Treatment preferences in Turkey for open fracture of the tibial diaphysis

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ABSTRACT

Objective: The purpose of this study was to investigate different treatment methods employed by orthopedic surgeons for open tibial fracture in adults.

Methods: Survey of 12 questions regarding treatment of open tibial fracture was conducted with 285 orthopedics and traumatology specialists in Turkey in personal interviews and using web-based technique.

Results: Of all survey participants, 99.6% responded that tetanus prophylaxis is necessary emergency procedure in cases of adult open tibial diaphysis fracture. In addition, 96.5% considered antibiotics administration necessary, 85.6% also selected irrigation with saline, 55.4% included debridement, and 45.3% temporary fixation. Only 4 (1.3%) respondents did not use aminoglycoside antibiotics. While 29.8% of those surveyed preferred external fixator as a definitive treatment method, 75.8% use intramedullary nail and 13.7% preferred plate method.

Conclusion: A wide variation was observed among orthopedics and traumatology specialists in Turkey regarding treatment of open tibial diaphysis fracture in adults. Data obtained from this study together with the available literature may be useful to further develop therapeutic approaches.

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Among open fractures encountered in orthopedics and traumatology practice, open tibial diaphysis fracture is relatively common. Since the soft tissue around the tibia is thin, fracture of the tibia often breaks through the skin. These fractures are prone to various complications, particularly infection, which can affect treatment outcomes and increase morbidity and treatment costs.1,2 In addition to preserving life, extremities, and functionality, one goal of treatment is to prevent infection.

There is no current data in the literature regarding preferences and practices of orthopedics and traumatology experts in Turkey with respect to treatment of adult open tibial diaphysis fracture. Results of the current study may prove useful in developing therapeutic approaches.

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Patients and methods

Survey respondents were 285 currently active orthopedics and traumatology specialists in Turkey.

Fractures of hand, finger, spine, and pelvis often require special approaches and additional expertise. However, fractures of long bones, particularly the tibia, are common and are most often treated by orthopedic surgeons. Gustilo-Anderson Classification was used in assessment of approach of orthopedic surgeons to all types of open tibial fracture and treatment variations.3

The survey, which was called “Treatment approaches to open tibial diaphysis fractures in adults,” comprised 12 questions, and was conducted with orthopedics and traumatology specialists in Turkey by personal interview or via email.

Survey questions used model of open tibia fracture. Questions related to situations requiring advanced reconstruction due to gunshot wound; open fracture with defect; fracture in patient with additional disease; fracture in children or geriatric patient; fracture of special region, such as spine, pelvis, hand, or finger; or fracture with vascular or nerve injury were not included.

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Only active professional orthopedics and traumatology specialists were surveyed; trainees, and those who are retired or not in active practice were excluded.

Survey questions inquired about early intervention practices, preferences in antibiotics and duration of use, preferences in type of fixation, performance of soft tissue reconstruction, and means of deciding necessity for amputation. Respondents were also asked about the type of institution at which they worked, years of expertise, type of institution at which they received their specialized education, and number of open tibia fracture cases they typically treated in a year. Response data were statistically analyzed using SPSS Statistics 22 software (IBM Corp., Armonk, NY, USA).

Results

Of total 2893 active orthopedics and traumatology specialists in Turkey, 9.85% were surveyed. Demographic data of survey participants are provided in Table 1.

Emergency interventions

Of all survey respondents, 99.6% agreed tetanus prophylaxis was required emergency procedure for case of adult open tibia diaphysis fracture. Furthermore, 96.5% also selected administration of antibiotics, 85.6% included irrigation with saline, 55.4% added debridement, and 45.3% included temporary fixation (Table 2).

Antibiotic usage period

Preferred antibiotics of participants according to type of fracture are provided in Tables 3 and 4. For Type I open fracture, 96.5% preferred first-generation cephalosporin (Cef-1), 21.8% selected aminoglycoside (AG), 5.3% penicillin (Pen), and 2.8% replied “other.” Response for preferred antibiotic for Type II open fracture was 96.5% Cef-1, 60.7% AG, 8.8% Pen, and 5.6% “other.” Type IIA/B open fracture preferences were 95.4% Cef-1, 96.8% AG, 30.5% Pen, and 23.9% “other.” For Type IIC open fracture, preferences were 94.4% Cef-1, 97.9% AG, 49.5% Pen, and 33.7% “other.”

Antibiotic preferences

Average duration of antibiotic treatment favored by respondents for open tibia fracture was 4.21 ± 2.99 days (range: 1–15 days) for Type I, 4.81 ± 3.46 days (range: 1–21 days) for Type II, 5.86 ± 4.10 days (range: 2–21 days) for Type IIA/B, and 6.16 ± 4.38 days (range: 2–21 days) for Type IIC (Table 5). Average duration of AG antibiotic use was 3.81 ± 1.96 days (range: 1–15 days). Only 4 (1.3%) of those surveyed stated that they did not use AG antibiotics.

Fixation preferences

Preferred method of fixation of Type I open fracture was 12.6% external fixator (EF), 93.7% intramedullary nail (IMN), 27.4% plate, and 1.8% “other” (Table 6). For Type II open fracture, responses were 23.9% EF, 87.4% IMN, 21.8% plate, and 0.7% “other.” Fixation method favored for Type III A/B open fracture was 84.2% EF, 45.3% IMN, and 10.2% plate. Preferred fixation method for Type IIC open fracture was 98.6% EF, 10.5% IMN, and 2.5% plate.

While 29.8% of the participants preferred EF as definitive treatment method, 75.8% continue with IMN and 13.7% continue with the plate method (Table 7).

Reamed or unreamed nails

When performing IMN fixation, 25.3% of the participants preferred to use unreamed nails, while 71.2% preferred reamed nails, and 3.5% use either reamed or unreamed nails, according to the case (Table 7).

Soft tissue reconstruction

When soft tissue reconstruction is needed in adult open tibial shaft fracture cases, 26% of participants stated that they routinely did it themselves, while 72.6% stated that they did not. Remaining 1.4% said sometimes they did it themselves and sometimes with assistance (Table 7).

Amputation decision

While 63.2% of the participants made decision regarding limb salvage or amputation based on the Mangled Extremity Severity
AG: aminoglycoside; Cef-1: first generation cephalosporin; Cip: ciprofloxacin; Met: metronidazole; Pen: penicillin; Sul: sulbactam.

### Table 4
Antibiotic regimen according to open fracture type.

| Type I antibiotic regimen | Type II antibiotic regimen | Type III A/B antibiotic regimen | Type III C antibiotic regimen |
|---------------------------|-----------------------------|---------------------------------|-------------------------------|
| Cef-1 73.7% | Cef-1 37.5% | Cef-1 0.4% | Cef-1 0.4% |
| Pen 2.8% | Cef-1 + AG 49.8% | Pen 0.4% | Pen 0.4% |
| Cef-1 + AG 19.3% | Cef-1 + Pen 0.4% | Cef-1 + AG 50.5% | Cef-1 + AG 26% |
| Cef-1 + Met 1.1% | Cef-1 + Met 0.7% | Cef-1 + Pen 0.4% | Cef-1 + Met 0.7% |
| Cef-1 + Cip 0.4% | Cef-1 + Cip 0.4% | Cef-1 + Met 1.4% | AG + Pen 1.4% |
| Pen + Met 0.4% | AG + Pen 2.5% | Pen + Met 0.7% | Pen + Met 0.7% |
| Cef-1 + AG + Pen 1.4% | Pen + Met 0.4% | Cef-1 + AG + Pen 23.5% | Cef-1 + AG + Pen 38.2% |
| Cef-1 + AG + Met 0.4% | Cef-1 + AG + Met 4.2% | Cef-1 + AG + Met 16.5% | Cef-1 + AG + Cip 0.4% |
| AG + Pen + Met 0.4% | Cef-1 + AG + Met 2.8% | Cef-1 + AG + Sul 0.4% | AG + Pen + Met 3.2% |
| Cef-1 + AG + Pen + Met 0.4% | Cef-1 + AG + Pen + Met 0.7% | Cef-1 + AG + Sul 0.4% | Cef-1 + AG + Pen + Met 5.6% |
| Cef-1 + AG + Pen + Met 0.7% | Cef-1 + AG + Pen + Met 2.1% | Cef-1 + AG + Pen + Met 5.6% | |

AG: aminoglycoside; Cef-1: first generation cephalosporin; Cip: ciprofloxacin; Met: metronidazole; Pen: penicillin; Sul: sulbactam.

### Table 5
Antibiotic application period according to open fracture type.

| | Min–max (days) | Mean ± SD (days) |
|-----------------|----------------|-----------------|
| Type I          | 1–15           | 4.21 ± 2.99     |
| Type II         | 1–21           | 4.81 ± 3.46     |
| Type III/B      | 2–21           | 5.80 ± 4.10     |
| Type III/C      | 2–21           | 6.16 ± 4.38     |

### Table 6
Fixation method according to open fracture type.

| | n | % |
|-----------------|---|---|
| Type I          | External fixator | 36 | 12.6 |
|                 | Intramedullary nail | 267 | 93.7 |
|                 | Plate | 78 | 27.4 |
|                 | Other | 5 | 1.8 |
| Type II         | External fixator | 68 | 23.9 |
|                 | Intramedullary nail | 249 | 87.4 |
|                 | Plate | 62 | 21.8 |
|                 | Other | 2 | 0.7 |
| Type III/B      | External fixator | 240 | 84.2 |
|                 | Intramedullary nail | 129 | 45.3 |
|                 | Plate | 29 | 10.2 |
| Type III/C      | External fixator | 281 | 98.6 |
|                 | Intramedullary nail | 30 | 10.5 |
|                 | Plate | 7 | 2.5 |

### Table 7
Definitive external fixator, type of intramedullary nail, soft tissue reconstruction, and amputation decision.

| | n | % |
|-----------------|---|---|
| Do you prefer EF as definitive treatment? | Yes | 85 | 29.8 |
| No | 216 | 75.8 |
| No, I prefer IMN and screws | 39 | 13.7 |
| If you use IMN, which type of nail do you prefer? | Unreamed | 72 | 25.3 |
| Reamed | 203 | 71.2 |
| Use both | 10 | 3.5 |
| If grafting or use of flap is necessary, do you do it yourself? | Yes | 74 | 26.0 |
| No | 207 | 72.6 |
| Sometimes | 4 | 1.4 |
| How do you make decision for limb salvage or amputation? | MESS ≥ 7 | 180 | 63.2 |
| Other | 81 | 28.4 |
| Both | 24 | 8.4 |

EF: external fixator; IMN: intramedullary nail; MESS: mangled extremity severity score.

Score (MESS) criteria, 28.4% replied that they use other criteria, and 8.4% said that they use a combination of MESS and other criteria (Table 7).

### Discussion

#### Emergency interventions

Early antibiotic treatment is extremely important in the treatment of open fracture. It has been demonstrated that those who take antibiotics within the first 3 h after the injury have a lower rate of infection. The period between injury and antibiotic administration, and injury and closure of the wound independently determine risk of infection in Type III open tibia fracture.4

Tetanus prophylaxis is among the primary applications for open fracture. Penetrating type of injury, burn or freeze injury, high-velocity gunshot injury, presence of clinical sepsis, and cases in which treatment takes place 6 h or more after injury should be considered at high risk for tetanus.9 Tetanus immunoglobulin, along with tetanus vaccination, should be provided in cases of high-risk injuries and unknown vaccination status.10

Irrigation is another primary application for open fracture. The irrigation process should be completed with physiological saline solution.11 It has not been demonstrated that adding antibiotics to the solution has additional benefit.12

Early intervention should include cleaning the wound, adequate removal of necrotic tissue, and wound debridement.13 It has been shown that late debridement of open tibial fracture increases incidence of infection14 and increases total financial expenditure.1 In a meta-analysis, it was reported that delayed debridement is not correlated with increase of deep infection rate in long bone open fracture.2

The vast majority of respondents preferred application of tetanus prophylaxis (99.6%), antibiotics (96.5%), and irrigation (85.6%) in emergency service; debridement (55.4%) and temporary fixation (45.3%) were of less importance.

#### Antibiotic preferences

A multidisciplinary working group has recommended cefazolin as the antibiotic of choice. The group proposed use of clindamycin as an alternative agent for patients with beta-lactam antibiotic anaphylaxis.15 Cef-1 is recommended in Type I and II open fractures, whereas Cef-1 + AG is recommended in Type III open fractures. Penicillin is additionally recommended for heavily contaminated wounds.13 However, Surgical Infection Society does not recommend the routine use of AG.16 In study conducted by Obrenskiy et al, large variations were reported in approaches of orthopedic surgeons. The authors found that early administration of AG was well supported, whereas penicillin administration was not. Surgeons should be aware of AG toxicity.17 Despite this, majority of our participants preferred AG, even though choice varied...
according to type of open fracture. The most preferred antibiotics of survey participants were Cef-1, AG, and penicillin, respectively. Combination antibiotic therapies were preferred in some instances, depending on type of fracture.

**Antibiotic usage period**

Duration of antibiotic usage proposed in various sources for open fracture is between 24 and 72 h, according to fracture type.\(^\text{22,23}\) However, IMN technique fixation preferences rate and bone healing rate.\(^\text{24}\) Participants mostly preferred to use IMN for Type I and Type II fractures, and EF in cases of Type IIIA/B and Type IIIIC. Majority of those surveyed do not use EF as definitive therapy method.

Plate was preferred fixation method for Type IIIC open fracture for 2.5% of participants. Surgeons explained that their preference was due to lack of C-arm intensifier in the operating room. Details of plate technique and implant choice were not evaluated in the present study.

**Reamed or undreamed nail**

In a meta-analysis, it was determined that there were no differences between use of reamed or unreamed IMN for open fracture in terms of union, infection rate or additional interventions.\(^\text{27,28}\) In another prospective, randomized, and controlled study, it was determined that there was no difference between reamed or unreamed IMN in terms of union, grafting, dynamization, or infection rate.\(^\text{29}\) Our study revealed that participants mostly preferred use of reamed IMN.

**Soft tissue reconstruction**

Early (<5 days) closure is recommended for soft tissue injuries in open fracture.\(^\text{30}\) Gastrocnemius flap is suggested for fracture of proximal third of tibia, soleus flap for middle third tibial fractures, and faciocutaneous flap or free tissue transfer for distal third tibial fracture.\(^\text{31}\) Majority of respondents stated that they get assistance with soft tissue reconstruction.

**Amputation decision**

It has been demonstrated that there was no significant difference in MESS values of patients who underwent limb preservation treatment and amputees. These findings indicated that MESS is neither sensitive nor accurate enough to form basis for decision to amputate.\(^\text{30}\) It has also been shown that lack of plantar sensation is not sufficient criterion for amputation and that sensation may return within 2 years.\(^\text{32}\) The majority of respondents in this study thought that MESS was adequate to make decision to amputate. Many factors influence decision on this issue and it can be said that evaluation systems currently in use are not sufficient.

Obremskey et al reported that they found great variation in treatment of segmental bone defects among orthopedic surgeons. Use of antibiotic-laden cement was routine, and bone-grafting time was commonly between 4 and 8 weeks after definitive treatment.\(^\text{33}\) We did not investigate decision to graft selection or timing in present study.

Limitations of our study are small sample size and lack of investigation of subtypes of open tibial fracture, such as presence of segmental bone defect.

As seen in other studies conducted elsewhere, wide variation was seen among orthopedics and traumatology specialists in Turkey regarding treatment of open tibial dia physeal fracture in adults. Data obtained from this study together with currently available literature may be of use to further develop therapeutic approaches.

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