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ORIGINAL ARTICLE

The outcome of proximal fifth metatarsal fractures: redefining treatment strategies

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Abstract

Background To optimize the treatment strategy and reduce treatment costs of proximal fifth metatarsal fractures, clinical and patient-reported outcome, and its determinants were addressed.

Methods A retrospective adult cohort study including 152 proximal fifth metatarsal fractures: 121 nonoperatively and 31 operatively treated. In the operative group, 21 were zone 1 and 10 zone 2 fractures. Median follow-up was 37.5 (IQR 20.8–52.3) months with a minimal follow-up of 6 months. Twenty-three demographic, fracture, and treatment characteristics were assessed as well as the healthcare costs. Outcome was assessed using the patient files, anterior-posterior and oblique X-rays, foot function index (FFI), visual analog score (VAS), and SF-36 questionnaires.

Results The median FFI, physical SF-36, and VAS scores did not significantly differ between nonoperatively and operatively treated patients. The FFI and physical SF-36 were predominantly affected by a history of mobility impairment and pre-existent cardiovascular diseases, whereas mental SF-36 correlated significantly with higher ASA-score. Overall complication rate was 5.9% (4.1 vs. 12.9%; $p=0.065$, nonoperative vs. operative, respectively). Nonunion was recorded in only one (nonoperatively) treated patient. The total healthcare costs for operative treatment were 4.2 times higher compared to nonoperative treatment (€1960 vs. €463 per patient, respectively).

Conclusion Overall, the clinical and patient-reported outcome was good. The foot function and quality of life were mainly affected by comorbidity, rather than fracture and treatment-related variables. Although nonoperatively treated patients indicated decreased mental quality of life, our study indicates that proximal fifth metatarsal fractures can safely be treated nonoperatively without the risk of nonunion, with fewer complications and lower healthcare costs.

Level of evidence 3.

Keywords Fractures · Metatarsal · Management · Outcome · Costing

Abbreviations

ASA-score	American Society of Anesthesiologists physical status score
BMI	Body mass index
DVT	Deep venous thrombosis
CVRF	Cardiovascular risk factors
FFI	Foot function index
SF-36	Short form 36
VAS	Visual analog scale
LOS	Length of stay
IQR	Interquartile range

Introduction

Fractures of the fifth metatarsal are the most common fractures of the metatarsals in children and adults [1, 2]. These fractures are frequently caused by a twist or fall. Although these are minor fractures, they can have a major impact on daily life and sport activities [1, 3, 4]. Proximal fifth

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metatarsal fractures are classified according to Lawrence and Botte [5]; zone 1 fractures are defined as avulsion fractures of the tuberosity, zone 2 fractures are the so-called Jones fractures of the metaphysis, and zone 3 fractures refer to the proximal diaphyseal fractures [4]. Zone 3 fractures are out of the scope of this study, because they are typically the result of a non traumatic cause [5].

Based on a series from 1990 [6], zone 1 fractures have been treated nonoperatively, whereas zone 2 fractures have been treated operatively. Cadaver studies showed that zone 2 fractures are at greater risk of developing a nonunion due to its precarious vascularization caused by the rupture of the nutrient artery [7, 8]. Operative treatment of zone 2 fractures remains controversial. However new insights into the treatment and outcome of such fractures have questioned this recommendation [9–11]. Konkel et al. have shown in small patient series that nonoperative treatment for both zone 1 and 2 proximal fifth metatarsal fractures can be done safely with high satisfaction rates and limited costs [12].

The aim of this large retrospective patient cohort study was to assess the outcome of nonoperative and operative treatments for zone 1 and zone 2 proximal fifth metatarsal fractures. We studied the functional outcome, general health status, and healthcare utilization. We identified those demographic and clinical characteristics that affect the outcome most to provide insight and improvement of the treatment strategies for proximal fifth metatarsal fractures.

Patients and methods

Patients

Between January 2010 and August 2016, a total of 152 patients aged 18 years and over with 93 zone 1 and 59 zone 2 fractures were included in this study; zone 3 fractures were typically (nontraumatic) stress fractures and excluded from this study [5]. The internal guidelines of the Department of Trauma Surgery state that patients with zone 2 proximal fifth metatarsal fracture with ≥ 2 mm fracture displacement require operative treatment, whereas zone 1 proximal fifth metatarsal fractures could be treated nonoperatively. Exclusion criteria were age less than 18 years, nonacute fractures (> 4 weeks), multiple trauma during study period, patients living abroad, and patients who did not master the Dutch language. In total nine patients had died at the start of the study and were excluded, as well. Follow-up was until August 1st 2016. This study was conducted in compliance with national legislation and the guidelines of the ethics committee of the University Hospitals Leuven.

Demography, fracture, and treatment characteristics

In total, 23 demographic and clinical variables were studied. All demographic and clinical information was retrieved from the electronic medical file database of the University Hospitals Leuven. The characteristics were grouped as ten demographic variables [age, gender, ASA-score, BMI, medication that impairs wound healing and callus formation, smoking, diabetes, other cardiovascular risk factors (CVRF), history of mobility impairment, and occupation], six fracture related variables (fracture type, affected side, displacement, multiple fragments, open fracture, and energy of trauma), seven treatment-related variables [length-of-treatment, non-weight bearing period, union, complication rate, surgical site infection, deep venous thrombosis (DVT), and reintervention rate].

Use of medication that impairs wound healing and callus formation included corticosteroids, adrenergic β-agonists, and chemotherapeutic agents. CVRF concerned current cardiovascular diseases (e.g., cerebrovascular accident, acute myocardial infarction, arterial hypertension, peripheral artery disease, and dyslipidemia). History of mobility impairment, either congenital or acquired, includes rheumatoid arthritis, hip and knee osteoarthritis, hallux valgus, or fibromyalgia. Based on X-rays, all proximal fifth metatarsal fractures were classified as either zone 1 (avulsion tuberosity) or zone 2 (Jones) following the classification by Lawrence and Botte [5]. Measurement of the fracture displacement at its widest point was conducted on the available X-rays and used to determine fracture diastasis. Complications included wound dehiscence, surgical site infection, paraesthesia, and DVT. Follow-up radiographs were used to determine nonunion as defined by the US Food and Drug Administration guidelines [13]. These state nonunion as a not completely healed fracture within 9 months of injury and with no progression toward healing over the past 3 consecutive months. Delayed union was diagnosed as no progression towards healing at 4 months [14]. Reintervention was defined as removal of the implant or revision of internal fixation.

Healthcare utilization

The health care costs described in this study are related to Belgium health care financing context and limited to costs induced by hospital-related care [15]. Five main hospital-related cost categories were defined: honoraria, materials, hospitalization, day care costs, and pharmaceuticals. Honoraria mainly consisted of fees related to medical activities, based on the fee for service principle. These activities included surgery, outpatient contacts, and imaging studies. Material costs are related to the implanted plates and screws. Hospitalization cost is the patient's actual length-of-stay

(LOS) multiplied by the average national day-based care fee (€418.55) in Belgium at the time of admission [16]. Day-care costs are related to plaster application and exchange of outpatients as well as removal of implants in daycare stay. The costs for pharmaceuticals consisted of all the drugs the patient received during hospitalization or during the time at the emergency room. All costs were allocated with prices of 2015.

Outcome measures

Questionnaires were sent to all patients to evaluate general health status and functional outcome. The foot function index [FFI] was used to determine the functional state; a lower score indicates better outcome [17]. Furthermore, the Visual Analog Scale [VAS] was used to determine pain: ranging from 0 (no pain) to 10 (worst pain imaginable). General health status was evaluated using the short form 36 health questionnaire (SF-36) [18]. The SF-36 is sub-categorized into physical functioning, role-physical, bodily pain, general health, vitality, social functioning, role emotional, mental health, and 1 year comparison. SF-36 is scored on each subcategory from 0 to 100 where a higher score indicates a better health status. In addition, time to return to work was recorded to further investigate the economic burden on society.

Statistical analysis

For statistical evaluation of all data, IBM SPSS 23.0 (SPSS Inc. Chicago IL, USA) was used. Continuous variables were presented as the median and interquartile distribution; categorical variables are presented as numbers and percentages. The Mann–Whitney *U* test was used for comparing nonparametric variables. Pearson correlation test for continuous and Spearman correlation test for nominal variables were used for testing correlation. Nominal variables were compared using Chi-square statistics. For all tests, a significance level of $p < 0.05$ was used. Stepwise multiple logistic regression analysis was conducted on all significant variables after bivariate analysis, to test for factors that independently influence outcome.

Results

Demographics

All demographic, fracture, and treatment-related characteristics are summarized in Table 1. One hundred and eleven patients responded to the questionnaires resulting in a total response rate of 73.0%. Responders were similar as compared to nonresponders on all demographic variables except for age; the median age was significantly higher in the responding patients; 53.9 (IQR 34.8–62.7) vs. 34.8 (IQR 21.2–50.6) years, $p = 0.003$; responders vs. nonresponders, respectively. The median follow-up was 37.5 (IQR 20.8–52.3) months with a minimal follow-up of 6 months and did not significantly differ between operatively and nonoperatively treated patients. Radiological union of the fracture was observed in 148 (97.4%) cases. Three (2.0%) fractures showed delayed bone healing, including 1 fracture after operative treatment. Only one zone 1 fracture was classified as nonunion after nonoperative treatment.

Healthcare utilization

All cost variables were assessed for operatively and nonoperatively treated patients, results are summarized in Table 2. To further assess influencing factors on cost, different process characteristics were reviewed to compare operative vs. nonoperative treatment. Total LOS was significantly higher ($p < 0.001$) in the operatively treated group with a median LOS of 1 (IQR 0–2) day vs. nonoperatively treated patients who were not hospitalized at all. The number of outpatient contacts in the operative group was significantly higher; 4 (2–5) versus 2 (1–3), respectively, $p = 0.001$ compared to the nonoperative group. Similar daycare stay, (either for plaster application and exchange, or implant removal) was reported in both groups; 2 (1–3) versus 2 (1–3), $p = 0.665$, nonoperative vs. operative, respectively.

Outcome

A total of 48 (31.6%) patients reported an FFI score of 0, indicating no clinical foot function-related disability. 12 (7.9%) Patients reported an FFI score over 20, indicating markedly worsened foot function-related disability, including 1 patient after operative treatment. The preoperative fracture displacement in these 12 patients ranged 0–3.5 mm, wherein the patient with the poorest FFI score (88.7) was treated nonoperatively for a zone 2 proximal fifth metatarsal fracture with 3.5 mm fracture displacement preoperatively. Regarding pain, 68 (44.7%) patients reported experiencing no pain on a daily basis. Seven (4.6%) patients reported daily pain with a VAS score greater than 4. All functional, clinical, and general health outcome scores for responding patients are summarized in Table 3. Overall, the mean return to work period was 5.2 weeks, with no significant difference between the operative and nonoperative groups ($p = 0.522$). In total, 7 (4.6%) patients did not return to work, 4 after nonoperative, and 3 after operative treatment (3.3 vs. 9.7%, $p = 0.423$, nonoperative vs. operative, respectively).

Table 1 Demography, fracture, and treatment-related characteristics ($n = 152$)

	Total ($n = 152$)	Operative ($n = 31$)	Nonoperative ($n = 121$)	p value
Age (years)	51.3 (27.1–61.4)	51.2 (31.2–60.8)	51.3 (24.4–63.3)	0.943
Gender				0.951
Male	89 (58.6%)	13 (41.9%)	71 (58.7%)	
Female	63 (41.4%)	18 (58.1%)	50 (41.3%)	
ASA				0.929
1–2	67 (44.1%)	29 (93.6%)	38 (31.4%)	
3	4 (2.6%)	2 (6.5%)	2 (1.7%)	
N/A	81 (53.3%)	0	81 (66.9%)	
BMI (kg/m^2)	25.0 (22.1–27.8)	25.5 (21.1–28.2)	25.0 (22.0–27.8)	0.864
Smoking	21 (13.8%)	4 (12.9%)	17 (14.0%)	0.567
Medication	2 (1.3%)	0	2 (1.7%)	0.616
DM	9 (5.9%)	2 (6.5%)	7 (5.8%)	0.642
Other CVRF	28 (18.4%)	5 (16.1%)	23 (19.0%)	0.427
Impairing history	24 (15.8%)	4 (12.9%)	20 (16.5%)	0.390
Occupation				0.078
None	9 (5.9%)	2 (6.5%)	7 (5.8%)	
Light	44 (28.9%)	15 (48.4%)	29 (24.0%)	
Moderate	27 (17.8%)	7 (22.6%)	20 (16.5%)	
Heavy	7 (4.6%)	2 (6.5%)	5 (4.1%)	
Pension	27 (17.8)	3 (9.7%)	24 (19.8%)	
N/A	38 (25.0%)	2 (6.5%)	36 (29.8%)	
Classification				0.265
Zone 1	93 (61.2%)	21 (67.7%)	72 (59.5%)	
Zone 2	59 (38.8%)	10 (32.3%)	49 (40.5%)	
Affected side				0.409
Left	68 (44.7%)	16 (51.6%)	52 (43.0%)	
Right	83 (54.6%)	15 (48.4%)	68 (56.2%)	
N/A	1 (0.7%)	0	1 (0.8%)	
Displacement (mm)	1.3 (0.6–2.2)	2.3 (1.6–3.4)	1.2 (0.5–1.8)	< 0.001*
Multiple fragments	19 (12.2%)	2 (6.5%)	17 (14.0%)	0.254
Energy of trauma				0.964
Low	144 (94.7%)	30 (96.8%)	114 (94.2%)	
High	5 (3.2%)	1 (3.2%)	4 (3.3%)	
N/A	3 (1.9%)	0	3 (2.5%)	
Treatment duration (weeks)	10.4 (4.9–21.1)	20.7 (8.4–52.7)	9.4 (4.8–16.0)	< 0.001*
NWBP (weeks)	2.0 (1.0–4.0)	2.0 (0.0–4.0)	2.0 (1.0–4.0)	0.184
Complication rate	9 (5.9%)	4 (12.9%)	5 (4.1%)	0.065
Wound dehiscence	3 (2.0%)	3 (9.7%)	0	0.001*
Surgical site infection	2 (1.3%)	2 (6.5%)	0	0.005*
DVT	2 (1.3%)	0	2 (1.7%)	0.471
Paraesthesia	3 (2.0%)	0	3 (2.5%)	0.376
Union				0.464
Yes	148 (97.4%)	30 (96.8%)	118 (97.5%)	
Delayed	3 (2.0%)	1 (3.2%)	2 (1.7%)	
No	1 (0.7%)	0	1 (0.8%)	
Reintervention rate	16 (10.5%)	10 (32.3%)	6 (5.0%)	< 0.001*

Continuous parameters are expressed as median values with their respective interquartile range. Percentage displayed is either according to total patients or to the respective treatment group. Statistical results are presented as p value and marked (*) if $p < 0.05$

ASA American society of Anesthesiologists, *N/A* data not available, *BMI* body mass index, *DM* diabetes mellitus, *CVRF* cardiovascular risk factors, *NWBP* nonweight-bearing period, *DVT* deep venous thrombosis

Table 2 Healthcare costs' comparison: nonoperative ($n = 121$) vs. operative treatment ($n = 31$)

Category	Per patient cost		Total		Relative share		p value
	Nonoperative	Operative	Nonoperative	Operative	Nonoperative (%)	Operative (%)	
Honoraria	€403 (304–492)	€1002 (830–1412)	€53,917	€35,508	86.4	52.4	< 0.001*
Materials	€0	€58 (28–173)	€0	€3961	0	5.8	< 0.001*
Hospitalization	€0	€438 (0–855)	€840	€15,893	1.3	23.3	< 0.001*
Daycare stay	€60 (30–74)	€88 (30–235)	€7061	€6289	11.3	9.3	0.023*
Pharmaceuticals	€0 (0–4)	€209 (104–243)	€533	€6279	1.0	9.2	< 0.001*
Total cost	€463 (352–574)	€1960 (1459–2956)	€62,353	€67,936	100	100	< 0.001*

Per patient costs show median cost per category followed by the respective interquartile range. Statistical results are presented as p value and marked (*) if $p < 0.05$

Table 3 Patient-reported outcome measures ($n = 111$)

	General	Operative	Nonoperative	p value
FFI	3.0 (0.0–22.0)	3.0 (0.0–21.8)	2.0 (0.0–22.0)	0.804
VAS	0.0 (0.0–1.0)	0.0 (0.0–1.0)	0.00 (0.0–1.0)	0.973
SF-36				
PF	90.0 (71.3–100)	92.5 (80.0–100)	90.0 (65.0–100)	0.273
PR	100.0 (75.0–100)	100.0 (100–100)	100.0 (56.3–100)	0.071
BP	76.0 (53.0–100)	88.0 (64.0–100)	76.0 (53.0–100)	0.185
GH	72.0 (58.3–82.0)	72.0 (57.0–86.5)	72.0 (62.0–82.0)	0.887
VT	70.0 (59.0–80.0)	70.0 (60.0–80.0)	70.0 (55.0–80.0)	0.666
SF	87.5 (75.0–100)	87.5 (87.5–100)	87.5 (75.0–100)	0.818
ER	100.0 (100–100)	100.0 (100–100)	100.0 (100–100)	0.006*
MH	84.0 (68.0–88.0)	84.0 (80.0–92.0)	80.0 (68.0–88.0)	0.021*
OY	3.0 (3.0–3.0)	3.0 (2.3–3.0)	3.0 (3.0–3.0)	0.092

Continuous parameters are expressed as median values with their respective interquartile range. Statistical results are presented as p value and marked (*) if $p < 0.05$

FFI Foot Function Index, *VAS* Visual Analog Scale, *PF* Physical Functioning, *PR* Physical Role, *BP* Bodily Pain, *GH* General Health, *VT* Vitality, *SF* Social Functioning, *ER* Emotional Role, *MH* Mental Health, *OY* One Year

What influences outcome?

Bivariate analysis on FFI, VAS, and SF-36 was performed in regard to all demographic variables, fracture classification, and treatment parameters. Results are presented in Table 4. Further investigation into influencing factors on patient-reported outcome measures was achieved by analyzing bivariate significant results in a linear logistic regression model. Regarding the FFI, worse functional outcome was associated with a medical history of mobility impairment ($p = 0.006$). There were no factors found with significant impact on pain. Subscales of the SF-36 were assessed separately. Regarding the 'Physical Functioning' and 'Physical Role' subscales, diabetes ($p = 0.006$ and $p < 0.001$ respectively) and a history of mobility impairment ($p = 0.003$ and $p < 0.001$ respectively) were associated with a lower outcome score. 'Bodily Pain' and 'General Health' were significantly influenced by a history of mobility impairment ($p = 0.008$ and $p = 0.013$, respectively). Regarding the 'Vitality' subscale, the energy of the trauma ($p = 0.033$) was found to be significantly associated with lower outcome scores. A higher ASA-score was associated with lower scores on 'Social Functioning' ($p = 0.003$) and 'Emotional Role' ($p = 0.041$). Furthermore, lower 'Emotional Role' and 'Mental Health' scores were both associated with a nonoperative approach ($p = 0.040$ and $p = 0.020$ respectively). The 'One Year' question in the SF-36 questionnaire reporting patient appraisal of shifting health over the last year was significantly associated with the presence of CVRF ($p = 0.031$). Return to work was independently moderate positively influenced by lower BMI ($p < 0.001$), while occupation ($p = 0.014$) and the intensity of the initial trauma ($p = 0.012$) had a weak positive influence. In other words, high BMI, heavier work, and higher levels of the initial trauma were associated with prolonged return to work.

Discussion

The goal of this study was to assess the functional, clinical outcome of nonoperative, and operative treatment for proximal fifth metatarsal fractures, and determine the factors that influence this outcome. Furthermore, we performed a cost analysis to assess the financial impact and the factors that drive the cost in the treatment modalities of proximal fifth metatarsal fractures.

Overall, the outcome of operative and nonoperatively treated patients was good and comparable between the operatively and nonoperatively treated patients, except for emotional role and mental health scores, which were significantly higher in operatively treated patients. In turn, emotional role (in addition to social functioning) was found to

Table 4 Correlation analysis ($n = 114$)

	FFI	VAS	SF36 PF	SF36 PR	SF36 BP	SF36 GH	SF36 VT	SF36 SF	SF36 RE	SF36 MH	SF36 OY	Return to work
Age[a]	0.995	0.770	0.000*	0.001*	0.002*	0.193	0.922	0.038*	0.305	0.950	0.456	0.007*
Gender	0.258	0.612	0.055	0.021*	0.326	0.599	0.684	0.540	0.098	0.358	0.250	0.503
ASA	0.428	0.619	0.007*	0.006*	0.132	0.049*	0.871	0.036*	0.029*	0.841	0.565	0.604
BMI[a]	0.504	0.169	0.016*	0.661	0.219	0.280	0.587	0.424	0.885	0.387	0.972	0.000*
DM	0.024*	0.066	0.000*	0.000*	0.126	0.034*	0.913	0.116	0.726	0.263	0.110	0.106
Smoking	0.463	0.773	0.482	0.792	0.545	0.868	0.899	0.096	0.220	0.523	0.150	0.159
Other CVRF	0.010*	0.225	0.410	0.396	0.925	0.039*	0.874	0.708	0.900	0.765	0.031*	0.278
Medication	0.298	0.441	0.209	0.145	0.251	0.655	0.097	0.191	0.643	0.512	0.911	0.753
Impairing history	0.004*	0.074	0.000*	0.000*	0.001*	0.001*	0.356	0.078	0.830	0.653	0.080	0.177
Occupation	0.457	0.515	0.001*	0.088	0.123	0.170	0.889	0.168	0.583	0.896	0.092	0.000*
Affected side	0.132	0.065	0.764	0.985	0.098	0.630	0.028*	0.849	0.451	0.505	0.437	0.401
Energy of trauma	0.869	0.331	0.645	0.976	0.189	0.165	0.023*	0.161	0.159	0.379	0.289	0.046*
Classification	0.805	0.497	0.085	0.193	0.170	0.513	0.895	0.939	0.929	0.503	0.763	0.067
Multiple fragments	0.680	0.825	0.296	0.647	0.650	0.067	0.833	0.476	0.254	0.971	0.096	0.700
Displacement[a]	0.122	0.271	0.806	0.768	0.362	0.873	0.776	0.704	0.154	0.489	0.507	0.328
Treatment type	0.805	0.973	0.275	0.071	0.186	0.888	0.668	0.819	0.005*	0.020*	0.092	0.526
Treatment duration[a]	0.664	0.296	0.191	0.163	0.955	0.695	0.684	0.598	0.321	0.199	0.303	0.462
NWBP[a]	0.559	0.291	0.873	0.425	0.098	0.800	0.595	0.949	0.172	0.890	0.057	0.042*
Union	0.884	0.652	0.814	0.719	0.733	0.725	0.298	0.875	0.787	0.818	0.306	0.563
Complication rate	0.944	0.735	0.552	0.641	0.386	0.973	0.377	0.691	0.617	0.891	0.669	0.164
Reintervention rate	0.254	0.721	0.528	0.344	0.107	0.077	0.591	0.349	0.053	0.442	0.910	0.242

Results are displayed as p value and marked (*) if $p < 0.05$

FFI Foot Function Index, *VAS* Visual analog Scale, *PF* Physical functioning, *PR* Physical Role, *BP* Bodily Pain, *GH* General Health, *VT* Vitality, *SF* Social Functioning, *RE* Emotional Role, *MH* Mental Health, *OY* One Year, *ASA* American Society of Anesthesiologists, *BMI* Body Mass Index, *DM* Diabetes Mellitus, *CVRF* cardiovascular risk factors, *NWBP* nonweight-bearing period

[a]Bivariate analysis was performed using Pearson and Spearman correlation for continuous and nominal variables, respectively. Continuous variables are marked

be determined primarily by pre-existing comorbidity (ASA-score). In parallel, the foot function, VAS, and physical SF-36 (physical functioning, physical role, bodily pain, and general health) were mainly driven by a history of mobility impairment and to a certain extent also by CVRF (e.g., diabetes mellitus). CVRF was associated as well with negative patient appraisal of their shifting health status over the last year. This indicates a bias towards lower functional scores and quality of life as a result of pre-existing conditions in these patients. Although the mean time to return to work (5.2 weeks) did not significantly differ between both groups, it was positively affected by higher BMI, physical moderate, and heavy occupation, and the fact that the fracture was caused by a high-energy event as defined by the guidelines of the Advanced Trauma Life Support.

In contrast, the complication and reintervention rate were significantly higher in the operative group. The overall complication rate was 5.9% (12.9% vs. 4.1%, operative vs. nonoperative, respectively, $p = 0.065$) which is rather low as compared to the literature ranging up to 67% [19, 20]. Despite preoperative fracture displacement being significantly larger in operatively compared to nonoperatively treated patients, only 1 zone 1 fracture (preoperative displacement of 3.0 mm) was classified as nonunion, showing no progression towards healing after nonoperative treatment. Furthermore, three (2.0%) fractures showed delayed union, including 1 after operative treatment. Of note, the median nonweight-bearing period of 2 weeks was equal in both groups. Although, fracture displacement was not found to be of any influence on functional outcome or pain perception, the poorest FFI score was reported in a patient with a nonoperatively treated zone 2 fracture with 3.5 mm fracture displacement preoperatively.

Zone 1 and 2 proximal fifth metatarsal fractures were equally distributed in the operative and nonoperative cohorts, 21 and 72 vs. 10 and 49, respectively. Our clinical and functional outcome for nonoperative treatment for zone 1 fractures is in accordance to the literature [9–11, 20–22]. Our results are also in line with Bigsby et al. who reported no significant difference in functional outcome between 62 zone 1 and 26 zone 2 fractures 1 year after nonoperative treatment [23]. However, there is still debate in the literature about nonoperative treatment for zone 2 fractures. Torg et al. suggested nonoperative or operative treatment depending on the functional demand of the patient [6]. Zwitser et al. recommended operative treatment mainly depending on the activity level of the patient [11]. A recent review by Cheung and Lui promotes nonoperative treatment for zone 1 fractures, but the early operative treatment for zone 2 fractures [9].

The length-of-treatment in our study was found to be twice as long in the operatively treated patients compared to the nonoperatively treated patients, with double the number of outpatient contacts. Subsequently, the treatment cost for proximal fifth metatarsal fractures were more than four times higher in the operatively treated patients, mainly due to the hospitalization and honoraria. The distribution of healthcare costs differs to what we have shown previously for the treatment of fibula fractures, wherein the relative share of fees is significantly higher here at the expense of hospitalization due to limited or no LOS [15]. In 2005, Konkel et al. already showed in small patient series that nonoperative treatment for both zone 1 and 2 proximal fifth metatarsal fractures can be done safely with high satisfaction rates and approximately at half the cost [12]. However, our health care costs are related to Belgium's health care financing context and limited to costs induced by hospital-related care [16].

Reviewing literature, our study including 152 patients with a response rate of 73.0% can be considered one of the largest cohort studies reporting on the outcome of proximal fifth metatarsal fractures [20–22, 24–26]. Although our treatment guideline clearly stated that zone 2 proximal fifth metatarsal fractures with ≥ 2 mm displacement required operative treatment and zone 1 fractures could be treated nonoperatively, we observed that a substantial number of the proximal fifth metatarsal fractures were not correctly classified preoperatively and therefore not treated as such. Surgeon and patient confounders played to some extent a role in deciding whether or not to operate. Nevertheless, selection bias is inherently intrinsic to a retrospective cohort study.

In conclusion, this study further supports that both zone 1 and zone 2 proximal fifth metatarsal fractures can safely be treated nonoperatively with good patient-reported outcome, less complications and reinterventions, lower healthcare cost, and without increased economic burden. Except for mental health, we could not reveal any other benefit of operative treatment for zone 1 and 2 proximal fifth metatarsal fractures. Impaired union was hardly observed and fracture displacement does not seem to play a major role here. Postoperative foot function, pain, and quality of life were mainly determined by the patient's pre-existing condition. Therefore, further prospective studies should focus on potential value of operative treatment in healthy young (athletic) patients and a cutoff for fracture displacement.

Compliance with ethical standards

Conflict of interest The authors declare that they have no competing interests.

Research involving human participants None.

Informed consent None.

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