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The burden of femoral shaft fractures in Tanzania

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ABSTRACT

Background: Road traffic injuries disproportionately affect low- and middle-income countries (LMICs) and are associated with femur fractures that lead to long-term disability. Information about these injuries is crucial for appropriate healthcare resource allocation. The purpose of this study is to estimate the incidence of femoral shaft fractures in Tanzania and describe the unmet surgical burden.
Methods: Study sites included six government hospitals across Tanzania. Investigators collected data from hospital admission and procedural logbooks to estimate femoral shaft fracture incidence and their treatment methods. Semi-quantitative interviews were conducted with relevant hospital personnel to validate estimates obtained from hospital records. Investigators gathered road traffic incident (RTI) statistics from national police reports and calculated femur fracture:RTI ratios.
Results: Femoral shaft fracture annual incidence rate ranged from 2.1 to 18.4 per 100,000 people. Median low and high femur fracture:RTI ratio were 0.54 and 0.73, respectively. At smaller hospitals, many patients (5–25%) were treated with traction, and a majority (70–90%) are referred to other centers. Barriers to surgery at each hospital include a lack of surgical implants, equipment, and personnel.
Conclusions: The incidence rate is similar to previous estimations, and it is consistent with an increased femoral shaft fracture incidence in Tanzania when compared to higher income countries. The femur fracture:RTI ratio may be a valid tool for estimating femur fracture incidence rates. There is an unmet orthopaedic surgical burden for femur fractures treatment at rural hospitals in Tanzania, and the barriers to treatment could be targets for future interventions.

Introduction

In 2016, musculoskeletal (MSK) injuries accounted for more deaths and disability-adjusted life years (DALYs) than HIV/AIDS, tuberculosis, and malaria combined [1]. Despite these data, injuries, particularly in low- and middle-income countries (LMICs), receive less financial support, and care is focused on prevention rather than treatment [2,3]. Many healthcare facilities in LMICs are underprepared to manage the increasing volume of patients with serious injuries [4,5].

Road traffic incidents (RTIs) heavily contribute to the injury burden. Despite accounting for roughly half of the world's automobiles, LMICs experience 90% of global road traffic mortality [6]. Additionally, 20–50 million people worldwide are disabled due to an MSK injury suffered in an RTI [6,7]. While having varying mechanisms of injury, RTIs are frequently cited as the most common cause of femoral shaft fractures in LMICs [8–11], and these fractures account for nearly 10% of all nonfatal traffic-related injuries [2]. For example, a study in Malawi reported that 87% of femur fractures occurred following high-energy trauma [8], and similarly, RTIs caused 86% of mid-shaft femur fractures in men under 40 in a study in Pakistan [9]. Previous literature has described using femoral shaft fracture incidence as a proxy for overall road traffic morbidity, and higher rates, possibly as high as 17% of all musculoskeletal injuries, of femoral fractures have been identified in LMICs [12,13]. Further research that collects empiric data is needed to understand the true burden of femur fractures and validate prior studies that have made estimates based on road traffic mortality data.

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With increasing economic growth and improved infrastructure, Tanzania has had a noted increase in transportation, but in 2016, this increase resulted in over 10,000 road traffic incidents most commonly due to motorcyclists, pushcart operators, and pedestrian injuries. With nearly 4500 reported injuries, there has also likely been a significant number of femoral shaft fractures [14]. The objective of this study was thus to estimate an incidence rate for diaphyseal femur fractures using data collected from medical records at multiple hospitals across Tanzania. The secondary objective was to assess current treatment patterns and barriers to surgical management.

Methodology

Hospitals in Tanzania are comprised of government institutions, mission-based facilities, and private hospitals. These facilities are organized in a hierarchical system, and the larger institutions (national and zonal) offer a greater range of specialized services. There is one national orthopaedic specialty hospital in Tanzania. There are three zonal level hospitals and 25 regional referral centers. We assumed that the majority of fractures would be referred to regional level hospitals rather than definitively managed at the district level. We selected a convenience sample of one national, one zonal, and four regional hospitals across a broad geographic distribution (Fig. 1). The study was approved by the National Institute for Medical Research (NIMR) in Tanzania.

Investigators collected quantitative data from hospital records and conducted qualitative interviews with hospital personnel. Hospital records included admission records and surgical logbooks at each facility. Investigators accessed admission records spanning a 12-month period at each institution to determine femur shaft fracture incidence. All patients admitted with a diagnosis of femur shaft fracture were included in the study and those diagnosed with a hip, femoral head, femoral neck, or distal (intra-articular) femur fracture were excluded. The decision to focus on femoral shaft fractures, at the exclusion of more proximal and distal fractures, was consciously made due to their high incidence as well as their significant disability. Improperly treated femoral shaft fractures have a disability weighting higher than for malaria and equivalent to untreated tuberculosis [15]. The study team recorded demographic data and information on injury mechanism when available.

Interviews were conducted with selected staff and focused on femur shaft fracture incidence, treatment modalities, and common barriers to surgery. Investigators interviewed the chief medical officer at each hospital who then identified additional key stakeholders for interview. All personnel provided informed consent to participate in the interviews which were recorded for later analysis.

The annual incidence of femur fracture was calculated for each region using the following formula:

$$Incidence\ Rate = \frac{Incident\ Cases\ of\ Femur\ Shaft\ Fracture}{Estimated\ population\ served\ by\ hospital}$$

The number of incident cases was estimated by the number of cases recorded in medical records. The population served by the hospital was estimated using the known census for the region combined with estimates of the proportion served by the hospital from interviews with hospital personnel.

As a check of external validity, RTI data from the same time period was gathered from publicly-available Tanzanian police records. We note that these police records do not make a distinction between those persons who were vehicle occupants versus those who were pedestrians injured by a vehicle. An RTI resulting in loss/damage of property, injury, or fatality is distinguished from a minor offence (wrong parking, unfastened seat belts, speeding) in the Tanzanian police records. The femur fracture incidence rates were divided by the RTI incidence rate to create a femur:RTI ratio. This was compared to similar ratios reported in the literature [12].

Investigators identified treatment modalities from surgical records in the same 12-month period. They included patients with a pre-operative diagnosis of femur shaft fracture or those with a

Fig. 1. shows a map of Tanzania, with the cities containing the study hospitals circled. Red represents the national hospital, yellow the zonal hospital, and blue the regional hospitals. Figure 'Reproduced with permission from the Lonely Planet website www.lonelyplanet.com © 2018, Lonely Planet'.

surgical treatment consistent with femur shaft fixation. The study team compared the data to hospital incidence and presented this as a percentage of patients receiving surgical treatment. Interviews also contained questions regarding treatment modalities. Medical personnel estimated the percentage of patients who underwent operative fixation versus definitive treatment with traction and those who were referred to a higher-level institution. Additionally, interviewees identified the most commonly used types of surgical fixation and the most common barriers to surgical fixation encountered at their hospital.

Results

Table 1 exhibits the raw incidence data of femur shaft fractures for each institution. Annual number of cases reported in admission books ranged from 48 to 1000 depending on hospital size and location. The estimated incidence from interview responses ranged from 150 – 750. Of note, larger hospitals consistently under-estimated the number of cases relative to hospital records while the reverse was true at smaller facilities.

Incidence rates per 100,000 people were calculated for each of the hospitals. As demonstrated in Table 2, these rates range from 2.1 to 18.4 per 100,000 people. The femur:RTI ratios varied between the hospitals. The median low ratio was 0.54, and the median high ratio was 0.73. Only two of the study sites recorded treating femoral shaft fractures primarily with surgical fixation. At the other four hospitals, a minority of patients or none at all received surgical fixation.

The most commonly cited barriers to surgical treatment are exhibited in Fig. 2 along with the percentage of interviewees who mentioned each reason. Hospitals with minimal surgical fixation most commonly cited a lack of implants and surgical equipment as barriers to surgical treatment. The other hospitals had variable responses but frequently mentioned “cost to patient” and “blood

Table 1
Femur fracture data collected from hospital logbooks and interviews at each of the hospitals included in the study.

Hospital Number	Hospital Name	Region	Hospital Level	Annual No. Cases from Admission Records	Annual No. Cases from Interviews	2016 Hospital Population Estimate
1	Ligula Hospital	Mtwara	Regional	48	150	1.335 million
2	Maweni Hospital	Kigoma	Regional	59	150	2.342 million
3	Iringa Hospital	Iringa	Regional	171	240	0.984 million
4	Dodoma Hospital	Dodoma	Regional	417	250	2.265 million
5	Bugando Medical Centre	Mwanza	Zonal	378	350	16.126 million
6	Muhimbili Orthopaedic Institute	Dar es Salaam	National	1000	750	48.677 million

Table 2
Femur fracture incidence rates for study hospitals with the resultant femur:RTI ratios. *per 100,000 people † 95% Confidence interval **From surgical logbooks.

Hospital Number	Hospital Level	Est. incidence from admission records*†	Road traffic incident rate*	Femur:RTI Ratio	Recorded % Treated Surgically**
1	Regional	3.6 [3.1 - 4.1]	4.9	0.63 – 0.84	0%
2	Regional	2.5 [2.1 - 2.9]	4.7	0.45 – 0.62	0%
3	Regional	17.4 [16.8 - 18.0]	12.2	1.38 – 1.48	36.4%
4	Regional	18.4 [18.0 - 18.8]	11.7	1.54 - 1.61	58.0%
5	Zonal	2.3 [2.1 - 2.5]	5.7	0.37 – 0.44	35.7%
6	National	2.1 [2.0 - 2.2]	20.2	0.10 – 0.11	61.2%

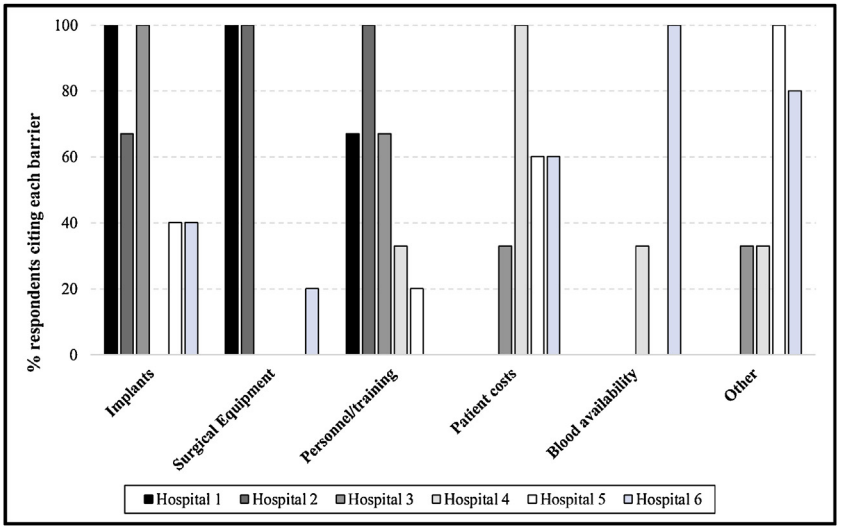

Fig. 2. Each bar represents the percentage of interview respondents citing a particular barrier to surgical care at their hospital.

availability" as being barriers to care. Other barriers to care included the use of traditional healers by patients and a lack of operating room availability.

Discussion

We conducted a mixed-methods study evaluating surgical logbooks and performing individual interviews in order to estimate the incidence rate of femoral shaft fractures in Tanzania where the road traffic fatality rate significantly exceeds the global average [16]. The resultant femoral shaft fracture incidence rate across each hospital is 2.1–18.4 per 100,000 people annually. The authors calculated a femur:RTI ratio which varied by hospital but trended towards a ratio of approximately 0.6. This study also evaluates barriers to surgical care at hospitals of differing size in Tanzania. Smaller, regional hospitals cited resource related factors whereas larger hospitals require more operating theater availability. This study is unique in its reporting of femur fracture incidence based on empiric data, and it is one of the few studies that provides insight into the growing incidence of femoral shaft fractures in LMICs.

The literature is sparse in regard to studies directly investigating the country-wide or global incidence of femur fractures in LMICs, and the burden varies by study. A national femur fracture incidence rate of 15.7–45.5 per 100,000 for LMICs has been previously reported [12]. This study, however, did not utilize empiric data, but rather, an algorithm for calculating an incidence rate. Mock and Cherian assessed the global burden of MSK injuries and estimated that the global incidence of femur fracture following an RTI was 4.3 per 100,000 [2]. A study in Sierra Leone explores the burden of nontraumatic injuries by body part, including upper leg problems and indicates that femur injuries comprise a substantial portion (12.6%) of the MSK burden [17]. Similarly, a study in Nepal described the countrywide MSK burden of disease without assessing an incidence rate. Femur injuries accounted for 2.4% of all injuries in that study [18]. A Malawian study describes the burden of trauma in district hospitals and reports that fractures of the lower limb (femur non-specified) accounted for 5.3% of the traumatic injury burden [19]. It is apparent that incidence data is necessary to better elucidate the ongoing burden of femur injuries in LMICs and to call attention to the need for more prospective studies describing MSK disease burden.

Our study also provides evidence for supporting the concept of a femur fracture to RTI ratio [12]. This concept maintains that, within a country, there should be a relatively consistent ratio of femur fractures to RTIs within an age-standardized group. Data to this effect were first reported in the 1990 Global Burden of Disease study [20], and this assumption was further used to mathematically calculate the global incidence of femoral shaft fractures [12]. The ratios in our study using empiric data, however, do have some variability between hospitals. To this point, there has been little, if any, new empiric data or investigations to demonstrate the validity of this concept. The ratios that we identify in our study are similar, but there is enough variation among a few of the hospitals that we cannot claim complete concept validity. However, we feel that our findings demonstrate promise for this potentially useful tool for estimating femur fracture burden in LMICs when data may be impossible to acquire or record keeping of suboptimal quality. Future studies should continue to assess the validity of this tool for estimating femur fracture burden.

We also report the current treatment modalities used in Tanzania for treatment of femoral shaft fractures and the presence of orthopaedic surgical burden. A femur fracture managed with intramedullary fixation is a cost-effective treatment in austere environments [21], but many hospitals in LMICs do not have robust surgical capacity. Hollis et al demonstrated this disparity finding that 40% of patients with femoral shaft fractures, who presented to a zonal, Tanzanian hospital, were treated with skeletal traction [22]. The present study quantifies femur fracture treatment across multiple institutions in Tanzania and identifies findings similar to Hollis et al. Surgical fixation is rarely used in smaller hospitals, and the majority of patients are treated with traction or referred to a different center. The hospitals face local budgetary constraints that may limit the number of femur fractures that can be managed with surgery. Furthermore, the hospitals that did not typically provide surgical treatment cited the lack of surgical implants/equipment and necessary surgical personnel/training as barriers to care. These barriers are potential targets for future interventions to improve surgical care for injuries in Tanzania.

There are several limitations of this study. Data quality and record keeping were variable across institutions. Some hospitals had thorough and organized admission records while other institutions had incomplete records or ambiguous diagnoses. In particular, mechanism of injury data was infrequently reported in a sufficient manner to make a claim as to the primary mechanism of injury in this study. However, other studies in LMICs have cited RTIs as being the most common cause of femoral shaft fractures, particularly among young men [8–11]. Investigators conducted interviews to estimate the incidence at a given location to account for inconsistencies in record keeping. While helpful, these interviews are subject to inherent recall bias. The incidence rates should also be viewed in the context of reporting on incidence data at regional government hospitals. Hospitals may have higher or lower femur fracture incidence rates depending on the local population and the RTI frequency. Additionally, investigators did not collect data from private, mission-based, or NGO hospitals in Tanzania that may be capable of treating femur fractures. Importantly, there is also missed femur fracture burden from patients who were seen at district level hospitals/clinics or by traditional bone-setters. These limitations likely result in an underestimation of the incidence of femur shaft fractures rather than an overestimation. A prospective study design would reduce bias, and the inclusion of all hospital types would broaden the scope of data collection.

Nevertheless, this study is novel in its collection of empiric data. The results indicate a high incidence of femur shaft fractures in Tanzania due to the growing rate of road traffic injuries in LMICs. While the US has a femoral shaft fracture incidence of 10–18 per 100,000 annually [23–25], the incidence in Tanzania is potentially much higher. A Malawian study supports the notion that the burden of femur fractures is rapidly increasing in resource limited settings and that there is inadequate surgical capacity to address this burden [19]. There is a clear need for improved healthcare resource allocation that specifically addresses treatment and prevention initiatives for femur fractures.

Conclusions

This study is the first to estimate femoral shaft fracture incidence in Tanzania using empiric data collected from multiple hospitals and provides support for a femur fracture:RTI ratio as a tool for estimating femur fracture incidence rates. The femur fracture incidence rate in Tanzania is 2.1–18.4 per 100,000 people annually. This is consistent with the high burden of injury that disproportionately affects LMICs and the unmet orthopaedic surgical burden for femur fracture treatment in Tanzania. There are numerous barriers to surgical treatment that are potential targets for future intervention. Addressing these barriers may lead to increased orthopaedic surgical capacity for treating femur fractures in Tanzania.

Conflicts of interest

The authors certify they have no financial or other conflicts of interest in connection with this manuscript.

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