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Clinical Issues in Tibia Shaft Fractures Performed Fasciotomy: A 4 Year Follow-up Study

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Abstract

Objective: The only known effective treatment for acute compartment syndrome is fasciotomy. Our aim is to present a long-term analysis of the clinical problems encountered by patients who underwent fasciotomy after suspicion of acute compartment syndrome with a tibial shaft fracture.

Methods: Thirty-three patients who were treated between 2013 and 2017, with at least 4 years of follow-up, and who remained after the exclusion criteria, were included in the study.

The total number of operations, total hospitalization time, and return to work time, second and 4th year visual analog scale (VAS) score in the crus area for pain assessment, second and 4th year American Orthopedic Foot & Ankle Association scala (AOFAS) score for ankle functionality, second and 4th year knee injury and osteoarthritis outcome score, short version (KOOS-PS) score for knee functionality parameters were obtained from the medical records of the patients. Information was added on whether the patients had complaints about the appearance of the fasciotomy area and whether they had changed their clothes for this situation.

Results: The mean time to return to work of the patients was 9.0±2.7 months. A significant difference was observed between the VAS and AOFAS scores of the patients in the 2nd year compared to the fourth year (<0.001, <0.001). Postoperative 4th year VAS, AOFAS and KOOS-PS scores of patients who developed pseudoarthrosis did not differ significantly from those of other patients (p=0.41, p=0.51, p=0.62).

Conclusion: The coexistence of tibial shaft fracture and fasciotomy can clinical cause problems affecting the social life of patients. It appears that clinical and functional scores are affected more significantly in the short term. We believe that patients should be informed about these issues at the beginning of treatment.

Keywords: Fasciotomy, tibia, fracture, acute compartment syndrome

INTRODUCTION

Acute compartment syndrome is a serious health issue that can result in severe morbidity if treatment is delayed (1). Fasciotomy is the only known effective treatment method for acute compartment syndrome (2). Clinically, acute compartment syndrome is most commonly associated with tibial shaft fractures and the coexistence of these two appears to be associated with poor clinical outcomes (3).

There are few studies in the literature examining the clinical long-term follow-up of these patients following fasciotomy treatment (3,4). Our hypothesis is that although the clinical problems of these patients are more evident in the early period, these problems are less effective in the long term. Our aim is to present a long-term analysis of the clinical problems encountered by patients who underwent fasciotomy after suspicion of acute compartment syndrome with a tibial shaft fracture.

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METHODS

After receiving Ethics Committee approval from the University of Health Sciences Turkey, Prof. Dr. Cemil Taşcıoğlu City Hospital (number: E-48670771-514.10), 76 fasciotomy performed tibia fractures between 2013 and 2017 were retrospectively analyzed. Inclusion criteria included being over the age 18, having at least four years of follow-up, having no additional injuries in the same extremity, having no neurological injuries and not having acute bone loss. Twelve patients without adequate medical records, 3 patients who had Gustillo-Andersen type 3c fractures, 1 patient who was under the age of 18, one patient who had peroneal nerve injury, one patient with acute death, and 25 patients without a tibial shaft fracture were excluded. The remaining 33 patients were included in the study.

The same surgical team operated on all the patients (T.O.B., M.A., A.C.T., A.Y.). The same team-decided fasciotomy in all the patients due to a suspicion of acute compartment syndrome. Pain, swelling, paresthesia, presence of pain with passive stretch were used as suspicious findings (5). All patients had a single lateral incision 4 compartment fasciotomy (6). The Tasarım Medical TF-ERS Rail Fixator® was applied to all patients using 6 mm Schanz nails from the medial side of the tibia to parallel to the posterior surface of the tibia, with at least three Schanz placed proximal and distal to the fracture line. The treatment of the fracture with this fixator was planned and it was applied to bridge the entire tibia (7).

All patients received traditional wet-to-dry dressings after fasciotomy (8), as well as the first generation cephalosporin and aminoglycoside prophylaxis. Debridement was performed if necessary at the 48th hour examination after clinical follow-up. The debridements were performed in the operating room under general anesthesia. If there was no microorganism growth in the culture taken between 5 and 7 days and the skin examination was appropriate, the wound was closed with split-thickness skin grafting (9). When there was microorganism growth in the culture, the closure operation was postponed and appropriate antibiotic therapy was started. Fasciotomy closure operations were performed by the plastic surgeons of our hospital.

Union times were calculated from the control roentgenograms of the patients. Delayed union was defined as the failure of fracture union by 20 weeks and nonunion was defined as a lack of union at 36 weeks and failure of the progression of fracture callus over a 6 week (3). Patients who nonunion, required additional surgical procedures. Deformity analyses were performed using the tibia anatomical axis from the patients' radiographs after union for deformity measurement. The shortness of more than 10 mm, a coronal angulation of more than 5 degrees, and a sagittal angulation of more than 10 degrees were deemed unacceptable and classified as deformity (10). Three senior orthopedic surgeons who did not perform the surgery evaluated the radiographs and their joint decisions were used as the basis. Preoperative and postoperative radiographic measurements were performed using the imaging software named INFINITT PACS (Picture Archiving and Communication Systems) version 3.0.11.4 (BN13)® used in our hospital.

Patients started isometric exercises and exercises for joint range of motion on the 1st postoperative day and continued isometric exercises until their fasciotomy was closed. Following the closure of the fasciotomy, isokinetic and muscle-strengthening exercises were initiated and continued until the return of the work.

Age, gender, fracture type, type of injury, soft tissue injury according to Gustillo-Andersen classification, infection development, causative microorganism if infection developed, the total number of operations, total hospitalization time, and return to work time, visual analog scale (VAS) score in the crus area for pain assessment, 2nd year American Orthopedic Foot & Ankle Association scala (AOFAS) score for ankle functionality, 2nd year knee injury and osteoarthritis outcome score, short version (KOOS-PS) score for knee functionality parameters were obtained from the medical records the patients. As time to return to work; It was determined as being able to start the profession before the trauma in people with a profession, and being able to do their daily work fully in people without a profession. The patients' most recent (minimum 48 months) VAS, AOFAS, and KOOS-PS scores were obtained by calling their registered phones and interviewing them. They were asked again during the interview if they had any complaints about the appearance of the fasciotomy area and if they had changed their any clothing modification due to this situation.

Statistical Analysis

The SPSS Windows version 24.0 package program was used for statistical analysis. Mean ± standard deviation was given for numerical variables as descriptive statistics and number and percentage values were given for categorical variables. The compliance of the data to a normal distribution was tested with the Shapiro Wilk test. Student's t-test was performed for the normally distributed features in comparison of numerical data in 2 independent groups while Mann-Whitney U test was performed for non-normally distributed features. The relationship of two independent variables at the categorical measurement level with other was tested using the chi-square test and Fisher's Exact test. A p value of <0.05 was considered statistically significant.

RESULTS

Of the patients, 30 (90.1%) were male and 3 (9.1%) were female. The mean age was 29.3±8.5. The mean duration of follow-up was 59.3±11.8 months.

According to the Arbeitsgemeinschaft für Osteosynthesefragen classification, the fracture types of the patients were A2 5 (15.1%), A3 10 (30.3%), B1 7 (21.2%), B2 6 (18.1%), B3 1 (3%), C2 2 (6.06%), C3 2 (6.06%). Eight (24.2%) of the patients suffered additional injuries, without the same extremity. Twenty-eight (84.8%) of the patients were involved in traffic accidents, two (6%) had fallen from a height, two (6%) had a gunshot injury, and one (3%) had crush-type injuries.

There were 24 (72.7%) closed fractures and 9 (27.3%) open fractures among the fractures. According to the Gustillo Andersen classification, 5 (55.5%) of the fractures were type 1, 1 (11.1%) were type 2, and 3 (33.3%) were type 3a. It was observed that patients with open fractures required statistically significantly higher rates of infection and debridement than patients with closed fractures ($p<0.001$, $p<0.001$). However, the rates of pseudoarthrosis in patients with open fractures were not significantly different from those in the other patients ($p=0.104$) and there was no significant difference in clinical VAS, AOFAS and KOOS-PS scores at the end of the fourth year ($p=0.41$, $p=0.51$, $p=0.62$).

The patients' average hospital stay after the first operation was 20.3±6.1 days, and the average total hospitalization time for fractures was 24.3±10.1 days. Debridement was required in 10 (30.3%) of the patients, and the duration of hospital stay (31.7±8.5) was significantly longer in these patients ($p<0.001$). The patients had undergone an average of 4.05±1.5 operations because of this fracture. In patients whose fasciotomy wounds required debridement before closure, the total number of operations was 6±1.05 ($p<0.001$).

The patients' average union time was 7.03±2.3 months. While 12 (36.3%) patients had delayed union, 10 (30.3%) patients required a second operation for nonunion, 6 (60%) of these patients were treated with tibial intramedullary nailing, and 4 (40%) patients were treated with Ilizarov type circular external fixator applications. The duration of hospitalization, return to work and the number of operations they underwent were significantly higher in those operated for non-union ($p<0.001$, $p<0.001$, $p<0.001$).

The patients' average time to return to work was 9.0±2.7 months.

While all patients had paresthesia in the fasciotomy area, 4 (12.1%) had dysesthesia in the fasciotomy area that required medical treatment, and 3 (18.1%) had dysesthesia in the donor area. While 16 (48.4%) of the patients stated that they were uncomfortable with the appearance of the wound, 5 (31.2%) of these patients stated that they had modified their clothes so that the wounds were not visible.

Cultures from 7 (21.2%) patients showed growth before their fasciotomy was closed. *Klebsiella* spp. growth was observed in 3 (42.8%) patients, *Staphylococcus aureus* growth in 3 (42.8%) patients, and *Pseudomonas aeruginosa* growth in 1 (14.2%) patient, and they were all treated with antibiotics and debridement. No patient had osteomyelitis.

Five (15.1%) of the patients had received medical treatment multiple times for peroneal tendonitis. The rate of developing dysesthesia following debridement or in patients who developed an infection in the fasciotomy area was not significantly different from that of other patients ($p=0.36$, $p=0.13$). However, the frequency of tenosynovitis problems was found to be significantly higher in both groups of patients who underwent debridement and developed an infection ($p<0.001$, $p<0.001$). Patients with recurrent tenosynovitis had significantly lower AOFAS scores at 2nd and 4th years ($p<0.05$). Table 1 shows the postoperative VAS, AOFAS, and KOOS-PS scores for the second and fourth years.

While the VAS scores of patients who required pseudoarthrosis surgery were significantly higher in the second year ($p<0.05$), no significant difference in the AOFAS or KOOS-PS scores was observed in the second year ($p=0.56$, $p=0.64$). Table 2 compares some parameters and clinical scores of patients who require pseudoarthrosis surgery with those of other patients.

There were no clinical complaints about the deformities in any of the five patients who had residual deformities. Patients' deformities were observed to be 10 degrees valgus in two patients, 1.5 cm shortness in two patients, and 7 degrees valgus and 1.5 cm shortness in one patient. Table 3 compares the clinical scores of patients with deformities to those of other patients.

Table 1. Comparison of the 2nd and 4th year postoperative clinical results of the patients

Mean ± SD*	Postoperative 2nd year	Postoperative 4th year	p**
VAS	3.06±0.9	1.9±1.04	**<0.001**
AOFAS	71.8±5.2	80.6±7.1	**<0.001**
KOOS-PS	72.2±4.8	76.9±16.6	0.13

*SD: Standard deviation, **Mann-Whitney U test. VAS: Visual analog scale, AOFAS: American Orthopedic Foot & Ankle Association scala, KOOS-PS: Knee injury and osteoarthritis outcome score, short version

Table 2. Some parameters of patients undergoing pseudoarthrosis surgery compared with other patients			
Mean ± SD*	**Pseudoarthrosis (+)**	**Pseudoarthrosis (-)**	**p****
Hospital stay (day)	35.2±6.6	20.8±6.3	**<0.006**
Return to work (month)	12.2±2.2	7.7±1.7	**<0.001**
Number of operations	5.3±1.5	3.5±1.1	**<0.002**
VAS***	2.1±0.5	2±1.1	0.68
AOFAS***	77±3.6	82.2±7.8	0.56
KOOS-PS***	73.9±6.6	73.9±6.6	0.72
*SD: Standard devitation, **Mann-Whitney U test, ***Postoperative 4th year. VAS: Visual analog scale, AOFAS: American Orthopedic Foot & Ankle Association scala, KOOS-PS: Knee injury and osteoarthritis outcome score, short version			

Table 3. Comparison of clinical scores of patients with and without deformity			
Mean ± SD*	**Deformity (+)**	**Deformity (-)**	**p****
VAS***	2.2±0.8	1.9±1.0	0.71
AOFAS***	75.6±1.6	82±9.2	0.11
KOOS-PS***	76.2±6.6	79.8±9.3	0.58
*SD: Standard devitation, **Mann-Whitney U test, ***Postoperative 4th year. VAS: Visual analog scale, AOFAS: American Orthopedic Foot & Ankle Association scala, KOOS-PS: Knee injury and osteoarthritis outcome score, short version			

DISCUSSION

The association of tibial fracture and compartment syndrome with poor clinical outcomes is mentioned in the literature (3). Although factors such as delayed rehabilitation processes, fasciotomy wounds, and skin graft problems, a high rate of pseudoarthrosis, and infection development are thought to contribute to these poor outcomes, there are no conclusive results in the literature (4). We think that our study examines the clinical and social problems of injury well in the medium-long term. We think that it is especially important to show an increase in clinical scores in the long term.

When closing the fasciotomy wound, split-thickness skin grafts are commonly used (9). This surgical procedure is associated with various issues, including poor appearance and pain in the fasciotomy area (9). In fact, this out-of-favor appearance may lead to avoidance of displaying the fasciotomy area and associated clothing modifications (11). This appears to be one of the important social issues confronting patients who have undergone fasciotomy. Although paresthesia at the fasciotomy area is generally well tolerated, dysesthesia is a significant clinical issue that may contribute to patient dissatisfaction (12). Tendon problems in the fasciotomy area appear to have a negative impact on clinical scores in both our study and the literature (13). The closure of the fasciotomy wound with a split-thickness skin graft may be a situation that adversely affects both social and clinical scores in the mid-long term. Although it has been reported in the literature that primary closure is associated with better clinical outcomes, it is impossible to apply it in every case (14). Therefore, primary closure may be a good option in appropriate cases.

Although nonunion and infection are more common in the association of fasciotomy and tibial shaft fracture, there appears to be no significant difference in the patients' clinical scores in the long term (15). Clinical scores are lower in the early period due to long treatment periods (4). This effect was more pronounced in our study, particularly in patients who developed pseudoarthrosis. Fasciotomy may affect the clinical scores of tibial shaft fractures, particularly in the early stages.

The aim of our technique, with the rail external fixator placed on the medial side of the tibia, is to reduce the possibility of deep infection in a patient with a fasciotomy wound (16), obtain a stable fixation, and make fasciotomy wound care easier (17). However, this system appears less stable against valgus forces generated by the cruris posterolateral compartment (18). As a result, a mild valgus deformity may be observed (18). However, for at least four years, these deformities do not appear to have a negative effect on clinical outcomes. In the case of compartment syndrome and tibial shaft fracture, this technique may provide safe and functional results in terms of bone infection.

Because of the additional surgical procedures required, fasciotomy appears to significantly increase both the duration of hospital stay and the cost (19). In our study, patients who required debridement stayed in the hospital for significantly longer. The higher infection rate in patients with open fractures may increase the cost of debridement and anti-biotherapy protocols. When the frequency of delayed union, nonunion, and the associated repetitive examinations, as well as longer labor loss, is added to this situation, the cost increase to both social institutions and the patient may become more clear. Since cost-related information could not be obtained from the medical records of the patients, we could not perform a cost analysis in

our study. We think that these results are valuable for our study and we think that this is an important shortcoming of our study.

Study Limitations

The limitations of our study were that it is a retrospective study, the relatively short follow-up period, the absence of a comparison group, the small number of cases, and the fasciotomy indication based on clinical findings. Determining the diagnosis of compartment syndrome with absolute values may be a method to prevent unnecessary fasciotomy and related morbidity (20,21). However, it is available in a limited centers due to its dependence on technical equipment (21). Therefore, many studies in the literature are based on clinical observations in the diagnosis of acute compartment syndrome (3,7,17,22).

CONCLUSION

As a result; the coexistence of tibial shaft fracture and fasciotomy can cause problems affecting the social life of patients. It appears that clinical and functional scores are affected more significantly in the short term. We believe that patients should be informed about these issues at the beginning of treatment.

Ethics

Ethics Committee Approval: University of Health Sciences Turkey, Prof. Dr. Cemil Taşcıoğlu City Hospital Ethics Committee approval was obtained (number: E-48670771-514.10).

Informed Consent: Written informed consent forms of all patients who were treated were obtained and recorded.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: T.O.B., M.A., A.Ç.T., A.Y., M.Y., N.E., Concept: T.O.B., E.İ.G., M.A., A.Y., N.E., H.G., Design: T.O.B., E.İ.G., M.A., A.Y., N.E., H.G., Data Collection or Processing: T.O.B., A.Ç.T., M.Y., N.E., Analysis or Interpretation: T.O.B., E.İ.G., A.Ç.T., M.Y., N.E., H.G., Literature Search: T.O.B., A.Ç.T., M.Y., N.E., Writing: T.O.B., A.Y., N.E.

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