates of infection and nonunion are still troublesome

Aim: To evaluate the role of the early primary closure of wound of the lower limb and the risk of infection and nonunion rate after primary closure.

Methods: 66 patients with a diagnosis of open fractures of lower limb admitted, reviewed by the orthopedic team and followed up for a minimum of 12 months from the time of review.

Results: During the period of two years, 66 patients with open fractures (54 male and 12 female) were treated with primary closure. The average age was 27.9 years (ranged 6-60 years). The average follow-up time was 10.48 months (range 5-24 months). Road traffic accidents (72.7%) were the most common causes of open fractures, followed by fall (24.2%), and gun shot (3.03%). According to anatomic location of open injuries, there were 24 fracture of the femoral shaft (36.4%), 28 fractures (42.4%) of the tibia and fibula and 12 ankle fractures (18.2%). Evaluation of wound injury showed that Gustilo type III (42.4%) were the most common type of open fractures, 39.4%, and 18.2% were type II and type I fractures, respectively. Of the 28 type III fractures, 78.6% (22 open fractures) had Gustilo IIIA type. All open fracture of lower limbs were initially stabilized, irrigated in combination with throughout debridement, and managed by primary closure. Immediate fixation and early closure were performed in more than 90% of open fracture, resulting in 0% superficial infection, 3% deep infection, 3% nonunion, and 3% re-operation. All patients with tibial shaft and tibia and fibula fracture underwent primary closure. For the 40 tibial shaft and tibia and fibula fractures, two cases of deep infection (5%), nonunion (5%), and reoperation (5%) were observed postoperatively. **Conclusion:** Primary closure of the wound in open fractures of the lower limb is an acceptable option in selected cases.

Keywords: Primary wound closure, infection, open fracture, Taiz city.

Introduction:

The management of open fracture remains a challenging problem for treating orthopedics and may lead to serious complications of infection, soft tissue injury, and nonunion.¹ The main goals of an open fracture of lower limb management are fracture stabilization, fracture healing, wound debridement, irrigation, and restoration of function.² The optimal management depend on the timing of closure of the fracture and surgical wounds, extent of the initial injury, severity and degree of wound contamination. Based on reviewed published literature,

timely adequate debridement, no skin loss, normal perfusion, intact sensation, local conditions allow stable skeletal fixation and bleeding skin margins closed by direct apposition under no tension are all widely accepted safe criteria for primary wound closure^{3,4,5}. Infection and nonunion are the most common sequel of open fractures and is clearly related to the severity of the associated soft tissue injury. The timing of closure of the wound in open fractures remains controversial.^{1,6-9} Several classification systems of open fractures including Gustilo & Anderson serve as effective management of open fractures.

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Historically in the literature, for type I and type II open fractures (Gustilo-Anderson Classification), primary closure or delayed primary closure using mesh skin grafts can usually be done five to seven days after injury.^{10,11} In type I IIA open fractures (when exposed bone is not a problem) closure can usually be done in five to seven days by the same method.¹¹ This idea is shared with others, 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.^{12,13} Hampton recommended closure between the fourth and seventh days provided the wound clinically clean.¹⁴ Larger defects continued to be left open to heal by the established secondary intention. There have been no published studies in Yemen aimed to evaluate the role of the early primary closure of wound of the lower limb. This study was done to evaluate the role of primary closure of open fractures and the development of infection and nonunion after primary closure.

Aim of the study: To evaluate the role of the early primary closure of wound of the lower limb and the risk of infection and nonunion rate after primary closure.

Subjects and Methods

Descriptive, cross-sectional study was administered from January 2007 to January 2009. Sixty-six patients with a diagnosis of open fractures of lower limb admitted and treated in major trauma referral center at Al-Safwa Hospital, Taiz, Yemen where participated in the study

All patients included in the study had been reviewed by the orthopedic team and followed up for a minimum of 12 months from the time of review. The following inclusion criteria were used in the current study: lower extremity open fracture, age older than 6 years old, and "blunt" trauma mechanism. Exclusion criteria were patients with insufficient data for analysis, burn injury, admitted in the emergency room with more than 24 hours after the injury, the presence of infection prior to the injury, death before the performance of orthopedic procedure; and those that

refused to sign the informed consent. The demographics data (age, sex, and co-morbidities), history of the wound, clinical details, medical records, radiographs, diagnoses, fracture management of all patients with fracture of lower limb were reviewed. Initial evaluation and management of a patient with an open fracture of lower limb were performed according to Trauma Life Support System guidelines.¹⁵

Open fractures of lower limb were managed according to Gustilo & Anderson. System classification of open fracture (Table1). Intravenous antibiotics were commenced in the emergency room and continued 7-10 days post-surgery. Antibiotics were given to all patients with a combination of ceftriaxone and Gentamycin for Gustilo type I. type II, and intravenous metronidazole was added to Ceftriaxone and Gentamicin for type III open fractures. Wound closure was chosen on the base of principals established by Gustilo and Anderson.^{10,11} All open fractures were treated in an operating room with initial through irrigation, debridement with excision of dead devitalized tissues, early fracture stabilization with definitive fixation and the type of fixation. During this stage, distal arterial pulses, capillary refill and overall colour of the limb, sensory and motor function and the presence of active bleeding from the wound were recorded.

Wound closure is attempted regardless of open fracture grade. Wounds that were loosely approximated with no tension on wound edges or the wounds initially repaired with primary closure and reopened for second-look debridement and closed 48 to 72 hours after initial closure considered as immediate primary closure. A wound that was initially left open and a serial debridement was performed, then the wound was approximated loosely or treated with flap or skin grafts, defined as delayed closure. Details of the wound, fracture healing, and all of the complication were recorded. Infection were diagnosed clinically in the presence of the fever, night sweats, tachycardia, chills, elevated C-reactive protein, elevated

ESR, new onset of pain at the level of the fracture or along the entire limb and nail insertion site; the tissues around the wound are red, swollen or tender, and persistent discharging sinus not necessarily with sequestrum formation or drainage revealed a positive bacteriologic culture, and radiographic sings of osteomyelitis (loss of cortical density at the fractures site, lucency around the nail or locking screws endosteal lysis. or periosteal reaction). Nonunion was defined as no progression of clinical and radiological healing after six months of immobilization^{16,17}. Written informed consent was obtained from the patients.

Data were entered and analyzed using SPSS, version 16. Descriptive statistics was applied for data analysis using (frequency, percentage and Mean).

Table 1: Classification system of open fracture according to Gustilo & Anderson

Type	Wound	Description	Sepsis rate
Type I	< 1 cm	Clean skin openinx, minimal muscle contusion: simple transverse or short oblique fractures.	0-2%
II	> I cm	With extensive soft tissue damage; minimal to the moderate component; simple transverse or short oblique fractures with minimal comminution.	2-4%
III	>10 cm	Extensive soft tissue damage and contamination.	
111A		Extensive soft tissue laceration. Adequate bone coverage: segmental fractures. Gunshot injuries. Minimal periosteal stripping.	5-10%
111B		Extensive soft tissue injury with periosteal stripping and bone exposure requiring soft tissue flap closure; usually associated with massive contamination.	10-50%
111C		Vascular injury requiring repair.	25-50%

Results

The mean age was 27.9 years (ranged from 6-60 years). The Mean follow-up time was 10.48 months (ranged from 5-24 months). Road traffic accidents (72.7%) were the most common causes of open fractures followed by fall (24.2%) and gun shot (3.03%). According to anatomic location of open injuries (Table 2) about two third of patients (60.6%) had tibial shaft and tibia with fibula fractures (42.4% were tibial shaft and 18.2% confined to tibia and fibula), 24 fractures confined to femoral shaft (36.4%), and two ankle fractures (3%). Evaluation of soft tissue wound injury showed that Gustilo III type fractures (42.4%) were the most common type of open fractures, 39.4% and 18.2% of open fractures were type II and type I, respectively. Of the 28 type III type fractures, 78.6% (22 open fracture) were Gustilo IIIA type. More than 90% (60 patients) of open fractures were managed by immediate primary closure and six. A total of 66 patients (54 male and 12 female) with a diagnosis of open fractures of lower limb were included in the study. Of these, 60 (90.9%) underwent immediate primary closure (Gustilo I, II, and IIIA) and six open wounds with extensive soft tissue injury and gross contamination (Gustilo IIIB and IIIC) were treated by secondary intention and skin grafting. Immediate primary closure of the wound of the open fractures of the lower limb (I, II, and IIIA type) after irrigation, debridement thoroughly and immediate fixation lead to clean wound, 0% of superficial infection, 3.3% (2/60) of deep infection (in Gustilo type II tibial fractures), 3.3% (2/60) of nonunion, and 3.3% (2/60) of reoperation. All patients with tibial shaft and tibia and fibula fracture underwent immediate primary closure. For the 40 tibial shaft and tibia and fibula fractures, two cases of deep infection (5%), nonunion (5%), and reoperation (5%) were observed postoperatively. All the soft tissue wounds healed sufficiently, and all fractures except two deeply infected type II tibial fractures fixed first with an external fixator, and the second with a plate where the fixator and plate were removed and Illizarove apparatus

were applied for treatment of infected non-union. These two patients were male (20 years and 25 years) with type II open tibial shaft fracture involved in motor Cycle presented to emergency services within 24 hours after trauma had fever and pus discharged postoperatively.

The Inflamed wound and drainage arising from tissues contiguous with the fracture site remains contaminated after IV antibiotics and drainage, and the fracture fixed with an external fixator and plate, and after six months the fixator in one case and the plate in the other were removed and Illizarove were applied.

Table 2: Type of fracture, site of injuries, type of fixation, and complications in patients with open fractures of the lower limb

Gustilo type	Site of Injuries				Total
	Femoral Shaft	Tibial Shaft	Tibia and fibula	Ankle	
1	6	6	0	0	12
11	8	16	0	2	26
111A	4	6	12	0	22
111B	2	0	0	0	2
111C	4	0	0	0	4
Type of fixation	IMN/ORIF/EF	IMN/ORIF/EF	EF/ORIF	EF	
Superficial infection	0	0	0	0	0
Deep infection	0	2/28 (7.1)	0	0	2 (3)
Nonunion	0	2 (7.1)	0	0	2 (3)
Re-operation	0	2 (7.1)			2 (3)

IMN-intramedullary nailing, ORIF-open reduction, and internal fixation, F.F-external fixations, IF- internal fixation.

Discussion

Infections of open wounds are likely caused by organisms acquired in the hospital rather than initial contamination of the wounds.^{7,10,11} According to recent studies, primary wound closure in the context of irrigation, timely adequate debridement, and immediate fixation may actually minimize the risk of infection, nonunion, reduce the length of stay associated with these injuries may be an acceptable procedure in appropriately selected patients.^{7,19-21,24}

Infection and nonunion were lower in the previously published reports, which is consistent with the results of the present work.

A retrospective study of 1025 open fractures of long bone conducted by Gustillo and Anderson, observed a decrease from 20% infection rate to 6% in type I and type II fractures treated with primary closure, whereas a 44% of infection rate were reported in type III injuries.¹⁰ The same authors¹¹ in their prospective study of 326 patients with open fractures have reported a 0% rate of infection developed in association with type I fractures, a 1% rate of infection with type II fracture, and a 9% with type II.

Investigators recommended primary closure for type I, type II fractures, and delayed primary closure for type III. Benson and colleagues reported prospectively the results of use of primary (44 wounds) and delay closure (38 wounds) in the management of open fractures.¹⁸ Half of the wounds (46%) were contaminated at the time of debridement and only three superficial wound infections were reported in primary closure (7%). Deep infection occurred postoperatively was independent of closure methods and they supported the use of primary wound closure in the treatment of open fractures.

De Long et al¹⁹ in a review of 119 open fractures wounds performed primary closure in eight seven of fractures wound (73%) and compared primary wound closure versus delayed. Wound care with aggressive debridement, irrigation with pulse lavage, and early fractures stabilization resulted in an overall 7% infection rate (8/118) and 16% (19/118) of delayed and nonunion rate. The authors conclude that immediate primary closure of open fracture wounds after a thorough debridement by an experienced fracture surgeon appears to cause no significant increase in infections or delayed union/nonunion. In addition, the early closure may decrease the requirement for subsequent debridement and soft-tissue procedures, thereby minimizing surgical morbidity, shortening hospital stays, and reducing costs. Furthermore, Moola F O et al²⁰ have demonstrated that

primary closure for all open fractures is efficient practice revealed no significant increase in postoperative risk of infection and delayed union or nonunion. Crowley et al²¹ found primary closure is acceptable option for Gustilo type I, II, and IIIA fractures, whereas Gustilo type IIIB and IIIC injuries should manage by specialized team. The consensus of opinion, these studies support the use of early primary closure of open fractures wound.

Primary closure after early stabilization of the wound, initial thorough irrigation and debridement were an acceptable procedure in the currently work for more than 90% of open fractures was safe option for all patients without increasing the rate of infection or nonunion which is consistent with the results of previously published literature. Based on reviewed published literature, use of aggressive approach in the management of open fractures of the tibial fractures is indicated when possible. Also, the present study investigates the infection rate after the immediate primary closure of the tibial shaft and tibia and fibula open fractures.

The rate of deep infection were 5%, a similar figure was observed in the previous literature. Hohmann and colleagues retrospectively analyzed 95 open tibial fractures, reported that infection rate (2%) was significantly lower with primary closure than with delayed closure (4%). Additionally, the length of stay following primary closure was shorter. Cullen et al²² had a retrospective study of 83 pediatric open tibial fractures, the type of the wound closure was chosen on the basis of soft-tissue injury, wound contamination. The wounds after irrigation and throughout debridement were closed primarily in 69.4% (57 patients), resulted in clean wounds. In a series of eighty-one open tibial shaft fractures, Reuss and Cole²³ managed 49 open fractures with primary closure and performed delayed closure in the treatment of 32 wounds. The authors found that primary closure resulted in 2% infection rate compared with 19% infection rate for delayed closure. The investigators found a

significant difference between serial debridement and rate of infection, and a higher fracture grade.

Conclusion

We conclude that primary closure of the open fractures in properly selected open wounds (type I, type II and type IIIA.) is an acceptable procedure that doesn't appear to increase the risk of postoperative infection, nonunion, and reoperation.

Recommendations

Further research is needed on primary wound closure in the treatment of open fractures of the lower limb.

Reference

- 1.Crowley DJ, Kanakaris Nk, Giannoudis PV. Irrigation of the wound in open fracture. J. Bone & Joint surgery. Br. 2007;89(5):580-5.
- 2.Olcruel S, Kalstrom G, danwardt Lilliestrom G. Treatment Of open fractures of the tibia and ankle. Clin Orthop. 1978;136:212-24.
- 3.Hartel R, Lambert SM, et al. On the timing of soft tissue reconstruction for open fractures of the lower leg. Arch Orthop Trauma Surg, 1999; 119:7-12.
- 4.Shtarker H, David R, Stolero J, Grimberg B, Soudry M. Treatment of open tibial fractures with primary suture and Ilizarov fixation. Clin Orthop Relat Res 1997; 335:268-274.
- 5.Kindsfater K, Jonassen EA. Osteomyelitis in grade II and grade III open tibia fractures with late debridement. J Orthop Trauma. 1995; 9:121-7.
- 6.Crowlev DJ, Kanakaris NK, Giannoudis PV. Debridement and wound closure of open fractures: the impact of the time factor on infection rates. Injury. 2007; 38:879-889.
- 7.Hohmann E, Tetsworth K, Radziejowski MJ, Wiesniewski TF. Comparison of delayed and primary wound closure in the treatment of open tibial fractures. Arch Orthop Trauma surg. 2007; 127: 131-136.

- 8.Giannoudis PV. A review of the management of open fractures of the tibia and femur. *J Bone Joint Surg.* March 2006.
- 9.Okike K, Bhattacharya T. Trends in the management of open fractures. A critical analysis. *Bone & Joint Surg. Am.* 2006; 88: 27 39-48.
- 10.Gustilo RB, and Anderson JT. Prevention of infection in the treatment of one thousand and twenty five open fractures of long bones: retrospective and prospective analysis. *J Bone and joint Surg.* 1976;58A: 453-458.
- 11.Gustilo RB, Mendoza RM, Williams DN. Problems in the management of type III (severe) open fractures: A new classification of type III open fracture. *J. Trauma.* 1984;24: 742-746.
- 12.Candle RJ, and Stein PJ. Severe open fractures of the tibia. *J. Bone and Joint Surg.* 1987;69-A : 801-807.
- 13.Byrd HS, Cierny GIII, Tebbetts JB. The management of open tibial fractures with associated soft tissue loss : external pin fixation with early flap coverage. *Plast reconstr surg.* 1981; 68: 73-9.
- 14.Hampton op Jr. Basic principles in management of open fractures. *JAMA* 1955; 159:417-419.
- 15.Kortbeek JB, Al Turki SA, All J, Antoine JA, Bouillon B, Brasel K, Syndsen LB. Advanced trauma life support: the evidence for change. *Journal of Trauma and Acute Care Surgery.* 2008;64(6):1638-1650.
- 16.Puno RM, Teynor JT, Nagano J. Gustilo RB. Critical analysis of results of treatment of 201 tibial shafts fractures. *Clin ortho.* 1980; 212:113-121.
- 17.Rosenthal R E, Macphail J A, Ortiz J E. Nonunion in open tibial fractures. Analysis of reasons for failure treatment. *J Bone and Joints Surg.* 1977;59-A: 244-248.
- 18.Benson DR, Riggins RS. Lawrence RM, Heoprich PD. Huston Al Harrison JA. Treatment of open fractures: A prospective study. *J Trauma.* 1983: 23:25-30.
- 19.Delong WG jr, Born CT, Wei SY, Petrik ME, Ponzior CW. Aggressive treatment of 119 open fracture wounds. *J Trauma.* 1999; 46:1049-1054.
- 20.Moola FO, Carli GK, Reindl R, Jacks D, Harvey EJ. Attempting primary closure for all open fractures: the effectiveness of an institutional protocol. *Canadian Journal of surgery.* 2014 June;57(3):E82-8.
- 21.Crowley DJ, Kanakaris NK, Giannoudis PV. Debridement and wound closure of open fractures: the impact of the time factor on infection rates. *Injury* 2007; 38:879-889.
- 22.Cullen MC, Roy DR, Crawford AH, Assenmacher J, Levys. Wen D. Open fractures of the tibia in children. *J Bone joint surg.Am* 1996;78: 1039-1047.
- 23.Reuss BL, Cole JD. Effect of delayed treatment of open tibial shaft fractures. *Am J Orthop* 2007;36:215-220.