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Calcium Sulphate Spacer in Open Tibia Fractures with Sub-segmental Bone Loss to Decrease the Need for Secondary Surgery.

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Introduction:

Traumatic tibial shaft fractures can be associated with an increased risk of nonunion and post-traumatic infection/osteomyelitis, particularly when a residual gap exists secondary to bone loss following an open fracture.[1,2] Current recommendations for treatment rely on various strategies involved with aggressive debridement, soft tissue reconstruction, and skeletal stabilization. Initial debridement and early wound management may include the use of antibiotic impregnated poly-methyl-methacrylate (PMMA) beads placed into the bed of the wound to create an antibiotic rich environment in the region of the fracture.[3-5] Subsequent management of the fracture may include sub-acute bone grafting of the bone defect to mitigate the risk of nonunion. Application of Bone Morphogenic Protein-2 (BMP-2) at the time of wound closure and definitive skeletal stabilization has been reported to both decrease the risk of infection and improve union rates.[6] Currently, BMP-2 is approved for use in open tibia factures treated with an intramedullary to decrease both the risk of nonunion and infection – however, BMP-2 can be cost prohibitive and concerns have been raised regarding the potential side effects and complications related to its use.[7]

Thus, in order to mitigate the negative financial, medical and social issues associated with infection and nonunion related to open tibia fractures, it is prudent to explore potentially viable alternatives in treating open tibia fractures that may help to decrease the incidence of these sequalae.

One such alternative is the use of Calcium Sulphates (CS) - with or without the addition of antibiotic - in open tibia fractures with boney defects. Calcium Sulphate has been shown to be an effective bone void filler and substitute for autograft in the setting of healing bone defects in a number of animal and human studies.[8-12] Additionally, Calcium sulphate has been shown to be effective both in-vitro and in-vivo as a delivery vehicle for

antibiotics in the setting of treatment for chronic osteomyelitis.[8,13,14] Indeed, in terms of antibiotic elution, it is at least equal to antibiotic laden polymethylmethacrylate (PMMA) in in-vitro studies.[15]

Previously, two retrospective studies on patients with open fractures treated with antibiotic laden Calcium Sulphate have been published on 26 and 15 patients respectively. While the authors were able to demonstrated a union rate of 22/26 and 12/15 respectively, the follow-up was short (10.5 and 8.5 months) and multiple extremity injuries were included in the analysis (such as humerus and metatarsal fractures).[16,17] **The purpose of this study is to prospectively study the effect of antibiotic laden Calcium Sulphate in the acute treatment of open tibia shaft fractures with a boney defect, examining specifically for the need for secondary operation or treatment for infection or nonunion.**

Methods:

Inclusion Criteria:

1. Skeletally Mature
2. Open Tibial Shaft Fracture
3. Bone Loss:
    a. non –segmental bone loss
    b. may require bone grafting
    c. will not require more than 10cc's of product to fill defect
4. Fixation with Intramedullary Rod
5. Closeable wound or coverage prior to discharge (2wks max)
6. Radiographic and Clinical Follow-up for one year

Exclusion Criteria:

1. Metabolic Bone Disease
2. Immunosuppression
3. Pathological Fracture (Tumor, Pre-existing Infection)
4. Pre-existing Infection
5. Soft-tissue coverage not obtained within two weeks from time of injury.
6. Use of Negative Pressure Dressing to definitively manage wound.
7. Use of external or implantable bone growth stimulator.
8. Unable to Full Weight Bear immediately post-operative.

Data Points:

1. Age
2. Sex
3. Medical Comorbidity
4. Smoking Status (Yes or No)
5. Wound Size (surface area)
6. Wound type (Gustilo Anderson and OTA)
7. Number of Surgical Debridements

8. Time to definitive closure.
9. Soft Tissue Reconstructive Procedure
10. Compartment Syndrome (Yes or No)
11. Fasciotomy (Yes or No)
12. Size of Defect
13. Volume of calcium sulphate used
14. Treatment of Defect
    a. Nothing
    b. PMMA with antibiotic (Vancomycin 1gram + Tobramycin 1gram)
    c. CS with antibiotic (Vancomycin 1gram + Tobramycin 1gram)
15. Need for subsequent secondary treatment:
    a. Superficial Infection (Antibiotic Treatment)
    b. Deep Infection (Surgical Treatment)
    c. Delayed Union (Dynamization, Exchange rodding, Bone grafting)
    d. Nonunion (Dynamization, Exchange rodding, Bone grafting)

Methodology:

Patients will be enrolled at a single facility (Harborview Medical Center-HMC). Patients who meet inclusion criteria will be assigned to one of the three treatment groups based on the night of presentation. Currently there are three teams that manage the trauma call at HMC (Red, Green, Blue) and alternate on a strict 1 in 3 rotation schedule. Patients that present on a night when the Red Team is on call will be treated as Group A (Nothing in bone defect at time of closure). Patients that present on a night when the Green Team is on call will be treated as Group B (antibiotic laden PMMA in bone defect at time of closure). Patients that present on a night when the Blue Team is on call will be treated as Group C (antibiotic laden CS in bone defect). All three methods of treatment are considered acceptable current standards of practice in the orthopedic trauma community on a local and national level. All patients will be treated similarly until the time of closure with respect to:

1. Prophylactic Antibiotics administered:

    a. Ancef 1 gram IV q12h until 48 hours following definitive wound closure and final debridement.
    b. Tobramycin 1-2 mg/kg IV q12h until 48 hours following definitive wound closure and final debridement.
2. Irrigation and Debridement
3. Wound Management
    a. Clean Type I, II and IIIa wounds will be closed primarily.
    b. Contaminated Type I, II, and IIIa wounds will be treated with antibiotic bead pouches until closure.
    c. Type IIIb wounds will be managed with antibiotic bead pouches until flap coverage that will occur no later than one week.
4. Mobilization
    a. All patients will be permitted Full Weight Bearing immediately post-operative.

Risks

There is no risk to the patient as all three treatment methods are current standard of practice both nationally and locally. All patient identifiers will be kept private. All data will be stored on a password protected database available only to the study team.

Benefits

The study performed will provide information regarding the optimal treatment strategy for transverse tibia fractures, and what the expected time to union is when using internal compression. This information is of benefit to patients, particularly when being counseled by surgeons regarding how long they can expect before obtaining radiographic union, and what the potential reoperation rate would be.

Procedures to Ensure Confidentiality

No patient identifiers will be used during the formal study. Identifiers such as name and medical record numbers will be used to identify patients with a transverse tibia fracture, and will be stored on a password protected departmental network in a master file. Data

files will be listed with subject number.

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