

Long Term Outcomes of Management of Open Fractures of Long Bone among Patients with a Surgical Implant Generation Network Nail at Kumi Orthopaedic Center, Uganda

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Abstract

Background: Open fractures are serious injuries with the potential for severe complications such as infection and non-union. Management of open fractures is challenging especially in areas like Uganda where appropriate human resources, infrastructure and medical care are not readily accessible. The introduction of new devices for fracture stabilization and the development of microsurgical procedures for soft tissue reconstruction have greatly improved the management of open fractures. Patients presenting with open fractures of long bones at Kumi Orthopaedic Center are managed with the help of SIGN nail for fracture stabilization. However, long-term outcomes for patients have not been documented. **Objective:** The objective of this study was to determine the long term outcomes of the management of open fractures of long bones among patients with a Surgical Implant Generation Network (SIGN) nail at Kumi Orthopaedic Center (KOC). **Methods:** A retrospective study of 39 patients with open fractures who were managed at KOC between 2010 and 2022. Data on patients' socio-demographic and clinical characteristics and outcomes (both physical and radiographic) was retrieved from the SIGN surgical online database of patients with over 1 year follow up period. **Results:** The mean age of patients was 40.3 years. The majority were male 32 (82.1%) and the commonest mechanism of injury was Road Traffic Accidents (RTA) 37 (94.9%). The majority did not have a clear record of having received antibiotics immediately after injury 29 (74.4%). However, most had a record of receiving antibiotics 1 hour before surgery 33 (84.6%). The most affected bone was the tibia 33 (84.6%). The commonest fracture type was Gustilo IIIa 18 (46.2%). On follow up; 10 (25.6%) developed an infection (osteomyelitis), 6 (15.4%) did not have a union on x-ray, 4 (10.3%) had a loose screw, 1 had an implant

breakage and also 1 patient had a varus deformity. However, there was no amputation recorded. **Conclusion:** The management of open fractures is still a major challenge in low and middle income countries like Uganda, which is still experiencing relatively high complication rates. Guidelines emphasizing the need for early antibiotic prophylaxis and faster access to surgical treatment are required for better treatment outcomes.

Keywords

Open Fractures, Outcomes, SIGN

1. Introduction

Open fractures are a leading cause of musculoskeletal morbidity in low and middle income countries and are more frequent in Sub-Saharan countries due to the rising rate of injuries from increased use of motorized transport [1] [2]. Open fractures can be managed using several methods [3]. However, in low-resource settings *i.e.*, low and middle income Countries (LMICs) like Uganda, many patients with open fractures do not get appropriate care for their injuries [4]. This can be attributed to the fact that appropriate human resources and infrastructure (including equipment, implants and surgical supplies) are not readily available and medical care is not readily accessible [5]-[7]. Individuals with open fractures also prefer to visit traditional bone setters when faced with musculo-skeletal injuries [8]. These are not qualified to treat severe injuries like open fractures and are often more likely to worsen and complicate injuries and also delay the seeking of proper care [9]. These complications due to delayed seeking of appropriate care make management even more difficult. At KOC, patients with open fractures are managed using various surgical techniques including SIGN intramedullary (IM) nails, plates and screws, and external fixation. KOC is one of the SIGN supported centers using SIGN nails to treat the majority of the long bone fractures. SIGN surgeons are required to record case reports and follow ups in the SIGN Online Surgical Data base (SOSD) by SIGN Fracture CARE International. However, the long term outcomes of these patients following treatment have not been well documented. Therefore, the aim of the study was to determine the long term outcomes of the management of open fractures of long bones among patients with a Surgical Implant Generation Network (SIGN) nail at Kumi Orthopaedic Center (KOC).

2. Methods

2.1. Study Design

This is a hospital-based retrospective cohort study conducted in Kumi Orthopaedic Center, which was located in semi-urban Uganda between January 2010 and December 2022. The hospital is a specialized Center serving a majority of the population in Eastern Uganda. All patients that present with an open fracture of a

long bone are managed with the help of a SIGN nail.

2.2. Study Population

The study included patients that had an open fracture(s) of long bones ranging from Gustilo I to Gustilo IIIc, managed at KOC as either a primary hospital or referred case and had a follow up visit recorded after 1 year (365 days). None of the patients that met the inclusion criteria were excluded.

2.3. Data Collection and Analysis

Data was retrieved from the SIGN online Surgical Data base (SOSD) using the semi-structured data abstraction tools. This included data on the patient socio-demographic characteristics, clinical characteristics and outcomes (both physical and radiographic).

The data was then extracted into excel sheets and analyzed using Stata version 17.0. Descriptive statistics were used to analyze the data and results presented as frequencies and percentages.

2.4. Ethical Issues

Ethical approval and waiver of consent were granted by Mbale Regional Referral Hospital Research and Ethics Committee (Ref no MRRH-2023-333) and the Uganda National Council of Science and Technology (Ref no HS3238ES).

3. Results

At the time of the study, 174 patients with Open fractures were found in the SOSD, of these 39 met the inclusion criteria of having a recorded follow up visit of one year and above. Of the 39 cases, 32 (82.0%) were male and 7 (18.0%) were female. The median age was 41 years with the youngest being 23 and the oldest being 76 years at the time of surgery. The commonest mechanism of injury was Road Traffic Accidents, 37 (94.9%) as shown in **Table 1** below.

Table 1. Socio-demographic characteristics of the 39 participants.

Variable	Frequency n = 39(%)
Age (Median, IQR)	41 (30 - 49)
Sex	
Male	32 (82.0)
Female	7 (18.0)
Mechanism of injury	
RTA	37 (94.1)
Gunshot	2 (5.1)
Type of admission	
Primary	29 (74.4)
Referral	10 (25.6)

The most affected bone was the tibia 33 (84.6%) especially the middle portion 18 (46.1%). The commonest fracture type was Gustilo IIIa 18 (46.1%) and the least was Gustilo I 3 (7.7%). Majority of the patients received antibiotics before surgery 33 (84.6%). However, majority did not have a known record of having received antibiotics immediately after injury 29 (74.4%). The media time to debridement following presentation was 8 hours. The median time to skin closure was 1 days with majority 19 (48.7%) having primary skin closure as illustrated in **Table 2** below.

Table 2. Clinical characteristics of the 39 participants.

Variable	Frequency n = 39(%)
Time to surgery (days) (Median, IQR)	3 (2 - 5)
Antibiotic use after injury	
Yes	10 (25.6)
Unknown	29 (74.4)
Antibiotic use before surgery	
Yes	33 (84.6)
Unknown	6 (15.4)
Bone	
Femur	6 (15.4)
Tibia	33 (84.6)
Location	
Proximal	4 (10.3)
Middle	18 (46.1)
Distal	16 (41.0)
Segmental	1 (2.6)
Type of fracture	
Gustilo I	3 (7.7)
Gustilo II	6 (15.4)
Gustilo IIIa	18 (46.1)
Gustilo IIIb	12 (30.8)
Time to debridement (hours) (Median, IQR)	8 (0 - 24)
Days to skin closure (Median, IQR)	1 (0 - 5)
Type of wound closure	
Primary	19 (48.7)
Secondary	6 (15.4)
Skin graft	7 (17.9)
Muscle flap	5 (12.8)
Fascio-cutaneous flap	1 (2.6)
Unknown	1 (2.6)

The infection rate on follow up was 25.6%. However, majority of the participants had healing on x-ray 33 (84.6%). There was no case of amputation recorded with only one case of varus deformity and implant breakage noted. On Physical examination, majority had painless full weight bearing 33 (84.6%) and had flexion more than 90 degrees 36 (92.3%) as indicated in **Table 3** below.

Table 3. Patient outcomes of the 39 participants.

Variable	Frequency n = 39(%)
Painless full weight bearing	
Yes	33 (84.6)
No	6 (15.4)
Healing on X-ray	
Yes	33 (84.6)
No	6 (15.4)
Flexion more than 90 degrees	
Yes	36 (92.3)
No	3 (7.7)
Infection (Osteomyelitis)	
Yes	10 (25.6)
No	29 (74.4)
Loose screw	
Yes	4 (10.3)
No	35 (89.7)
Implant breakage	
Yes	1 (2.6)
No	38 (97.4)
Amputation	
Yes	0 (0)
No	39 (100.0)
Deformity	
Yes	1 (2.6)
No	38 (97.4)

4. Discussion

Open fractures are serious injuries and significant sources of morbidity and mortality. These are difficult to treat because of the increased risk of complications specifically infections with rates ranging as high as 52% [10]. The infection rate in this study of 25.6% is lower compared to the 30% that was obtained by a systematic review done on studies in different parts of Africa [11] and the 31.4% infection

rate found in Cameroon [12]. However, it is higher than 8.1% found in the USA [13] and 14.6% found in China [14].

The higher infection rate can be attributed to high energy injuries with heavy contamination as evidenced by the majority of the fractures being Gustilo IIIa (46.1%) and Gustilo IIIb (30.8%) in this study. These fractures have been shown to be more prone to infection [15] [16].

Delayed administration of antibiotics following injury could also explain the high infection rate. Early antibiotic prophylaxis has been demonstrated to unequivocally reduce the risk of infection following an open fracture [17]-[19]. Most surgeons deem a period of less than 1 hour as the optimal time for antibiotic administration, which is substantiated in the literature [16] [17].

Delayed time from injury to surgery could also have contributed to the high infection rate. This could be due to delayed referral from primary health care facilities or seeking of professional help by the patients. Traditionally, 6 hours was considered the standard time for formal surgical irrigation and debridement following injury to minimize infection risk following an open fracture. However, a 2015 prospective observation study extended the time limit to 12 and even 24 hours with no significant effect on infection rates [20]. More recently, a meta-analysis of observational studies showed an increased infection risk in grade IIIa fractures and higher when irrigation and debridement were delayed more than 12 hours [21]. Based on these studies early surgical irrigation and debridement should be emphasized to minimize infection risk. Surgical treatment should be performed no later than 24 hours' post-injury for grade I and II open fractures and within 12 hours for grade III open fractures, although earlier treatment may be preferable.

However, recent studies have shown that the time from injury to debridement is not a significant prognostic factor in the management of open fractures [22] but rather the quality of the debridement and adequate stabilization of the fracture are helpful in improving outcomes in the management of open fractures.

The relatively lower infection rate compared to that found by the systematic review could be attributed to the early wound closure *i.e.*, 48.7% had primary wound closure and also stabilization with the SIGN nail which has been shown to have better surgical outcomes compared to other fixation methods [23].

We also found a lower non-union rate (15.4%) compared to 27.9% found by a study in a level 1 trauma center in USA [24]. However, it is higher than the 9.7% found by a systematic review in the USA [13]. The lower non-union rate could be due to the stable fixation using the SIGN nail. SIGN nail requires reaming of the canal, which has the advantage of stimulating blood flow. The reaming gets deposited at the fracture site acting as a bone graft which has osteo-inductive and osteo-conductive properties. Reaming also provides for the use of a wide diameter nail which provides better stability required for healing [25].

The higher non-union rate could be associated with the higher energy of trauma among the patients managed at KOC which are known to be more prone to non-

union [26]. The relatively high infection rate could also explain the high non-union rates as infections have been known to cause non-unions [27].

This study was limited by the fact that only data on long bones that were treated with SIGN nails was available. A prospective study looking at all open fractures of all bones treated using various methods would be needed to give a more wholesome picture of the treatment outcomes. This was a single center study and therefore subject to information bias. A multicenter study would help evaluate for variability and allow comparability of results, thus providing a better picture of current outcomes in most of the population.

5. Conclusion

The management of open fractures is still a major challenge in low and middle income countries like Uganda, which still experiences relatively high complication rates *i.e.*, infection and non-union rates which affect the quality of life of the patients. Policies that mitigate the occurrence of these high energy injuries from RTAs should be strengthened. Guidelines emphasizing the need for early antibiotic prophylaxis and faster access to surgical treatment need to be sensitized and enforced in an effort to better treatment outcomes among patients with open fractures.

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Conflicts of Interest

We do not have any conflict of interest to disclose.

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