Foot fracture may predict poor patient reported functional outcomes in lower extremity reconstruction of the traumatically injured lower extremity: A case-control study.

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Research Article

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Abstract

Background A paucity of evidence currently exists regarding factors affecting the success of lower extremity reconstruction at restoring a functional limb. We aim to determine the effect of foot fracture on outcome measures of ambulatory success after lower extremity salvage in a trauma population.

Methods A retrospective chart review was performed on 63 patients presenting to an urban level 1 trauma center between 01/2007 and 01/2015 who received soft tissue coverage of a lower extremity traumatic wound. Demographics, injury, and perioperative data were recorded. Patients were administered the Lower Extremity Functional Scale (LEFS) questionnaire via phone. The LEFS is out of 80 possible points. Ambulatory success is measured on a scale of 0 to 4 across 20 activities, with 0 indicating “extreme difficulty or inability to perform activity”, and 4 indicating “no difficulty”. Functional outcomes were compared using a two-tailed two-sample unequal variances t-test.

Results This study represents data on the 63 unique patients treated with vascularized flaps whom we attempted to contact. A total of 21 patients completed the LEFS questionnaire, representing an overall response rate of 33%. Responders to the surveys included 4 (19%) patients with foot fractures and 17 (81%) without foot fractures. Average total LEFS scores were significantly lower in patients with foot fractures (23.8 ± 5.9) than in patients without (36.2 ± 19.2) foot fractures ($p = 0.04$). With respect to the SF36 functional scale, patients with foot fractures paradoxically reported significantly higher measures of physical functioning (81 ± 11) in comparison to those without a foot fracture (59 ± 25) at a p-value of 0.02, and role limitation due to physical health (98 ± 3) versus those with no foot fracture (74 ± 37) at a p-value of 0.02.

Conclusion Sustaining a foot fracture during severe traumatic injury that necessitates lower extremity reconstruction may result in significantly decreased ambulatory success scores. Fractures of the foot may predict poor patient reported functional outcomes following lower extremity reconstruction and should be considered as a factor in the pre-operative risk and benefit assessment when deciding whether to attempt reconstruction of the mangled limb.

Introduction

Lower extremity injuries are a leading cause of hospital admissions among adolescents and adults ages 18 to 54.[1,2] These injuries account for nearly 250,000 hospitalizations each year, more than half of which are for major extremity trauma involving an open fracture, crush injury, or major soft-tissue injury resulting from a motor vehicle crash, pedestrian accident, fall, or industrial accident.[1] Limb salvage is a viable alternative to amputation at many trauma centers across the United States.[2] However, factors that ultimately influence long-term ambulatory success after limb reconstruction or amputation have not been well evaluated in the literature.[1–5]

The Lower Extremity Assessment Project (LEAP), a multicenter study of severe lower extremity trauma in a United States population, attempted to assess significant differences in functional outcomes of limb reconstruction and amputation.[1] The study also sought to identify factors that may influence these outcomes. The results of the LEAP study indicated that regardless of whether the patient underwent below-the-knee amputation or limb salvage, long-term physical and psychosocial outcomes are often very poor following lower extremity trauma.[1,6,7] The level of disability at two years after lower extremity reconstruction was equivalent to that of amputation at the time of injury.[8] The LEAP study also found that patients with hindfoot or ankle injuries requiring free tissue transfer had Sickness Impact Profile (SIP) scores significantly worse than those patients undergoing below-the-knee amputation.[1,7]

Patient reported outcome measures (PROMs) such as the Lower Extremity Functionality Scale (LEFS) provide a validated measure of physical ability following lower extremity reconstruction.[9–11] The LEFS is simple to administer and there is no strong evidence to suggest that the SIP produces more meaningful evaluation of ambulatory success over the LEFS.[9] The LEFS is also more applicable to a wider range of patients with lower-extremity conditions and therefore may produce more uniform results when comparing various outcomes.[9,12]

Reconstruction of injuries below the distal femur typically results in functional outcomes equivalent to those of amputation.[7] This study aims to evaluate the relationship between foot fractures and PROMs in individuals with traumatic lower extremity injuries undergoing successful limb reconstruction. It was hypothesized that injuries of the foot are associated with poor functional outcomes as assessed by the LEFS.

Methods

Study Design

This study was conducted utilizing a retrospective chart review of a prospectively maintained database of vascularized soft tissue transfers to the lower extremities performed between January 2007 and December 2015 at a level 1 trauma center, Los Angeles County Hospital. No funding was utilized for this study. These patients were identified with CPT codes 15738 (subcategory of flaps; skin and/or deep tissue procedures) and 15756 (subcategory of other flaps; grafts procedures). Inclusion criteria included traumatic mechanism of injury and use of a vascularized local or free flap. Patients with Gustilo 3B and 3C tibial fractures were included; patients with closed tibial fractures, soft tissue injury less than 10 cm in largest dimension, and without vascular injury requiring surgical revascularization on presentation who required flap coverage following sequential debridement were excluded.

Seventy-seven unique patients were identified that met initial inclusion and exclusion criteria, 13 of whom had foot fractures. Eleven patients did not have a phone number available in the medical chart; these patients were excluded as we were unable to attempt to contact them. Three patients underwent secondary amputation; these patients were excluded on the basis that they had failed the limb salvage

pathway. All methods were carried out in accordance with EQUATOR guidelines. All experimental protocols were approved by the department of surgery at LAC + USC medical center.

Outcome Measures

The LEFS evaluates physical function across 20 different everyday activities. The ambulatory success scale for each measure is from 0 (“extreme difficulty or inability to perform activity”) to 4 (“no difficulty”). The overall scale is from 0 (“maximal disability”) to 80 (“no disability”).

The 36-Item Short Form Survey Version 2 (SF-36; RAND Corporation) evaluates health status and health-related quality of life in 8 categories - Physical Functioning, Role Limitations due to Physical Problems, Bodily Pain, General Health Perceptions, Vitality, Social Functioning, Role Limitations due to Emotional Problems, and General Mental Health. These outcome measures were selected for this study, as they are well documented in the literature as valid assessment tools and standardized for use in the setting of lower extremity trauma.

Data Collection and Outcomes

Patient information including phone number, age, gender, anthropometrics, comorbidities, injury characteristics, procedure characteristics, and postoperative events were collected from the electronic medical record. Three attempts were made to contact each of the 63 remaining patients in either English or Spanish. Patient reported functional outcomes were the major longitudinal outcome measure of this study. The LEFS and SF36 questionnaires were administered over the phone across all patients from 05/22/2016–06/23/2016 (1 month). Family members were utilized as a proxy when the patients could not be reached. Forty-two patients were unable to be reached by telephone or refused to participate. The 21 patients that completed the LEFS and SF36 questionnaires were further divided into two groups; 4 patients with foot fractures and 17 patients without foot fractures to serve as the control group. Informed consent was obtained from all patients prior to participating in the survey and study.

Data Analysis

Continuous data was evaluated using two-tailed two-sample unequal variances t-tests (alpha = 0.05). Categorical variables were evaluated with Fischer’s exact test (alpha = 0.05). Total LEFS score was calculated by summing responses to the individual questions. SF-36 scores were recoded, summed to a raw scale score, and transformed to a 0 to 100 scale in accordance with Ware et al. [How to Score Version 2 of the SF-36 Health Survey].

Results

Demographics

This study represents data on the 63 unique patients treated with vascularized flaps whom we attempted to contact. A total of 21 patients completed the LEFS questionnaire, representing an overall response rate of 33%. Responders to the surveys included 4 (19%) patients with foot fractures and 17 (81%) without foot fractures (Fig. 1). Age of the overall study group ranged from 17 to 68 years old. Responders and

patients with foot fractures were not significantly different than nonresponders and patients without foot fractures with respect to age, gender, BMI, history of smoking, history of hypertension, or history of diabetes mellitus. Responders were significantly more likely than nonresponders to have an American Society of Anesthesiology (ASA) classification of grade 3 at initial presentation ($p = 0.04$). Patients with foot fractures were not significant difference in their American Society for Anesthesiology (ASA) classification than patients without foot fractures (Table 1).

Injury Characteristics

No patients sustained a spinal cord injury or underwent amputation of the limb contralateral to the reconstructed lower extremity, and all patients were ambulatory prior to injury. Patients who were injured as a result of motorcycle collisions were significantly more likely to respond to the surveys than patients injured by other mechanisms ($p = 0.04$). Patients who responded to the survey were significantly more likely to have received a plate and screws, whereas nonresponders were more likely to have received an intramedullary rod as definitive fixation of their tibial fracture ($p = 0.03$). Responders and patients with foot fractures were not significantly different than nonresponders and patients without foot fractures with respect to incidence of vascular injuries, arterial injury requiring repair (such as those patients with a Gustilo 3C classification fracture), lower extremity fracture contralateral to the limb requiring reconstruction, hip fracture, or femur fracture (Table 2).

Foot Fracture Characteristics

The four patients in the foot fracture group sustained five total foot fractures. These fractures included two hindfoot calcaneal fractures, one midfoot navicular fracture, and two forefoot metatarsal fractures (Table 3). None of the patients experienced an open foot fracture.

Flap Characteristics

There was no significant difference in types of flap used in patients with foot fractures and patients without foot fractures (Table 4). Soleus flaps were more common in nonresponders than in responders to the survey ($p = 0.01$). Three patients with gastrocnemius flaps experienced flap loss requiring replacement with latissimus flaps. An additional 3 patients had 2 flaps placed to achieve sufficient soft tissue coverage.

Hospital Course With Follow Up Time

There was no significant difference between responders and nonresponders in time from injury to flap placement, time from injury to initiation of physical therapy, or time from injury to completion of LEFS or SF36v2 questionnaires. Questionnaire responders with foot fractures had significantly shorter times from injury to flap placement, time from injury to initiation of physical therapy, and time from injury to completion of questionnaires. Time to completion of questionnaires ranged from 17–37 months for patients with foot fractures and 16 to 104 months for patients without foot fractures (Table 5).

LEFS Functional Outcomes

Total LEFS scores ranged from a low of 7 to nearly the highest score of 75 (Table 6). Patients with foot fracture had total LEFS scores that were significantly lower than patients without foot fractures ($p = 0.04$). Patients with foot fractures had significantly lower scores for LEFS measures of “walking between rooms” at 1.3 ± 1.0 versus those without a foot fracture at 2.7 ± 1.2 ($p = 0.04$), “walking two blocks” at 1.0 ± 0.0 versus those without a foot fracture significantly higher at 2.1 ± 1.4 ($p = 0.01$) and “running on even ground” at 0.0 ± 0.0 versus those without a foot fracture at 0.7 ± 1.4 ($p = 0.05$). Average total LEFS scores were significantly lower in patients with foot fractures (23.8 ± 5.9) than in patients without (36.2 ± 19.2) foot fractures ($p = 0.04$). The four patients with foot fractures could not run-on even ground at all and had difficulty walking up or down stairs or walking for an extended period of time. Ambulation for the most part was limited to walking between rooms, with difficulty (Fig. 2).

SF36 (v2) Functional Outcomes

Perhaps paradoxically, patients with foot fractures reported significantly higher measures of physical functioning (81 ± 11) in comparison to those without a foot fracture (59 ± 25) at a p-value of 0.02, and role limitation due to physical health (98 ± 3) versus those with no foot fracture (74 ± 37) at a p value of 0.02. There was no significant difference in measures of bodily pain, general health perceptions, vitality, social functioning, role limitations due to emotional problems, or general mental health in patients with and without foot fractures (Table 7).

Discussion

The decision of whether to amputate or to salvage a mangled limb remains an important question. The LEAP study provides the best evidence to date on limb-threatening trauma of the lower extremity.[14] Our findings confirm that patients with foot fractures experience substantially worse patient-reported functional outcomes than their counterparts without foot fractures. Overall LEFS scores were found to be significantly lower in patients with foot fractures. Significant differences were predominantly found in questions related to ambulation (including walking between rooms, walking two blocks, or running on even or uneven ground), whereas most questions related to non-ambulatory activities (such as rolling over in bed, getting into and out of the bath, sitting for one hour, or putting on shoes or socks) were not significantly different between groups. These findings highlight the essential role of the foot in ambulatory activities.

A number of factors may contribute to worse functional outcome in patients with foot fractures. Although it is colloquially known that patients with foot fractures may have worse injuries with compound fractures there is little data to support this. In addition, patients with foot fractures may have delayed time to attempted ambulation, full weight bearing, or physical therapy. Patients with foot fractures may have decreased self-efficacy. They may have increased rates or arthrodesis which inhibit dorsiflexion of the ankle joint therefore making ambulation exceedingly difficult. Finally, LEAP derived studies and other case-control studies have shown that chronic pain may be the major contributing factor to many of the above complications, such as delayed attempts to ambulate, fear of weight-bearing, delayed time to physical therapy, and decreased self-efficacy.[15,16]

Several limitations apply to the results of this study. Although the overall rates of follow-up exceeded 80 percent at 2 years, the patients who were lost to follow-up were likely representative of a different demographic than the patients who completed the survey. Patients lost to follow-up may have had less self-efficacy, faced social barriers (such as limited transportation or uncertain immigration status), or experienced neurologic or psychiatric comorbidities which inhibited their ability to navigate the healthcare system. Thus, our results may underestimate the extent of disability in the patients we could not capture. However, the rate of loss to follow-up was similar in the patients with foot fractures to those without foot fractures, and all available data on the 545 patients in the entirety of the lower extremity trauma database from which this study was derived, who underwent at least one follow-up evaluation, were used in the analysis. Another limitation of this study is intrinsic to the LEFS, which reflects the patient's own perceptions of function rather than objective measure of physical ability. Patients with foot fractures may overestimate their disability and physical limitations. However, this could also prove to be just as important a measure of quality of life and ambulatory success given that patients' self-efficacy largely dictates long-term outcomes.

The results of this study are expected to be generalizable to adult patients with blunt and penetrating trauma with lower extremity defects requiring soft tissue vascularized reconstruction. The study population included a wide variety of ages, both genders, and a multitude of mechanisms of injury. Given that the study was conducted at a Level 1 urban trauma center with immediate access to Plastic Surgery subspecialists trained in microsurgical reconstruction, limitations may apply to patients presenting to rural facilities without subspecialist care. However, the majority of reconstructions in our study group were delayed (between 72 hours to three months from injury to lower extremity reconstruction).[17] Delay for transfer to a tertiary facility does not preclude lower extremity reconstruction as long as perfusion to the distal extremity is able to be reestablished.

The question remains however whether patients with traumatic injury to the lower extremity which includes a fracture of the foot would be best treated with amputation or reconstruction of the mangled limb to optimize functional outcomes.

Conclusion

In trauma patients with injuries necessitating lower extremity reconstruction, patients with foot fractures report worse physical function, particularly in actions related to ambulation. Fractures of the foot may predict poor patient reported functional outcomes following lower extremity reconstruction and should be considered as a factor in the pre-operative risk and benefit assessment when deciding whether to attempt reconstruction and salvage of the mangled limb.

Declarations

Funding: No funding was used for this study.

Conflicts: No conflicts of interest to report.

Ethical Approval: Not necessary for this study.

Informed Consent: Informed consent was obtained from each patient prior to patient participation in survey and study.

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Tables

Due to technical limitations the Tables are available as downloads in the Supplementary Files.

Figures

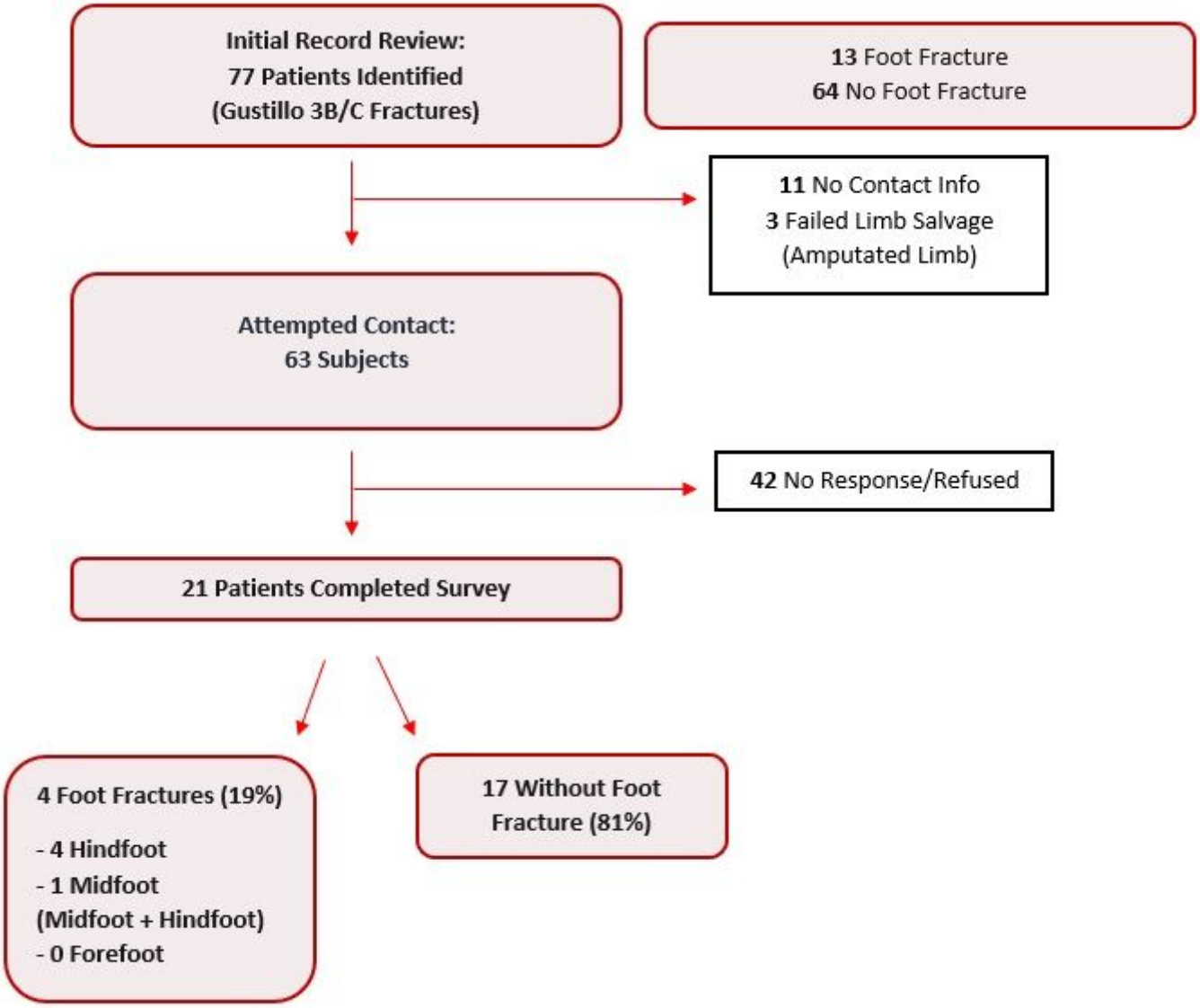

Figure 1

Four patients with foot fractures and 17 patients without foot fractures met inclusion criteria and completed the LEFS questionnaire.

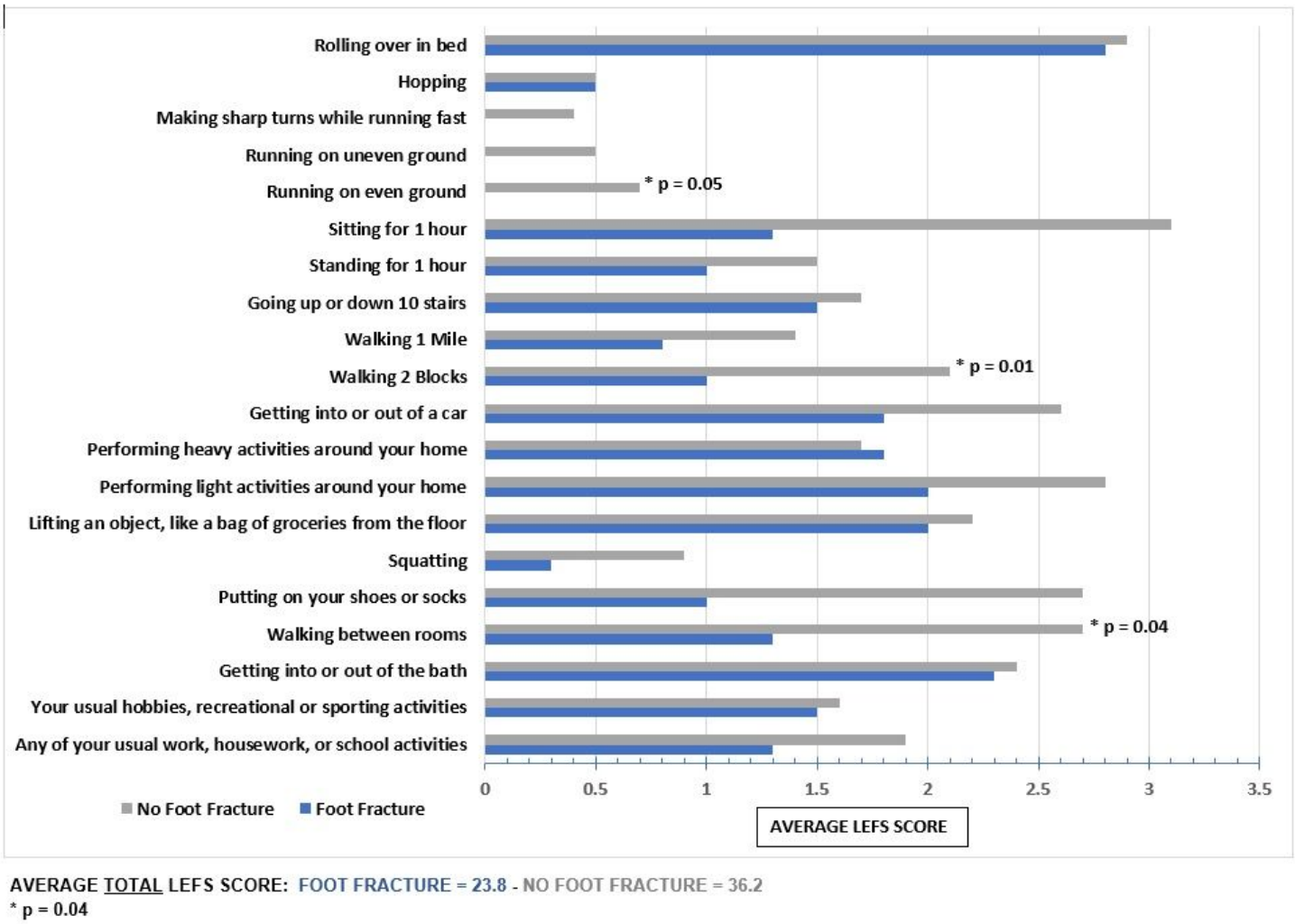

Figure 2

Patients with foot fracture reported lower average LEFS score in every category, with significantly lower scores in a number of individual categories, particularly those pertaining to walking and running, as well as their overall scores in comparison to those patients without a foot fracture.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Table1.xlsx
- Table2.xlsx
- Table3.xlsx
- Table4.xlsx
- Table5.xlsx
- Table6.xlsx

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