Closed Tibial-Shaft Fractures: Which Ones Benefit From Surgical Treatment?

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Abstract

Closed tibial-shaft fractures can usually be managed effectively with cast or brace immobilization if acceptable alignment is maintained and cyclic loading (weight-bearing) is initiated early. However, certain tibial fractures are at greater risk for nonunion or malunion and merit consideration for early operative stabilization. Among the tibial fracture characteristics that warrant fixation are instability, metaphyseal-diaphyseal location, significant limb edema, and the need for repeated realignment procedures. Deleterious patient-specific factors, such as obesity, poor compliance, and health conditions favoring immediate function, should also be considered. Absolute criteria for stabilization include coronal angulation exceeding 5 degrees, sagittal angulation greater than 10 degrees, rotation greater than 5 degrees, shortening exceeding 1 cm, displacement greater than 50%, and severe comminution (loss of 50% or more of cortical circumferential continuity). Relative indications for fixation include an inability to bear weight, distal or oblique fractures, prominent edema, and patient-specific considerations necessitating early function. When tibial stabilization is preferable, the authors believe that closed locked intramedullary nailing is the treatment of choice.

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Fracture of the tibial diaphysis is considered to be the most common long-bone injury.[1] The standard treatment for the majority of closed tibial-shaft fractures consists of closed reduction and cast immobilization. This method has proved to be generally successful[2-5] and offers reliable healing without the risks inherent in any operative procedure.[6] However, a subset of patients have less than satisfactory outcomes with closed treatment,[6,7] and the literature continues to be ambiguous in identifying those fractures best managed operatively.

The difficulty in establishing surgical indications for closed tibial-shaft fractures is, in part, due to the fact that most clinical reports emphasize only the incidence of union or the time to bone healing as the indicator of treatment success. Trafton[7] astutely recognized that variables such as morbidity during treatment and ultimate function also merit consideration before the optimal treatment for a particular patient or fracture can be determined. Loss of limb alignment is a frequent sequela of cast or brace treatment of tibial fractures, yet no consensus exists on the long-term consequences of malalignment or the limits of acceptable deformity.[1] Residual ankle and/or knee stiffness often occurs after prolonged immobilization.[8,9] Finally, despite the acceptable union rates for cast or brace treatment of closed tibial fractures, delayed union or frank nonunion continues to occur in certain situations.[3,6,9]

Increasing familiarity with recent advances in fracture-fixation technology and greater appreciation of their benefits have prompted many surgeons to become more aggressive in their approach to the closed tibial-shaft fracture.[6,10-12] However, these more invasive treatment methods are not without potential complications, which must be weighed against their benefits. Dynamic compression plates are capable of restoring limb alignment and permit adjacent joint motion, but can be associated with considerable soft-tissue morbidity[13] and limitation of early weight-bearing.[7] External fixation, which is less invasive and therefore more soft-tissue "friendly," can also restore and maintain limb alignment; however, external fixation requires an extremely tolerant and compliant patient, daily pin-site care to avoid infections, serial management decisions throughout treatment, and usually cast or brace

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immobilization after removal.[7] Intramedullary (IM) nailing has also been recommended for the closed tibial-shaft fracture, but it represents an appreciably greater risk for infection and compartment syndrome than use of other fixation devices.[14,15]

The lack of standard assessment criteria for closed tibial-shaft fractures[16] has made meaningful comparison between existing studies of closed treatment and internal fixation extremely difficult. With this understanding, we will present a selection rationale for operative management of closed tibial fractures. Reported indications and outcomes of closed treatment will be reviewed and compared with those of surgical management. Finally, we will discuss the operative techniques most commonly employed for stabilization and the options for fixation.

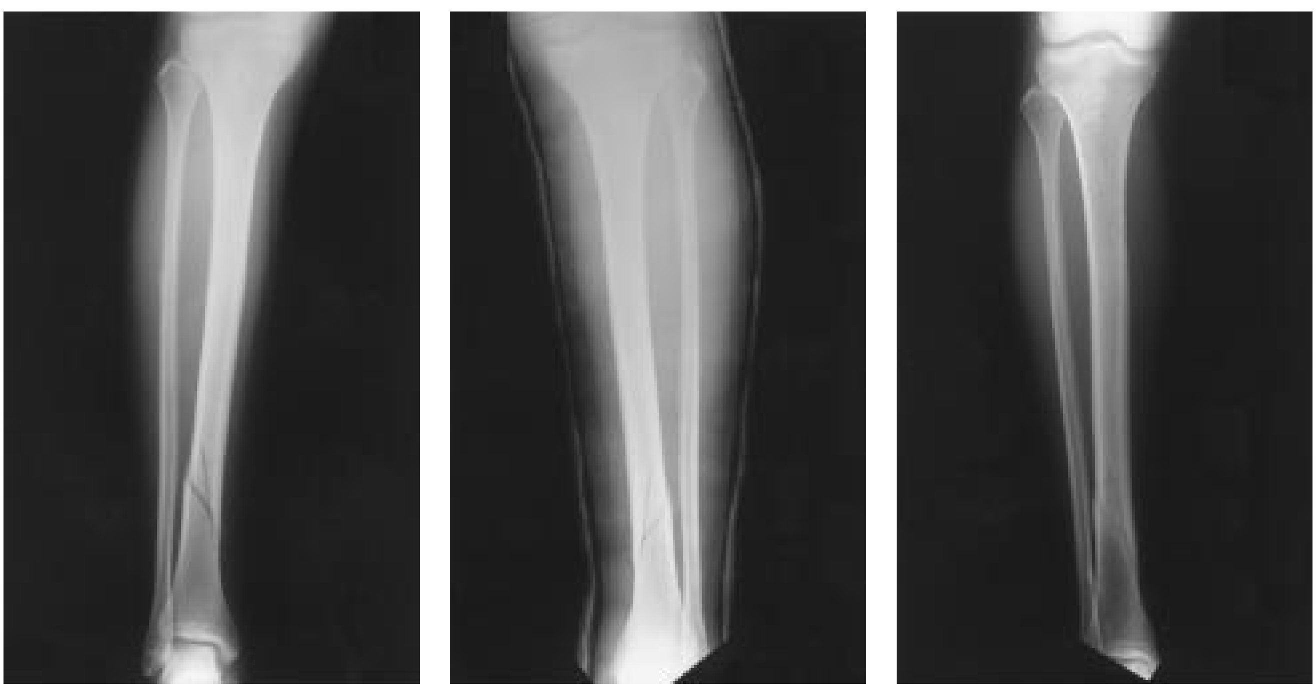
Closed Treatment

Indications and Outcomes

Our criteria for operative treatment are predicated on the fact that most closed tibial-shaft fractures can be effectively treated by closed cast or brace immobilization[3,6,7,14,17] (Fig. 1). In a classic study, Nicoll[3] analyzed the treatment of 705 tibial fractures. He found that closed treatment achieved overwhelmingly favorable results, which convincingly argues against routine surgical intervention. Nicoll insisted that surgery was justified only if it could reduce the incidence of deformity, joint stiffness, and delayed union or nonunion.

Sarmiento et al[4] modified the traditional long-leg cast treatment by applying a functional brace at approximately 4 weeks while encouraging active limb weight-bearing and adjacent joint motion to enhance healing and minimize functional compromise. This simple "philosophical" modification of closed management produced even faster union with less knee or ankle stiffness. Other reports of the use of early weight-bearing claimed rates of union and functional success as high as 100%[17] and applauded closed treatment for both its simplicity and its limited expense.

Despite the obvious merits of nonoperative management, it must be noted that not all patients with closed tibial-shaft fractures are guaranteed a satisfactory result (Fig. 2). In a review of the data on 27 tibias treated by casting, Waddell and Reardon[18] found that reduction was lost in 9 patients, 5 required cast wedging, and 3 were treated with late internal fixation. Limb deformity, especially in the more unstable fracture, is often unavoidable.[1] In the study by Sarmiento et al,[4] approximately 22% of the



A B C

Fig. 1 **A,** Low-energy, nondisplaced, adequately aligned closed tibial fracture. **B,** Fracture was treated in an early-weight-bearing cast. **C,** Healing and alignment at 3 months were sufficient to allow unprotected ambulation.

Fig. 2 Closed (cast) treatment of this tibial fracture resulted in union, but at the expense of cosmesis and with significant loss of length and residual valgus angulation.

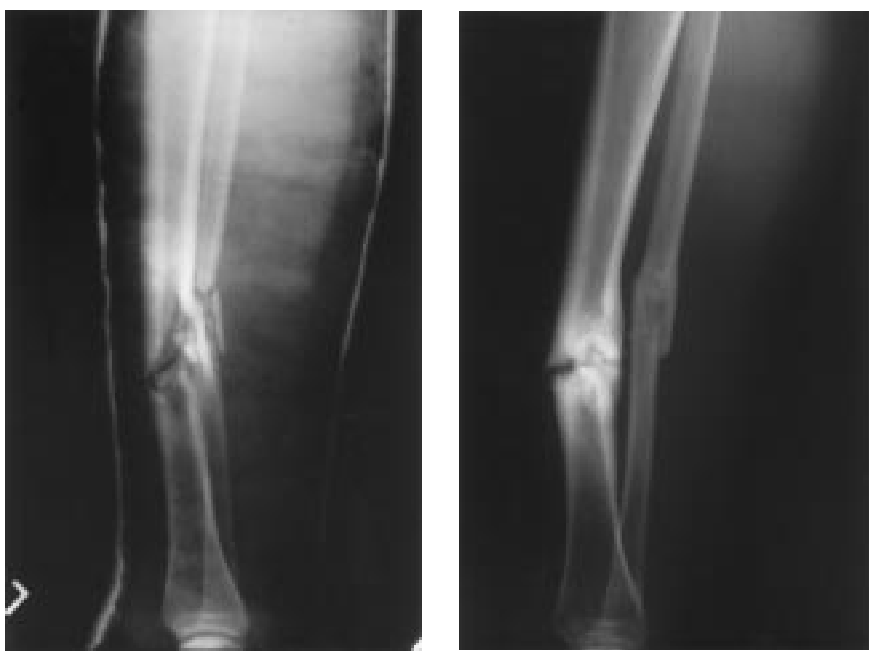
with eventual limb-length discrepancy. Digby et al[8] documented severe comminution in 8% of 103 patients treated with cast bracing and noted that shortening of 2 cm or more occurred in 9% of patients.

Prolonged knee and/or ankle immobilization is usually essential for adequate closed management, and the result is often joint stiffness. Even with earlier weight-bearing, residual joint stiffness has been reported in approximately 20% to 30% of patients.[4,18] Digby et al[8] found that, due to lingering ankle and subtalar stiffness, 27% of the patients treated with casts could not run long after a return to otherwise normal functional status.

The incidence of nonunion after treatment of closed tibial fractures can approach 6%.[6] In many cases of uneventful fracture union, the healing process can be slow, especially when early weight-bearing is not possible[17] (Fig. 3). The presence of an intact fibula has been implicated as a major risk factor for tibial delayed union or malunion.[9] Even after union of a displaced spiral fracture, the persistent risk of refracture may justify repeated attempts at a more anatomic closed reduction.[19] When the closed treatment of spiral and other fractures results in the need for repeated manipulation to maintain reduction or when the healing period is prolonged, the cost-effectiveness of this mode of treatment can be challenged.[7]

Although conservative treatment of closed tibial-shaft fractures usually produces acceptable results, reported complication rates of up to 66%[18] support the need for comprehensive criteria with which the clinician can select those patients perhaps better treated operatively. While reemphasizing that any criterion must be individualized to patients with “acceptable” results after closed treatment nevertheless had angulation greater than 5 degrees. At issue is not whether residual deformity occurs with closed methods, but the extent of residual deformity that is considered excessive.[1]

If fracture instability threatens acceptable alignment, what factors best predict stability? Böstman[2] reported that closed reduction is very difficult to maintain with initial displacement by more than 50% of the tibial width and with distal-third spiral fractures. The extent of comminution may directly correlate



A B

Fig. 3 **A,** High-energy, comminuted closed tibial fracture managed in a non-weight-bearing long-leg cast. **B,** Despite adequate immobilization, a frank atrophic nonunion was evident at 4 months.

reflect the needs or function of each patient, we will present our indications for more invasive treatment of closed tibial-shaft fractures. Among the factors that suggest that standard closed-treatment methods may be inadequate are (1) fracture characteristics that retard or inhibit fracture healing, (2) fracture instability likely to result in significant deformity, (3) associated factors that limit the patient's function or recovery, and (4) cost.

Fracture Healing

Successful fracture union in the tibia, as defined by Sarmiento et al,[4] entails the following factors: (1) the patient's ability to bear weight painlessly, (2) the absence of clinically detectable motion at the fracture site, and (3) visible bridging callus across the fracture on plain radiographs. The temporal distinction between delayed union and nonunion, unfortunately, is not always as clearly defined. Usually, delayed union is designated at 4 to 6 months after injury, and frank nonunion is established by 8 to 12 months.[4,13] Regardless of the reliability of union in the majority of closed tibial-shaft fractures treated with casts or bracing, the potential for compromised healing should be recognized acutely in some fractures and should prompt consideration of early surgical fixation.

The fracture characteristic most apt to indicate the need for early operative intervention is significant instability of the healing limb. Excessive comminution or excessive initial fracture displacement may have considerable inhibitory effects on fracture healing[2,3] (Fig. 4). Severe comminution, defined as the loss of 50% or more of cortical circumferential continuity, often reflects the extent of energy or trauma sustained by the bone and soft tissue and can further increase the risk of delayed union or nonunion for biologic as well as obvious biomechanical considerations.[14] Major displacement, defined as translation of 50% or more of the width of the bone at the fracture site, was implicated as the cause of up to 50% of delayed unions or nonunions in one study.[17]

Significant comminution or displacement can also lengthen the time to mobilization or weight-bearing, thereby depriving the patient of the fracture-healing stimulus of early axial limb loading. DaCosta and Kumar[20] reviewed closed tibial fractures in 44 patients and found that 28 patients ambulated early (mean period after injury, 11.5 days), while 16 remained in a long-leg cast and did not ambulate until a mean of 119 days after injury. Time to union for the early-weight-bearing group was half that for the late-weight-bearing group (82 days versus 157 days).

A B

Fig. 4 **A,** Low-energy comminuted spiral oblique closed tibial fracture with 100% displacement. **B,** Despite multiple attempts to achieve and maintain reduction with cast immobilization, nonunion was evident clinically and radiographically after several months.

Comminution and displacement are not always contraindications to early weight-bearing. Although we prefer to delay weight-bearing in these situations, immediate axial loading of the limb is an excellent method of establishing the degree of instability in the comminuted or displaced fracture. Ideally, closed treatment is reasonable if reduction can be maintained with a below-knee cast or functional brace so as to allow early mobilization. If fracture instability is excessive, recurrent loss of alignment may adversely affect union. Repeated reduction attempts have correlated not only with delayed union but also with limb refracture.[5]

Partial initial stability of the limb (i.e., in the presence of an intact fibula) may also inhibit fracture healing. Teitz et al[9] reported altered fracture union in 26% of adult patients with closed tibial fractures but intact fibulae who were treated with cast immobilization. Sixty-one percent of the patients experienced one or more complications during treatment. The authors theorized that the intact fibula prohibited axial loading of the tibia and thereby deprived the fracture site of weight-bearing stimulus.

In addition to these structural factors, a number of other relative factors should be considered before simply designating routine closed management the optimal treatment of a particular closed tibial fracture. The pathologic nature of the injury (e.g., the presence of a neoplastic condition or osteoporosis) and a variety of systemic factors (e.g., chronic disease, nutritional status, patient's body habitus or age, and multiplicity of injuries) should also be evaluated as part of the decision-making process. A nonsurgical management course can always be initiated and then aborted early if the fracture characteristics or factors known to be detrimental to healing are recognized and a criterion for more invasive treatment has been established for the individual injury or patient.

Malalignment

The most frequent complication of nonoperative management of a closed tibial fracture is loss of acceptable alignment. Aside from the obvious cosmetic concerns, deformity can alter normal load distribution by concentrating the weight-bearing stress in adjacent major joints and precipitating early osteoarthritic changes. Therefore, establishing a threshold for operative intervention is especially crucial in addressing the issues of limb deformity and its long-term effects on function. However, the extent of limb alignment likely to induce symptoms or significant osteoarthritic changes is controversial[16] (Table 1).

Fracture instability can clearly have a profound adverse effect on healing limb alignment. Transverse fractures are more stable and appear to be more amenable to closed management and earlier axial loading.[11] The more complex fracture patterns demonstrate greater instability and constitute a major impetus for operative stabilization. Among these higher-risk fracture patterns, crucial factors include the degree of fracture obliquity, the presence of a spiral pattern, and the extent of fracture comminution.[2,3,8] Another reliable indicator of instability is initial fracture displacement of 50% or more of bone width. In a review of 192 spiral fractures with lateral displacement by more than 50% of the tibial width, it was found that reduction was maintained in only 18%.[2]

Fracture location may also affect the likelihood of maintaining limb alignment with closed methods. Fractures of the proximal or distal aspect of the tibia are especially difficult to immobilize, even when the cast extends to incorporate the adjacent joint. Unfortunately, most tibial fractures occur in the distal third of the bone,[16,23] and angulation can be extremely difficult to control nonoperatively at this level.[14]

Effective limb casting or bracing is highly dependent on the ability of the limb to tolerate a well-fitted device, and pronounced limb edema may inhibit the early application of adequate external support.[24] A snugly applied cast is especially contraindicated in patients at risk for compartment syndrome (estimated incidence, 1% to 10% of all patients with tibial fractures).[23] Even the most conservative clinician should consider fixation if casting is plagued by the repeated need for anesthesia in multiple attempts to restore limb alignment.[18]

Table 1
Sampling of the Widely Variable Limb-Alignment Standards Deemed Acceptable in the Literature

Study	Varus	Valgus	Anterior or Posterior	Rotation	Shortening
Bone and Johnson[14]	…	5°	…	15°-20°	10 mm
Bostman[19]	5°	5°	…	…	10 mm
Collins et al[10]	5°	5°	5°-10°	…	10 mm
Haines et al[21]	4°	4°	…	5°	13 mm
Jensen et al[6]	8°	8°	15°	…	20 mm
Johner and Wruhs[13]	5°	5°	10°	10°	…
Nicoll[3]	10°	10°	10°	10°	20 mm
Puno et al[22]	10°	10°	20°	…	20 mm
Trafton[7]	5°	5°	10°	10°	15 mm
van der Werken and Marti[12]	…	…	…	15°-20°	…

Is residual limb deformity actually important in the functional outcome of most patients? Some authors report that a small degree of angular malalignment of the tibia can lead clinically to premature ankle degeneration.[25] In the laboratory, relatively minor angulation of the tibia in a rabbit study induced premature osteoarthritic changes in the knee.[26] The degree of deformity that ultimately becomes functionally significant, however, has yet to be established.[27] The relevance of an angular deformity may also be dependent on the level at which the tibia is fractured. In an in vitro study, Tarr et al[28] demonstrated that an angular deformity of 15 degrees had little effect on ankle contact when it was localized to the proximal or medial tibia; in the distal tibia, however, the contact area in the tibiotalar joint was decreased by as much as 42%.

Despite this laboratory evidence to the contrary, other authors suggest that a correlation between deformity and poor functional outcome does not exist. In a retrospective review of 20 closed tibial fractures 20 years after injury, Merchant and Dietz[29] found no posttraumatic arthritis in the adjacent knee or ankle, regardless of the residual deformity of either structure. We hypothesize that a patient's ability to tolerate tibial deformity may be, in part, a function of the extent of rotatory or angular alignment of the limb before injury.

Limb shortening, a frequent sequela of closed treatment, is as controversial as angulation with regard to the limits that are deemed acceptable.[30] Haines et al[21] suggested that only patients with more than 2 cm of shortening require a lift. Johner and Wruhs[13] concluded that shortening was acceptable only if it could be limited to 5 mm or less. We agree that an “acceptable” amount of leg-length discrepancy is dependent on the individual patient’s functional expectations or demands, but designate 1 cm of shortening as warranting more aggressive measures. Interestingly, Sarmiento et al[4] found that, regardless of the degree of shortening deemed acceptable, there was no difference between the amounts of shortening depicted on the initial and final radiographs in 80% of cases. They surmised that if initial shortening is significant, acute treatment should be operative in the absence of other mitigating factors.

A B C

Fig. 5 **A,** Closed tibial fracture healed in approximately 5 degrees of varus angulation. Patient complained of significant early medial ankle joint pain on ambulation. **B,** Realignment osteotomy with plate fixation was performed. **C,** After healing and plate removal, full functional recovery was achieved without residual ankle symptoms.

Function

The functional outcome of patients with closed tibial-shaft fractures is probably the most important consideration when deciding on the best mode of treatment for a particular fracture or patient. Unfortunately, tibial fractures occur predominantly in the young, healthy, and economically active patient population.[3,16,21] The short- and long-term ramifications of persistent disuse or seemingly moderate discrepancies in length or angular malalignment remain unclear.

Although it would appear that posttraumatic ankle arthritis does not usually complicate tibial malunion, arthrosis has been known to occur (Fig. 5). Teitz et al[9] anecdotally reported the cases of two patients with severe ankle osteoarthritis less than 2 years after tibial malunions with deformities of 15 and 5 degrees. In a review of 28 tibial fractures managed closed with a mean follow-up of 8.2 years, Puno et al[1] established a direct correlation between the extent of residual limb malalignment and the clinical outcome in the ankle, but not in the knee. On the basis of data obtained from questionnaires and evaluation surveys, Bone et al[31] recently found that patients treated with IM nailing had better functional outcomes than patients treated with casting.

The effects of limb shortening on immediate or ultimate function are unknown. The literature suggests that anywhere from 0.5 to 2.0 cm of shortening is acceptable.[13,21] Limb shortening of 2.5 cm or more has obvious cosmetic and gait disadvantages, but the long-term consequences are controversial. Some authors postulate that leg-length discrepancy has deleterious effects beyond the affected limb itself, as evidenced by one report that suggests significant length discrepancy may potentiate the development of low back pain.[32] Also, significant rotational deformity may accelerate adjacent joint degeneration. Van der Werken and Marti[12] reported a case in which severe posttraumatic ankle arthritis occurred 14 years after injury in a patient with malunion characterized by 20 degrees of internal rotation.

Conservative treatment with long-leg casting results in prolonged joint immobilization, restricted ambulation, and extended rehabilitation requirements to regain a preinjury level of function.[7] In contrast, the properly selected patient who undergoes surgical fixation can expect less time in recovery, minimal deformity, and essentially no lingering disability. This is especially true of IM nail fixation, after which return to function is virtually immediate and rehabilitation rapid. In the series of Gad et al,[11] in which almost 100 patients with tibial fractures were treated with IM nailing, the mean time from injury to return to work was 11.4 weeks. These functional results were obtained with a minimal risk of complications, which in this patient group included only one case of pulmonary embolism and one case of compartment syndrome.

The patient's ultimate functional outcome probably has its greatest impact on the total cost of the injury to society. The actual expense of treatment does not end with the selection of cast treatment or surgery. A truly fair comparison must consider the patient's total time out of work (and tolerance thereof), the risk of prolonged disability, and the likelihood of later surgery, but studies including these variables are not available. When all of these outcome factors are considered, the initial expense of surgical fixation may be minimal compared with patient-dependency costs.

Operative Treatment

Indications and Outcomes

Definitive, generally accepted criteria for the open reduction and internal fixation of closed tibial fractures may never exist. The inability of physicians to agree on uniform assessment standards in the clinical literature makes comparisons between studies difficult. This problem is highlighted in a study by Bridgman and Baird,[16] who demonstrated that the incidence of an unsatisfactory outcome in their patients with closed tibial-shaft fractures could vary from 4% to 12%, depending on the criteria used. Therefore, only after careful literature analysis should the physician establish a personal threshold for operative fixation of closed tibial fractures.

In conjunction with analysis of the medical literature, case-specific variables, such as the characteristics of the individual patient and injury and the surgeon's experience, must be considered. Recent studies comparing conservative management (casts and functional braces) with closed nailing have demonstrated that the IM nail produces superior overall results.[30,31] It is irrefutable, however, that a substantial number of the patients in these studies were satisfactorily treated conservatively. We have concluded that selected factors will aid the clinician in determining which patients will be better served by operative treatment.

The excellent union rates reported with conservative management of closed tibial fractures appear to be highly dependent on the patient's ability to initiate early weight-bearing (cyclic loading) on the fractured limb. Consequently, surgical stabilization should at least be considered for all unstable fractures in which early weight-bearing is prohibited. Similarly, significant residual malalignment presents the risks of posttraumatic ankle arthritis and cosmetic deformity. Following attempts at closed management, residual angulation exceeding 5 degrees in the coronal plane and 10 degrees in the sagittal plane, shortening by more than 1 to 2 cm, and malrotation exceeding 5 degrees should also be considered indications for fixation.

Factors specific to the individual patient may also influence the quality of outcome and should not be ignored in the decision-making process. A particular patient's obvious noncompliance or need for earlier function with less limitation may be an indication for acute stabilization. The cost consciousness of the present health-care environment encourages the physician, the patient, and the health-care payer to further support this approach if an unacceptable functional outcome is likely to occur.

When fracture stabilization is required, plates and external fixation appear to maintain alignment and/or stability in exchange for a host of other soft-tissue, pin-site, and functional concerns. The fixation modality with the most successful rate of union and the least risk of complications or functional limitation is closed IM nailing, which will be discussed in more detail in the next section. However, the benefits of the IM nail must be constantly weighed against the risk, albeit small, of infection or compartment syndrome and the possible need for additional surgery to eventually remove the retained nail.

Selection of Operative Techniques

The modern enthusiasm for more aggressive management of selected closed tibial fractures has paralleled the development of a vast array of improved fixation devices available to the surgeon. All stabilization techniques have both inherent risks and intrinsic benefits, and the appropriateness of their application will ultimately depend on how they compare over time with closed treatment.

Plate fixation of the tibia, which offers the ability to achieve and maintain anatomic alignment, has a certain appeal.[6,24,33] Dynamic compression plating and lag-screw fixation have improved the union rates with this mode of stabilization. However, plates continue to be associated with increased soft-tissue morbidity, and early weight-bearing is not always feasible.[7] Even if union is uneventful, plates, like other internal-fixation devices, may require a separate procedure for hardware removal. The rate of refracture after plate removal has been reported to be as high as 11%,[6] far exceeding the rates obtained with other implants.

External fixation, a less invasive mode of stabilization, provides better fracture stabilization than a cast, permits earlier ankle and knee range of motion, and, among fixation devices, is the most respectful of soft-tissue swelling.[33] However, the success of external fixation is strongly dependent on patient compliance and requires intensive physician management and decision making throughout the healing process. Weight-bearing, although permissible, is not always guaranteed, and certain complications (e.g., pin-tract infections) may be unavoidable.[18] A period of cast or brace immobilization is usually required after removal of the external fixator.

The implant with the greatest appeal in the management of closed tibial-shaft fractures warranting fixation is the IM nail. The historical success with IM nailing in the femur[30,34,35] and the advent of interlocking have naturally led to use of the nail in the tibia.[10,11,14] In a review of 56 tibial fractures treated with reaming and IM nailing, Collins et al[10] reported 100% union by 5 months, anatomic rotational alignment, angulation consistently less than or equal to 5 degrees, and crutch-assisted weight-bearing, depending on the fracture, usually within 72 hours. In another series reported by Gad et al,[11] reamed IM nailing of 71 closed tibial fractures resulted in 100% union. Knee and ankle motion was well maintained, and patients were able to return to work early.

The complications associated with IM tibial nailing include infection. The incidence of infection reported in various studies ranges from 0.9% to as high as 6%,[1,4,29] with the higher rate usually attributed to opening the fracture site to facilitate nail placement. The other major risk with IM tibial nailing is compartment syndrome. Moed and Strom[15] reported two cases of anterior tibial compartment syndrome after IM nailing. In a separate canine study, the same authors found the anterolateral compartment pressure to be particularly at risk with medullary reaming. McQueen et al[36] studied compartment pressures in 67 patients treated with IM tibial nailing and did not detect pressure differences between injuries attributable to whether the fracture was open or closed, was due to high- or low-energy trauma, demonstrated mild or severe soft-tissue disruption, or was treated early (in less than 24 hours) or later. The overall incidence of compartment syndrome secondary to fracture in that study was 1.5%, and IM nailing did not appear to increase the risk of this complication.

The clinical use of nailing has expanded beyond the classic Küntscher nail with the advent of interlocking nails, which allow IM nail fixation of the more distal or comminuted fracture. Several authors report impressive results with the use of the interlocking nail in complex injuries.[34,37,38] Recently, this technique has been further modified with the development of nonreamed nails and a better understanding of the indications for dynamization (removal of the screw on one side of a fracture to increase load within the bone).

Laboratory studies have demonstrated that cortical blood flow is significantly more compromised with reamed nailing than with nonreamed nailing.[39] Nonreamed nails present an increased risk of implant failure, due to their smaller size and the possibility of fracture comminution secondary to placement of noncannulated nails without the aid of a guide wire. Otherwise, clinical studies have demonstrated an outcome similar to that for reamed nails.[38]

Although several authors have recommended early dynamization, the majority of fractures treated with static nailing (i.e., with both bone ends having screws in place) appear to heal uneventfully. Improved early bone healing and callus formation have been demonstrated with dynamization,[40] but no clear clinical benefit has been reported. Axial micromotion appears to be present even in static nailing, providing sufficient impetus for healing.

Since early dynamization can result in shortening and malrotation, routine early dynamization is inadvisable. Dynamization can be performed, if necessary, when the risk of displacement is low or at about 2 to 4 months. In cases of delayed union or nonunion, dynamization alone may favorably affect bone union. In a report on interlocking nailing by Wu and Shih,[37] 33% of nonunions united after dynamization.

Summary

We believe that cast or brace treatment remains the standard of care for most closed tibial fractures. Minimization of complications with conservative treatment is dependent on patient compliance and maintenance of fracture stability in reasonable alignment despite early controlled bracing or weight-bearing. In the majority of cases, conservative treatment will permit a return to the preinjury functional level after an acceptable healing period. Closed tibial fractures that do not satisfy those criteria constitute the subset of injuries that we believe would be better managed acutely with closed IM nailing.

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