EARLY FUNCTIONAL OUTCOMES OF CLOSED TIBIAL PLATEAU FRACTURES IN A KENYAN SETTING

A thesis submitted in partial fulfillment of the requirements of Master of Medicine Degree in Orthopaedic Surgery

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DEDICATION

I dedicate this work to my wife Catherine, Casey, Kaylyn and Kyle.

ABBREVIATIONS

AO…………………………… *Association for the study of internal fixation*

ERC………………………… Ethical Research Committee

KNH ………………………… Kenyatta National Hospital

KOOS…………………… Knee injury and Osteoarthritis Outcome Score

OA ………………………… Osteoarthritis

OTA………………………… Orthopaedic Trauma Association Committee

PCEA……………………… Presbyterian Church of East Africa

POP……………………….. Plaster of Paris

SPSS………………………… Statistical Package for Social Sciences

TPFs………………………… Tibial Plateau Fractures

UON…………………………. University of Nairobi

VAS…………………………. Visual Analog Scale

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ABSTRACT

BACKGROUND: Tibial plateau fractures result from compressive axial forces alone, or combined with varus or valgus stresses on the knee and may interfere with the functional integrity of the joint. These fractures can be managed non-operatively or surgically, based on the availability of resources and magnitude of the injury. Functional outcomes of these fractures is based on the complexity of the injury and the type of treatment provided. The purpose of this study is to determine the early functional outcome of tibial plateau fractures and correlate it with severity of injury and treatment in a Kenyan setting.

OBJECTIVES: To describe the pattern and early functional outcome of closed tibial plateau fractures at Kenyatta National and PCEA Kikuyu hospitals.

STUDY POPULATION: Forty-four adult patients diagnosed with tibial plateau fractures in Orthopaedic wards and clinics of PCEA Kikuyu and Kenyatta National Hospitals.

STUDY DESIGN: Descriptive Cross-sectional Study

MATERIALS AND METHODS: A sample of 44 adult patients diagnosed with tibial plateau fractures at PCEA Kikuyu and Kenyatta National Hospitals were recruited in the current study by convenient sampling. Patient demographic characteristics including age and gender were recorded. Details on the cause and mechanism of injury were documented. The patients' primary and secondary injuries were clinically assessed and documented. The post injury radiographs were used to classify the fractures according to the Schatzker classification system. The patients were thereafter managed according to the individual hospital's protocol. After treatment, the patients were reassessed on the third day, 2nd week, 6 weeks and 3 months for wound healing. The patient's functional status at 3 months after treatment was determined using the modified Rasmussen's clinical-radiological criteria. All the collected data were recorded in sheets for analysis.

DATA MANAGEMENT: Data were coded and entered into SPSS version 25 for Windows®. Means and standard deviation were determined for the qualitative and quantitative variables. The ANOVA test was used to compare functional outcomes scores in the different fracture groups, and A P value of ≤ 0.05 was considered significant at 95% confidence interval.

RESULTS: The male female ratio was 5: 1. The mean age of the participants was 37±11 with age range of 18 to 55 yrs. Soft tissue injuries at presentation ranged from soft tissue edema (n= 34), meniscal tears (n=5), blisters (4), bruises (n=4), compartment syndrome (n=2), lateral collateral ligament tear (n=2). The initial management of all the patients was similar, and it included analgesics and a back-slab support. Thereafter a temporary spanning external fixation device was used in five cases. Definitive management was either non-operative (n= 11; 25%) or surgical (n=33; 75%). Plates were used in 30 patients while one had multiple screws. One patient was managed using a spanning external fixator. The modified Rasmussen Clinical outcome Scores were reported as excellent, good, fair and poor in 5, 14, 1 and 24 patients respectively at twelve weeks after care. Modified Rasmussen radiological outcome Scores were recorded as excellent, good, fair, poor in 22, 12, 6, 4 patients respectively. The mean VAS pain score at twelve weeks was 4±2.

CONCLUSIONS: Traumatic tibial Plateau fractures are common in the young males in our setting. These fractures are predominantly managed surgically with excellent radiological outcomes. The early functional outcomes of care of these patients is poor. Longer follow up period is recommended to fully assess the clinical outcomes of care of patients with tibial plateau fractures.

CHAPTER ONE: **INTRODUCTION AND LITERATURE REVIEW**

INTRODUCTION

The knee has a medial and lateral tibial plateau, on which the menisci sit and articulate with the femoral condyles. Tibial plateau fractures (TPFs) are uncommon injuries resulting from high or low energy, axial compressive traumatic forces alone or combined with varus or valgus stress on the knee [1]. These types of fractures only account for one percent of all fractures [2]. Seventy percent of isolated tibial plateau fractures occur to the lateral plateau, whereas 25% are isolated medial tibial plateau fractures [2, 3]. These fractures are articular and are a risk to the functional integrity of the knee joint [4]. The geometry and deviation of the fracture depend on several factors, including the magnitude and direction of the force applied the degree of knee flexion during the injury and, finally, the bone quality. These fractures maybe difficult-to-manage injuries and can affect young adults or elderly patients [4].

Tibial plateau fractures are mainly classified either using the Schatzker or the OTA/AO systems [5, 6, 7]. The Schatzker system classifies these fractures from type I to VI while the OTA/AO system classifies these fractures either as class A, B or C depending on the severity of the injury and the degree of articular involvement [5, 6, 7]. These fractures often have additional soft tissue injury, which affects patient's recovery after the initial injury [8].

When treating intra-articular fractures, the goal is to obtain a stable joint permitting early range of motion for cartilage nourishment and preservation [9]. Various treatment modalities have evolved over the years, with mixed results. These include; traction or closed treatment with cast bracing [10]. Surgical procedures including circular frames, percutaneous screw fixation, open reduction/internal fixation (ORIF), arthroscopically assisted reduction, fixed angle devices, the use of novel grafting methods to address articular depression and arthroplasty have also been advocated [1,4].

Subsequent rehabilitation includes varied duration of protection from weight bearing and immobilization [5]. Studies have suggested that the final functional outcome of TPF is directly dependent on these factors: degree of joint depression, extension and separation of the fracture line of the tibial condyles, degree of comminution, metaphyseal and diaphyseal dissociation, and integrity of the soft tissue envelope [1-4].

Several validated patients reported tools have been developed to assess the functional outcomes after tibial plateau fracture treatment. These include the Knee Injury and Osteoarthritis Outcome Score (KOOS), Western Ontario & McMaster Universities Osteoarthritis Index (WOMAC), and Modified Rasmussens Score (MRS). Several studies have reported the functional outcome of care of TPF as good, with reported rates of patient satisfaction ranging between 65% and 85% [1, 11, 12]. Most of these studies were conducted in high resource settings and evaluated patients who had been surgically managed. None of the studies was based in our local Kenyan setting.

The literature lacks recent, well defined middle age population-based studies describing the pattern of tibial plateau fracture, treatment and functional outcome in a Kenyan Population. The aim of the present study therefore is to describe the pattern and functional outcome of tibial plateau fractures in a Kenyan setting.

LITERATURE REVIEW

Epidemiology

Worldwide tibial plateau fractures are an uncommon injury and constitute approximately 1% of all long bone fractures [13]. Their incidence has been reported between 13/100,000/year and 26/100,000/year with a substantial variation in time and geography [14]. Evidence suggests that the incidence is changing quickly because of underlying changes in trauma mechanisms especially with motorization and motorcycle related injuries. Tibial plateau fractures have been reported to show a bimodal distribution with peaks in the younger and older age groups for both genders with male predominance [15]. The average age at the time of fracture has been reported to be between 44.5 years and 54.5 years in some studies [15].

Tibial Plateau Fracture distribution according to the AO classification was first reported by Albuquerque et al in 2013 [14]. AO type 41-B3 and 41-C3 fractures have the most common fracture types, representing 57% of all tibial plateau fractures [15]. Unicondylar fractures account for approximately two-thirds of all tibial plateau fractures. Open TPF account for 17% of the fracture [20]. Low-energy falls have been reported as the predominant mode of injury in the unicondylar fractures and bicondylar fractures in the elderly. High-energy trauma is the predominant mode of injury in the complex bicondylar fractures in the younger age groups where road traffic accidents in conjunction with falls from a height accounts for most fractures. The incidence of tibial plateau fractures admitted as multitrauma patients lies between 16% and 41% [16].

Diagnosis of Tibial Plateau Fractures

The diagnosis of tibial plateau fractures is not always obvious. It is not uncommon for patients with incomplete fractures or stress fractures to have their diagnosis confirmed weeks after a clinical picture of persistent knee pain that is unresponsive to the usual clinical measures. A detailed clinical history and imaging study are important factors for diagnosis. Traditionally, initial radiograph diagnosis should include anteroposterior (AP), lateral, internal and external oblique [4]. In cases of highly comminuted fractures, anteroposterior radiograph with traction is recommended, with the aim of removing the overlap of the femur, diverting the metaphysis, and better understanding the outline of the joint. Computed tomography is of great value in determining the location and magnitude of the depressed fragments [17]. Although the three-dimensional reconstruction of images does not have the same accuracy as CT scans, it allows for the visualization of the tibial epiphysis from different perspectives, allowing for better understanding and treatment planning. Although MRI has not yet been formally included in the routine evaluation of most patients, there is evidence that its use improves the agreement between different observers on the classification of the fracture and the method of approach [18].

Classification of tibial plateau fractures

The fracture pattern dictates the treatment plan and the risk for complications and to some extent the patient outcome [19]. Three classification systems, Schatzker, OTA/AO and three column systems are important, and are widely sued to classify tibial plateau fractures [5, 7]. While Schatzker and AO/OTA classification systems are based on the radiograph, the 3-column system is based on the CT scan. Maripuri et al. (2008) claimed that the Schatzker classification was superior to the AO classification in terms of both inter-observer reliability and intra-observer reproducibility [21]. They also concluded that none of the classifications was able fully to describe all fracture types. However, Ramos et al., (2013), was able to differentiate between two biomechanically different fracture subsets, one with continuity between a part of the articular surfaces and the diaphysis (I-IV types) and one without such continuity (V-VI types) using the Schatzker classification [11].

The Schatzker classification is pathoanatomical and suggests treatment strategies and this classification remains central to the language of tibial plateau fractures. This system classifies tibial plateau fractures into six classes, lateral tibial plateau fracture without depression (I), lateral tibial plateau fracture with depression (II), compression fracture of the lateral (IIIA) or central (IIIB) tibial plateau, medial tibial plateau fracture (IV), bicondylar tibial plateau fracture (V), and tibial plateau fracture with diaphyseal discontinuity (VI) [Figure 1]. Fractures I - IV are unicondylar, while V and VI are bi condylar. In the Schatzker classification, each increasing numeric fracture category indicates increasing severity, reflecting not only increased energy imparted to the bone at the time of injury but also an increasingly worse prognosis. Meaning that Schatzker class I - III are low energy while IV - VI are high energy. And therefore, orthopedic surgeons find the Schatzker classification useful in assessing the initial injury, planning management, and predicting prognosis. The Schatzker classification system was therefore used in the current study.

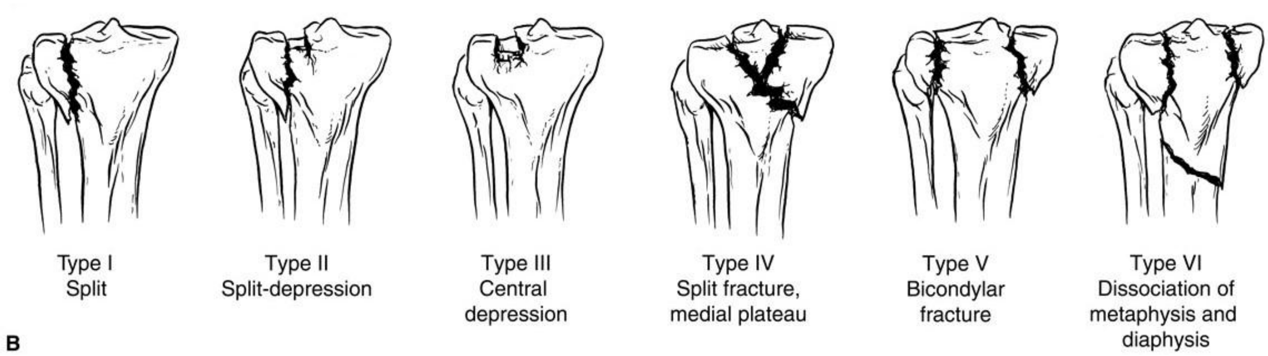

Figure 1: The Schatzker classification system of TPF (Open source image)

The OTA/AO classification also works well for the proximal tibia and remains the key international classification of fractures. In the OTA system, there are three classes of tibial plateau fractures, class A, B and C. Class A fractures are extra - articular and technically are thought not to be tibial plateau fractures [Figure 2]. Class B fractures are partial articular where the concept of split and depression to describe the pattern of the fracture is used. Class C fractures are completely articular. In all the three classes, the OTA system sub classifies each fracture in three groups according to the severity of the comminution.

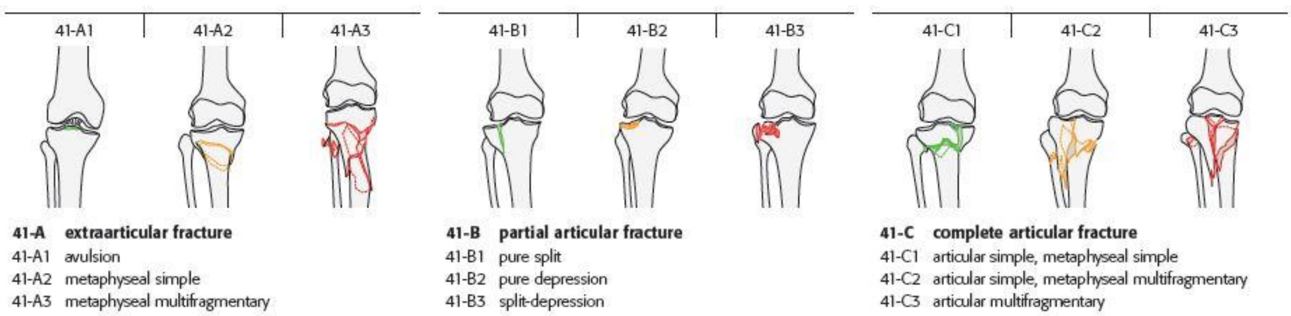

Figure 2: The OTA/AO classification system of TPF (Open source image)

Similar to many fracture classifications, the OTA/AO and the Schatzker classifications of tibial plateau fractures have been found to have less than excellent interobserver reliability [11]. Additionally, neither of these classifications includes fracture dislocation patterns, an important association in high energy patterns.

Management options for Tibial Plateau Fractures

The principles and techniques of treating tibial plateau fractures have evolved dramatically over the last 50 years. In the decades of the 1950s, 60s, and 70s these fractures were predominately treated nonoperatively and published results indicated that favorable outcomes were possible using a variety of techniques including traction, cast bracing, and even spica casting [22]. Apley controlled deformity using longitudinal traction, encouraged early knee motion, and reported satisfactory results [23]. Lansinger et al. in a 20-year follow-up of patients originally reported by Rasmussen showed that nonoperative treatment for fractures with less than 10 degrees of coronal instability resulted in favorable outcomes [24].

They found 89% good and excellent clinical results. Spica casting after closed reduction led to good and excellent results in 85% of patients. Cast bracing was frequently used for tibial plateau fractures as an isolated treatment with satisfactory results [25]. With improved methods of internal fixation, operatively reducing and fixing tibial plateau fractures became common in the 1980s. These techniques had the advantages of reducing the articular surface, aligning the limb, and mobilizing the knee early after injury with less encumbering external devices. Similar to non-operative techniques, favorable results were reported for the majority of patients. Criteria were developed for which fractures needed to be surgically reduced but this remains an area of controversy even today and different surgeons continue to use different criteria for operative intervention [26].

In general, tibial plateau fractures are to be operated on, but the decision whether to operate or not, on a specific fracture should be based on the fracture morphology, the soft tissues and the patient's general condition, and the expected limb axis and articular surface restoration [4]. Usual indications for surgical treatment are: intra-articular displacement of ≥ 2 mm, metaphyseal-diaphyseal translation of > 1 cm, angular deformity of > 10° in the coronal (varus-valgus) or sagittal plane, open fracture, associated compartment syndrome, associated ligament injury requiring repair and associated fractures of the ipsilateral tibia or fibula [27]. Management in the early stages of treatment should focus on preventing further soft-tissue injury while waiting to repair the fracture [4]. Knee immobilization can be achieved by splinting or by external fixation. The use of a staged approach using external fixation is recommended in complex patterns and high-energy trauma, especially in cases of axial instability [28].

The main objectives in definitive treatment of articular fractures of the knee are the restoration of articular congruity and stability, the axial and rotational alignment of the limb, and stability and early motion of the joint [4]. The eventual alignment of the knee after fracture healing is determined by a combination of the presence or absence of extra-articular fracture deformity, residual articular depression, and knee instability.

Complications of management of tibial plateau fractures

Reported complications of management of tibial plateau fracture management could be short term, intermediate and long term. Short term complications include infection, deep venous thrombosis and compartment syndrome [30, 31]. Intermediate complications include knee joint stiffness, malunion and nonunion. While long term complications include post traumatic osteoarthritis (PTOA) [32]. Studies report that 20% to more than 50% of patients who had had joint trauma develop OA and represent ∼12% of all OA cases. Common causes leading to PTOA include intra-articular fractures and meniscal, ligamentous and chondral injuries [33]. Post traumatic osteoarthritis has been associated with trauma induced chondrocyte necrosis, collagen rupture, gycocaminoglycan loss and hemathrosis [34].

Outcomes of tibial plateau fractures

The prognosis of tibial plateau fractures directly depends on four factors: degree of joint depression, extension and separation of the fracture line of the tibial condyles, degree of comminution and metaphyseal and diaphyseal dissociation, and integrity of the soft tissue [35].

In most studies, the fracture pattern has an effect on patient outcome [1]. In one study, medial condylar fractures and bicondylar fractures with a medial tilt were found to have less favorable results than lateral side patterns, and varus was more poorly tolerated than valgus [5]. Another study showed better results in unicondylar than bicondylar fractures [36]. In general, it is difficult to compare the results of surgical treatment of tibial plateau fractures since there are a wide ranges of fracture patterns leading to variable results and the factors that potentially affect outcome are contrasting for different patterns. The factors that most predictably lead to favorable outcomes are also controversial. However, they include patient related factors such as the age of the patient, injury related factors and treatment related factors [37]. Since treatment is under the surgeon's control it leads to the most controversy and the relative importance of limb alignment, articular reduction, and associated ligament and meniscal injuries are all areas that spark controversy [1].

Clinicoradiological criteria for functional outcome

There is a growing interest in the patient reported outcomes of care. The Canadian orthopaedic and trauma Society (2006), has shown that individuals with proximal tibial fractures have residual limb specific and general health deficits even after optimum care [38]. Studies have also shown that good radiological outcomes after care of the tibial plateau fractures does not necessarily guarantee good functional outcomes [36]. Several validated tools are used to assess knee functional outcomes following tibial plateau fractures. These include the Knee injury and Osteoarthritis Outcome Score (KOOS), WOMAC Osteoarthritis index and the Modified Rasmussens Assessment Criteria [11, 12]. It is however of note that none of these tools has been validated in our local Kenyan setting. Additionally, none of them is classified as the gold standard. While the KOOS entirely uses the patient report on the function of the knee, the Modified Rasmussens Score additionally captures the radiological features of the healing bone. Nonetheless, there is no consensus as to which tool is the best to use to document functional outcome after tibial plateau injury.

There are few studies that have documented patient reported outcomes of care of tibial plateau fractures [11, 39]. Using the Knee injury and Osteoarthritis Outcome Score (KOOS) and VAS in their study, Ramos et al., (2013) reported that the Ilizarov fixator was well tolerated, with good overall restoration of function. In Jansen's study, many patients had poor outcomes following ORIF of intraarticular tibial plateau fractures [39]. The Modified Rasmussens Score (MRS) has been used to document good functional outcomes after plating of Schatzker V and VI tibial plateau fractures, with very minimal soft tissue damage [12, 42]. Of note is that all these studies have focussed on particular groups of tibial plateau fractures and compared the functional outcomes to specific modalities of surgical care. Besides reports from South Africa, none of these studies was carried out in the sub Saharan Africa, specifically in low resource settings where there maybe delays in definitive care of these fractures.

In the current study, we used the Modified Rasmussen's Score to report the functional outcome after knee management because this score has both clinical and radiological features and hence may give a global picture of function and healing of the fraction.

JUSTIFICATION

Tibial plateau fractures are often caused by road traffic crushes and can compromise the integrity of the knee joint with subsequent reduction in function. With the advent of motorbike transport, there has been significant increase in road traffic crushes in Kenya, with an increase in the incidence of tibial plateau fractures. In our setting, the functional outcome of care of patients with tibial plateau fractures is underreported. Kenyatta National Hospital is a public owned referral health facility with stretched resources which handles large numbers of trauma patients and often with delays in definitive surgical care of the patients. PCEA Kikuyu hospital is a mid-sized faith based private hospital with an active orthopaedic unit. This study was useful now to provide up-to-date information on the basic epidemiology of tibial plateau fractures in an unselected Kenyan patient population. This study reports on the trauma mechanisms, documenting care and functional outcome of management using validated tools.

STUDY QUESTION

What are the functional outcomes of care of patients with tibial plateau fractures at PCEA Kikuyu and Kenyatta National Hospital?

OBJECTIVES

Broad Objective

To study the pattern, management and early functional outcomes of closed tibial plateau fractures as seen at Kenyatta National and PCEA Kikuyu Hospitals.

Specific Objective

1. To determine the pattern of tibial plateau fractures seen at PCEA Kikuyu and Kenyatta National Hospitals.
2. To determine the different modalities of management of tibial plateau fractures.
3. To determine patient functional status after tibial plateau fracture management.
4. To correlate the functional outcome to the pattern of injury.

CHAPTER TWO: PATIENTS AND METHODS

Study design

Prospective cross - sectional study.

Study setting

Orthopaedic Departments of KNH and PCEA Kikuyu Hospitals. PCEA Kikuyu is a 30-bed orthopedic hospital, located 25 Km to the West of Nairobi. It serves residents of Kiambu county and receives referrals from many hospitals all over the country. Kenyatta National Hospital has a 128 Bed orthopaedic Unit, and receives referrals from all over the country.

Sample size estimation

The sample size was determined by the use of Eng et al., (2003) statistical formula for descriptive studies [40]:

$$N = \frac{4\sigma^2(z_{\text{crit}})^2}{\mathrm{D}^2}$$

Where

N = Desired sample size

σ = is the assumed SD for the group, which is 10, based on the study by Rohra et al., 2016 on functional outcomes of tibial plateau fractures [12].

Zcrit = The standard normal deviate set at 1.96 which corresponds to 95% confidence level.

D = The total width of the expected confidence interval. Which is 6.

Therefore, in substitution:

$$N = \frac{4*10^2*1.96*2}{6^2} = 42$$

Selection criteria

A sample of 42 patients diagnosed with tibial plateau fractures at Kenyatta National Hospital and PCEA Kikuyu Hospital were recruited for the current study.

Inclusion criteria

1. Patients with closed tibial plateau fractures

Exclusion criteria

The following patients were excluded from this study. Those with;

1. Open fractures
2. Knee dislocation
3. Skeletal immaturity patient's younger than 18yrs.
4. Pre - existing osteoarthritis of the knee.
5. Patients with multiple fractures
6. Patients who are medically unfit for surgery.

Ethical Considerations

Ethical approval was sought from the Kenyatta National Hospital - University of Nairobi Ethics and Research Committee (KNH-UoN ERC), permission was sought from the management of the PCEA Kikuyu hospital and a signed informed signed consent obtained from patients before recruitment into this study (Appendix I and II). This was an observational study; therefore, no experiments (interventions) were performed on the patients. Patients received care as provided for in the hospitals, the outcome of which were described in this study. Participation in this study was purely voluntary, without any monetary benefits. Patients who did not wish to participate in this study were free to do so, and that did not jeopardize their subsequent care. All the patient data were kept confidential; patients' names and phone numbers were not used in the current study. All the data sheets were shredded after the study.

Study Methods

Two research assistants were recruited, one at PCEA Kikuyu Hospital, and the other at KNH. These were registered clinical officers specialised in orthopaedics. These assistants were useful in identifying eligible patients for this study. They were also useful in tracking of the patients after care. Patient demographic characteristics including age and gender were recorded in the data sheets (Appendix III). Details on the cause and mechanism of injury were sought. The patients were clinically assessed for the tibial plateau associated injuries. The post injury orthogonal anteroposterior and lateral radiographs, with standardized magnification and calibration, were assessed by the principal investigator alongside a consultant orthopaedic surgeon for the pattern of the injuries and classified according to the Schatzker classification system. Other parameters such as the articular step, condylar widening and inclination were noted and recorded in the data sheets. The patients were thereafter managed according to the hospital's protocol. For the surgically managed group, the patient was mobilized after 24 hours, for 2-5 days the range of motion allowed was 0-20°, from the 5th day the range of motion were gradually allowed to be increased to 90° or more [41]. After two weeks, full range of movement were allowed. Participants were reassessed at the 2nd, 6th and 12th postoperatively, for wound healing, active range of motion and pain. For both (surgically and non-operatively managed) groups of patients, post care orthogonal radiographs at 6 weeks and three months were assessed according to the criteria formulated by Rasmussen (1973); The articular step-off: the maximal depression or displacement of the articular surface in an axial direction on antero-posterior and lateral projections, condylar widening: measured in comparison with the ipsilateral femoral condyles and plateau tilt: the angle in the varus or valgus direction as measured on the antero-posterior projections perpendicular to the long axis of the tibia. All measurements were made using a goniometer. Outcomes of treatment, complications of the injury and care were also recorded. The patients' functional status at 3 months were assessed using the Modified Rasmussens Score (Appendix). All the collected data were recorded in sheets for analysis.

Data Management

The collected data were coded and entered into SPSS version 25 for Windows®. Means and standard deviation were determined for the quantitative variables. Univariate and multivariate regression models were used to associate the different outcomes and patient satisfaction to the fracture patterns and care provided. A P value of < 0.05 was considered significant at 95% confidence interval. Data was presented using tables and charts.

CHAPTER THREE: RESULTS

Forty-four patients were recruited into the current study. These were 37 males and 7 females. The male female ratio was 5: 1. The mean age of the participants was 37±11yrs with age range of 18 to 55yrs. The mean age of male and female patients was 37±11yrs and 33±7yrs respectively. Ten patients were excluded from the current study due to loss of follow up and were therefore not included in the final analysis.

Mode of injury

Most (41%) patients sustained injuries following RTA as passengers in motor vehicles. Thirty-three (33) percent of the injuries were associated with motorbike accidents, 22% fell from a height while one of the patients was assaulted. Most (80%) patients presented to the facilities immediately after the injury. The rest had been attended to elsewhere only to be transferred in between two days and a week after the injury. The injuries were either on the right (60%) or left (40%) limb. There was no association between the mode of injury and the injured limb. Schatzker IV fractures were the commonest TPF that were seen, while type II were the least common. There was no correlation between the type of fracture and the mechanism of injury (Table 2).

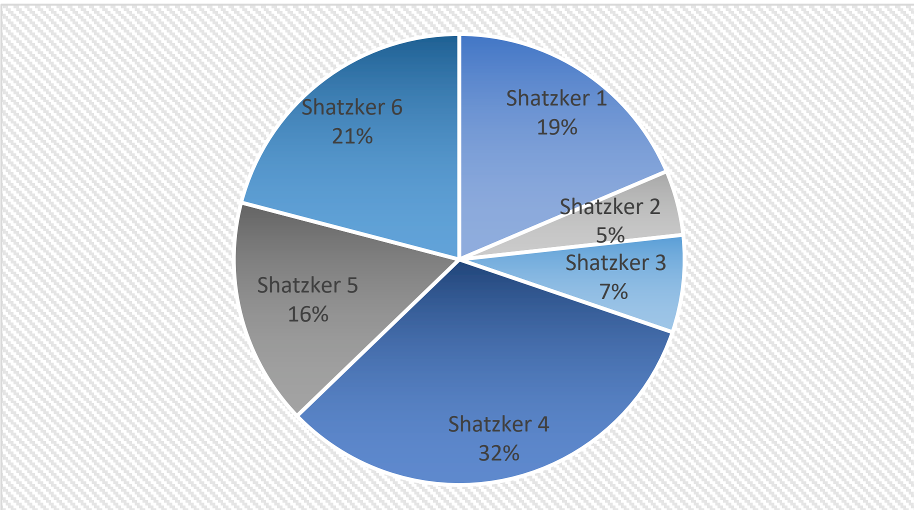

Figure 3: Types of Tibial plateau fractures

Table 1: Cause of Injury versus the affected limb

Cause of Injury	Affected Limb		Total
	Right	Left	
Motorbike	8	6	14
Motor vehicle	12	8	20
Fall	5	4	9
Assault	1	0	1
Total	26	18	44

Table 2: Cross tabulation between the type of TPF and the cause of the injury.

	Motor Vehicle Accident	Motor Bike Injuries	Fall from Height	Total
Type I	4	3	1	8
Type II	1	0	1	2
Type III	0	2	1	3
Type IV	7	4	3	14
Type V	3	2	2	7
Type VI	4	3	1	8

State of soft tissue

There was a mixed picture of the state of the soft tissues. These ranged from edematous soft tissues (n= 34), blisters (4), bruises (n=4), medial meniscal tear (n=4), compartment syndrome (n=2), lateral collateral ligament tear (n=2), medial collateral ligament tear (n=1) and common peroneal nerve injury (1).

Initial Management

The initial management of all the patients was similar. It included analgesics and a back-slab support. A temporary spanning external fixation device was used in five cases. This device was replaced with a more definitive management plan in three cases, while in two cases, it was used to definitively manage these fractures. They were removed after six and seven weeks respectively.

Definitive management

The definitive management of these fractures was either surgical (75%) or non-operative (25%). In the non-operatively managed patients, a POP was used.

Table 3: Schatzker classification versus the definitive management of tibial plateau fractures.

		Definitive management		Total
		Non-operative	Surgical	
Schatzker Classification	1	1	7	8
	2	1	1	2
	3	1	2	3
	4	3	11	14
	5	2	5	7
	6	3	6	9
Total		11	32	43

The duration of the POP ranged from 5 to 8 Weeks. In the surgically managed patients, the fractures were openly reduced with fixation using plates (26), Screws only (4), Spanning fixator (2). Among the patients who were fixed using plates, 16 had single plates, while the rest (10) had dual plate used. This was followed by standard post-operative care of the patient and range of motion exercises.

Table 4: Surgical Management of Tibial Plateau fractures

		Definitive management				Total
		External Fixator	Screws	Single plate	Double plate	
Schatzker Classification	1		4	3	0	7
	2			1	0	1
	3			2	0	2
	4			9	2	11
	5	1	0	0	4	5
	6	1	0	0	5	6
Total			4	16	10	32

Complications

The reported early complications included compartment syndrome (n=1) and wound breakdown (n=3). Intermediate complications reported included infection (n=6) and malunion (n=4). It is of note that all the malunions were found in cases which were non-operatively managed. Malunions were observed in non-operatively managed patients who had Schatzker III (n=1), Schatzker IV (n=1) and Schatzker VI (n=2).

Pain Scores

The worst resting pain at three months was reported on the VAS scale as 0 to 10. The mean worst VAS pain was 4±2. More than half of the patients reported the pain as occasional while, 20 reported the pain as significant. None of the patients reported no pain at all at rest.

Patient reported outcomes

Using the clinical modified Rasmussen's score, 23 (52.3%), 1 (2.3%), 15 (34.1%) and 5 (11.4%) of the patients reported their outcomes as poor fair, good and excellent respectively. Using the radiological modified Rasmussen's, the fracture fixation and reduction was assessed as poor, fair, good or excellent in 4 (9.1%), 6 (13.6%), 12 (27.3%) or 22 (50%) respectively. The clinical outcomes were influenced by the initial Schatzker scores of the patients (Table 5). Using the Pearson's correlation model, worse Schatzker injuries had poorer clinical outcomes as opposed to the better injuries (Coefficient = -0.830, P=0.028).

Table 5: Schatzker classification versus the MRS clinical outcomes.

		Recoded MRS Clinical				Total
		Poor	Fair	Good	Excellent	
Schatzker Classification	1	2		5	1	8
	2	1	0	1	0	2
	3	3	0	0	0	3
	4	7	1	2	4	14
	5	4	0	3	0	7
	6	6	0	3	0	9
Total		23	1	14	5	44

Patient’s with less complex injuries (Schatzker I - III), had overall better radiological outcomes as compared to the patients with worse injuries – Table 6 (Schatzker IV - VI) [Coefficient -0.2; P = 0.023].

Table 6: Schatzker Classification versus MRS Radiological assessment

		MRS Radiology recoded				Total
		Poor	Fair	Good	Excellent	
Schatzker Classification	1	0	0	2	6	8
	2	0	0	2	0	2
	3	1	0	1	1	3
	4	0	2	5	7	14
	5	0	1	2	4	7
	6	3	3	0	3	9
Total		4	6	12	21	44

Inasmuch as the numbers between the two groups were not equal, non-operatively managed patients had relatively poorer radiological outcomes compared with the ones who were surgically managed (Table 7). However, at twelve weeks only five out of 44 patients reported their clinical status as excellent (Table 8). These patients were surgically managed.

Table 7: Definitive management versus MRS radiological assessment

		MRS Radiology				Total
		Poor	Fair	Good	Excellent	
Definitive management	Non-operative	2	5	2	2	11
	Surgical	2	1	10	20	33
Total		4	6	12	22	44

Table 8: Definitive management versus MRS clinical assessment

		MRS Clinical				Total
		Poor	Fair	Good	Excellent	
Definitive management	Non-operative	9	1	1	0	11
	Surgical	14	0	14	5	33
Total		23	1	15	5	44

CHAPTER FOUR: DISCUSSION

The purpose of this study was to determine the functional outcome and correlate with severity and treatment in a Kenyan setting.

The mean age of patients who suffered from tibial plateau fractures in the current study was 37±11 years. Most fractures were reported in men, compared to women. Previous reports have suggested that traumatic tibial plateau fractures occur more commonly in individuals aged between 44 and 54years who suffer high energy injuries such as motor vehicle and motorbike accidents [14, 15]. Tibial plateau fractures affect slightly younger males in this study population compared to reports from other studies. This may be because of the relatively young active population who are likely to be involved in these injuries.

Most of the injured in this study were passengers within motor vehicles, with motor bike related injuries as the second most common cause of trauma. This is different from observations of Albuquerque (2013), who noted that 40% of these fractures are caused by a fall from a height, with 22% caused by motorcycle crash. Increased public transport safety and regulation can reduce motor vehicle caused injuries. A very small number of the patients suffered injuries secondary to a fall from a height with one patient who was a victim of physical violence.

The affected limb was either right (60%) or left almost in equal proportions. The mechanism of injury or gender did not determine the affected limb. Most of the fractures were Schatzker class IV. This is contrary to previous reports that suggested that 70% of tibial plateau fractures affect the lateral plateau [2,3, 14]. In this setting, the cause of injury and gender do not explain the type of fracture that was sustained. But this analysis may be biased because the predominant causes of injury were either motor vehicle or motorbike related injuries. It is also of note that more than two thirds of the patients had Shatzker class IV and above injuries, while the rest had lower level injuries. In young adults, low grade Schatzker injuries (I-III) are sustained from low energy injuries while the high-grade injuries (iv- vi) are caused by high energy trauma [5]. The high energy injuries reported in the current study explain the observed patterns of injury.

The associated soft tissue injuries ranged from bruises, blisters, generalized edema, peroneal nerve injury and compartment syndrome. There was therefore need to delay the definitive care of the fracture to allow soft tissue healing and prevent further soft tissue injury in patients with tibial plateau fractures in line with best practice guidelines [4]. The initial care of the injuries included limb elevation, the use of back slabs, analgesics, skin care and spanning external fixators in five of patients. Limb elevation and has been shown to reduce fracture associated edema, obviate the need for circumferential dressings and improve outcomes of care [4, 46]. The average duration of the spanning external fixator was three weeks, before it was replaced by a definitive process. The delay in conversion of the fixator to a more definitive management may have been related to inadequate theatre resources and the prevailing doctors strike in Kenya at that period of time. In two patients however, this fixator was used as the definitive care of the patients. Mankar et al., (2012) reported good outcomes in the management of tibial plateau fractures using external fixators as definitive devices. The principal of ligamentotaxis is used to approximate fragments when using an external fixator [29, 46].

The definitive care of patients with tibial plateau fractures was in this setting predominantly surgical. Tibial plateau fractures being articular injuries, usually require anatomic reduction of the fragments involved with absolute stability [22]. Some of the patients were managed non-operatively. This was partly occasioned by the unavailability of implants due to financial reasons; the Kenyan doctors strikes during part of the study period and patients' choice. The patients who were managed non-operatively were immobilized in casts for six weeks before range of motion exercises were started. Very few modern studies report on non-operative management of tibial plateau fractures [25, 48]. Some authors have reported good outcomes in non-operative care of non-displaced tibial plateau fractures [25]. Non-operative management of highly comminuted tibial plateau fractures is preferred to instrumentation, because it is associated with fewer complications [48].

Surgical care of tibial plateau fractures was largely by open reduction and internal fixation using plates and screws. Multiple techniques of approach were used, based on the type of the fracture and the surgeon's choice. During each of the approaches, the surgeons aimed at anatomical reduction of the fragments and restoration of the joint lines. Surgical management of tibial plateau fractures has undergone significant evolution [12, 42]. Ramos et al (2013) reported management of these fractures using ring fixators. However, ring fixators were not used in this setting.

The early complications related to the injury and its care included wound breakdown (n=2), infections (n=6) and malunion (n=4). In two patients the wound gaped on the second week. These gaping wounds were observed in patients who had prolonged tissue edema. Two had deep surgical site infections, discharging wounds necessitating the removal of the plate. The rest had superficial infection which was managed using antibiotics. The rate of surgical site infection in this study was about 7%. This relatively high rate of infections can be associated with the soft tissue injury associated with tibial plateau fractures, experience of the surgeon or poor technique [43]. Additionally, patients with open fractures had been excluded from the current study. Malunion was noted in the patients who were non-operatively managed. These are fractures which had significant articular depression with varus or valgus deformity of the knee joint at twelve weeks. Non-operative management of articular fractures is prone to inadequate reduction and re-displacement of the fragments even with initial adequate reduction [44]. During the study period none of the surgically managed patients had loss of reduction.

Both radiological outcomes and patient reported outcomes after the care of tibial plateau fractures were assessed in this study. Patients with lower Schatzker classified injuries had better clinical and radiological outcomes at 12 weeks of care. While patients who had higher injuries had relatively poorer clinical outcomes. Two patients who were non-operatively managed had excellent radiological results at 12 weeks. These patients had non-displaced fractures which were held in situ by cast for 6 weeks before commencing knee mobilization exercises. Non-displaced or minimally displaced tibial plateau fractures can be well managed non-operatively with good outcomes [24].

In agreement with observations by Rohra et al (2016), on the overall patients who were surgically managed had good to excellent radiological outcomes in almost all the cases. These observations were equally made by Prasad et al (2013). The current study is unique because observations from all the patients who had tibial plateau fractures were made, not focusing on particular Schatzker classes like in the Prasad (2013) study. In this study, single locked plates were largely used because a large number of fractures were unicondylar. This study also joins few studies that have focused on radiological outcomes of tibial plateau fracture care using the MRS. MRS radiological score can be measured, reproduced and determined in this setting.

Most studies have reported excellent clinical outcomes after care of tibial plateau fractures [1, 9, 12, 42]. In this setting only five patients reported the outcomes to be excellent. The discrepancy in these observations can be attributed to the short duration of follow up in the current study. In the other studies, patients were followed up to three years post care. Additionally, these studies focused on the functional clinical outcomes after using particular implants, such as dual versus single plating (12). On the contrary, this study reported functional outcomes of all patients with tibial plateau fractures irrespective of the method of care of these patients. This is because the Kenyatta National Hospital and PCEA Kikuyu hospitals are teaching hospitals with orthopaedic specialists and trainees who are exposed to different approaches to injury and fractures based on the individual experience of the specialists. Furthermore, KNH as a public hospital is sometimes strained by the high burden of trauma which stretches the theatre use and care of some patients. Additionally, the reported results are early functional outcomes, which invariably may improve with subsequent follow up of the patient for several years.

Limitation of the study

The patients were managed by different clinicians, who used different modalities of care and rehabilitation protocols and hence introducing multiple confounders to the outcomes of care. Additionally, it was not always possible to assess the full functions of some of the patients as they had not fully healed to their almost preinjury state. Some of the responses from the patients are subjective as are based on their expectations of the care that was provided. This introduces some bias in the psychometric analysis of the patient's condition.

Conclusions

Traumatic tibial Plateau fractures are common in the young males in this setting. These fractures are predominantly managed surgically with excellent radiological outcomes. The early functional outcomes of care of these patients is poor.

Recommendations

Longer follow up period is recommended to fully assess the clinical outcomes of care of patients with tibial plateau fractures. Standardizing of care of these fractures is also recommended to make rational comparisons and outcome reports in the hospital.

REFERENCES

1. Manidakis N, Dosani A, Dimitriou R, Stengel D, Matthews S, Giannoudis P. 2010. Tibial plateau fractures: functional outcome and incidence of osteoarthritis in 125 cases. International Orthopaedics (SICOT). 34:565-570.
2. Agnew SG. 1999. Tibial Plateau Fractures. Operative Techniques in Orthopedics. 9(3): 197-205.
3. Fenton P, Porter K. 2011. Tibial Plateau Fractures: A review. Trauma. 13(3): 181-187.
4. Prat-Fabregat S, Camacho-Carrasco P. 2016. Treatment strategy for tibial plateau fractures: an update. Effort Open Review. 1:225-232.
5. Schatzker J, McBroom R, Bruce D. 1979. The tibial plateau fracture: the Toronto experience 1968-1975. Clin Orthop Relat Res. 138:94-104.
6. Müller ME, Nazarian S, Koch P, Schatzker J. 1990. The comprehensive classification of fractures of long bones. New York: Springer. 50 – 51.
7. Müller ME, Nazarian S, Koch P, Schatzker J. 2012. The comprehensive classification of fractures of long bones. Berlin, Heidelberg: Springer Science & Business Media. 60 – 61.
8. Stannard JP, Lopez R, Volgas D. 2010. Soft tissue injury of the knee after tibial plateau fractures. J Knee Surg. 23 (4):187-92.
9. Ambulgekarl RK, Kothari P, Berlia R. 2016. A study of Outcome of Tibial Plateau Fracture with Minimally Invasive Percutaneous Plate Osteosyntheisis (MIPPO) Technique. Indian Journal of Orthopaedics Surgery. 2(3):236-239.
10. Gupta RK, Dev B, Singh H. 2013. Displaced Tibial Plateau Fractures: Is There a Role Of Conservative Treatment In The Present Scenario. 15: 28-32.
11. Ramos T, Ekholm C, Eriksson BI, Karlsson J, Nistor L. 2013. The Ilizarov external fixator--a useful alternative for the treatment of proximal tibial fractures. A prospective observational study of 30 consecutive patients. BMC Musculoskelet. Disord. 14: 11.

12. Rohra N, Suri HS, Gangrade K. 2016. Functional and Radiological Outcome of Schatzker type V and VI Tibial Plateau Fracture Treatment with Dual Plates with Minimum 3 years follow-up: A Prospective Study. J Clin Diagn Res.; 10(5): RC05-RC10.

13. Court-Brown CM, Caesar B. 2006. Epidemiology of adult fractures: a review. *Injury*. 37(8):691-697.

14. Albuquerque RP, Hara R, Prado J, Schiavo L, Giordano V, Amaral NP. 2013. Epidemiological study on tibial plateau fractures at a level I trauma center. Acta Ortop Bras. 21(2):109-15.

15. Elsoe R, Larsen P, Nielsen NPH, Swenne J, Rasmussen S, Ostgaard SE. 2015. Population-Based Epidemiology of Tibial Plateau Fractures. *Orthopedics.* 38(9):e780-e786.

16. Ebraheim, N. a, Sabry, F. F. & Haman, S. P. 2004. Open reduction and internal fixation of 117 tibial plateau fractures. Orthopedics. 27: 1281-1287.

17. Chan PS, Klimkiewicz JJ, Luchetti W. 1997. Impact of CT scan on treatment plan and fracture classification of tibial plateau fractures. J Orthop Trauma 11:484-9.

18. Yacoubian SV, Nevins RT, Sallis JG, Potter HG, Lorich DG. 2002. Impact of MRI on treatment plan and fracture classification of tibial plateau fractures. J Orthop Trauma. 16(9):632-637.

19. Martin JS, Marsh JL. 1997. Current classification of fractures. Rationale and utility. Radiol Clin North Am. 35(3):491-506.

20. Society, C. O. T. 2006. Open reduction and internal fixation compared with circular fixator application for bicondylar tibial plateau fractures. Results of a multicenter, prospective, randomized clinical trial. J. bone Jt. surgery. 88: 2613-2623.

21. Maripuri SN, Rao P, Manoj-Thomas A, Mohanthy K. 2008. The classification systems for tibial plateau fractures: how reliable are they?. Injury. 39: 1216-1221.

22. Jensen DB, Rude C, Duus B. 1990. Tibial plateau fractures. A comparison of conservative and surgical treatment. J Bone Joint Surg Br 72:49-52.

23. Apley AG. 1956. Fractures of the lateral tibial condyle treated by skeletal traction and early mobilisation; a review of sixty cases with special reference to the long-term results. J Bone Joint Surg Br 38-B:699-708.

24. Lansinger O, Bergman B, Korner L et al. 1986. Tibial condylar fractures. A twenty-year follow-up. J Bone Joint Surg Am 68:13-19.

25. Delamarter R, Hohl M. 1989. The cast brace and tibial plateau fractures. Clin Orthop Relat Res. 242:26-31.

26. Rasmussen PS. 1973. Tibia condylar fractures: Impairment of knee joint stability as an indication for surgical treatment. J Bone Joint Surg Am. 55-A: 1331-1334.

27. Hall JA, Beuerlein MJ, McKee MD. 2009. Canadian orthopaedic trauma society. Open reduction and internal fixation compared with circular fixator application for bicondylar tibial plateau fractures. Surgical technique. J Bone Joint Surg [Am]. 91:74-88.

28. Borrelli J Jr. 2014. Management of soft tissue injuries associated with tibial plateau fractures. J Knee Surg. 27:5-9.

29. Donaldson LJ, Cook A, Thomson RG. 1990. Incidence of fractures in a geographically defined population. *J Epidemiol Community Health*. 44(3):241-245.

30. Laible C, earl-royal E, Davidovitch R, Walsh M, Egol KA. 2012. Infection after spanning external fixation for high-energy tibial plateau fractures: is pin site-plate overlap a problem? J Orthop Trauma. 26:92-7.

31. Shah CM, Babb PE, McAndrew CM. 2014. Definitive plates overlapping provisional external fixator pin sites: is the infection risk increased? J Orthop Trauma. 28:518-22.

32. Papagelopoulos PJ, Parsinevelos AA, THemistocleous GS, Mavrogenis AF, Korres DS, Soucacos PN. 2006. Complications after tibia plateau fracture surgery. Injury. 36: 475 -484.

33. Favero M, Ramonda R, Goldring MB, Goldring SR, Punzi L. 2015. Early knee osteoarthritis. RMD Open. 1(Suppl 1):e000062.

34. Colwell CW, D'Lima DD, Hoenecke HR, Fronek J, Pulido P, Morris BA, Chung C, Resnick D, Lotz M. 2001. In vivo changes after mechanical injury. Clin Orthop Relat Res. 391 (Suppl): S116-S123.

35. Lachiewicz PF, Funcik T. 1990. Factors influencing the results of open reduction and internal fixation of tibial plateau fractures. Clin Orthop Relat Res. 210:215.

36. Ahearn N, Oppy A, Halliday R, Rowett-Harris J. 2014. The outcome following fixation of bicondylar tibial plateau fractures. Bone Joint J. 96-B:956 - 62.

37. Rademakers MV, Kerkhoffs GM, Sierevelt IN, Raaymakers EL, Marti RK. 2007. Operative treatment of 109 tibial plateau fractures: five- to 27-year follow-up results. J Orthop Trauma. 21 (1):5-10.

38. The Canadian Orthopaedic Trauma Society: Open reduction and internal fixation compared with the circular fixator application for bicondylar tibial plateau fractures. Results of a multicenter, prospective, randomised clinical trial. J Bone Joint Surg Am. 2006, 88;12: 2613-2623.

39. Jansen, H., Frey, S. P., Doht, S., Fehske, K. & Meffert, R. H. Medium-term results after complex intra-articular fractures of the tibial plateau. J. Orthop. Sci. (2013). doi:10.1007/s00776-013-0404-3

40. Eng J. 2003. Sample size estimation: How many individuals should be studied? Radiology. 227: 309–313.

41. Vasanad GH, Antin SM, Akkimradi RC, Policepatil P, Naikawadi G. 2013. Surgical Management of Tibial Plateau Fractures, A Clinical Study. J Clin Diagn Res. 7(12): 3128-3130.

42. Prasad GT, Kumar TS, Kumar Rk, Murthy GK, Sundaram N. 2013. Functional outcome of Schatzker type V and VI tibial plateau fractures treated with dual plates. Indian J Orthop. 47:188-94.

43. Dubina AG, Paryavi E, Manson TT, Alimon C, O'toole RV. 2017. Surgical site infection in tibial plateau fractures with ipsilateral compartment syndrome. Injury. 48 : 495 – 500.

44. Meena S, Sharma P, Sambharia AK, Dawar A. 2014. Fractures of Distal Radius: An Overview. J Fam Med Prim Care. 3: 325 – 332.

45. Mankar SH, Golhar AV, Badwalk PS, Faizan M, Kalkotwar S. 2012. Outcome of complex tibial plateau fractures treated with external fixator. Indian J Orth. 46: 570 – 574.

46. Borelli J. 2014. Management of Soft Tissue Injuries Associated with Tibial Plateau Fractures. J Knee Surg. 27:5–10.

47. Hohl M. 1991. Fractures of the proximal tibia and fibula. In: Rockwood C, Green D and Buckolz R (eds) Fractures in Adults, 3rd ed. Philadelphia: J.B Lippincott, 1725–1761.

48. Young M, Barrack RL. 1994. Complications of internal fixation of tibial plateau fractures. Orthopaedic Rev. 23: 149 – 154.

APPENDIX I: CONSENT FORM

Participant number………………………

This is a kind request for your participation in a medical research. The principal investigator will explain this research to you. Please take your time to make your decision before participating. If you have any questions feel free to ask the investigator.

Aim of study: This study aims at documenting patient management and outcomes after tibial plateau fractures.

Benefits: Tibial plateau fractures are common. We have not followed up keenly to find out the rate of patient satisfaction after care of patients with these fractures.

Risks: During this study, you will not be exposed to any additional risks beyond the normal risks that occur during care of patients of tibial plateau fractures. In this study, your care plan will not be changed at all.

Ethics: Your consent will be highly appreciated. Your consent to this study will be to allow us to interview you before and after the care as well as take some data concerning the procedure you are to undergo in your treatment plan. We will not intervene in anyway during your procedure, meaning, you will receive care as planned according to the hospital protocol. Your participation in this study is voluntary. Participating in this study does not put you at any additional risk beyond that which you may have during the surgery. You will not be compensated to participate in this study.

Confidentiality: The identities of the subjects will be concealed by use of participant numbers instead of names and no information concerning them will be published except that which is directly related to the research. Moreover, no information will be disclosed to any unauthorized persons.

Humble request: Therefore, I humbly request you to participate and allow us to collect data concerning your procedure. Participation will be entirely on a voluntary basis and there will be no coercion nor any financial compensation whatsoever to the participants. The choice of the patients to participate will be highly respected regardless of their decisions. Even when you choose not to participate, this decision will not affect your subsequent care. Data will be collected within the time approved by

Kenyatta National Hospital/ University of Nairobi Ethics and Research Committee (KNH/UoN- ERC). The investigator can be reached through mobile phone number 0721486182 and the chairperson of KNH/UoN-ERC can be reached through 020-7264009.

INDEPENDENT CERTIFICATE FORM

I the undersigned have been explained to and have understood the above and willingly accept to participate in the research study.

Signature …………………………….. Date ……………………………………..

I the investigator, having explained in detail the purpose of this study, hereby submit that confidentiality of the data collected will be maintained and only details relevant to the study will be revealed.

Signature ……………………………….. Date …………………………………..

INVESTIGATOR

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Dr. John King'ori, P.O BOX 30197-00100, University of Nairobi,Nairobi, Kenya. Phone number 0725979524.

Chairperson of KNH/UoN-ERC can be reached through 020-7264009.

APPENDIX II: CHETI CHA RUHUSA
Namba ya mshiriki ……………………………..

Hili ni ombi kwako kwa kushiriki kwako katika utafiti wa matibabu. Mpelelezi mkuu atakuelezea kuhusu utafiti huu. Tafadhali chukua muda kufanya uamuzi wako kabla ya kushiriki. Ukiwa una swali lolote kuhusiana utafiti huu jiskie huru kumuuliza mtafiti.

LENGO LA UTAFITI: Upasauaji wa muundi. Tungependa kufuatilia kwa kina wagonjwa wote ambao wanapata matibabu haya ili kunakili matokeo yao.

MUHIMU: Umuhimu wa Kunakili Jinsi wagonjwa wanavyoendele baada ya matibabu ya muundi uliovunjika.

MAADILI: Ili utafiti huu ufanyike, hatuna budi ila kuomba ruhusa yako na ushirikishi wako. Utakapokubali, utapata matibabu yako ipaswavyo kwa kiwango kilichowekwa na hospitali. Hautaongezwa madhara yoyote kwa kuwa umehusika kwenye utafiti huu. Kuhusika kwako kwenye huu utafiti ni kwa hiari yako, na hautalipwa kwa kuhusika.

USIRI: Majina ya washiriki hayatatumika na badala yake nambari zitatumika kutambulisha washiriki, Hii ni kwa nia ya kuficha utambulisho ya wanaoshiriki. Aidha, majibu ya utafiti huu utaonekana na watu walioidhinishwa pekee.

OMBI : Ushiriki wako katika uchunguzi huu ni wa kujitolea na hapatakuwa na fidia yoyote ya kifedha. Uchunguzi huu utafanywa katika muda ulioidhinishwa na kamati cha KNH-UON/ERC, kati ya mwezi wa Septemba hadi Novemba 2016. Uamuzi wako kushiriki utapewa heshima ya juu. Kutokubali kushiriki katika utafiti huu kutaeleweka na kuheshimika, na hakuta katiza kwa vyovyote matibabu yako.

Unaweza kuwasiliana mtafiti mkuu kupitia nambari ya simu 0721486182. Katibu mkuu wa KNH-UON/ERC anaweza kupatikana kupitia hii nambari 020-7263009.

FOMU YA IDHINI

Mimi mshiriki nathibitisha nimeyafahamu aliyonieleza mtafiti na nimekubali kwa hiari yangu kushiriki katika uchunguzi huu.

Sahihi ……………………… Tarehe………………………….

Mimi mtafiti nathibitisha ya kwamba nimemweleza mshiriki kuhusu uchunguzi huu ipasavyo na habari inayohusiana na uchunguzi huu tu ndio itakayochapishwa.

Sahihi ya mtafiti …………………………… Tarehe ………………………

MTAFITI

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Chairperson of KNH/UoN-ERC can be reached through 020-7264009.

APPENDIX III: DATA COLLECTION SHEET

1. BIODATA: Case No __Phone No ______________Age____Yrs Gender: M FM
2. INJURY
    1. Injury Timing: Date of Injury ______Time of Injury_____
    2. Cause of Injury: Motor Bike Motor Vehicle Other (Specify)
    3. Role in Accident: Passenger Driver Pedestrian
    4. Affected limb Right Left Both
1. STATE OF SOFT TISSUE:
    1. Compartment syndrome: Yes No
2. INVESTIGATIONS
    1. Radiographs: Schatzker I II III IV V VI Unclassified
3. MANAGEMENT PLAN

    Initial Management
    a. Temporary External Fixator Yes No
    b. Others
        a. Back Slab Yes No
        b. Specify ________________

    Definitive management

    a. Date of management: Duration from the date of injury
    b. Conservative (Specify)
        a. ______________
        b. _____________________

    b. Operative / stabilization method
        1. Plating Yes No
        2. Ilizarov Yes No
        3. Bone grafting Yes No
        4. Arthroscopic assisted reduction Yes No
        5. Other: Specify ______________________
4. Duration of Hospital Stay _____ Days
5. COMPLICATIONS
    1. Early complications (Day 0 – 14)
        1. Compartment Syndrome Yes No
        2. Wound breakdown Yes No
        3. Deep Vein Thrombosis Yes No
        4. Secondary Dislocation Yes No
        5. Nerve Injury Yes No
        6. Reoperation Yes No
    2. Intermediate complications (6 Weeks)
        1. Wound Infection Yes No
        2. Osteomyelitis Yes No
        3. Stiff Knee Yes No ROM: Flexion arc______
        4. Malunion Yes No
        5. Peroneal Nerve Injury Yes No
        6. Others
            1. ________________
            2. ________________

6. Worst pain score in the last 6 weeks**:** **(**1-10) __________

MODIFIED RASMUSSENS CRITERIA FOR CLINICAL ASSESSMENT (12 WEEKS)

ATTRIBUTE	SCORE	
Pain		
None	6	
Occasional	5	
Stabbing pain in certain positions		3
Constant pain after activity		1
Significant rest pain		-3
Walking Capacity		
Normal Walking capacity for Age		6
Walking Outdoors (> 1 Hour)		5
Walking outdoors (15 min – 1 hour)		3
Walking outdoors (<15 Min)		1
Wheelchair/bedridden	**-3**	
Knee Extension		
Normal	4	
Lack of Extension (< 10^0)		2
Lack of Extension (> 10^0)		0
Lack of Extension (> 20^0)		-2
Total Range of Motion		
Full	6	
Atleast 120^0	5	
Atleast 90^0	3	
Atleast 60^0	1	
< 60^0	-3	
Stability		
Normal Stability in extension and 20^0 flexion		6
Abnormal Stability in 20^0 flexion		4
Instability in extension < 10^0 flexion		2
Instability in extension >10^0 flexion		0
Power of Quadriceps		
Grade 5	2	
Grade 3-4	1	
Grade<3	- 2	
Maximum Score	**30**	
Excellent	28-30	
Good	24-27	
Fair	20-23	
Poor	<20	

MODIFIED RASMUSSENS CRITERIA FOR CLINICAL ASSESSMENT (12 WEEKS) - SWAHILI

KIPENGELE	**SCORE**
Uchungu	
Hakuna	6
Kidogo	5
Yauma kwa position Fulani fulani	3
Kila baada ya shuguli	1
Uchungu hata bila kazi	-3
Uwezo wa kutembea	
Kawaida	6
Kutembea nje Zaidi ya saa moja	5
Kutembea nje (Dakika 15 hadi saa moja)	3
Kutembea nje chini ya dakika 15	1
Huwezi kutembea kamwe	**-3**
Kunyorosha goti	
Kawaida	4
Kishindwa Chini ya 10^0	2
Kushidwa Zaidi ya 10^0	0
Kishindwa Zaidi ya 20^0	-2
Uwezo wa kukunja goti	
Yote	6
Hadi 120^0	5
Hadi 90^0	3
Hadi 60^0	1
$< 60^0$	-3
Msimamo wa goti	
Goti halichezi likinyoroshwa na kunjwa hadi 20^0	6
Goti linacheza likikunjwa hadi 20^0	4
Linacheza likinyoroshwa na kunjwa $< 10^0$	2
Linacheza likinyoroshwa na kunjwa $>10^0$	0
Nguvu za misuli	
Gradi 5	2
Gradi 3-4	1
Gradi<3	- 2
Hesabu ya juu	**30**
Nzuri sana	28-30
Nzuri	24-27
Afadhali	20-23
Mbaya	<20

MODIFIED RASMUSSENS CRITERIA FOR RADIOLOGICAL ASSESSMENT 12 WEEKS)

ATTRIBUTE	SCORE
Articular Depression	
None	3
<5mm	2
6-10mm	1
>10mm	0
Condylar Widening	
None	3
<5mm	2
6-10mm	1
>10mm	0
Varus/Valgus angulation	
None	3
$<10^0$	2
$10 - 20^0$	1
$>20^0$	0
Osteoarthritis	
None/No progress	1
Progression by 1 grade	0
Progression by >1 grade	-1
Maximum Score	
Excellent	9-10
Good	7-8
Fair	5-6
Poor	<5