Original Research

# Clinical and functional outcomes of Paediatric femoral shaft fractures managed non-operatively at Nkhotakota District Hospital, Malawi

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## Abstract

**Background**

Femoral shaft fracture is a common paediatric injury, managed non-operatively with skin traction in Malawian public hospitals. The clinical and functional outcomes of this treatment modality are unknown in Malawi.

**Methods**

We retrospectively identified all children who were managed at Nkhotakota District Hospital with skin traction after sustaining closed femoral shaft fractures from January 1, 2013 to December 31, 2016. We collected demographic characteristics and treatment history from the patient's inpatient medical records, then invited each patient to undergo in-person follow-up clinical and functional assessment.

**Results**

We identified 149 patients. Gallows traction 26 (17%) and 123 Bucks skin traction (83%). The mean age for Gallows traction was 10 months (95% CI: 8-11), most were males (16, 62%). Fall was the most common cause of injury (19, 73%), and mean hospitalization of 15.8 days (95% CI: 13.8-17.9). Eighteen patients (69%) were followed up at a mean of 4.2 years after discharge, all were full weight bearing, had achieved radiographic fracture union, and had no functional limitations or pain during regular activity. Buck's skin traction mean age was 5.2 years (95% CI: 4.7-5.8), most were males (82, 67%), and fall (85, 69%). We followed up 83 patients (67%) at a mean of 4.1 years after hospital discharge, all of whom had achieved radiographic fracture union. All but one patient were full weight bearing and had normal gait. At follow-up, 14 patients (17%) reported some level of pain, 5 patients reported that their injury limited their return to household chores, and 2 reported that their injury also limited their return to school.

**Conclusion**

Despite the limitations of this study, non-operative management of paediatric femoral shaft fractures at Nkhotakota District Hospital may have good clinical and functional outcomes and minimal complications. A future prospective study may be helpful to confirm these findings.

**Key Words**: Children, femoral shaft fractures, non-operative treatment, skin traction.

## Introduction

In Africa, trauma is the most common cause of death among children five to fourteen years old[1]. In Malawi, paediatric injuries are common and account for 31% of all trauma patients thus adults and children[2]. Femoral shaft fractures in childhood account for 1.6% of all bony injuries[3] and 33.7% of long bone fractures[4]. The incidence of femoral shaft fractures has been estimated at 1% of children under the age of 12 years[5]. Pediatric femoral shaft fractures can be managed non-operatively and operatively. The choice of management is influenced by patient age, size, location and site of the fracture (fracture personality), concomitant injuries, social circumstances, and healthcare-associated costs[6, 7, 8]. These fractures typically heal rapidly, and minimal angulation and shortening tend to correct with physiologic bone remodeling[9].

Due to limited surgical capacity, non-operative treatment is the standard of care for most patients treated in Malawian public hospitals[10, 11, 12]. At our institution, Nkhotakota District Hospital, all paediatric patients with femoral shaft fractures are treated definitively as inpatients with skin traction, where a constant axial traction force is applied to the injured extremity via adhesive tape on the skin[13] A retrospective study by Urban[14] on long-term outcomes of the treatment of paediatric femoral shaft fractures treated with Bryant's vertical traction showed that treatment was simple and safe, with excellent functional outcomes and few serious complications. Other retrospective studies performed in Nigeria and Cameroon have demonstrated high rates of fracture union with non-operative treatment of pediatric femoral shaft fractures[6, 15].

In Malawi, there are no formal studies documenting the clinical or functional outcomes of paediatric femoral shaft fractures managed non-operatively in public hospitals. We therefore sought to retrospectively assess the clinical and functional outcomes of paediatric patients with femoral shaft fractures who were treated with skin traction at Nkhotakota District Hospital, Malawi over a three-year period. The main objective of this study was to assess the clinical outcomes of paediatric femoral shaft fractures in patients treated with skin traction at Nkhotakota District Hospital, Malawi from January, 2013 to December, 2016.

## Methods

We retrospectively identified from the inpatient medical



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records all children aged 14 years or younger who were admitted and treated for femoral shaft fractures at Nkhotakota District Hospital from 1st January 2013 to 31st December 2016. Patients older than 14 years were excluded from this study as they are approaching or have reached skeletal maturity, and thus femoral shaft fractures in this age group are better treated as adult injuries[16]. We excluded all polytraumatized patients, patients with open fractures, and patients with congenital musculoskeletal conditions like osteogenesis imperfecta. From the medical records, we obtained socio-demographic characteristics including age, sex, home village and medical comorbidities. We also documented fracture mechanism, fracture characteristics, treatment given, and the timeline of treatment course from date of injury to date of hospital discharge. We documented associated injuries and complications during the course of treatment.

### *Treatment technique*

Skin traction was used in the treatment of all patients included in this study. First, each patient's skin was cleansed, shaved, and dried thoroughly. Next, commercially available, medical-grade cloth tape was applied directly to the skin in long strips starting at the foot and extending proximally up the lower extremity to the knee. The tape was then over-wrapped with a layer of bandage up to but not beyond the level of the patient's fracture. The distal most ends of the tape strips were fashioned into a loop, through which traction was applied. For patients age 2 years and younger, we used Gallows traction (Bryant's traction), where both limbs were strapped and suspended from an overhead beam with an inelastic cord. The patient's body weight provided the axial traction force (Figure 1).

In children older than 2 years, we used Buck's skin traction, where the patient's knee was maintained in full extension with weights connected to the distal tape loops and hung over the end of the hospital bed.

All patients were hospitalized and kept on bed rest for the duration of their treatment in traction. Routine personal hygiene and nutrition were all maintained with the assistance of the patients' guardians and nursing staff. Once patients demonstrated clinical signs of fracture union – including lack of fracture site tenderness, a palpable firm callus at the fracture site, and ability to perform a straight leg raise – final x-rays were performed to assess for radiographic fracture union.

### *Follow-up assessments*

We invited each patient identified from the inpatient records to participate in a follow-up assessment. Patients were contacted by phone when able, we made radio announcements, and the first author (EM) – a practicing orthopedic clinical officer – performed in-person follow-up assessments in the patients' homes. We sought informed consent from their parents/guardians prior to their participation in the follow-up assessments.

During follow-up, we documented each patient's weight bearing status (full weight-bearing, partial weight-bearing, non-weight-bearing) and use of walking assistive devices. We clinically evaluated each patient's gait (normal or antalgic), and fracture union on most recent x-ray. Patients without a final x-ray available for review were referred to Nkhotakota District Hospital for new x-rays, and funds were provided for round-trip transportation. We performed functional assessments, asking each patient whether the injury had affected their return to school or household chores. We also asked patients to rate on a scale from 0 to 10 how much functional limitation or pain they experienced in the 7 days prior to follow-up assessment.

Gallows traction

Bucks skin traction

### *Data Analysis*

We compiled a list of home Traditional Authorities (TAs) reported for all patients in the study. We used geospatial visualizations by Redivis (Redivis, Inc., Mountain View, CA, USA) to estimate travel distance for each patient from the home TA to Nkhotakota District Hospital. We separated our cohort by treatment method (Gallows versus Buck's skin traction) and compared the two groups with regards to demographic and clinical variables. For the cohort treated with Buck's skin traction, we separated the cohort based on functional outcomes and compared demographic and clinical variables for those with and without functional limitations. We performed all analyses using Microsoft Excel (Seattle, WA, USA), SAS 9.4 (SAS Institute Inc., Cary, NC, USA), and Statistical Package for Social Sciences (SPSS, IBM Corp., Armonk, NY, USA). The Malawian National Health Sciences Research Committee provided ethical approval of the study (protocol #18/09/2154).

## Results

A total of 149 patients were identified from the case files between 1st January 2013 and 31st December 2016. A total

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**Table 1: Characteristics of pediatric patients with femoral shaft fractures treated in gallows and skin traction at Nkhotakota District Hospital, Malawi.**

| | Gallows traction N (%) | Skin traction N (%) |
|---|---|---|
| Total (% of total cohort) | 26 (17) | 123 (83) |
| Age (SD) | 10 months ± 4 months | 5.2 years ± 3 years |
| Sex | | |
| Female | 10 (38) | 41 (33) |
| Male | 16 (62) | 82 (67) |
| Traditional Authority | | |
| Malengachanzi (16.3km) | 8 (31) | 26 (21) |
| Mphonde (17.3km) | 6 (23) | 13 (11) |
| Mwansambo (57.1km) | 0 (0) | 16 (13) |
| Kanyenda (62.2km) | 6 (23) | 26 (21) |
| Mwadzama (65.0km) | 6 (23) | 29 (24) |
| Kafuzira (82.4km) | 0 (0) | 12 (10) |
| Unknown | 0 (0) | 1 (1) |
| Estimated Transit Distance | | |
| Mean ± SD (in km) | 38.3 ± 23.9 | 49.6 ± 23.6 |
| <20 km | 14 (54) | 39 (32) |
| ≥20 km | 12 (46) | 83 (68) |
| Time to presentation | | |
| Not delayed (0-1 days) | 22 (85) | 115 (94) |
| Delayed (2 or more days) | 4 (15) | 8 (7) |
| Medical Comorbidities | | |
| Impertigo | 0 (0) | 1 (1) |
| Malaria | 1 (4) | 4 (3) |
| Septic right knee/polio | 0 (0) | 1 (1) |
| Squamous cell carcinoma | 0 (0) | 1 (1) |
| Upper respiratory tract infection | 0 (0) | 2 (2) |
| None | 25 (96) | 114 (93) |
| Mechanism of injury | | |
| Fall | 19 (73) | 85 (69) |
| Hit by a falling object | 2 (8) | 4 (3) |
| RTA | 1 (4) | 12 (10) |
| Sports | 0 (0) | 7 (6) |
| Unknown | 4 (15) | 15 (12) |
| Fracture segment | | |
| Proximal third | 0 (0) | 8 (7) |
| Middle third | 14 (54) | 53 (43) |
| Distal third | 2 (8) | 23 (19) |
| Unknown | 10 (38) | 39 (32) |
| Fracture laterality | | |

**table 1 cont...**

| | | |
|---|---|---|
| Left | 15 (58) | 58 (47) |
| Right | 11 (42) | 62 (50) |
| Unknown | 0 (0) | 3 (2) |
| Concomitant injuries | | |
| Distal radius/ulna fracture | 0 (0) | 1 (1) |
| Metacarpal fracture | 0 (0) | 1 (1) |
| None | 26 (100) | 121 (98) |
| Complications | | |
| Blisters | 0 (0) | 10 (8) |
| Septic heel | 0 (0) | 1 (1) |
| None | 26 (100) | 112 (91) |
| Weight-bearing status | | |
| Full | 18 (100) | 82 (99) |
| Partial | 0 (0) | 1 (1) |

Percentage of each cohort is given in parenthesis, unless otherwise specified. Traditional Authorities are sorted in ascending order by distance from each Traditional Authority to Nkhotakota District Hospital. Distances are provided in parenthesis next to each Traditional Authority name. Nkurunziza et al, defined referral delay as a referral taking place two or more days after referral recommendation. We similarly defined presentation delay as presentation to hospital two or more days after injury[22].

**Table 2: Time intervals from injury to follow-up assessment for pediatric patients with femoral shaft fractures treated with gallows and skin traction at Nkhotakota District Hospital, Malawi.**

| Time intervals (in days) | Gallows traction | Skin traction | P-value |
|---|---|---|---|
| Injury to hospital arrival | 0.7 ± 1.5 | 0.6 ± 0.9 | 0.799 |
| Hospital arrival to start of treatment | 0 ± 0 | 0.1 ± 0.8 | 0.271 |
| Treatment start to end | 15.8 ± 4.9 | 24.4 ± 7.3 | <0.001 |
| Treatment end to hospital discharge | 0 ± 0 | 0 ± 0.1 | 0.319 |
| Discharge to follow-up X-ray | 1542.9 ± 356.4 | 1496.7 ± 388 | 0.670 |
| Discharge to follow-up assessment | 1505.4 ± 384.1 | 1507.1 ± 405 | 0.987 |

All time intervals are reported in days. P-values are reported from independent t-test comparisons between patients treated in gallows versus skin traction.

**Table 3: Functional outcomes of pediatric patients with femoral shaft fractures treated in skin traction at Nkhotakota District Hospital, Malawi.**

| Functional outcome | N (%) |
|---|---|
| Return to School | |
| Yes, without limitations | 81 (98) |
| Yes, but limited by injury | 2 (2) |
| Return to Chores | |
| Yes, without limitations | 78 (94) |
| Yes, but limited by injury | 5 (6) |
| Functional Score | |
| 0 | 76 (92) |
| 1 | 2 (2) |
| 2 | 3 (4) |
| 3 | 1 (1) |
| 4 | 1 (1) |
| Pain Score | |
| 0 | 69 (83) |
| 1 | 5 (6) |
| 2 | 5 (6) |
| 3 | 2 (2) |
| 4 | 2 (2) |

Percentage of each cohort is given in parenthesis. Functional scores are reported on a 10-point scale, with a score of 0 meaning that the injury had no effect on regular daily activities over the past 7 days prior to follow-up assessment, and a score of 10 meaning the injury completely prevented the patient from doing regular daily activities. Pain scores were assessed on a 10-point scale, with a score of 0 meaning the patient had no pain, and a score of 10 meaning the patient had the worst possible pain in the injured extremity in the last 7 days prior to follow-up assessment. None of the patients had a pain nor functional score of more than 4.

of 26 patients (17%) were treated with Gallows traction and 123 patients (83%) were treated with Buck's skin traction. There were 51 females and 98 males. Ages ranged from 1 month to 14 years with a mean of 4.5 years ± 3 years. A total of 101 patients (68%) underwent follow-up examination.

### *Gallows traction cohort*

The mean age of the cohort was 10 months (95% CI: 8-11), with 10 females (38%) and 16 males (62%). Eight patients (31%) were from the Traditional Authority (TA) Malengachanzi, with 6 patients (23%) coming from each of the TAs Mphonde, Kanyenda, and Mwadzama. Mean estimated transit distance from hometown to hospital was 38.3 kilometers (95% CI: 28.7-48.0). Four patients (15%) presented two or more days after injury, and the remaining 22 (85%) presented on the day of or the day after injury.

**Table 4: Comparison of patients with and without functional limitations at follow-up assessment.**

| | No limitations N (%) | Functional limitations N (%) |
|---|---|---|
| Total (% of total cohort) | 69 (83) | 14 (17) |
| Age | 5.0 years ± 2.6 years | 6.5 years ± 4.3 years |
| Sex | | |
| Female | 27 (39) | 4 (29) |
| Male | 42 (61) | 10 (71) |
| Traditional Authority | | |
| Malengachanzi (16.3km) | 14 (20) | 2 (14) |
| Mphonde (17.3km) | 9 (13) | 1 (7) |
| Mwansambo (57.1km) | 10 (14) | 4 (29) |
| Kanyenda (62.2km) | 10 (14) | 3 (21) |
| Mwadzama (65.0km) | 18 (26) | 2 (14) |
| Kafuzira (82.4km) | 8 (12) | 2 (14) |
| Estimated transit distance | | |
| Mean ± SD (in km) | 49.4 ± 24.2 | 54.3 ± 22.0 |
| <20 km | 23 (33) | 3 (21) |
| ≥20 km | 46 (67) | 11 (79) |
| Time to presentation | | |
| Not delayed (0-1 days) | 63 (91) | 14 (100) |
| Delayed (2 or more days) | 6 (9) | 0 (0) |
| Mechanism of injury | | |
| Fall | 56 (82) | 10 (71) |
| Hit by falling object, road traffic accident, or sport | 12 (18) | 4 (29) |
| Fracture segment | | |
| Proximal third | 4 (7) | 3 (21) |
| Middle or Distal third | 57 (93) | 11 (79) |
| Fracture laterality | | |
| Left | 35 (51) | 5 (36) |
| Right | 34 (49) | 9 (64) |
| Year of treatment | | |
| 2013 | 23 (33) | 2 (14) |
| 2014 | 23 (33) | 1 (7) |
| 2015 | 17 (25) | 5 (36) |
| 2016 | 6 (9) | 6 (43) |

For all patients, treatment was initiated on the day of hospital arrival. Fall was the most common mechanism of injury (19 patients, 73%), followed by being hit by a falling object (2 patients, 8%) and road traffic accident (1 patient, 4%). No patients had concomitant injuries or complications during inpatient treatment. One patient had malaria at the time of hospitalization, and all remaining patients had no medical comorbidities. Patients were hospitalized for a mean of 15.8 days (95% CI: 13.8-17.9) (Table 1).

Eighteen patients (69%) were available for follow-up examination, at a mean of 4.1 years (95% CI: 3.6-4.7) after hospital discharge. Of these 18 patients, all were noted to be bearing full weight on the extremity, with normal gait. All patients achieved radiographic union on follow-up x-rays, which were performed at a mean of 4.2 years (95% CI: 3.7-4.8) after hospital discharge. No patients reported functional limitations or pain during regular activity (Table 1).

### *Buck's skin traction cohort*

The mean age of the cohort was 5.2 years (95% CI: 4.7-5.8), with 41 females (33%) and 82 males (67%). Most patients presented from TA Mwadzama (29 patients, 24%), Malengachanzi (26, 21%), and Kanyenda (26, 21%). Mean estimated transit distance was 49.6 kilometers (95% CI: 45.4-53.8), which was significantly longer than for the gallows traction cohort ($p = 0.035$). Eight patients (7%) presented two or more days after injury, and the remaining 115 (94%)

**Table 5: Relative risks of functional limitation at follow-up assessment by mechanism of injury, fracture segment, and year of treatment for pediatric patients treated with skin traction for femoral shaft fractures at Nkhotakota District Hospital, Malawi.**

| | Rate of Functional Limitation | RR (95% CI) | P-value |
|---|---|---|---|
| Mechanism of injury | | | 0.231§ |
| Fall[a] | 15.2% (10/66) | 1 | |
| Hit by falling object, road traffic accident, or sport | 25% (4/16) | 1.65 (0.59-4.59) | |
| Fracture segment | | | 0.116§ |
| Proximal third | 42.9% (3/7) | 2.65 (0.96-7.29) | |
| Middle or Distal third[a] | 16.2% (11/68) | 1 | |
| Year of treatment | | | 0.002* |
| 2013-2014[a] | 6.1% (3/49) | 1 | |
| 2015-2016 | 32.4% (11/34) | 5.28 (1.59-17.53) | |

[a]Reference category. Statistical comparisons were performed using (§) Fisher's exact test, and (*) Chi-squared test based on sample size and data distribution.

presented on the day of or the day after injury. Treatment was initiated on the day of hospital arrival for all but two patients, for whom treatment began on the first and the ninth hospital days. Fall was the most common mechanism of injury (85 patients, 69%), followed by road traffic accident (12 patients, 10%), sports (7 patients, 6%), and being struck by a falling object (4 patients, 3%). Most patients had an isolated injury (121, 98%), one patient had a concomitant distal radius fracture, and one patient had a metacarpal fracture. Nine patients (7%) had medical comorbidities, the most common being malaria (4 patients) and upper respiratory tract infection (2 patients). During hospitalization, 10 patients (8%) developed blisters from the tape used for skin traction, one patient developed a septic heel wound, and the remaining 112 patients (91%) had no complications (Table 1). Patients were hospitalized for a mean of 24.4 days (95% CI: 23.1-25.8), which was significantly longer than for patients treated in gallows traction ($p < 0.001$) (Table 2).

Eighty-three patients (67%) were available for follow-up examination, at a mean of 4.1 years (95% CI: 3.9-4.4) after hospital discharge. One patient was noted to be bearing partial weight on the extremity at follow-up, with the remaining 82 patients bearing full weight. 82 patients reportedly walked with a normal gait with one patient walking with an antalgic gait. All 83 patients achieved radiographic union on follow-up x-rays, which were performed at a mean of 4.1 years (95% CI: 3.8-4.4) after hospital discharge (Table 1 and 2).

Sixty-nine of the 83 patients (83%) reported no functional limitations or pain during regular activity. Fourteen patients (17%) reported some level of pain during the 7 days prior to follow-up assessment, with an average score of 2.1 (range 1-4) out of 10 on the visual-analog scale. Seven of these patients reported that their injury had affected their daily activities in the 7 days prior to follow-up assessment, with an average score of 2.1 (range 1-4) out of 10. In terms of functional limitations, 5 patients reported that their injury limited their return to household chores, and 2 reported that their injury also limited their return to school (Table 3).

Patients with functional limitations were older than patients without limitations (6.5 years vs 5.0 years), though this was not statistically significant ($p = 0.218$). The most common home TAs were Malengachanzi (14, 20%) and Mwadzama (18, 26%) for patients without functional limitations, and Mwansambo (4, 29%) and Kanyenda (3, 21%) for patients with functional limitations. Estimated transit distance was approximately 50km for both groups. Six patients without functional limitations (9%) presented 2+ days after injury, with the remaining 63 patients without functional limitations and all 14 patients with functional limitations presenting 0-1 days after injury (Table 4).

Though not statistically significant, patients injured by a falling object, road traffic accident, or sports demonstrated a 65% increased risk of functional limitations at follow-up assessment compared to patients injured by a fall (RR 1.65, 95% CI 0.59-4.59, $p=0.231$). Patients with proximal-third femoral shaft fractures were 2.65 times more likely to have a functional limitation at follow-up assessment compared to patients with middle- or distal-third femoral shaft fractures (RR 2.65, 95% CI 0.96-7.29, $p=0.116$). Patients who were treated at Nkhotakota District Hospital during 2015 and 2016 were 5 times more likely to have a functional limitation at follow-up examination compared to patients treated during 2013 and 2014 (RR 5.28, 95% CI 1.59-17.53, $p=0.002$) (Table 5).

## Discussion

All patients achieved radiographic union, and over 86% (87/101) had no functional limitations.

The major drawback of skin traction is prolonged hospitalization. The mean length of hospitalization in this study was 24.4 days for patients 2-14 years and 15.8 days for patients less than 2 years, which is lower than that of Akinyoola et al, which was 6.7 weeks[6]. This could be due to low number of patients with associated injuries in our cohort (1.3%), which could influence the length of hospitalization[17]. Our cohort's 66% male dominance was similar to the study by Esenyel et al, which showed 73.9% male dominance[18]. Femoral shaft fractures in children often result from automobile accidents, falls from high places and other high energy trauma[19]. In this study, fall was the most common mechanism of injury (70%). Non-union is a rare complication of paediatric femoral fractures[9]. All patients

in our cohort were found to achieve radiographic union at follow-up. Patients who were treated at Nkhotakota District Hospital during 2015 and 2016 were 5 times more likely to have a functional limitation at follow-up examination compared to patients treated during 2013 and 2014 (RR 5.28, 95% CI 1.59-17.53). This could be because remodeling is still taking place as its only 3 to 4 years post injury as compared to 2013 and 2014 which is 5 to 6 years post injury. There is therefore a need to do a follow up study to find out if these outcomes will improve with time.

Patients with proximal-third femoral shaft fractures were 2.65 times more likely to have a functional limitation at follow-up assessment compared to patients with middle- or distal-third femoral shaft fractures. This is likely due to the deforming forces that the iliopsoas creates on the proximal fragment, making proximal-third diaphyseal fracture harder to reduce with skin traction. These patients may benefit from surgical management or from 90-90 skeletal traction[20].

Delayed presentation among pediatric patients with fractures has been reported to be as high as 28% in Malawi[21]. However, only 8% of patients in this study presented late. This may be due to the debilitating nature of femoral shaft fractures and the availability of care at Nkhotakota District Hospital, which was an average transit distance less than 50km for patients in our cohort.

The absence of treated mosquito nets in the paediatric surgical ward may have contributed to the 3% of patients who had malaria infection in the course of their hospitalization.

This study has several important limitations. Firstly, fracture characteristics could not be documented for 49 patients (33%) because initial injury x-rays were often unavailable for review. Without an electronic medical record at Nkhotakota District Hospital, x-rays are not stored on site, and we relied on patients keeping their own hardcopy x-rays or clinicians documenting fracture characteristics in the record. Facilities to store x-rays, whether in hardcopy or electronic, would be helpful when examining outcomes for patients. Secondly, accurate addresses were not documented in the medical record, so estimated travel distances were calculated for each patient from the center of his or her home Traditional Authority to Nkhotakota District Hospital. These estimates may not accurately represent actual travel distances for patients who live in rural villages far from the center of the Traditional Authority. Thirdly, outcomes of patients were not documented in the medical record, requiring that patients were identified from the record and invited to participate in follow-up assessments. Using this methodology, we were able to perform follow-up assessments for 132 patients (73% of the cohort). A prospective study may be helpful in the future to improve follow-up rates. Fourthly, the first author (E.M.), who had treated all patients initially, then performed all assessments in person. This may have introduced a bias towards under-reporting complications or functional impairments. Future studies may benefit from independent assessments by research staff who did not participate in initial patient care. Lastly, although malunion is a known complication of non-operative treatment for femoral shaft fractures[16], we were unable to evaluate the presence of malunion in our cohort. Angular deformity, hip and knee range of motion, and limb length were not recorded during follow-up assessments, which represents a major limitation of our study. Further investigation may be warranted into the prevalence of malunion among patients managed non-operatively in Malawi. Training of Malawian providers on how and why to perform clinical outcome assessments may be helpful to encourage objective documentation and foster a culture of evidence-based quality improvement.

In conclusion, despite the limitations of this study, non-operative management of paediatric femoral shaft fractures at Nkhotakota District Hospital may have good clinical and functional outcomes and minimal complications. There is a need to provide insecticide treated mosquito nets in paediatric surgical ward. There is also a need to improve documentation and secure storage of radiographs. Lastly, there is also a need to follow up patients who were treated more recently to see their outcomes as they were found to have poor outcomes.

## Disclosures

The authors would like to disclose that there are no conflicts of interest associated with this research or the completion of this manuscript.

## Ethical approval

Ethical approval was given by the Malawian National Health Sciences Research Committee, protocol #18/09/2154.

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## Authors' contributions

Elijah Mlinde: study design, data collection, analysis and writing.

Dr. Linda Chokotho: study design and writing.

Dr. Kiran Agarwal-Harding: study design, analysis and writing.

## Conflicts of interest

None.

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