



Cohort Study

Recovery of pre-injury functional state following operative treatment of displaced femoral neck fractures; a prospective cohort study

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ABSTRACT

Background: The incidence of fracture neck of femur (FNF) has been projected to increase significantly. This study sought to determine the recovery of preinjury functional state following operative treatment of displaced FNF. **Materials and methods:** A six-month prospective cohort study was conducted at Kenyatta National Hospital (KNH) and PCEA Kikuyu Mission Hospital (KMH) between November 2008 and May 2009. Sixty patients were enrolled using a pre-tested questionnaire. The Western Ontario and McMaster Universities Osteoarthritis index (WOMAC) scores were used. The functional outcome measures included pain, stiffness and activities of daily living (ADL). Stratification and subgroup analysis were done especially based on age. Student's *t*-test and χ^2 test were used for comparison between variables as appropriate with a $p < 0.05$ being considered statistically significant.

Results: Majority of the patients recruited were males (68%) with a mean age of 51.6 years. Eighty eight percent of the patients had a mean negative early functional outcome score. Hemiarthroplasty (HA) and Total Hip Arthroplasty (THA) had comparable early post-operative functional outcome while Osteosynthesis (OS) had a poorer ADL outcome. Prolonged hospital stay was associated with a poor ADL outcome ($p = 0.020$). Use of the antero-lateral approach to the hip was associated with a better ADL outcome in patients older than 50 years ($p = 0.007$).

Conclusions: At three months post-operatively, most patients have not fully recovered their pre-injury level of function and independence. Both HA and THA are associated with better early functional outcome compared to OS.

Study type: Original research.

1. Introduction

How well patients are able to regain their pre-injury level of function and independence is a measure of the success or failure of a treatment regime [1,2]. To date there are still controversies in the choice of appropriate treatment for displaced femoral neck fractures and the problem is whether to reduce the fracture and use internal fixation or perform partial or total hip replacement arthroplasty [3,4]. There is significant morbidity and mortality associated with fracture neck of

femur (FNF) especially in the elderly [5]. In Kenya however, majority of these fractures occur in the young and economically productive age-group mainly following road traffic injuries (RTI) [6]. Despite advances in surgical hardware and techniques, femoral neck fractures (FNFs) still pose a significant clinical challenge and are also expensive to manage [7]. Several factors mainly related to the anatomy of the femur neck (especially the blood supply, angiogenic inhibiting factors, geometry, pattern of synovial membrane cover and capsular attachments), and the weightbearing function, are thought to be responsible [8,9]. The

Abbreviations: ADL, Activities of Daily Living; ASA, American Society of Anesthesiologists; FNFs, Femoral Neck Fractures; FNF, Femoral Neck Fracture/ Fracture Neck of Femur; HA, Hemiarthroplasty; KMH, PCEA Kikuyu Mission Hospital; KNH, Kenyatta National Hospital; LOS, Length of Hospital Stay; OS, Osteosynthesis (Internal fixation); RTI, Road Traffic Injuries; SPSS, Statistical Package for the Social Sciences; THA/R, Total Hip Arthroplasty/ Replacement; UON, University of Nairobi; WOMAC, Western Ontario and MacMaster Universities Osteoarthritis Index.

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problem of FNF was considered “unsolved” by the earlier orthopedic surgeons; Ambroise Pare and Sir Asley Cooper [3]. The advice of Sir Asley Cooper (1822) was to treat the patient and let the fracture go [3]. Functional outcome is influenced by several patient and non-patient factors which may vary from one set-up to another [3,4,10–16]. In the contemporary setting, outcome assessment has been necessitated by the dramatic increase in health care costs and practice-pattern variations [7, 17–19]. In Kenya however, there is paucity of data on the outcome following operative treatment of these fractures [6,20,21]. The aim of this study was to determine the degree of recovery of early functional outcome following operative treatment of displaced FNF in a peri-urban and urban tertiary orthopedic center in Kenya; by assessing the degree of pain, stiffness and activities of daily living (ADL). The factors affecting this outcome were also assessed.

2. Patients and methods

2.1. Study design and setting

A six-month prospective cohort study was conducted at the orthopaedic trauma wards and the orthopaedic out-patient clinics of Kenyatta National Hospital (KNH) and PCEA Kikuyu Mission Hospital (KMH) between November 12th, 2008 and May 11th, 2009; both days inclusive. This study was after approval by the respective ethical committees (Appendices 1 and 2). It has been conducted in accordance with the World Medical Association’s Declaration of Helsinki, 2013 and registered with Clinical Trials database [22]. The reporting is based on Strengthening the Reporting of Cohort Studies in Surgery (STOCSS) guidelines [23].

2.2. Study sample

The sample size was derived from the formula by Lwanga and Lemeshow [24]; $n = z^2pq/d^2$

Where “p” is the expected proportion of patients undergoing operative treatment for displaced fracture neck of femur in KNH and KMH;

“d” the confidence limit; “q” = (1-p) % and;

“z” is the standard deviation of the 95th percentile (1.96).

A confidence limit of 0.05 is used.

Therefore; $n = (1.96)^2 \times 0.041 (1-0.041)/(0.05)^2 = 60.419$.

The calculated sample size was 60 patients. The “p” value has been derived from the proportion of patients with displaced FNF (who underwent operative intervention) from patients admitted with fractures in KNH and KMH orthopedic/trauma wards during the months of January to August 2008, which was 4.1%. During this period, there were about 2700 fracture patients admitted with 112 undergoing operative treatment for displaced FNF. There is no published literature on local prevalence of FNF or on the proportion of patients undergoing operative treatment.

2.3. Study patients and data collection

Sixty patients (18 years of age and above) who underwent operative treatment for displaced fracture neck of femur (FNF) at KNH and KMH during the study period were enrolled using a pretested questionnaire (Appendix 3). This was after a written informed consent was granted (Appendix 4). Patients who had un-displaced or bilateral FNF, concomitant pelvic or lower limb fracture/dislocation, multiple injuries, confusion, previous ipsilateral FNF or FNF surgery, operative treatment done outside the study setting, malignant/pathological fractures or peri-prosthetic fractures; patients who were non-ambulatory prior to injury and those with chronic pain syndrome and/or on chronic opioid use, were all excluded. Enrollment was done at/or within three months of hospital admission.

Assessment of function was conducted at enrollment for the pre-injury functional status and at three months post-operatively for the post-operative functional status. The Western Ontario and McMaster Universities Osteoarthritis index (WOMAC) was used [25]. The outcome measures included pain, stiffness and activities of daily living (ADL) for the functional limitation arm of this scoring system [25]. The functional outcome correlates assessed included the patients’ demographic features, pre-injury functional status, type of operation, surgical approach, patients’ co-morbidities and associated complications. The timing for wound assessment was arbitrarily fixed by the investigators to fit in the discharge and clinic attendance routines of the two hospitals. No randomization was done and patients remained in their study groups according to the intention-to-treat principle.

2.4. Principles of management for displaced FNF at KNH and KMH

The standard treatment practice in the two institutions entails a comprehensive clinical assessment at admission, preoperative evaluation and optimization with a continuum of rehabilitative efforts. The acute management is guided by the ATLS® principles with the other associated injuries and comorbid conditions appropriately treated. The lead surgeons in the two facilities are usually a senior resident or a consultant orthopedic surgeon with comparable experience and surgical competence. The preferred definitive treatment is osteosynthesis for the younger patients and arthroplasty for the older patients. Prophylactic anticoagulation and antibiotic therapy are given to all patients. The choice of operative approach and type of surgery is by the team of Surgeons guided by several patient and non-patient factors. The type of anesthesia is determined by the anesthesiology team. Post-operative rehabilitation includes amongst others, early ambulation with early weightbearing (usually on the first postoperative day) for the arthroplasty group and delayed weightbearing for the osteosynthesis group.

2.5. Definition of terminologies

The **duration of stay to surgery**, period between admission and definitive surgical operation; **total length of stay**, period from admission to discharge from hospital; **Fall with mild trauma**, a fall on a relatively flat ground (mainly tripping) or from a height lower than 4.5 m; **fall with severe trauma**, a fall from a height, either one floor or higher (at least 4.5 m high); **early outcome**, outcome within 3 months of definitive surgical intervention; **early complications**, complications occurring within three months post-operatively; **Chronic pain syndrome**, pain lasting longer than three months from the initial noxious stimuli and not responding to first-line analgesics; **Skeletal maturity**, confirmed on plain X-ray as fusion of the proximal femoral capital epiphyses.

2.6. Data analysis

Data were entered into a coded data sheet and analyzed using the Statistical Package for the Social Sciences (SPSS), Inc., for windows version 15 [26]. For purposes of this study, those above 50 years of age were regarded as elderly and this informed the basis for the age stratification used in data analysis [27]. Stratification and subgroup analysis were done based on age, gender, modality of treatment, surgical approach, as well as presence or absence of complications. The WOMAC scores for each sub-scale (pain, stiffness and ADL) were normalized into a scale of 0–100 (zero indicating worst symptoms and 100 least symptoms). Each sub-scale was evaluated independently. The scores were either categorized or analyzed as means with the categories being 90–100 for excellent results, 80–89 for good results, 70–79 fair, 60–69 poor, and below 60 a failed result. Categorical data were expressed as proportions with comparison between variables performed using cross tabulation and Pearson’s Chi-squared test. Continuous variables were expressed as means and standard deviations. The Student’s *t*-test was used to compare the differences for significance. For comparable data, a

$p < 0.05$ was considered statistically significant.

3. Results

3.1. Demographics and baseline characteristics

All the sixty patients ($n = 60$) enrolled were evaluated and there was no loss to follow-up. The patients' ages ranged from 18 to 96 years with a mean of 51.6 (± 18.2) years. There was male preponderance (41 patients, 68%). Minor trauma accounted for a similar proportion of injuries as severe trauma with the latter being either following a fall from a height (10 patients, 16.7%), Road Traffic Injuries (RTI) (19 patients, 31.7%) or assault with direct trauma to the hip (one patient, 1.7%). Falls accounted for 66.7% of the injuries. RTI mainly occurred in those ≤ 50 years of age while fall with mild trauma, mainly in those above 50 years (Table 1, Table 2, eTable 1, eFig. 1). Sixty-two percent of the fractures were Garden's IV (eTable 1).

The commonest comorbidity was cardiovascular with all being due to hypertension (9 patients, 40.9%). Most musculoskeletal comorbidities were due to osteoarthritis (eFig. 2). For the arthroplasty group, 55% underwent HA (Table 2, eFig. 3, eFig. 4). The commonest post-operative complication was anemia affecting 4 patients, all of whom were managed on hematinics alone (eFig. 5). Intraoperative transfusion rates were high due to intraoperative blood loss especially for those fractures with delay to surgery (Table 2). Two patients had superficial wound infection. Fifty-six patients (93.3%) had wound healing within seven days postoperatively (eFig. 6).

Majority of the patients were operated between one to fourteen days after injury (Table 3, eFig. 7). Thirty-five (58.3%) patients stayed in the hospital for a period of 1–14 days with only 4 patients (6.7%) staying beyond sixty days from admission to discharge (eFig. 8).

3.2. Functional outcome

The ADL scores showed a negative outcome in all the patients while majority of the patients had a negative score for pain (81.6%) and stiffness (83.3%) outcome when the pre-injury and post-operative WOMAC scores were compared for each patient (Table 4, Fig. 1), with the difference remaining significant even on age stratification, $p < 0.001$ (eTable 2, eTable 3).

Table 1
Demographic characteristics.

Factor		Frequency (n)	Percentage (%)
Sex^a	Male	41	68.0
	Female	19	32.0
Age groups (in years)	18–30	07	11.6
	31–50	22	36.7
	51–70	21	35.0
	>70	10	16.7
Level of formal education	None	15	25.0
	Primary	16	26.7
	Secondary	17	28.3
Employment status	Tertiary	12	20.0
	Not employed	20	33.3
	Self employed	15	25.0
	Employed by other	24	40.0
ASA class (pre-operative)^b	Retired	01	1.7
	I	30	50.0
	II	26	43.0
Co-morbidities	III	04	7.0
	Absent	36	63.3
	Present	22	36.7

^a The male patients who were ≤ 50 years of age were 25 (61% of males) while females were 4 (21% of females).

^b ASA - American Society of Anesthesiologists.

Table 2
Treatment characteristics.

Factor		Frequency (n)	Percentage (%)
Treatment modality	OS	24	40.0
	HA	20	33.3
	THA	16	26.7
Surgical approach^a	Lateral	31	52.0
	Antero-lateral	29	48.0
Type of anesthesia	General	18	30.0
	Spinal	42	70.0
Transfusion pattern	Transfused	36	60.0
	Not transfused	24	40.0
Prophylaxis against VTE^b	Heparin	21	35.0
	Enoxaparin	39	65.0
	Ceftriaxone	27	45.0
Antibiotic prophylaxis	Cefuroxime	13	21.7
	Cloxacillin	11	18.3
	Others	09	15.0

OS – Osteosynthesis; HA – Hemiarthroplasty; THA – Total Hip Arthroplasty.

^a Type of anesthesia used was chosen by individual anesthesiologist.

^b VTE – Venous Thromboembolism.

Table 3
Duration from injury to hospital discharge ($n = 60$).

Duration (Days)	Mean (SD) ^a	Median	Minimum	Maximum
Injury to hospital admission	31.9 (60.0)	5.0	1.0	268.0
Admission to surgery	17.4 (28.2)	7.0	1.0	140.0
Injury to surgery	49.3 (61.5)	26.0	4.0	269.0
Surgery to hospital discharge	8.2 (5.9)	6.5	2.0	42.0
Length of hospital stay (LOS)	25.6 (32.4)	14.0	4.0	163.0

^a Most of the parameters show a standard deviation (SD) more than the mean; hence the median values are used in the analysis.

Table 4
Mean pre-injury versus postoperative WOMAC scores ($n = 60$).

Outcome measure		Mean (SD)	Minimum	Maximum	p
Pain	Before	99.3(1.95)	90	100	0.003*
	After	83.2(13.50)	35	100	
Stiffness	Before	97.5(6.78)	75	100	0.043*
	After	79.2(14.30)	25	100	
ADL	Before	98.5(4.01)	79.4	100	0.034*
	After	80.3(9.24)	57.4	94.1	

*Significant $p < 0.05$.

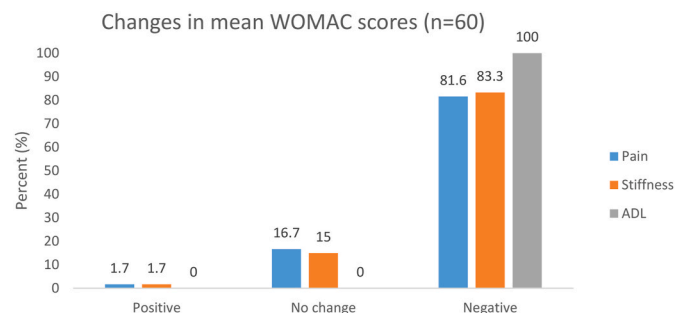


Fig. 1. Changes between pre-injury and post-operative WOMAC scores ($n = 60$).

Those above 50 years of age had a significantly better mean score for pain (less pain) post-operatively compared to those aged 50 years and below ($p = 0.006$) (Table 5). Amongst those 50 years of age and below, those who underwent OS scored poorly on pain ($p = 0.031$) compared to

Table 5
Difference in mean pain outcome scores according to age, sex, co-morbidity, treatment modality, surgical approach, type of anesthesia and complication(s).

Factor	Pain score three months after operation				P
	n	Mean (SD)	Minimum	Maximum	
Age in years	≤50	29	78.3(14.6)	35	0.006*
	51+	31	87.7(10.7)	70	
Sex	Male	41	81.7(14.8)	35	0.222
	Female	19	86.3(9.7)	70	
Comorbidity	Yes	22	78.6(17.5)	35	0.089
	No	38	85.8(9.8)	70	
Treatment modality	HA	20	83.0(20.3)	35	0.082
	THA	16	89.1(9.5)	70	
	OS	24	79.4(5.4)	70	
Surgical approach	Lateral	31	82.3(8.74)	70	0.602
	Anterolateral	29	84.1(17.30)	35	
Type of anesthesia	General	18	82.5(10.18)	55	0.094
	Spinal	42	83.5(14.8)	35	
Complications	Yes	06	80.0(12.2)	70	0.961
	No	54	83.5(13.7)	35	

*Significant $p < 0.05$. HA – Hemiarthroplasty; THA – Total Hip Arthroplasty; OS – Osteosynthesis.

those treated by HA (eTable 4). Only two patients >50 years of age underwent OS and so were not considered in data analysis (eTable 5).

The score for stiffness was significantly better amongst those ≤50 years of age ($p < 0.0001$), and the male patients ($p = 0.027$) (Table 6). However, when stratified by age, the gender difference was not significant (eTable 6, eTable 7).

The OS group had a significantly poor mean ADL score compared to HA or THA ($p=0.002$) (Table 7). Amongst those ≤50 years, HA was associated with a significantly better ADL score than OS ($p < 0.0001$) (eTable 8). Only two patients underwent THA in this age group and were excluded in the analysis. There was no significant difference noted in mean ADL score between HA and THA (eTable 9). Amongst those older than 50 years, presence of comorbidities was associated with worse mean ADL outcome score ($p=0.016$); while the use of anterolateral approach to the hip was associated with a better mean ADL score than the lateral approach ($p = 0.007$) (eTable 9).

4. Discussion

There was a male preponderance noted in the study and majority of the patients were relatively young (mean age, 51.6 ± 18.2 years). This was consistent with findings reported in other local series [6,21]. Studies from the USA and western European countries however, indicate a female preponderance with a relatively elderly population (mean ages above 70 years) [28,29]. Nyarango [6] and Ochieng [21] in separate local studies found that these fractures are commoner in the younger age

group (mean ages of 45 and 53 years respectively).

This study, found that severe trauma resulted in equal proportions of FNF (50% each) just as minor trauma. This could possibly be due to the almost equal age distribution (mean 51.6 years and median 51 years) and the improving life expectancy locally with a more elderly population than before. A fall, either with mild or severe trauma, was the commonest etiologic factor (66.7%) though RTI resulted in a significant proportion of the injuries (31.7%). RTI was the main etiologic factor in those of 50 years and below while fall with minor trauma was the dominant etiologic factor in those above 50 years of age. The increased predisposition to a fall from physical deconditioning, slower reflexes, poor eyesight amongst others; and the increased rate of osteoporosis with advancing age makes falling, especially with minor trauma the commonest etiologic factor in the elderly population [28,29].

At three months postoperatively, most patients had not fully recovered their pre-injury level of function and independence. All the patients had not fully recovered their preinjury ADL function and only 18.4% and 16.7% respectively had recovered their preinjury function as measured by pain and stiffness score (Table 4, eTable 2, eTable 3, Fig. 1). Those older than 50 years had a better functional outcome for pain (mean score 87.7 versus 78.3, $p = 0.006$), but a poorer outcome for stiffness (mean score 72.8 versus 86.1, $p < 0.0001$) than those of 50 years and below (Table 5, Table 6). Age had no significant effect on ADL (Table 7).

Majority of those above 50 years of age in this study underwent treatment by arthroplasty while those of 50 years and below (actually

Table 6
Difference in mean stiffness outcome scores according to age, sex, co-morbidity, treatment modality, surgical approach, type of anesthesia and complication(s).

Factor	Stiffness score three months after operation				P
	n	Mean (SD)	Minimum	Maximum	
Age in years	≤50	29	86.1(8.1)	75	<0.0001*
	51+	31	72.8(15.9)	25	
Sex	Male	41	82.0(12.9)	50	0.027*
	Female	19	80.9(8.4)	25	
Comorbidity	Yes	22	75.3(10.2)	63	0.109
	No	38	81.5(15.9)	25	
Treatment modality	HA	20	74.6(17.9)	25	0.195
	THA	16	80.7(14.3)	63	
	OS	24	82.1(9.9)	50	
Surgical approach	Lateral	31	82.2(12.03)	50	0.707
	Anterolateral	29	76.0(16.0)	25	
Type of anesthesia	General	18	80.8(13.1)	50	0.747
	Spinal	42	78.5(14.9)	25	
Complications	Yes	06	75.3(11.2)	63	0.426
	No	54	79.7(14.6)	25	

*Significant $p < 0.05$. HA – Hemiarthroplasty; THA – Total Hip Arthroplasty; OS – Osteosynthesis.

Table 7

Difference in mean ADL outcome scores according to age, sex, co-morbidity treatment modality, surgical approach, type of anesthesia and complication(s).

Factor	ADL score three months after operation				P	
	n	Mean (SD)	Minimum	Maximum		
Age in years	≤50	29	80.1(8.1)	69.2	94.1	0.906
	51+	31	80.4(10.4)	57.4	94.1	
Sex	Male	41	80.0(9.7)	57.4	94.1	0.730
	Female	19	80.8(8.4)	58.8	94.1	
Comorbidity	Yes	22	78.1(9.6)	57.4	89.7	0.164
	No	38	81.5(8.9)	61.8	94.1	
Treatment modality	HA	20	83.4(9.4)	58.8	94.1	0.002*
	THA	16	83.9(9.3)	57.4	94.1	
	OS	24	75.2(6.7)	60.3	88.2	
Surgical approach	Lateral	31	76.1(9.3)	57.4	94.12	0.295
	Anterolateral	29	84.7(6.9)	72.1	94.12	
Type of anesthesia	General	18	76.8(9.2)	60.3	94.12	0.659
	Spinal	42	81.8(9.0)	57.4	94.12	
Complications	Yes	06	71.6(8.1)	57	82	0.257
	No	54	81.2(8.9)	59	94	

*Significant $p < 0.05$.

HA – Hemiarthroplasty; THA – Total Hip Arthroplasty; OS – Osteosynthesis.

below 30 years of age) were mainly treated using OS (eFig. 3 and Table 2). This was consistent with the understanding of the pattern of blood supply to the hip, the healing patterns of FNFs and other treatment choice determinants [8,9,11,12]. Since OS is associated with a poorer outcome compared to arthroplasty as found in this study and other series [4,10,12,13,30], its widespread use in those below 50 years of age can partly explain the poorer outcome for pain in the younger group. However, age has been shown in many studies to independently influence functional outcome, with advancing age generally being associated with a poor outcome [4,10,14]. Sex had no significant effect on early post-operative pain and ADL outcome (Tables 5 and 7), though outcome for stiffness was better amongst the males (mean score 82 versus 80.9, $p = 0.027$) (Table 6). When corrected for age however, the difference in stiffness was not significant (eTables 6 and 7). Co-morbidity has been found to be associated with a negative impact on functional outcome in many studies [4,10]. Even though this study did not find any statistically significant difference in functional outcome with the presence of comorbidity, when stratified by age, the presence of comorbidity in those >50 years of age was associated with a significantly poor ADL score (mean score 75.9 versus 84.7, $p = 0.016$) (eTable 9).

When compared with the OS cohort, the HA and THA groups had better outcome for pain (mean scores 79.4 versus 83 versus 89.1, $p = 0.082$) and ADL (mean scores 75.2 versus 83.4 versus 83.9, $p = 0.002$) (Tables 5 and 7). However, there was no significant difference in stiffness outcome noted, $p = 0.195$ (Table 6). Most studies comparing HA and THA found varying short- and long-term functional outcomes [4,5,10,12,13,30,31]. We found no significant difference in early functional outcome between HA and THA (eTables 5,7 and 9).

The in-hospital delay to surgery had a median of 7 days while the duration from injury to surgery had a median of 26 days. Nyarango [6] had previously reported that the in-hospital delay can take up to 20 weeks, mainly worse amongst the cases referred from other institutions to the tertiary facility. This study found no significant effect of the duration from injury to surgery on functional outcome, findings corroborated by other studies [32,33]. The delay to surgery could have been due to delay in availing the necessary implants despite a good socio-economic standing for the majority of the patients or delay in getting bed space in the tertiary orthopedic centers (Table 1, Table 3, eFig. 7). Prolonged LOS was associated with a poor mean ADL outcome ($p = 0.020$) though this was mainly due to preoperative delay to surgery. Warrakah [20] found poor function with prolonged post-operative in-hospital stay.

The lateral (Hardinge or Liverpool) approach was the preferred method of access to the hip especially for OS in this study, $n = 31$ (52%) (Table 2). These findings were consistent with a previous report by

Warrakah who found that the lateral approach was more popular locally being used in 84% of the patients who underwent Austin Moore HA [20]. In this study, the antero-lateral (Watson-Jones) approach was associated with a better ADL outcome amongst patients above 50 years of age when compared to the lateral approach (mean score 84.0 versus 68.1, $p=0.007$), though there was no statistically significant difference in postoperative pain and stiffness outcome (eTable 9). Amongst the patients undergoing Austin Moore HA, Warrakah [20] found that the lateral approach was associated with a better functional outcome compared to the antero-lateral approach. Most of the patients had no post-operative complication, $n = 54$ (90%). Anemia was the commonest complication affecting 4(7%) patients while 2(3%) patients had wound sepsis/dehiscence (eFig. 5). Anemia has been shown to independently impact negatively on mobility [34].

4.1. Strengths and limitations

The follow-up period gave a good assessment of the short-term outcome. However, three months may not be adequate for full healing and therefore, objective assessment of full functional recovery. The practice of consecutive enrollment of all those who met the inclusion criteria could add to the strength of the study. However, lack of randomization could lead to bias. The study setting were two tertiary institutions, urban and peri-urban which might give a representative sample; being the main referral facilities. However, a broadened multi-institutional and multi-national study may give a better representation of patients with FNF. The almost homogeneous patient baseline characteristics and limited practice pattern variation in the two institutions could add to the strength of the study. The presence of confounders can contribute to bias. However, the use of stratification and subgroup analysis may reduce likelihood of confounding and hence bias.

4.2. Recommendation

Multicentre randomized controlled studies are necessary to further look at the functional outcome following treatment for displaced fracture neck of femur. Long-term follow-up to establish the long-term outcome is equally necessary. Since prolonged hospital stay is associated with poor functional outcome, ensuring prompt treatment may help reduce this duration and thus improve on the outcome.

5. Conclusion

This study has shown that in Kenya, majority of FNFs occur in the younger economically productive age group and at three months post-

operatively, most patients have not recovered their pre-injury level of function and independence. It supports the fact that both Hemiarthroplasty and Hip Arthroplasty are associated with better early functional outcome compared to Osteosynthesis.

Authors declaration

All the Authors contributed to the conceptualization of the study, study design, data analysis, data interpretation and the writing of this manuscript. Prof. Atinga and Dr. Awori were the University Supervisors and Dr. Raduma participated in all aspects of the study as the principal investigator; additionally, undertaking data collection and compilation. Dr. Kingori further assisted with data collection and follow-up of patients at PCEA Kikuyu Mission Hospital. All the authors approve of the final manuscript.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.amsu.2021.102682>.

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This research did not receive any specific grant from funding agencies in the public, commercial or not-for-profit sectors. The authors have no conflict of interest whatsoever.

Data statement

Raw data will be available on request to the extent that doesn't breach data confidentiality promised to the participants in this study.

Please state whether ethical approval was given, by whom and the relevant Judgement's reference number

Ethical approval was granted by the Kenyatta National Hospital/University of Nairobi Ethics and Research Committee (Reference P271/10/2008) vide their letter KNH/UON-ERC/A/104 dated 12 November 2008.

Authority to undertake the study was also granted by PCEA Kikuyu Mission Hospital's Board of Management (vide their letter dated 17 October 2008 and revised 30 September 2009).

Research registration Unique Identifying number (UIN)

1. Name of the registry: [ClinicalTrials.gov](https://clinicaltrials.gov)
2. Unique Identifying number or registration ID: Protocol ID: UniNairobiClinicalTrials.gov ID: NCT04879472
3. Hyperlink to your specific registration (must be publicly accessible and will be checked): <https://clinicaltrials.gov/show/NCT04879472>

Author contribution

Authors; Ochieng' Sephenia Raduma, Kingori John, Awori Kirsteen Ondiko, Ating'a John Ernest Oluoch: All the Authors contributed to the conceptualization of the study, study design, data analysis, data

interpretation and the writing of the final manuscript. Prof. Atinga and Dr. Awori were the University Supervisors during the study and Dr. Raduma participated in all aspects of the study as the Principal Investigator. Dr Raduma additionally, undertook data collection and compilation. Dr. Kingori also additionally assisted with data collection and follow-up of patients at PCEA Kikuyu Mission Hospital. All the Authors approve of the final manuscript.

Guarantor

The Guarantor is the one or more people who accept full responsibility for the work and/or the conduct of the study, had access to the data, and controlled the decision to publish. Please note that providing a guarantor is compulsory. The Guarantor for this manuscript is; Ochieng' Sephenia Raduma, drraduma@yahoo.co.uk

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