International Journal of Current Advanced Research
ISSN: O: 2319-6475, ISSN: P: 2319-6505, Impact Factor: SJIF: 5.995
Available Online at www.journalijcar.org
Volume 6; Issue 10; October 2017; Page No. 6937-6944
DOI: http://dx.doi.org/10.24327/ijcar.2017.6944.1046

Research Article

ANATOMICAL DETERMINANTS OF INJURY SEVERITY OF MOTORCYCLE ATTRIBUTABLE FEMUR FRACTURES AT TWO TEACHING HOSPITALS IN UGANDA

***Herman Lule[1]., Xaviour. F. Okedi[2] and Robinson Ssebuufu[3]**

[1]Department of Surgery, Kampala International University Teaching Hospital (Uganda)
[2]Department of Surgery, Kampapala International University, Western Campus (Uganda)
[3]Faculty of Clinical Medicine & Dentistry, Kampala International University, Western Campus (Uganda)

A R T I C L E I N F O

Article History:

Received 26th July, 2017
Received in revised form 19th August, 2017 Accepted 25th September, 2017
Published online 28th October, 2017

Key words:

Accident, Anatomical Patterns, Determinants, Fracture Femur, Injury Severity, Motorcycle, Uganda

A B S T R A C T

There is paucity of data on anatomical determinants of motorcycle related femoral fracture injury severity in Uganda. Such data are clinically relevant to guide treatment options. We conducted a cross sectional descriptive and analytical hospital based study of consecutively recruited patients to establish the anatomical patterns and determinants of injury severity of motorcycle related femoral fractures, presenting at Accident and Emergency Departments of two Ugandan teaching hospitals, between December 2016 and June 2017. Ethical clearance was obtained from Mbarara University of Science and Technology Research and Ethics Committee (IRB No.19/10-16). Using investigator-administered questionnaire, we recorded radiological patterns of femur fractures and used the Kampala Trauma Score II to determine injury severity. We conducted multiple logistic regression analysis and computed odds ratios using IBM SPSS 20.0. statistics for windows (Armonk. NY: IBM Corp) at 95% Confidence Interval and $P<0.05$ as statistically significant, to determine anatomical sites of femur fracture significantly associated with a severe Kampala Trauma Score II. Of 230 patients, the femoral shaft 72.6% (n=167) was the most fractured anatomical site. Sustaining an open femoral fracture (OR 2.124; 95% CI [1.885-2.427], particularly involving the femoral neck (OR 4.222 [1.294-13.776] 95% CI, P=0.016) and femoral shaft (OR 1.155; 95% CI [1.101-1.902]; P=0.024) were significantly associated with a severe Kampala Trauma Score II. Prospective studies are required to determine how these anatomical determinantsof femoral fracture injury severity impact on long term functional outcome.

INTRODUCTION

Mortality ascribable to injuries in Sub-Saharan Africa outnumber that attributable to HIV,TB and malaria combined (Luboga *et al*., 2009). In Uganda, majority of these injuries are musculoskeletal with most trauma centres admitting a minimum of 150 fractures per month (Luboga *et al*., 2009) of which 8.9% are femoral (Galukande *et al*., 2009). Over 41% of all road traffic injuries are attributable to motorcycles in Uganda (Kigera *et al*., 2010; Kamulegeya *et al*., 2015), contributing to significant traumatic bone loss amongst mainly economically productive young male adults of low socio-economic status (Chalya *et al*., 2012).

Lower limb injuries are the most common motorcycles related musculoskeletal injury amongst multiply injured young male patients in Uganda (Tran *et al*., 2015; Tumwesigye *etal*., 2016) and Kenya (Sisimwo *et al*., 2014), contributing up to 55% of all injuries sustained sequelae to motorcycles. This figure is comparable to that reported in Tanzania (Chalya *et al*., 2010; Chalya *et al*., 2012; Chalya *et al*., 2014), West Africa (Sampson *et al*., 2015; Ayinla *et al*., 2012; Kortor *et al*, 2010; Elachi *et al*., 2014) and South Africa (Lamont *et al*., 2015), confirming the popularity of motorcycle transport means in Africa. However the African motorcycle reported accident burden, though comparable to 55.2% reported in Brazilian studies (Chandran *et al*., 2012; De Vasconcellos, 2013; Cavalcanti *et al*., 2013), is much higher than that reported in United Arab Emirates (Hefny *et al*., 2012) and developed countries like South Korea (Chung *et al*, 2014) and United States at large (French & Gumus, 2014). The femur uniquely being the "longest, strongest, largest and heaviest tubular bone in the human body" (Anyaehie *et al*., 2015); with head, neck, trochanters, shaft and condyles involved in lower extremity load bearing; requires high energy to fracture any of its parts. However, when any of its vascular parts fracture, one does risk up to three litres of blood from their cardiac output (Anyaehie *et al*., 2015), warrantying the surgeon's time and consumables for fixation without which mortality or morbidity for severely displaced and comminuted fractures would ensue. However,

Corresponding author:* **Herman Lule
Department of Surgery, Kampala International University Teaching Hospital (Uganda)

there is paucity of published data in Uganda on the epidemiology of femoral fractures and anatomical determinants of injury severity despite high levels of reported motorcycle ascribable multisystem injuries in this patient category.

REVIEW OF LITERATURE

Literature from retrospective studies in neighbouring East African countries show that majority of traumatic fractures involve lower limbs, with incidence of road traffic accident related femoral fractures in Tanzania reported to be 18% of which 54% of these are related to motorcycles and mainly involve the mid shaft (Hollis *et al*., 2015). These femoral fractures are mainly a burden of males younger than 30 years (Luboga *et al*., 2009; Hollis *et al*., 2015), with significant economic implications to already constrained health systems in developing countries. Whether majority of motorcycle related femoral fractures are open or closed and what anatomical sites of fractures are associated with a severe injury outcome remain poorly documented in Uganda, despite the diverse trends in management and complications that can occur in these different anatomical fracture sites. A Nigerian retrospective study (Anyaehie *et al*., 2015) rates prevalence of open femoral fractures at 8.4% although motorcycle ascribable fractures could have been under-represented given the fact that the authors' included low energy and stress fractures. Knowledge of what anatomical site is associated with poor injury severity can significantly influence the clinicians' intention to operate or manage the patient conservatively.

Patients with femoral fractures in Uganda often fail to access timely surgical care due to resource constraints and some opt out of proper surgical care for traditional bone setters, contributing to poor immediate and long term injury outcome related to neglected delays of treatment of complex fracture patterns (Naddumba, 2008). Annually, Uganda registers 2.8% permanent disability related to road traffic accidents (Kamulegeya *et al*., 2015; Murray, 2015) but the burden ascribable to motorcycle related femoral fractures is scanty despite the fact that this unique musculoskeletal injury contributes to the longest bed occupancy amongst patients admitted at the Country's National Referral Hospital, Mulago; with 8.3days average duration of hospitalization (Kigera *et al*, 2010). The immediate mortality related to hemorrhage of open femoral fractures (Gandhi *etal*., 2014; Lane *et al*., 2015), poses additional risk of HIV transmission; in the era of 7.5% HIV prevalence amongst Ugandan motorcyclists (Lindan *et al*., 2015). Long term avascular necrosis, non-union and osteoarthritis are often reported if the femoral head or trochanteric regions are involved (Min & Kim, 2011; Ai *et al*., 2013). Such injuries often require expensive dynamic compression screws for proper management (Gandhi *et al*., 2014),otherwise prolonged skeletal traction along with its thromboembolic complications would be warranted for a good functional outcome (Smith *et al*., 2011; Magetsari *et al*., 2014). A long term study of femoral neck fractures by (Singh, 2013) reported complication rates of up to 60% overall, with avascular necrosis occurring on 40% concurrently with non-union. Such complications often require re-operation and revision surgery associated with significant morbidity and mortality (Carpintero *et al*., 2014; Kates, 2016), alongside cost implication in already constrained health systems in developing countries. Although there is evidence from Nigeria (Anyaehie *et al*., 2015) and Tanzania (Hollis *et al*., 2015), that certain femoral fracture patterns are more prevalent in certainage-groups, with high energy traumatic shaft fractures being more commonly reported in the young as opposed to proximal fractures in the elderly, these were retrospective studies with record bias and could not account for high energy occult proximal and distal fractures (Rodriguez-Merchan *et al*., 2013), that can occur due to axial forces transmitted through the hip and knee in the event a young motorcyclist or passenger landed on a flexed knee. Knowledge of how different anatomical femoral fracture patterns influence immediate injury outcome would not only inform clinical practice of intentions to operate but also guide counter preventive measures.

MATERIALS AND METHODS

Based on the conceptual framework described by (Lule *et al*., 2017a), we hypothesised that the different anatomical patterns of fracture of the femur categorised as involving the femoral neck, trochanter, shaft, supracondyles or condyles would have sigificant bearing on the immediate morbidity and theoretical impact on the severity of Kampala Truma Score II, described as mild(9-10), moderate (7-8) or severe injury (≤6) as shown in (Table.1).

Table 1 Showing the Kampala Trauma Score II, adapted from (Mutooro *et al*, 2010)

Category	Clinical Parameters	Description	Score
A	Age (Years)	5-55	1
		<5>55	0
B	Systolic BP on admission	>89mmhg	2
		89-50	1
		<=49	0
C	Respiratory rate on admission	10-29bpm	2
		>=30	1
		<=9	0
D	Neurological status	A	3
		V	2
		P	1
		U	0
E	Score for serious injuries	None	2
		One	1
		>one	0

Sample Size Calculation

The sample size was calculated using the Keish and Leslie (1965) formula;

$N=Z^2PQ\div D^2$; Where N=Minimum sample size required, Z is the standard normal deviate at α=5% (1.96 at 95% confidence interval), P and Q are the population proportions, where P=Probability of sustaining a femoral fracture attributable to motorcycles, Q is (1-P) and D is the level of precision desired (margin error rate of 0.05). Based on the 18%prevalence of road traffic accident ascribable femoral fracture reported by (Hollis *et al*., 2015) in a Tanzanian survey; then substituting P=0.18;

$$N=\frac{(1.96)^2 x 0.18 x 0.82}{(0.05)^2} = 227$$

A total of 230 patients were consecutively recruited by the end of the six months study period.

Study Settings and Duration

We recruited patients with motorcycle attributable femoral fractures as defined by (Lule *et al*., 2017a), presenting within 24 hours at the accident and emergency departments of two

Ugandan specialised tertiary teaching hospitals, including Mbarara Regional Referal Hospital [government aided teaching Hospital for Mbarara University of Science and Technology (http://www.health.go.ug/content/mbarara-regional-referral-hospital)] and Kampala International UniversityTeaching Hospital, which is a privately owned specialised teaching hospital for the Kampala International University (http://ameca.org.uk/directory/listing/kampala-international-university-teaching-hospital-uganda), from 5/12/2016 to 5/06/2017.

Study Design and Procedure

This was a cross sectional descriptive and analytical study. In accordance with the National Institute of Health guidelines on research involving use of human subjects, we obtained ethical clearance from Mbarara University of Science and Technology (MUST) Research and Ethics Review Committee (IRB No.19/10-16). Permission to collect data was sought from the respective hospital administrators. Informed consent/assent were sought from study participants and or legally authorised representative who were asked to indicate their consent by signatures or thumb print in the presence of the investigating team.

After primary survey and emergency resuscitation in acccordance with the American College of Surgeons' Advanced Trauma Life Support (ATLS) protocol (Radvinsky *et al*., 2012),we used a purposively designed precoded investigator-administered questionnare to collect data on clinical parameters covered by the Kampala Trauma score II and X-ray findings of the femur bone fractures at the time of admission to the accident and emergency departments. Decision on mode of treatment or clinician's intention to manage the patient operatively was documented to determine how this would vary between anatomical sites of fracture and degree of injury severity.

Quality Control

Radiographs of anatomical patterns of femoral fractures were interpreted by two independent orthopedic surgeons. In the event that the two orthopedic surgeons did not agree on a particular fracture pattern, a third opinion was sought from another independent orthopedic consultant, whose decision was regarded final. Being a cross section study, the quality and completeness of data collected using a tool designed specifically for this study protocol could easily be controlled. We excluded referrals from tertially hospitals whose specialist care had been already initiated and patients dying on arrival before radiological assessment to ensure completeness of the data tool.

Data analysis

We analysed data using IBM SPSS 20.0. statistics for windows (Armonk. NY: IBM Corp) under technical supervision of a Biostatician. We computed percentages for femoral neck, trochanteric, shaft, supracondylar and condylar fractures. After adjusting for pre-hospital factors earlier demonstrated to have a sigificant impact on severity of KTS II in similar trauma settings (Lule *et al*., 2017a), we correlated anatomical sites of femoral fracture with severity of injury, using Likelihood ratio tests for paired data and multiple logistic regression analysis and odds ratios at 95% confidence interval, setting ($p<0.05$) as statistically significant; in order to determine anatomical fracture sites independently and significantly associated with a severe KTS II of (≤ 6).

RESULTS

Anatomical patterns of Motorcycle related femoral fractures associated with injury severity

Of the 230 patients, majority 65.3% (n=150) sustained an open femoral fracture. Open fractures were significantly associated with higher Odds for a severe KTS II (OR 2.124; 95% CI [1.885-2.427]; P=0.003). The femoral shaft 72.6% (n=167) was the most commonly fractured anatomical site amongst patients sustaining fracture of the femur secondary to motorcycle related accidents (Fig.1).

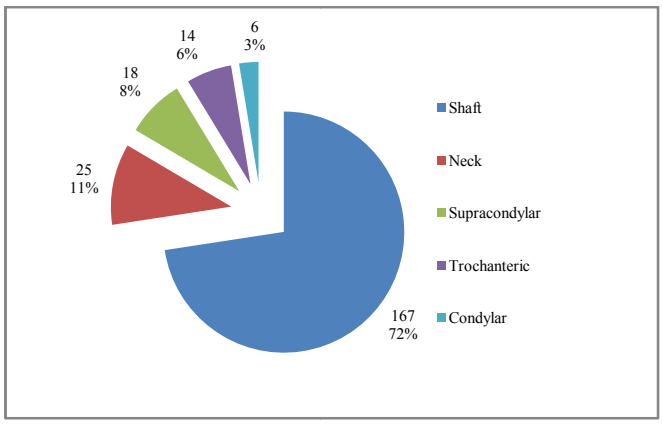

Figure 1 Showing prevalence of different anatomical patterns of femoral fractures amongst patients sustaining motorcycle related accidents

After adjusting for fracture category as open or closed, there was an association between the different anatomical sites of femoral fracture and severity of Kampala Trauma Score II (X^2=28.662, P<0.001; df=8). The femoral neck (OR 4.222 [1.294-13.776] 95% CI, P=0.016) and femoral shaft fractures (OR 1.155; 95% CI [1.101-1.902]; P=0.024) were independently associated with higher odds for a severe Kampala Trauma Score II (Fig.2).

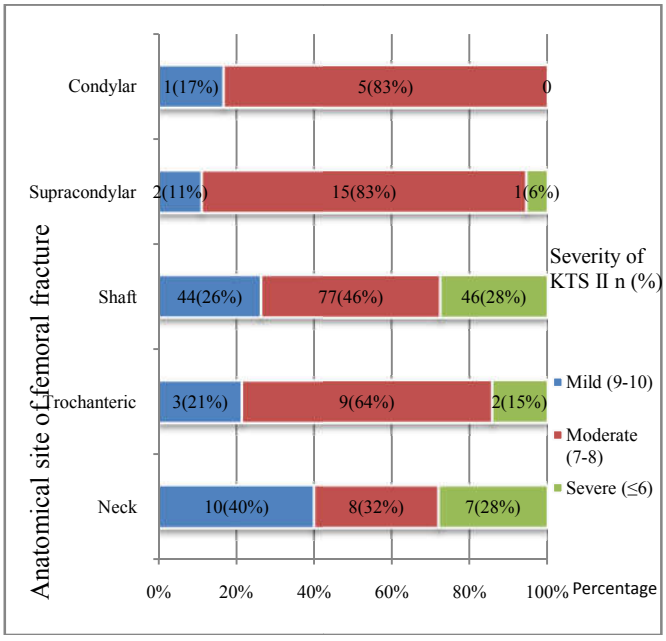

Figure 2 Showing relationship between different anatomical sites of femoral fracture and severity of Kampala Trauma Score II

Decision on mode of treatment versus anatomical fracture site and injury severity

Of the 230 participants, majority 51.3% (n=118) were operatively managed by either open reduction-internal or external fixation, whereas 48.7% (n=112) were managed conservatively either by traction or casting. Patients with a mild or moderate KTS II had higher Odds for conservative management (OR 1.168; 95% CI [1.101-1.351]) compared to those with a severe KTS II (OR 0.602; 95% CI [0.371-0.978]). This was statistically significant (P=0.036). Patients sustaining femoral shaft fractures were twice more likely to be treated operatively compared to other anatomical sites (OR=2.305; 95% CI [1.104-4.812]; P=0.024) (Table.2).

The resistance to tensile and shear forces also differ by different anatomical sites of femoral bone, with the femoral neck having the greatest resistance to crack initiation and propagation for both tension and shear loading while the femoral shaft having the least (Brown *et al,* 2000). It has also been shown that the femoral neck and condyles have a higher mineral density, cross-sectional area, and cortical thickness compared to femoral shaft, which makes the femoral shaft more prone to shear forces and energy absorption(Brown *et al*., 2000), explaining a high prevalence of femoral shaft fractures in tthe present study. Motorcycle accidents may worsen the pre-existing tensile strain on the lateral femoral shaft imposed by daily walking (Martelli *et al*., 2014).

Table 2 Showing relationship between anatomical site of femoral fracture, severity of KTS II and decision on mode treatment

Decision on mode of treatment * Severity of Kampala Trauma Score (KTSII) * Anatomical site of femoral fracture Cross tabulation						
Anatomical site of femoral fracture			Severity of Kampala Trauma Score (KTSII); n (%)			Total
			Mild (9-10)	Moderate (7-8)	Severe (≤ 6)	
Neck	Decision on mode of treatment	Conservative (Skeletal Traction OR Casting)	6(24%)	7(28%)	5(20%)	18(72%)
		Operative (Open Reduction and Internal OR External Fixation)	4(16%)	1(4%)	2(8%)	7(28%)
		Total	10(40%)	8(32%)	7(28%)	25(100%)
Trochanter	Decision on mode of treatment	Conservative (Skeletal Traction OR Casting)	1(7%)	6(43%)	2(14%)	9(64%)
		Operative (Open Reduction and Internal OR External Fixation)	2(14%)	3(21%)	0(0%)	5(36%)
		Total	3(21%)	9(64%)	2(14%)	14(100%)
Shaft	Decision on mode of treatment	Conservative (Skeletal Traction OR Casting)	22(13%)	36(22)	14(8%)	72(43%)
		Operative (Open Reduction and Internal OR External Fixation)	22(13%)	41(25%)	32(19%)	95(57%)
		Total	44(26%)	77(46%)	46(28%)	167(100%)
Supracondylar	Decision on mode of treatment	Conservative (Skeletal Traction OR Casting)	0(0%)	9(50%)	0(0%)	9(50%)
		Operative (Open Reduction and Internal OR External Fixation)	2(11%)	6(33%)	1(6%)	9(50%)
		Total	2(11%)	15(83%)	1(6%)	18(100%)
Condylar	Decision on mode of treatment	Conservative (Skeletal Traction OR Casting)	0(0%)	4(67%)		4(67%)
		Operative (Open Reduction and Internal OR External Fixation)	1(17%)	1(17%)		2(33%)
		Total	1(17%)	5(83%)		6(100%)
Total	Decision on mode of treatment	Conservative (Skeletal Traction OR Casting)	29(13%)	62(27%)	21(9%)	112(49%)
		Operative (Open Reduction and Internal OR External Fixation)	31(14%)	52(23%)	35(15%)	118(51%)
		Total	60(26%)	114(50%)	56(24%)	230(100%)

DISCUSSION

Anatomical patterns of motorcycle related femoral fractures associated with injury severity

The femoral shaft 72.6% (n=167) was the most commonly fractured anatomical site amongst patients sustaining femoral fracture secondary to motorcycle related accidents, followed by femoral neck 10.9% (n=25), supracondylar 7.8% (n=18) and condylar fractures 3% (n=6) in that order. These findings are comparable to the Tanzanian study (Hollis *et al*., 2015). There was an association between the different anatomical sites of femoral fracture and severity of Kampala Trauma ScoreII in the present study (X^2=28.662, p<0.001; df=8). Femoral shaft; (OR 1.155; 95% CI [1.101-1.902]; P=0.024); and femoral neck (OR 4.222; 95% CI [1.294-13.776]; P=0.016) fractures were more more likely to be associated with a severe Kampala Trauma Score II. Cadaveric studies have shown that there is a difference in microstructure and composition between the femoral shaft, neck and more distal part of the femur (Yeni & Norman, 2000).

The femur being larger and a stronger vascularised bone with musclar protection, femoral fractures require a large amount of force transmitted from a direct blow like from a motorcycle to motorcycle collision or from indirect force transmitted as when the motorcyclist or passenger lands on the flexed knee. However once a fracture occurs, the protective musculature causes displacement, which might result in neurovascular injury and significant bleeding worsening the Kampala Trauma Score II, that relies partly on systolic blood pressure. In this case open fractures not only bleed but also add potential risk for infection. The narrow circumference and angle of the neck of the femur allow not only considerable range of motion at the hip joint but also predispose the femoral neck to extraordinary shearing forces. When these forces exceed the strength of the bone, a fracture does ensue. Proximal femoral fractures may disrupt vascular suply provided mainly by branches of the medial and lateral circumflex femoral arteries and to a lesser extent, the foveal artery to the head of the femur thus risking avascular necrosis. The high vascularity of the proximal femur could account for

the injury severity posed by neck fractures in the present study. Distal femoral condyle fractures accounted for 3% (n=6) of all femoral fractures in the present study, resuting from inadvatent landing on a flexed knee. This type of knee injury can potentially result in neurovascular compromise or compartment syndrome, with resultant risk of limb loss.

The present study demonstrated that majority 65.3% (n=150) of patients involved in motorcycle related accidents sustained an open femoral fracture. Patients with open femoral fractures were twice more likely to have a severe KTSII (OR 2.124; 95% CI [1.885-2.427]. This association was statistically significant (P=0.003). Also patients with open fractures were more likely to have more than one injury (polytrauma) compared to those with closed fractures (43.0% vs. 21.0%, P = 0.041), particularly head injuries. It is therefore important that clinicians involved in care of these patients regard open femoral shaft fractures as high-energy surrogate markers of polytrauma in motorcycle related injuries. In addition to localized tissue hypoxia and acidosis in adjacent soft tissues, open femoral fractures are associated with severe hemorrhage and hypotension, which directly impact on severity of the Kampala Trauma Score II. Higher odds for complications has also been earlier reported for open femoral fractures in a multicentre study (Taitsman *et al*., 2009).

Decision on mode of treatment of motorcycle related femoral fractures

The current study demonstrated that majority 51.3% (n=118) of patients were operatively managed by open reduction and internal or external fixation versus conservative management either by traction or casting. Patients with a severe KTSII were more likely to be managed operatively (OR 1.940; 95% CI [1.039-3.622]; P=0.036), making the Kampala Trauma Score II a good predictor of intention to operate on motorcycle related femoral fractures. The higher operative rate (51.3%) in the present study could be attributed to higher prevalence of open femoral fractures, but also depict the current trends in fracture management. Closed femoral fractures were associated with higher Odds for conservative management (OR 1.643; 95% CI [1.345-2.007]; P<0.001) compared to open femoral fractures (OR 0.3587; 95% CI [0.231-0.552]; P<0.001). Due to inflammatory and localized tissue hypoxia, there is tendency to delay operation or to conservatively manage closed femoral fractures for fear of wound breakdown and deep infection of incisions placed in such compromised tissue (Tull & Borrelli, 2003), except when complications like compartment syndrome are imminent. Patients sustaining femoral shaft fracture were twice more likely to be treated operatively compared to other anatomical sites (OR=2.305; 95% CI [1.104-4.812]; P=0.024), thus a total of 56.9% (95/167) femoral shaft fractures were managed operatively.

Although there was an earlier concerns of fat embolic events sequelae to intramedullary reaming (Wolinsky *et al*., 2002), and high rates of infected non-union (Taitsman *et al*., 2009), which led to a delay in the nailing of open femoral shaft fractures for one week; there is current evidence that immediate internal fixation for multiple long-bone fractures, including those with bilateral femoral shaft fracture and concomitant injuries is associated with a better treatment outcome (Kumar & Narayan, 2014). In a publication of five hundred and twenty cases, the change to immediate internal fixation of all type-I and II open femoral fractures did not increase the risk of infections (Kumar *et al*., 2014). This had been evaluated earlier in the paediatric population as well(Pandya & Edmonds, 2012).

The second most commonly operated fracture in the present study was the supracondylar 50% (9/18), followed by trochanteric 35.7% (5/14), condylar 33.3% (2/6) and femoral neck 28% (7/25) in that order. Although the operative rates seem low for these anatomical patterns of femoral fracture, expensive and technically demanding dynamic compression screws and plates were required to manage these injuries. Authors (Mittal & Banerjee, 2012), describe management of trochanteric fractures in detail although there is still a concern of nonunion associated with distal femoral fractures (Ma *et al*., 2016).The morbidity of such fractures in terms of implant failure, knee stiffness and chronic traumatic arthritis of the hip and knee joints can financially constrain these patients in the long term (Petsatodis *et al*., 2010). Few femoral neck fractures were treated operatively given the fact that some of these patients were elderly or young enough to qualify for skin traction. However there is expanding indications for total hip replacement for elderly population and younger patients (Shah *et al*., 2014), except that for physiologically younger patients, preservation of the natural hip anatomy and mechanics is arguably a priority in management because of their high functional demands (Pauyo *et al*., 2014).

Although this particular study looked at immediate treatment decision and injury severity outcome within 24 hours, studies that have evaluated skin traction as conservative method of management of femoral neck fractures have reported higher rates of deep venous thrombosis, pressure sores and prolonged hospital stays compared to those managed operatively (Kigera *et al*, 2010). There is a concern though for periprosthetic fractures amongst patients managed operatively (Shah *et al*., 2014). The operative standard of care for patients with femoral neck fractures in the present study was by open reduction and internal fixation, with primary intention of risk reduction for avascular necrosis.Avascular necrosis, non-union and osteoarthritis are not uncommon in femoral head or trochanteric fractures (Min & Kim, 2011; Ai *et al*., 2013); and often require expensive intramedullary nailing and dynamic compression screws for proper management (Gandhi *et al*., 2014).

A recent meta-analysis indicated the risk of avascular necrosis of femoral head was significantly higher after closed reduction and internal fixation compared with open reduction and internal fixation, but no association was shown between the healing rate and the two reductions for femoral neck fracture (Wang *et al*., 2014). These findings are also true for the paediatric population (Song, 2010), although femoral neck shortening (Zlowodzki *et al*., 2008) and subsequent fracture can occur following hardware removal (Shaer *et al*., 2012). Higher long term complication rates can be expected in Ugandan settings, where patients can decide to opt out of proper surgical care for traditional bone setters, contributing to poor injury outcome related to neglected delays (Naddumba, 2008), particularly in a setting of 7.5% HIV prevalence amongst Ugandan motorcyclists (Lindan *et al*., 2015). HIV patients on protease inhibitors have been shown to have higher risks for hip fractures (Wensing *et al*., 2010).

CONCLUSIONS

Sustaining an open femoral neck or femoral shaft fractures were independent anatomical determinants of injury severity of motorcycle ascribable femoral fractures. The femoral shaft was the most common fractured anatomical site with independently higher odds for being treated operatively. The Kampala Trauma Score II was a good predictor of injury severity and clinicians' intentions to operate in this patient category.

Recommendations

Clinicians should vigilantly prioritise emergency care for motorcycle related accident patients presenting with open femoral neck and shaft fractures who are most at risk of severe immediate injury outcome. Future prospective studies are required to determine how these anatomical determinants of femoral fracture injury severity impact on long term functional outcome.

Study limitations

The two facilities had no functional computerised tomographic scan services at the time of the study and as such, coronal plane distal femoral fractures could have been missed.

Aknowledgement

This work was funded by the Kamapala International University. The content of this paper is solely the responsibility of the authors and do no reflect any offical views of their institutional affiliations. We are grateful to the staff at accident and emergency departments of Mbarara Regional Referral Hospital and Kampala International University Teaching Hospital for their selfless support during the recruitment of study participants.

References

Ai, Z.-S., Gao, Y.-S., Sun, Y., Liu, Y., Zhang, C.-Q., & Jiang, C.-H. (2013). Logistic regression analysis of factors associated with avascular necrosis of the femoral head following femoral neck fractures in middle-aged and elderly patients. *Journal of Orthopaedic Science : Official Journal of the Japanese Orthopaedic Association*, *18*(2), 271-6. http://doi.org/10.1007/s00776-012-0331-8

Anyaehie, U. E., Ejimofor, O. C., Akpuaka, F. C., & Nwadinigwe, C. U. (2015). Pattern of femoral fractures and associated injuries in a Nigerian tertiary trauma centre. *Nigerian Journal of Clinical Practice*, *18*(4), 462-466. http://doi.org/10.4103/1119-3077.151761

Ayinla, T., Gboyega, A., Sarah, A., & Olugbenga, J. (2012). Factors Influencing High Rate of Commercial Motorcycle Accidents in Nigeria. *American International Journal of Contemporary Research*, *2*(11).

Brown, C. U., Yeni, Y. N., & Norman, T. L. (2000). Fracture toughness is dependent on bone location--a study of the femoral neck, femoral shaft, and the tibial shaft. *Journal of Biomedical Materials Research*, *49*(3), 380-389.

Carpintero, P., Caeiro, J. R., Carpintero, R., Morales, A., Silva, S., & Mesa, M. (2014). Complications of hip fractures: A review. *World Journal of Orthopedics*, *5*(4), 402-11. http://doi.org/10.5312/wjo.v5.i4.402

Cavalcanti, A. L., Lucena, B. M., Rodrigues, I. S. A., Silva, A. L., Lima, T. T., & Xavier, A. F. C. (2013). Motorcycle accidents: Morbidity and associated factors in a city of northeast of Brazil. *Tanzania Journal of Health Research*, *15*(4). http://doi.org/10.4314/thrb.v15i4.x

Chalya, P. L., Mabula, J. B., Dass, R. M., Mbelenge, N., Ngayomela, I. H., Chandika, A. B., & Gilyoma, J. M. (2012). Injury characteristics and outcome of road traffic crash victims at Bugando Medical Centre in Northwestern Tanzania. *Journal of Trauma Management & Outcomes*, *6*, 1. http://doi.org/10.1186/1752-2897-6-1

Chalya, P. L., Mabula, J. B., Ngayomela, I. H., Kanumba, E. S., Chandika, A. B., Giiti, G., … Balumuka, D. D. (2010). Motorcycle injuries as an emerging public health problem in Mwanza City, north-western Tanzania. *Tanzania Journal of Health Research*, *12*(4), 214-221. http://doi.org/10.4314/thrb.v12i4.55500

Chalya, P. L., Ngayomela, I. H., Mabula, J. B., Mbelenge, N., Dass, R. M., Chandika, A., … Ngallaba, S. E. (2014). Injury outcome among helmeted and non-helmeted motorcycle riders and passengers at a tertiary care hospital in north-western Tanzania. *Tanzania Journal of Health Research*, *16*(4). http://doi.org/10.4314/thrb.v16i2.4

Chandran, A., Sousa, T. R. V., Guo, Y., Bishai, D., Pechansky, F., & The Vida No Transito Evaluation Tea. (2012). Road Traffic Deaths in Brazil: Rising Trends in Pedestrian and Motorcycle Occupant Deaths. *Traffic Injury Prevention*, *13*(sup1), 11-16. http://doi.org/10.1080/15389588.2011.633289

Chung, Y., Song, T. J., & Yoon, B. J. (2014). Injury severity in delivery-motorcycle to vehicle crashes in the Seoul metropolitan area. *Accident Analysis and Prevention*, *62*, 79-86. http://doi.org/10.1016/j.aap.2013.08.024

de Vasconcellos, E. A. (2013). Road safety impacts of the motorcycle in Brazil. *International Journal of Injury Control and Safety Promotion*, *20*(2), 144-51. http://doi.org/10.1080/17457300.2012.696663

Elachi, I. C., Okunola, B. B., Yongu, W. T., Onyemaechi, N. O., Odatuwa-Omagbemi, O. D., Ahachi, C. N., & Mue, D. D. (2014). Motorcycle-related injuries at a university teaching hospital in north central Nigeria. *Nigerian Medical Journal : Journal of the Nigeria Medical Association*, *55*(6), 452-5. http://doi.org/10.4103/0300-1652.144693

French, M. T., & Gumus, G. (2014). Macroeconomic fluctuations and motorcycle fatalities in the U.S. *Social Science and Medicine*, *104*, 187-193. http://doi.org/10.1016/j.socscimed.2013.12.019

Galukande, M., Jombwe, J., Fualal, J., & Gakwaya, A. (2009). Boda-boda Injuries a Health Problem and a Burden of Disease in Uganda : a Tertiary Hospital Survey. *East and Central African Journal of Surgery*, *14*(2), 33–37.

Gandhi, R. R., Overton, T. L., Haut, E. R., Lau, B., Vallier, H. a, Rohs, T., … Shafi, S. (2014). Optimal timing of femur fracture stabilization in polytrauma patients: A practice management guideline from the Eastern Association for the Surgery of Trauma. *The Journal of*

Trauma and Acute Care Surgery, *77*(5), 787-795. http://doi.org/10.1097/TA.0000000000000434

Hefny, A. F., Barss, P., Eid, H. O., & Abu-Zidan, F. M. (2012). Motorcycle-related injuries in the United Arab Emirates. *Accident Analysis and Prevention*, *49*, 245-248. http://doi.org/10.1016/j.aap.2011.05.003

Hollis, A. C., Ebbs, S. R., & Mandari, F. N. (2015). The epidemiology and treatment of femur fractures at a northern tanzanian referral centre. *Pan African Medical Journal*, *22*. http://doi.org/10.11604/pamj.2015.22.338.8074

Kamulegeya, L. H., Kizito, M., Nassali, R., Bagayana, S., & Elobu, A. E. (2015). The scourge of head injury among commercial motorcycle riders in Kampala; A preventable clinical and public health menace. *African Health Sciences*, *15*(3), 1016-1022. http://doi.org/10.4314/ahs.v15i3.41

Kates, S. L. (2016). Hip fracture programs: Are they effective? *Injury*, *47*, S25-S27. http://doi.org/10.1016/S0020-1383(16)30006-7

Kigera, L. Nguku, E. K. N. (2010). The Impact of Bodaboda Motor Crashes on the Budget for Clinical Services at Mulago. *East and Central African Journal of Surgery*, *15*(1), 57–61.

Kortor, J., & Ugbeye, N. (2010). Lower limb injuries arising from motorcycle crashes. *Nigerian Journal of Medicine : Journal of the National Association of Resident Doctors of Nigeria*. http://doi.org/10.1136/bmj.2.5598.178-c

Kumar, G., & Narayan, B. (2014). Closed intramedullary nailing of femoral fractures. A report of five hundred and twenty cases. In *Classic Papers in Orthopaedics* (pp. 515–517). http://doi.org/10.1007/978-1-4471-5451-8_135

Lamont, M., & Lee, R. (2015). Arrive Alive Road Safety in Kenya and South Africa. *Technology and Culture*, *56*(2), 464–488. http://doi.org/10.1353/tech.2015.0063

Lane, M. ., Nahm, N. ., & Vallier, H. . (2015). Morbidity and mortality of bilateral femur fractures. *Orthopedics*, *38*(7), e588–e592. http://doi.org/10.3928/01477447-20150701-56

Lindan, C. P., Anglemyer, A., Hladik, W., Barker, J., Lubwama, G., Rutherford, G., … Campbell, J. (2015). High-risk motorcycle taxi drivers in the HIV/AIDS era: a respondent-driven sampling survey in Kampala, Uganda. *International Journal of STD & AIDS*, *26*(5), 336–45. http://doi.org/10.1177/0956462414538006

Luboga, S., Macfarlane, S. B., Von Schreeb, J., Kruk, M. E., Cherian, M. N., Bergstr??m, S., … Debas, H. T. (2009). Increasing access to surgical services in Sub-Saharan Africa: Priorities for national and international agencies recommended by the Bellagio essential surgery group. *PLoS Medicine*. http://doi.org/10.1371/journal.pmed.1000200

Lule, H., Ssebuufu, R., & Okedi, X. F. (2017). Prehospital Factors Associated with Injury Severity of Motorcycle Related Femoral Fractures at Mbarara and Kampala International University Teaching Hospitals in Uganda. *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*, *16*(8), 79–92. http://doi.org/10.9790/0853-1608107992

Ma, Y. G., Hu, G. L., Hu, W., & Liang, F. (2016). Surgical factors contributing to nonunion in femoral shaft fracture following intramedullary nailing. *Chinese Journal of Traumatology - English Edition*, *19*(2), 109-112. http://doi.org/10.1016/j.cjtee.2016.01.012

Magetsari, R., Dewo, P., Nugroho, A. S., & Lanodiyu, Z. (2014). Deep Vein Thrombosis in Elderly Patients following Surgery for Fracture of the Proximal Femur. *Malaysian Orthopaedic Journal*, *8*(3), 7-10. http://doi.org/10.5704/MOJ.1411.002

Martelli, S., Pivonka, P., & Ebeling, P. R. (2014). Femoral shaft strains during daily activities: Implications for atypical femoral fractures. *Clinical Biomechanics*, *29*(8), 869-876. http://doi.org/10.1016/j.clinbiomech.2014.08.001

Min, B.-W., & Kim, S.-J. (2011). Avascular necrosis of the femoral head after osteosynthesis of femoral neck fracture. *Orthopedics*. http://doi.org/10.3928/01477447-20110317-13

Mittal, R., & Banerjee, S. (2012). Proximal femoral fractures: Principles of management and review of literature. *Journal of Clinical Orthopaedics and Trauma*. http://doi.org/10.1016/j.jcot.2012.04.001

Murray, C. J. et al. (2015). Global, regional, and national disability-adjusted life years (DALYs) for 306 diseases and injuries and healthy life expectancy (HALE) for 188 countries, 1990-2013: Quantifying the epidemiological transition. *The Lancet*, *386*, 2145–91. http://doi.org/10.1016/S0140-6736(15)61340-X

Mutooro S.M, Mutakooha E, K. P. (2010). A Comparison of Kampala Trauma Score II with the New Injury Severity Score in Mbarara University Teaching Hospital in Uganda. *East and Central African Journal of Surgery*, *15*(1), 62–71.

Naddumba, E. K. (2008). Musculoskeletal trauma services in Uganda. In *Clinical Orthopaedics and Related Research* (Vol. 466, pp. 2317–2322). http://doi.org/10.1007/s11999-008-0369-2

Pandya, N. K., & Edmonds, E. W. (2012). Immediate Intramedullary Flexible Nailing of Open Pediatric Tibial Shaft Fractures. *Journal of Pediatric Orthopaedics*, *32*(8), 770–776. http://doi.org/10.1097/BPO.0b013e318270468b

Pauyo, T., Drager, J., Albers, A., & Harvey, E. J. (2014). Management of femoral neck fractures in the young patient: A critical analysis review. *World Journal of Orthopedics*, *5*(3), 204–17. http://doi.org/10.5312/wjo.v5.i3.204

Petsatodis, G., Chatzisymeon, A., Antonarakos, P., Givissis, P., Papadopoulos, P., & Christodoulou, A. (2010). Condylar buttress plate versus fixed angle condylar blade plate versus dynamic condylar screw for supracondylar intra-articular distal femoral fractures. *Journal of Orthopaedic Surgery (Hong Kong)*, *18*(1), 35–8. http://doi.org/10.1177/230949901001800108

Radvinsky, D. S., Yoon, R. S., Schmitt, P. J., Prestigiacomo, C. J., Swan, K. G., & Liporace, F. a. (2012). Evolution and development of the Advanced Trauma Life Support (ATLS) protocol: a historical perspective. *Orthopedics*, *35*(4), 305-11. http://doi.org/10.3928/01477447-20120327-07

Rodriguez-Merchan, E. C., Moraleda, L., & Gomez-Cardero, P. (2013). Injuries associated with femoral shaft fractures with special emphasis on occult injuries. *Archives of Bone and Joint Surgery*, *1*(2), 59–63.

Sampson, W., & Tawiah, R. (2015). Exploring the Predictors of Accident Severity in Urban Ghana, *5*(14). Retrieved from www.iiste.org

Shaer, J. a, Hileman, B. M., Newcomer, J. E., & Hanes, M. C. (2012). Femoral neck fracture following hardware removal. *Orthopedics*, *35*(1), e83-7. http://doi.org/10.3928/01477447-20111122-34

Shah, R. P., Sheth, N. P., Gray, C., Alosh, H., & Garino, J. P. (2014). Periprosthetic Fractures Around Loose Femoral Components. *Journal of the American Academy of Orthopaedic Surgeons*, *22*(8), 482-490. http://doi.org/10.5435/JAAOS-22-08-482

Singh, G. (2013). Non Union of Fracture Neck of Femur for Intertrochanteric Osteotomy. *Journal of Universal College of Medical Sciences*, *1*(3), 33-36. http://doi.org/10.3126/jucms.v1i3.8762

Sisimwo, P. K., Mwaniki, P. K., & Bii, C. (2014). Crash characteristics and injury patterns among commercial motorcycle users attending Kitale level IV district hospital, Kenya. *Pan African Medical Journal*, *19*. http://doi.org/10.11604/pamj.2014.19.296.4885

Smith, E. B., Parvizi, J., & Purtill, J. J. (2011). Delayed surgery for patients with femur and hip fractures-risk of deep venous thrombosis. *The Journal of Trauma*, *70*(6), E113-6. http://doi.org/10.1097/TA.0b013e31821b8768

Song, K.-S. (2010). Displaced fracture of the femoral neck in children: open versus closed reduction. *The Journal of Bone and Joint Surgery. British Volume*, *92*(8), 1148–51. http://doi.org/10.1302/0301-620X.92B8.24482

Taitsman, L. A., Lynch, J. R., Agel, J., Barei, D. P., & Nork, S. E. (2009). Risk Factors for Femoral Nonunion After Femoral Shaft Fracture. *The Journal of Trauma: Injury, Infection, and Critical Care*, *67*(6), 1389-1392. http://doi.org/10.1097/TA.0b013e318182afd0

Tran, T. M., Fuller, A. T., Kiryabwire, J., Mukasa, J., Muhumuza, M., Ssenyojo, H., & Haglund, M. M. (2015). Distribution and characteristics of severe traumatic brain injury at mulago national referral hospital in Uganda. *World Neurosurgery*. http://doi.org/10.1016/j.wneu.2014.12.028

Tull, F., & Borrelli, J. (2003). Soft-tissue injury associated with closed fractures: evaluation and management. *The Journal of the American Academy of Orthopaedic Surgeons*, *11*(6), 431–438.

Tumwesigye, N. M., Atuyambe, L. M., & Kobusingye, O. K. (2016). Factors associated with injuries among commercial motorcyclists: Evidence from a matched case control study in Kampala City, Uganda. *PLoS ONE*, *11*(2), 1-18. http://doi.org/10.1371/journal.pone.0148511

Wang, W., Wei, J., Xu, Z., Zhuo, W., Zhang, Y., Rong, H., … Wang, P. (2014). Open reduction and closed reduction internal fixation in treatment of femoral neck fractures: a meta-analysis. *BMC Musculoskeletal Disorders*, *15*, 167. http://doi.org/10.1186/1471-2474-15-167

Wensing, A. M. J., van Maarseveen, N. M., & Nijhuis, M. (2010). Fifteen years of HIV Protease Inhibitors: raising the barrier to resistance. *Antiviral Research*. http://doi.org/10.1016/j.antiviral.2009.10.003

Wolinsky, P., Tejwani, N., Richmond, J. H., Koval, K. J., Egol, K., Stephen, D. J. G., … Weiss, A.-P. C. (2002). Controversies in intramedullary nailing of femoral shaft fractures. *Instructional Course Lectures*, *51*, 291-303.

Yeni, Y. N., & Norman, T. L. (2000). Fracture toughness of human femoral neck: Effect of microstructure, composition, and age. *Bone*, *26*(5), 499-504. http://doi.org/10.1016/S8756-3282(00)00258-1

Zlowodzki, M., Ayieni, O., Petrisor, B. a, & Bhandari, M. (2008). Femoral neck shortening after fracture fixation with multiple cancellous screws: incidence and effect on function. *The Journal of Trauma*, *64*(1), 163-169. http://doi.org/10.1097/01.ta.0000241143.71274.63

How to cite this article:

Herman Lule *et al* (2017) 'Anatomical Determinants of Injury Severity of Motorcycle Attributable Femur Fractures at Two Teaching Hospitals in Uganda', *International Journal of Current Advanced Research,* 06(10), pp. 6937-6944.
DOI: http://dx.doi.org/10.24327/ijcar.2017.6944.1046

****