

# EXTERNAL PIN FIXATION WITH EARLY FLAP COVERAGE FOR OPEN TIBIAL FRACTURES WITH SOFT TISSUE LOSS

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### Abstract

*Meaningful data on the management of open tibial fractures cannot be obtained unless one categorizes the injury according to fracture type, degree of soft tissue loss and the velocity of the injury. Treatment by converting the type III injury to a type II injury with well vascularized soft tissue is presented. Eighteen patient with 20 type III and type III(a) wounds were treated in a prospective fashion employing a combined orthopedic and plastic surgical scheme based on the tenets of early radical debridement, a “second look” operation, muscle or fasciocataneus flap cover within the first 3 weeks for injury. All fractures united in a mean time of 6.0 months. The mean hospitalization was 6.2 weeks. There have been chronic infection, osteomyelitis nonunion, shortening or tissue breakdown.*

**Keyword:** *Open tibial fractures, external pin fixation*

### Introduction

The management of open tibial fractures has varied and changes are generally the consequence of dissatisfaction with existing techniques. Fixation may be obtained with external plaster, internal fixation across the fracture or external pins remote from the fracture. The soft tissues may be managed by primary closure, delayed primary closure, open technique with secondary healing or by employing grafts or flaps. Complex open tibial fractures with concomitant soft tissue are associated with a high rate of complications and treatment failures using the previously mentioned management regimens. The purpose of this study is to evaluate a treatment sequence based on early aggressive wound management and fracture coverage in an attempt to alter the natural history of complex open tibial fractures with respect to union, infection rate and time and cost of hospitalization and rehabilitation.

### Methods

#### Classification of Injury

By altering Gustillo’s classification of the open fracture wound so that the parameters of the soft tissue injury are better described, a classification considering the velocity of the injury, the fracture

type and the associated soft tissue injury is available (Table-I).

**Table I**

*Fracture type and the associated soft tissue injury*

Type I	Low-energy forces causing a spiral or oblique fracture pattern with skin laceration less than 2 cm and relatively clean wound.
Type II	Moderate energy forces causing comminuted or displaced fracture pattern with skin laceration less than 2 cm and moderate adjacent skin and muscle contusion but without devitalized soft tissues.
Type III	High-energy forces causing a significantly displaced fracture pattern with severe comminution, segmental fracture or bone defect with extensive associated skin loss and devitalized muscle.
Type IV	Fracture pattern as in type III but with extreme energy forces as in high velocity gunshot wounds, a history of crush or degloving or associated vascular injury requiring repair.

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Aside from capturing the useful clinical parameters for categorizing injury, this classification segregates wounds according to a progressive loss of vascularity. The forces and fracture pattern in the type I injury may allow both the periosteal and endosteal circulation to remain intact. In the more severe type II injury, the endosteal circulation is certainly disrupted and the wound is dependent on periosteal and soft tissue circulation. In the type III injury, both the periosteal and endosteal circulation are lost and healing is dependent on vascular ingrowth from the surrounding soft tissue envelope.

### Clinical protocol

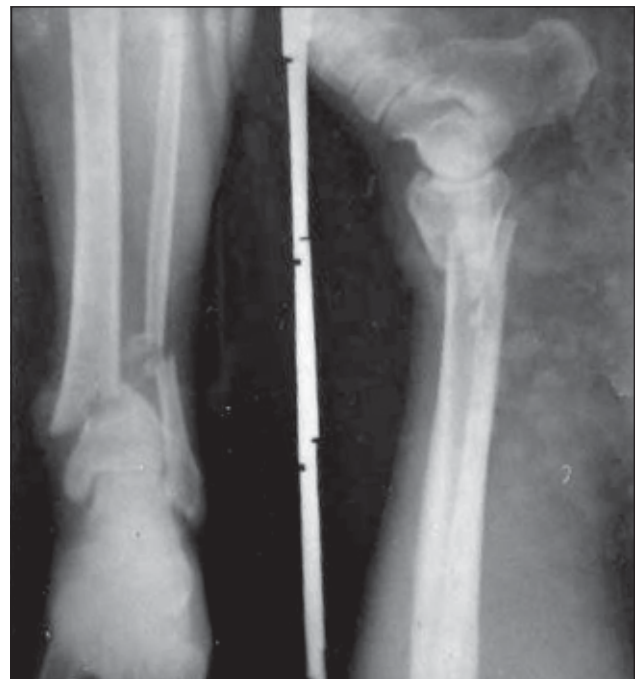
A combined orthopedic and plaster surgical approach to the type III and type III(a) lower extremity injury was designed with prospective guidelines based on the tenets of early radical wound debridement, a "second look" operation, muscle flap cover within 5 days of injury, external pin fixation, and ambulation within the first 3 weeks of injury. All patients received parenteral antibiotics and frequent local wound care to avoid desiccation.

Different specific steps of wound management can be identified:

- (a) Emergency room care: Tetanus prophylaxis, cephalosporin prophylactic antibiotics, moist sterile Betadine dressing over the wound, immobilization of the fracture with splint and wound culture.
- (b) Operation within 6 to 8 hours of injury is initiated with copious water-jet irrigation of the soft tissues and fracture.
- (c) Extensive radical soft tissue debridement: All nonviable tissues can be removed from the wound with the assurance that well-vascularized soft tissue envelope can be provided. The skin is excised until bleeding dermis is encountered. All exposed subcutaneous tissue and fascia are removed. Surrounding muscle is excised if there is any question about its viability. The parameters of color, turgor, bleeding and contractibility are used. Any small chips of bone not attached to soft tissues are removed. Large fragments of bone, whether attached or unattached, are retained in the wound. Every effort is made to clean these fragments of bone of embedded foreign material. All fragments, regardless of size, that have maintained viable soft tissue attachments are left in the wound. Nerves, vessels and important tendons are preserved.

- (d) Compartment fasciotomy is performed whenever the muscles are bulging from edema or when arterial repair is required.
- (e) Percutaneous pin fixation is the preferred method of stabilizing the fracture (A A F).
- (f) Detached but viable muscles are draped over the fracture and any exposed bone. If there is minimal devascularization of the muscles, formal myoplasty is undertaken to effect coverage of the wound. When the injury is more extensive, the wound and any exposed bone or fracture are covered with a Betadine soaked gauze dressing to avoid desiccation.
- (g) A "second look" operation under anesthesia is undertaken 48 to 72 hours following

the injury in order to assess progression of devitalized tissue. All flaps are released in order to thoroughly inspect the wound bed. Debridement is repeated and definitive muscle, local fasciocutaneous flaps (proximal/distal) fasciocutaneous flaps are provided if minimal devitalized tissue is present. When devitalized tissue is found, a moist dressing applied and a third debridement is scheduled in 48 hours, at which time definitive flap coverage is anticipated.



**Fig-1:** Fracture lower end of tibia & fibula (Gustilo type III-B)



**Fig-2:** Fracture fixed with external fixator. Soleus muscle raised for wound coverage.



**Fig-3:** Fracture united

- (h) Definitive wound coverage is provided within the first 5 days of injury. The preferred modalities are local muscle flaps, Gastrocs, Soleus, fasciocutaneous flaps. Skin grafts to exposed muscle are applied primarily and secondarily.
- (i) The extremity is elevated 30 to 45 degrees postoperatively.
- (j) Ambulation with weight-bearing is begun in the first 3 weeks following injury.
- (k) Fixation is changed to a patellar-bearing below-knee plaster brace when the soft tissues and fracture are stable.

### Results

Eighteen patients with 20 type III and III (a) open tibial fractures have been treated in a prospective manner according to the guidelines outlined. Follow-up time ranges from 1 to 34 months. Patient ages

range from 20 to 61 years, with a mean of 30.4 years. By classification, 15 patients with 17 fractures had type III injuries, while 3 patients with 3 fractures had type III (a) injuries (Table-II).

**Table II**  
*Types of Fracture in Treatment*

Number (Patients per fractures)	Type-III 15/17	Type-III(a) 3/3
Age	20 to 61(mean 32)	24 to 32 (mean 28)
Union (month)	4.0	4.1
Hospital (Weeks)	4.2	3.8
Deaths	0	0
Infections	0	1
Nonunion	0	0
Delayed union	1	0
Other	1 (Pulmonary embolus)	

All fracture gave united in a mean time of 4.0 months. One delayed union requiring 6 months occurred. There has been no chronic infection, osteomyelitis, nonunion or shortening. The mean hospital stay has been 6.0 weeks. The soft tissues have remained stable in all patients.

There has been one complication involving a type III(a) shotgun wound. Following muscle-flap cover and free primary bone graft three compartment necrotizing fasciitis occurred requiring below knee amputation. Aside from this early wound problem, no significant differences in the courses of type III and type III(a) wounds is seen. However, type III(a) wounds have predictably demonstrated dead tissue on "second look" and several patients have been excluded from the study because of failure to gain coverage in the first 5 days of injury.

### Discussion

The classification system suggested in this study is thought to be extremely beneficial to both the investigator and the practicing surgeon.<sup>1</sup> To the investigator it provides means of standardizing the open tibial fracture so that meaningful comparisons of treatment can be ascertained. The practicing surgeon identifies the clinically significant parameters that are useful in selecting treatment and determining prognosis. Further, the classification focuses on the progressive loss of vascularity with each sequential category and emphasizes the importance of providing a vascularized soft tissue envelope in type III wounds.

The choice fixation significantly affects the outcome of type III injuries. Although the closed plaster techniques advocated by Brown and Truetta show impressive union rates approaching 100 percent, distinct disadvantages are apparent among type III patients.<sup>3,4</sup> Persistent drainage for greater than 6 months occurred in approximately 30 percent and significant shortening was noted. When the soft tissue loss is extreme and there are large segments of exposed bone, healing by secondary scarring can be prolonged and the ultimate stability of the scar may prove unsatisfactory, compromising the eventual rehabilitation of the extremity. With internal plates, rigid fixation can be achieved, but at the expense of periosteal and soft tissue stripping, which further devascularizes the fracture. Published series show a 20 to 30 percent incidence of nonunion and chronic infection among type III patients with internal fixation.<sup>5,6</sup> External pin fixation affords rigid stabilization without further devascularizing the fracture site. Anatomic alignment can be maintained. Experience with external fixation with open wound technique shows favorable union rates of approximately 100 percent, but an incidence of chronic infection of 10 to 20 percent.<sup>7,8</sup> These observations suggest that internal plate fixation and the closed plaster method described by Brown and Truetta lend themselves well to the management of the open type I and type II tibial fracture, where and adequate soft tissue envelope exists and where fracture stability is not a problem.<sup>3,4</sup> External pins with early muscle or muscle skin flap coverage seem most appropriate for the more severe type III and III (a) injuries.

The timing of wound closure is extremely important. The precedent for this concept was established during World War II, when open tibial fractures were closed by delayed primary suture or graft between the fourth and sixth days.<sup>9,10</sup> In this series, closure of wounds by the fifth day of injury has resulted in a low incidence of infection. Those patients whose wounds are not closed in the first 5 days have experienced a much higher complication rate, with soft tissue and bone infection, nonunion and amputation observed.

The selection of muscle or skin fascia flaps as the primary modality of cover is supported by laboratory experience demonstrating that devascularized long bone fractures receive their principal vascular in

growth from muscle tissue. Union times comparable with those for the less complex type I and type II injuries emphasize the importance of the well vascularized soft tissue cover which these flaps provide.<sup>11,12</sup>

The principal of radical wound debridement with a "second look" procedure to ensure that all dead tissues have been removed cannot be overemphasized and is probably the single most important step. As stated by Truetta in his book *Treatment of War Wounds and Fracture*, "Sepsis will not follow if all devitalized tissue is excised." The low incidence of infection in these contaminated wounds must be attributed to timely delayed primary wounds closure in the presence of a well vascularized wound bed free of nonviable tissue.

Ambulation within the first 3 weeks of injury and latter conversion of external fixation to a below knee patellar bearing cast brace takes advantage of the principal biomechanical factor influencing the initial Wound milieu toward new bone formation instead of fibrous tissue or fibro-cartilage. The importance of these factors is substantiated in those clinical series employing closed plaster immobilization as the primary management modality.

This study can be criticized on the basis of patient selection because it does not include 20 "consecutive" type III fractures. Multiple traumatized patients with contraindications to general anesthesia preclude a consecutive series.

The role of amputation in type III open tibial fractures cannot be overlooked. Amputation with an immediate fitting below knee prosthesis is a consideration when there has been a loss of protective sensation to the sole of the foot with disruption of the posterior tibial nerve, in the elderly patient who is a poor risk for repeated anesthesia and in those individuals whose management is complicated by severe soft tissue and bone infection that will likely culminate nonunion and a protracted course. Exceptions must be made for the child whose capability for nerve regeneration is great. Patient selection for limb salvage is greatly influenced by the wishes and health of the patient, in addition to the relative importance of motion, sensation and stability in the extremity. A supple, stable extremity is all that is required for locomotion. Sensory and motor loss can be managed by an ankle foot orthosis (sach heel, total contact shoe and rocker bottom



soles are optional) that provides the benefits and negates the disadvantages of the prosthesis.

### Conclusion

Type III open tibial fractures treated with external pin fixation and early flap coverage with 5 days of injury demonstrate fracture union and a period of hospitalization comparable with those expected for the less severe type I and type II injuries. The complication rate of 5 percent in these preliminary results stands in sharp contrast to the 30 percent incidence of infection and nonunion, to the severe shortening and to the prolonged hospitalization for the other methods of treatment of this severe injuries.

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