UNIVERSITY OF NAIROBI

PATTERNS, COMPLICATIONS AND EARLY FUNCTIONAL OUTCOMES OF ACETABULAR FRACTURES IN THREE URBAN HOSPITALS IN KENYA

By

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A dissertation submitted in partial fulfilment of the requirements for the award of the degree of Master of Medicine (M. Med) in Orthopaedic Surgery in the University of Nairobi.

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July 2022

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DEDICATION

I dedicate this work to my dear wife Diana Okello, for her love, counsel, encouragement and patience, as well as my daughter Moraa and son Adogo. Thank you for the cheer, perseverance and belief in me.

LIST OF ACRONYMS AND ABBREVIATIONS

AVN	Avascular necrosis
AO/OTA	Arbeitsgemeinschaft für Osteosynthesefragen foundation/Orthopedic Trauma Association
AP	Anterior Posterior
AM	Abductor Moment
ASIS	Anterior Superior Iliac Spine
BM	Body Mass
BMI	Body Mass Index
CT	Computer Tomography
DVT	Deep Venous Thrombosis
EPUAP	European Pressure Ulcer Advisory Panel
ERC	Ethics and Research Committee
HO	Heterotopic Ossification
HHS	Harris Hip Score
IOV	Iliac Oblique View
KNH	Kenyatta National Hospital
MAP	Merle d'Aubigné-Postel
MCFA	Medial Circumflex Femoral Artery
NCRH	Nakuru County Referral Hospital
NTSA	National Transport and Safety Authority
OOV	Obturator Oblique View
ORIF	Open Reduction Internal Fixation
PE	Pulmonary Embolism
PSIS	Posterior Superior Iliac Spine
SPSS	Statistical Package of Social Sciences
SSI	Surgical Site Infection
THR	Total Hip Replacement
UON	University Of Nairobi
WHO	World Health Organization
2D/CT	Two Dimensional Computed Tomography
3D/CT	Three Dimensional Computed Tomography

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ABSTRACT

Background: Acetabular fractures are a subset of pelvic fractures commonly occurring due to high-energy trauma, and present a unique challenge to orthopaedic surgeons due to their inherent complexity. Motor vehicle crashes constitute approximately 1.24 million global deaths annually, with a further 20 – 50 million suffering either a minor or major injury.

Kenya has an estimated road fatality rate of 27.8 per 100,000 population, according to a 2018 World Health Organization report. Road crash statistics for Kenya as at 31st October 2020 released by the National Transport and Safety Authority (NTSA) indicate a 5.8% increase in fatalities compared to the same period in 2019. There is limited local and regional data on acetabular patterns and outcomes.

Study objective and justification: To determine patterns, complications, and early outcomes of acetabular fractures in patients at three urban hospitals in Kenya. This will inform policy, training, prevention and resource allocation.

Study Setting and Design: A prospective cohort study undertaken at Kenyatta National, Nakuru County Referral, and Coptic Hospitals.

Methods: Fourty six adult patients who presented to the Accident and Emergency departments of the participating hospitals that met the inclusion criteria were recruited. Fracture classification was based on images of plain antero-posterior radiographs and CT scans. Observations for early outcomes were made in the course of their inpatient stay and clinic follow-up. A Harris Hip Scores and lower limb length discrepancy was measured at 12 weeks post-management.

Data analysis: Data were collated using a data collection sheet, and analysed using the

IBM®Statistical Package of Social Sciences (SPSS)® Statistics version 26. Fracture patterns, complications, fracture management modalities and Harris Hip Score measures were analyzed descriptively and presented in graphical and tabular form. Harris Hip Scores were correlated with fracture patterns, time to surgery and management modalities using Pearson's Chi- square test and Fisher's exact test. Multiple regression analysis was be employed for multivariate analysis of collected data.

Study Utility: This study set out to draw associations between fracture morphology, complications, treatment methods and early functional outcomes. It is hoped that it will inform the practice of acetabular fracture management.

Results: Fourty six patients were included in the study, with most (89.1%) being males. The age ranged from 18 – 72 years (Mean 34.9yrs ± 13.1yrs). A majority of the patients, (67.4%) were treated at the Kenyatta National Hospital, 14 (30.4%) at NCRH and only 1 (2.2%) had complete data at Coptic Hospital at the end of the study. The patients' Harris hip scores ranged from 51 – 95 with a mean score 76.6 (± 9.7) considered a fair score. Fracture displacement ranged from 0 – 44 mm with a mean of 19.5mm (± 13.9mm) using 2-Dimensional CT cuts. The posterior wall and the transverse with posterior wall fracture patterns were the most prevalent patterns (23.9%). Operative treatment undertaken in most patients (58.7%). There was a statistically significant correlation between HHS and fracture displacement ($p<0.001$), operative fracture management ($p< 0.001$) and duration of hospital stay ($p<0.024$).

Conclusion: Operative management is best suited for displaced fractures, with non-operative care reserved for those with minimal displacement or those unfit for surgery. A majority of patients underwent surgical fixation (58.7%), indicative of the severity of injury and fracture displacement necessitating operative care. Of note is the poorer HHS in patients with initially

large fracture displacement, and longer hospital stay. Higher HHS were seen in operatively managed patients. The HHS performed early showed agreement with scores done a year after surgery, suggesting that early scoring may help predict future functional outcomes.

Recommendations: Acetabular fractures have the potential for sequelae that hamper activities of daily living, with pain and disability. They pose a risk for the development of post traumatic arthritis of the hip joint, that may necessitate total hip arthroplasty. Measures to ensure anatomical reduction, early surgery, reduced length of hospital stay, and operative management for displaced fractures should be undertaken, which include prioritization of these patients for surgery, and increasing the pool of expertise able to tackle these complex fractures. Educating road users of all cadres and other occupations at risk on safe and considerate road use and workplace safety is paramount to reducing the occurrence of these high energy injuries.

1.0 INTRODUCTION

1.1 Background

Acetabular fractures frequently result from high-energy trauma and have historically been infrequent.(1,2) Their severity is demonstrated by the fact that the earliest descriptions were from autopsy studies of patients involved in severe trauma.(3) Mutiso et al found 87 per cent of pelvic fractures occur due to motor vehicle accidents, representing a high-energy mechanism of injury.(4) Road traffic accidents cause almost 1.24 million deaths globally annually, with a further 20 – 50 million suffering injuries of varying severity. Adults aged 15 to 44 years make up 59% of global traffic deaths. (5) As at the year 2009, motorcyclists comprised 7% of all traffic deaths in Kenya. Kenya has an estimated road fatality rate of 27.8 per 100,000 population.(6) Current road crash statistics for Kenya as at 31st October 2020 released by the National Transport and Safety Authority (NTSA) indicate a 5.8% increase in fatalities compared to 2019. The NTSA estimates that road traffic accidents cost the Kenyan economy nearly Ksh 14 billion annually.(7)

Acetabular fractures are primarily caused by road traffic accidents, with rates ranging between 40% (8), and 76% (9). Other causes include falls from a height and sports injuries.(2) Legislated seatbelt use in Canada in 1987 saw a marked decrease in acetabular fractures and other associated injuries.(10) Enforcement of safety measure adherence for road users and industrial workers has the potential to significantly reduce the incidence.

There is scant literature on acetabular fracture patterns in East African region. Determining complications and early outcomes, and their correlation with fracture morphology, has the potential to inform better decision making in patient care.

1.2 Problem Statement

Acetabular fractures as a subset of pelvic fractures pose a unique challenge to the injured and orthopaedic surgeons. The hip being a joint that bears tremendous forces has an increased propensity to suffer the sequelae of injury if an anatomic reduction is not restored. The morbidity of acetabular fractures affects activities of daily living and pain-free ambulation. Acetabular fractures are associated with complications such as hip dislocation and neurological injury. Currently, there is scant literature on fracture patterns and outcomes in the Kenyan setting.

1.3 Justification and Significance

Congruency of the articular surface in displaced acetabular fractures highly correlates with functional outcomes. (11,12)

There is currently no study that has determined acetabular fracture patterns and outcomes in Kenya. It is yet to be determined how many are managed operatively or non-operatively, and the spectrum of complications emerging during patient care.

With the increasing use of motorcycles in Kenya in both urban and peri-urban areas, the burden of road traffic accidents continues to rise, placing a great strain on existing healthcare systems. The complexity of these fractures requires appropriate radiographic imaging and specialized orthopaedic care, which is limited to tertiary healthcare facilities. Therefore, an efficient referral system and timely treatment planning are required for optimal functional outcomes.

As the current thinking shifts strongly towards operative management for most of these patients, objective outcome measures must guide decision making and aid in appropriate patient selection for both operative and non-operative care. This study aims to identify potential areas of improvement in making policies that streamline and strengthen referral systems, ensuring that patients suffering this injury type are managed expediently.

1.4 Study Question

What are the patterns, complications and early outcomes of acetabular fractures at KNH, NCRH, and Coptic Hospital?

1.5 Main Objective

To determine the patterns, complications and early outcomes of acetabular fractures at three urban hospitals in Kenya

1.6 Specific Objectives

1. To determine acetabular fracture patterns based on the Letournel Classification at three urban hospitals in Kenya.
2. To determine early outcomes in patients with acetabular fractures (first 3 months).
3. To assess early outcomes measured as hip function using the Harris Hip Score at 12 weeks post-management.

2.0 LITERATURE REVIEW

2.1. Anatomy

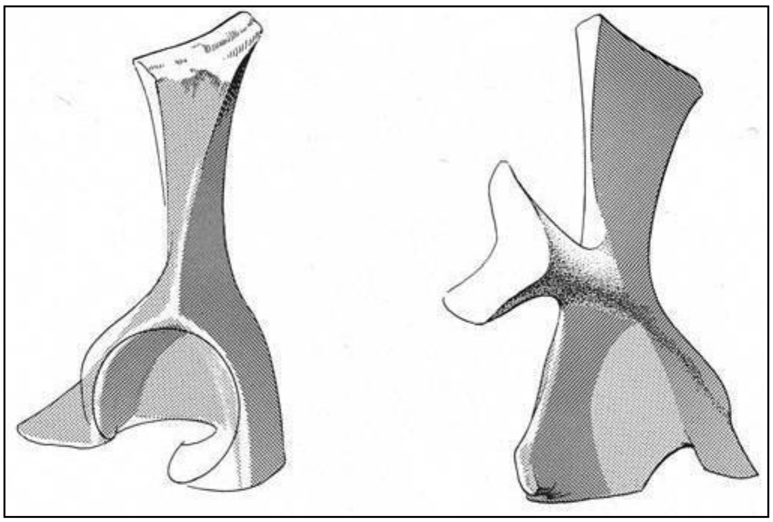
The pelvis is the bony structure that transmits upper body weight to the lower extremities and is made of the sacrum with the two innominate bones.(13)

The acetabulum is made up an anterior and posterior column that converge in the supracetabular region.(13–15) These two columns join the axial skeleton through the sciatic buttress, a segment of dense bone that extends posteriorly forming the articulating surface of the sacroiliac joint.(16) The anterior and posterior walls project from the respective columns, forming the acetabular cup.(14) The ilium, ischium, and pubis converge centrally forming the acetabular cavity. The semi-lunar cartilaginous portion of the acetabulum is the main weight transmitter, from innominate bone to lower limb(16), and surrounds the non-articular cotyloid fossa.(14)

The anterior column is the larger portion of the two, extending from the superior pubic ramus to the iliac wing. The posterior column runs from the ischiopubic ramus as the ischium to the ilium.(14) The column concept envisions the anterior column as comprising the anterior half of the iliac crest, the iliac spines, the anterior half of the acetabulum, and the pubis, with the posterior column comprising the ischium, the ischial spine, the posterior half of the acetabulum and the sciatic notch. (16) These two columns when visualized enface form the Greek lambda sign (λ) with the acetabulum at the confluence of the two arms. (See Figure 1)

The column concept is key not only in the classification but also in guiding surgical approaches.(17) The weight-bearing portion is the roof or dome. The quadrilateral plate is a segment of bone forming the medial acetabular wall and the lateral border of the true pelvic cavity.(18)

Figure 1: Anterior and Posterior acetabular columns (Inverted Y).



Adapted from *Fractures of the Acetabulum. M Tile. 2005, Springer, p 295*

2.2 Hip Joint Biomechanics

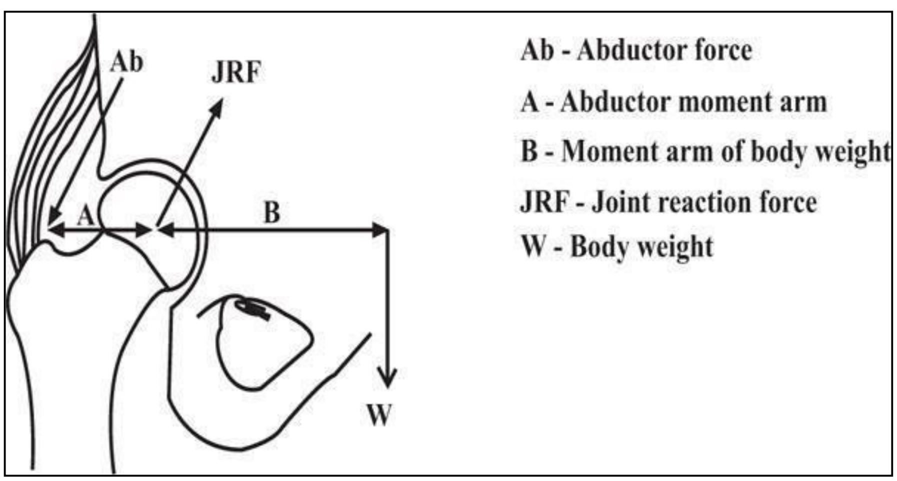
Mechanical forces affecting the hip joint are difficult to precisely elucidate.(17) Forces are greatest in the mid-stance position of the gait cycle and are derived from Body Weight (BW) and abductor moment. BW is centred anterior to S2 vertebrae, exerting its actions at the hip joint by rotating the pelvis about the femoral head towards the centre of gravity. The Abductor moment (AM) counteracts this by rotating the pelvis outwards. (17) During single-leg stance, BW and AM are equal, thus maintaining an upright position. (Figure 2)

The joint reactive force is the compressive force at the femoral-acetabular joint resulting from the need to balance Body Weight and Abductor Moment. The main contributor to this force is muscular forces at the pelvic level when standing, with a small input from body weight. These forces are highest during stair descent.(19,20)

The weight-bearing segment varies with the position of the femoral head and the acetabulum during the gait cycle. During normal loading, a large area of the articular surface participates in load transmission. On the femoral head, the anterior superior and posterior surfaces are involved. Two columns of force are created, and the force is transmitted within two acetabular margins into the acetabular fossa.

Matta delineated the most important load-bearing acetabular segment.(21) Recent literature has described specific zones in the acetabulum that if fractured is associated with poorer outcomes. These have been determined to be the acetabular roof and posterior wall.(22)

Figure 2: Mechanical forces acting across the hip joint.



Adapted from *Basic Science Considerations in Primary Total Hip Replacement Arthroplasty. Mirza et al, 2010, The Open Orthopaedics Journal, Volume 4, page 170.*

2.3. Fracture Management

1.3.1 Surgical Management

Surgical fixation is the preferred management, with the accuracy of fracture reduction (anatomical reduction) being the strongest determinant of functional outcome. (23) However, conservative management of some fractures in the elderly has yielded encouraging results, with pain and the capacity to do regular daily self-care activities regarded as outcome measures after treatment. (24,25) Fracture patterns amenable to non-surgical management are those with medialization of the femoral head and/or joint congruity. (11)

The timing of surgery is an important factor, with delays causing poorer radiological and functional outcomes. Patients with elementary/simple fracture patterns have better outcomes if operated on within 15 days, with those having associated/complex patterns best surgically managed within 5 days. Post-surgical complications may include iatrogenic nerve injury, infection, avascular necrosis, heterotopic ossification, post-traumatic hip arthritis, and thromboembolic events (21).

Indications for surgery are multifactorial, with considerations of age, medical conditions, bone quality, associated injuries, and patient expectations.(26) However, absolute indications for surgery include irreducible dislocations, open fractures, associated vascular injuries, intra-articular loose fragments, and neurological deterioration post-reduction suggestive of sciatic nerve entrapment.(26)

2.3.2 Surgical Approaches

The surgical approaches employed in operative management are the Ilioingunal, Kocher-Langenbeck, the Extended Iliofemoral Approach, and the Modified Stoppa approach. These exposures offer different levels of access to both the anterior or posterior columns and walls.

The Ilioingunal approach grants exposure to the anterior column, quadrilateral surface, and the upper posterior column.(27) It is employed in anterior column/anterior wall, anterior column posterior hemitransverse, and transverse and posterior column fractures. (27) This approach needs the development of access points, the lateral, middle, and medial windows that enable access to the anterior column and quadrilateral surface.

The lateral window (lateral to the iliopsoas) provides access to the ilium's inner surface, the pelvic brim, and the anterior sacroiliac joint. The middle window is between the iliopsoas and the femoral vessels enabling visualization of the quadrilateral plate and the pelvic brim. The medial window is medial to the femoral vessels, and enables access to the pubic symphysis and the superior pubic ramus. (27) Limitations of this approach include limited access to posterior column structures unless a modification is made – the extended Ilioinguinal approach, where the iliac incision is extended posteriorly to the posterior superior iliac spine (PSIS).

The Kocher-Langenbeck approach enables exposure of the whole extent of the posterior column, posterior wall, ischial spine, greater and lesser sciatic notches, and the retroacetabular surface. It is employed in fixation of posterior column/posterior wall, transverse and T-type fractures.(27) Visualization of the acetabular dome is enabled by the division of the gluteus medius and minimus tendons. Access to the greater and lesser sciatic notches is gained through raising of the piriformis muscle and the conjoint tendons. The quadrilateral plate may be palpated through the greater sciatic notch. (27)

It poses the danger of iatrogenic injury to the Medial Femoral Circumflex Artery (MFCA) and the sciatic nerve. The deep branch of the MFCA is the principal vascular supply to the femoral head. (27) Iatrogenic sciatic nerve injury is a possibility, thus intimate knowledge of the varied course and relations of the sciatic nerve is necessary. The nerve most commonly emerges anterior to the piriformis (84%), may divide into its tibial and common peroneal components before pelvic exit (14.6%), traverse the muscle in the bipennate muscular variant (11.7%) or transect the piriformis tendon (0.8%).(28)

The Extended Iliofemoral Approach allows exposure to both the anterior and posterior columns. It was developed by Letournel and Judet in 1974. (29)Indications for its use include complex both column displacement and subacute fractures (more than 3 weeks old). It enables inspection of all of the iliac fossa, iliac crest, sacroiliac joint, and superior pubic ramus. This approach poses a risk of iatrogenic injury to the Lateral Femoral Circumflex Artery and the Superior Gluteal Artery.

The Modified Stoppa Approach as first described by Cole and Bolhofner (30), is an Anterior Intrapelvic Extraperitoneal (AIP) approach.(31) It provides exposure to the pubis, the quadrilateral plate, the sciatic buttress, and the notch together with the anterior sacroiliac joint. It has the advantage of improved quadrilateral and posterior column access, as well as avoiding the middle window used in the Ilioinguinal approach. It is indicated in anterior wall and column fractures, posterior hemitransverse, and some posterior, transverse, and T-shaped fractures. It is however contraindicated in posterior (column and wall) only patterns.(31) Complications encountered in using this approach include external iliac vein injury, wound infection, sciatic nerve palsy, and fixation failure.

2.3.3 Non- Operative Management

Non-surgical management is an option in minimally displaced or non-displaced fractures (<2mm step), fractures with secondary congruency, or fractures not affecting the weight-bearing surface of the acetabulum as seen on CT imaging.(32) An intact weight earing dome is seldom present in displaced fractures, accounting for only 5% of acetabular fractures.(32) In the elderly, femoral head medialization despite displaced acetabular wall fragments may also qualify for this modality.(11)

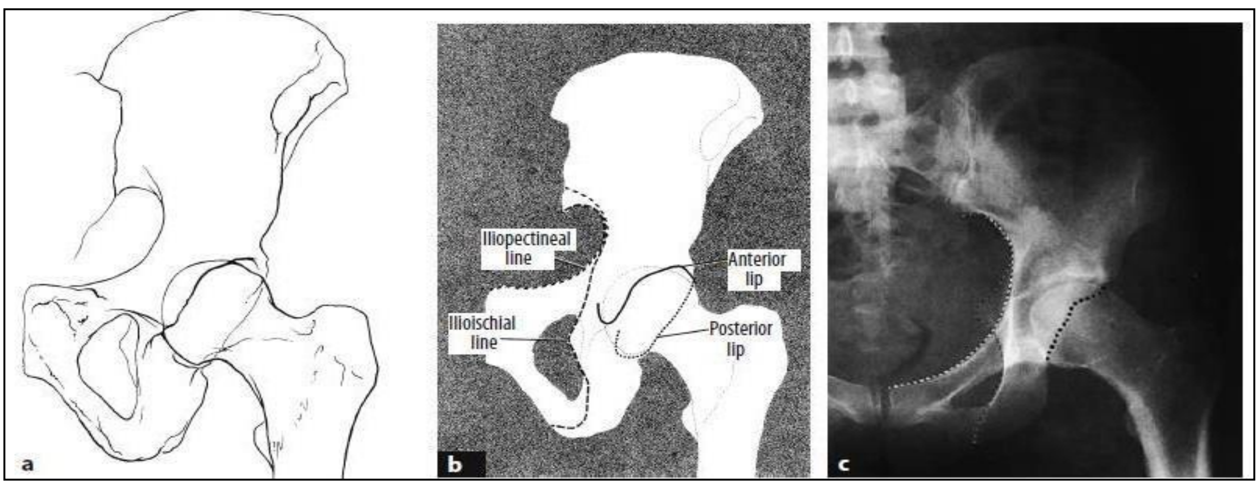
Patients with inadequate bone stock as seen in metabolic bone disease, or with osteopenia as in the elderly may be managed non-operatively initially.(12) This is done with bed rest, and skeletal traction for six weeks, to allow early joint motion. Close radiological follow-up is performed, and if displacement occurs or secondary congruency is lost then the decision is made for operative management, which should ideally be performed within the first 21 days post-injury.(12) Goals early on are good pain management and early mobilization. The first radiographs should be obtained two weeks post-injury. After skeletal traction has been halted at six weeks, toe-touch weight-bearing may be commenced. Pain is then assessed at the first clinic visit, at which the decision to continue with non-operative care is made. If pain is unchanged or worsening, then operative care should be offered.(33)

2.4. Acetabular Fracture Classification

2.4.1 Imaging

Radiographic evaluation of acetabular fractures requires four views (34), a standard anteroposterior pelvic view, to exclude contralateral acetabular or other pelvic fractures, an anteroposterior radiograph centred on the hip of interest, and two accurately taken 45-degree oblique views (Judet views). Figure 4 illustrates key anatomic landmarks. Fractures crossing these landmarks determine fracture classification as well as fracture displacement and hip joint congruity.

Figure 3: Pelvic and Hip Landmarks



Pelvic and Hip Landmarks a. Anatomical landmarks as seen on AP radiograph. b. The major landmarks: iliopectineal line (anterior column), ilioischial line (posterior column). c. AP hemipelvis radiograph with lines described in b. Adapted from *Fractures of the acetabulum, M. Tile 1984*

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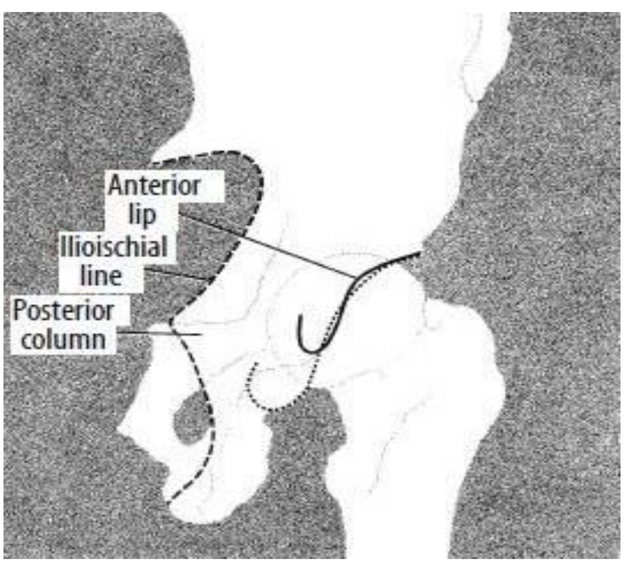
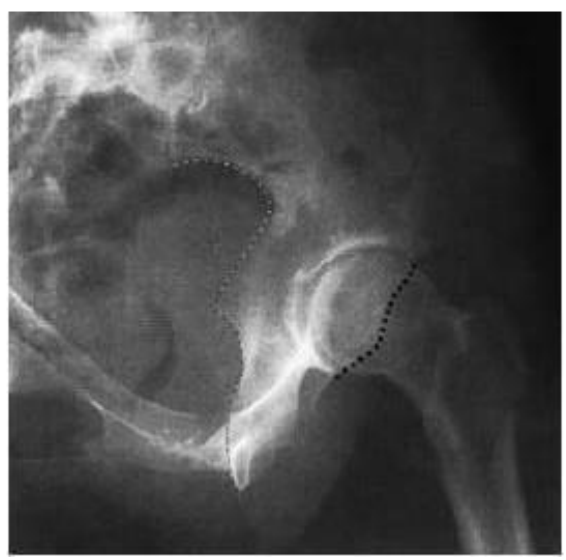
The Iliac Oblique View (IOV) is taken with the patient supine and turned 45 degrees towards the injured side. In this view, the affected side's obturator ring is in line with the x-ray beam and is therefore not visible, whereas the iliac wing is spread out.(34) This view provides an evaluation of the posterior column, anterior acetabular wall, iliac crest, ischium, and quadrilateral surface.(34)

In the Obturator Oblique View (OOV), the patient lying supine is turned 45 degrees away from the affected/injured side. In this view, the obturator foramen is visualized enface, with the superimposition of the anterior and posterior iliac spines. This view gives clear assessment of the anterior column, posterior acetabular wall, and coronal iliac wing displacements.(34)

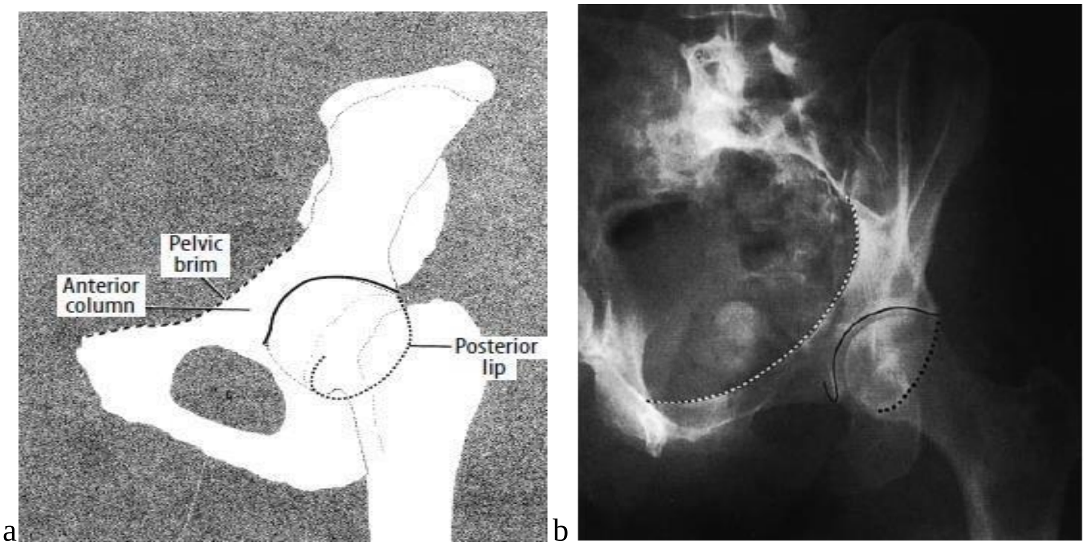
Figure 4: The Iliac Oblique View

a 

b  .

a. shows the key anatomical lines. b is an iliac oblique view of the hemipelvis showing superimposed posterior column (white dotted line) and anterior acetabular wall/lip (black dotted line) Adapted from *Fractures of the acetabulum, M. Tile 1984.*

Figure 5: The Obturator Oblique View

a b


a. shows the key anatomical lines. b is an obturator oblique view of the hemipelvis showing superimposed anterior column (white dotted line), posterior acetabular wall/lip (black dotted line) Adapted from *Fractures of the acetabulum, M. Tile 1984*

Erroneous classification of these injuries may lead to inappropriate management and poor outcomes.(35) Initially, using plain radiographs for classification had a low accuracy rate of < 65% when used by experienced Orthopaedic surgeons and 11% in inexperienced surgeons.(36,37) With the development of 3D CT imaging, accuracy in diagnosis and classification has improved considerably.(38)

Beaulé et al using Judet views and axial CT demonstrated little additional value in 2D CT in determining fracture classification.(39) Similarly, Visutipol et al in a study of intraobserver reproducibility and interobserver reliability classifying 20 patients found no added benefit from incorporating 3D CT in classification.(40)

However, O'Toole et al. looked at whether 3D CT improved fracture classification compared to plain radiographs. These were all compared with intraoperative findings as the gold standard, with plain radiographs having a poorer correlation with intraoperative findings compared to 3D CT.(41)

In a study by Tazeabadi et al.(35), a comparison in the accuracy of determining fracture pattern and classification between Judet views and 3D CT was made, showing a much higher agreement between 3D CT and intraoperative findings (94.7% of cases) compared to Judet views (34.2%). This strongly suggests that 3D CT is superior to Judet views in characterizing acetabular fractures. Furthermore, Kickuth et al. compared axial CT to 3D CT in acetabular fracture classification, showing significant superiority of 3D CT over axial CT.

These studies support the use of both plain radiography and 3D CT reconstruction to come to the most accurate fracture classification. Axial CT views have the added advantage of assessing acetabular impaction, femoral head injury, fracture displacement, identifying intra-articular fragments, assessing joint congruity and are therefore essential in the imaging series.

2.4.2 Letournel Classification

Precise fracture classification is key in guiding surgical treatment.(13,42) The Letournel classification remains the most predominantly employed.(12,15) The Tile modification of this classification was adopted as the comprehensive classification by the AO/Association (Arbeitsgemeinschaft Fu¨r Osteosynthesefragen), whose categorization guides surgical approach and reduction techniques.

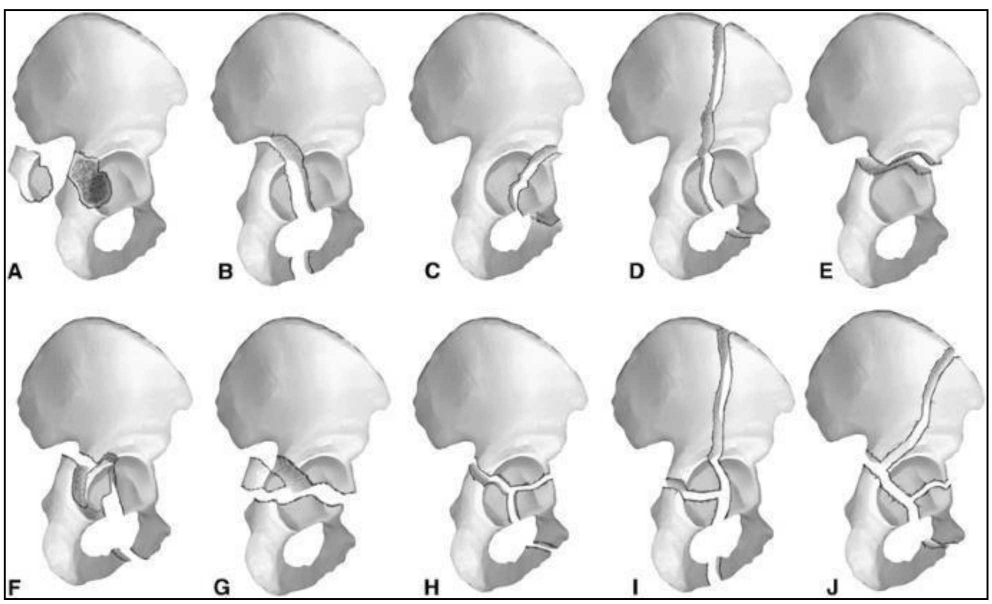
The Letournel classification system is an anatomical system with two groups, each with five subtypes.(1) The significance of this classification, as noted by its creators, is that it determines the surgical approach.(12) This system divides them into the Simple/Elementary group and the Complex/Associated group.

Table 1: Acetabulum Fractures - The Letournel Classification

The 5 simple patterns are the following:
• Posterior wall fractures (A)
• Posterior column fractures (B)
• Anterior wall fractures (C)
• Anterior column fractures (D)
• Transverse acetabular fractures (E)
The 5 complex/associated patterns are combinations of the simple patterns:
• Posterior column with a posterior wall fracture (F)
• Transverse with a posterior wall fracture (G)
• T-type fracture (H)
• Anterior column with a posterior hemi-transverse fracture (I)
• Both column fracture (J)

Adapted *from Acetabulum fractures: Classification and Management, Letournel E., 1980, Clin Orthop Relat Res*

Figure 6: Letournel Classification of Acetabular Fractures



Adapted from *Classifications in Brief: Letournel Classification for Acetabular Fractures. Timothy B. Alton MD & Albert O. Gee MD. 2014, Clinical Orthopaedics and Related Research® volume 472, pages35–38*

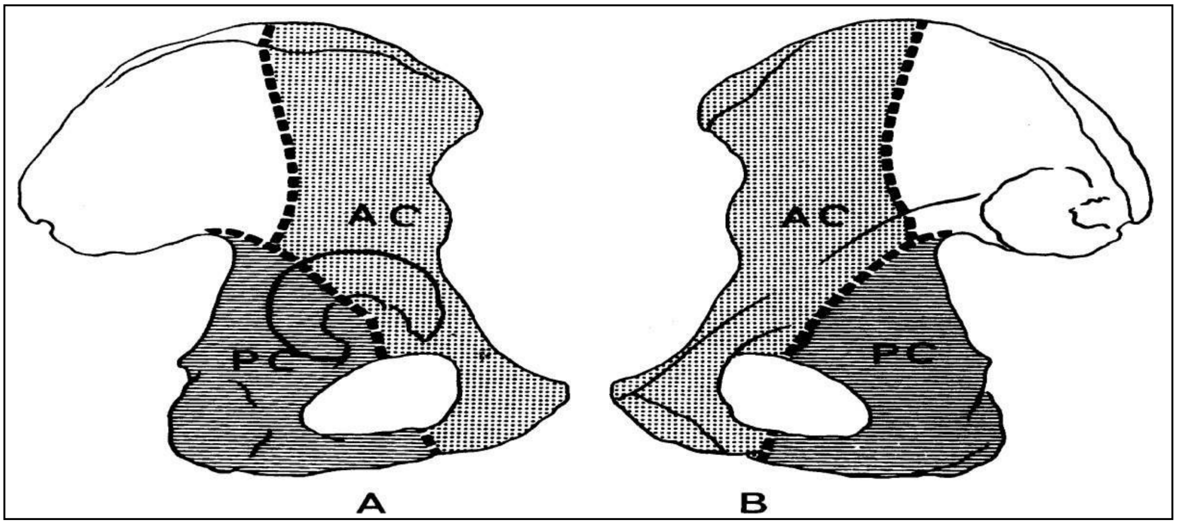
Before the Letournel classification, Armstrong et al published their findings and a classification system based on their experiences in the Royal Air Force, describing four types of injuries, involving hip dislocations, fracture to the acetabular "floor", rim, and fracture to the femoral head.(43) This was later modified in the 1950s by Thompson and Epstein, with five categories.

Letournel in 1961 published his first series on fracture management and classification of acetabular fractures, a series of seventy-five cases. Before this, acetabular fractures had been classified broadly as central fractures and dislocations of the hip with associated acetabular fractures. This description was lacking in its recognition of intermediary fracture patterns. The first descriptions by Letournel initially classified them into seven patterns, both elementary and associated.(29)

The landmark paper in 1964 by Judet et al provided surgeons with a classification system and a clearer understanding and a treatment plan for this class of injuries.(44) In the seminal paper, the AP and two 45 degree views, ("Judet" views), were described. These are the AP pelvic radiograph, the Obturator oblique view, and an Iliac oblique view. (1)The Letournel anatomic classification has 2 groups, the Elementary and Associated group, each having five fracture patterns.(12) This classification was confirmed and updated following radiographic and surgical data from a series of 647 acetabular fractures, 582 of which underwent surgical management.(34)

It describes the anterior/iliopubic column as running from the anterior aspect of the superior iliac crest to the pubic symphysis and the posterior/ilioischial column running from the greater sciatic notch to the ischial tuberosity.(34)

Figure 7: Schema of Anterior and Posterior Columns



(AC)Anterior column and (PC) Posterior columns. Outer (A) and inner (B) surface of the innominate bone. Adapted from *Acetabular Fractures Revisited: Part I, Redefinition of the Letournel Anterior Column. Harris et.al, June 2004, AJR: 182*

Letournel divided acetabular fractures into elementary and associated fractures. Elementary fractures include Posterior wall, Posterior column, Anterior wall, Anterior column, and Transverse acetabular fractures. The Associated fractures are more complex, and include T-shaped fracture, Posterior wall, and posterior column, Transverse and posterior wall, Anterior column/wall and posterior hemi-transverse, and Both column fractures.(34)

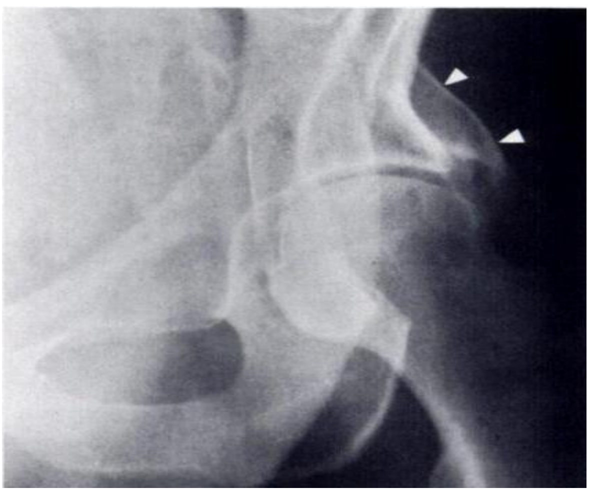
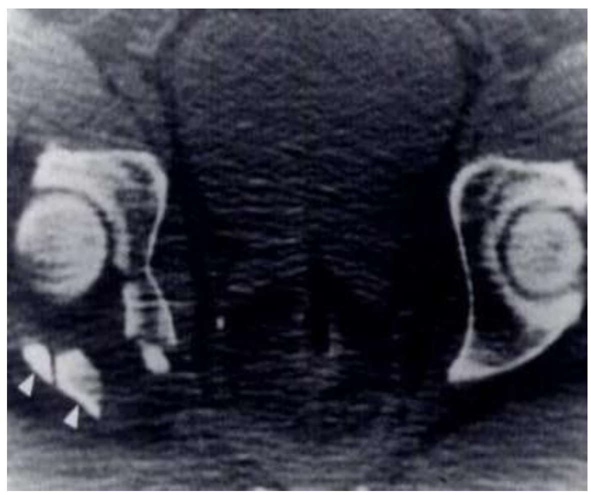
2.4.3 Elementary Fracture Patterns

i. Posterior Wall Fractures

In Letournel's first series of 157 cases, Posterior wall fractures constituted 24.2%. (34) He described this as separation of the posterior articular surface, leaving most of the posterior column unaffected, and is frequently associated with posterior femoral head dislocation. (34)

79% of these fractures in this series were simple separations, with 21% having associated marginal impaction requiring reduction to restore joint congruity. (34) They also have associated sciatic nerve injury. They are best viewed using the OOV, revealing the fragment size and the frequently posteriorly dislocated femoral head. (34) Posterior wall fractures are the most common pattern, constituting 27% of all acetabular fractures (12,14,34) 2D CT aids in visualizing femoral head position and fracture fragments using, axial, coronal and sagittal cuts.(14) 3D CT enables viewing extent of wall disruption and quadrilateral plate involvement.(14)

Figure 8: Obturator Oblique View Posterior wall fragment

a  b 

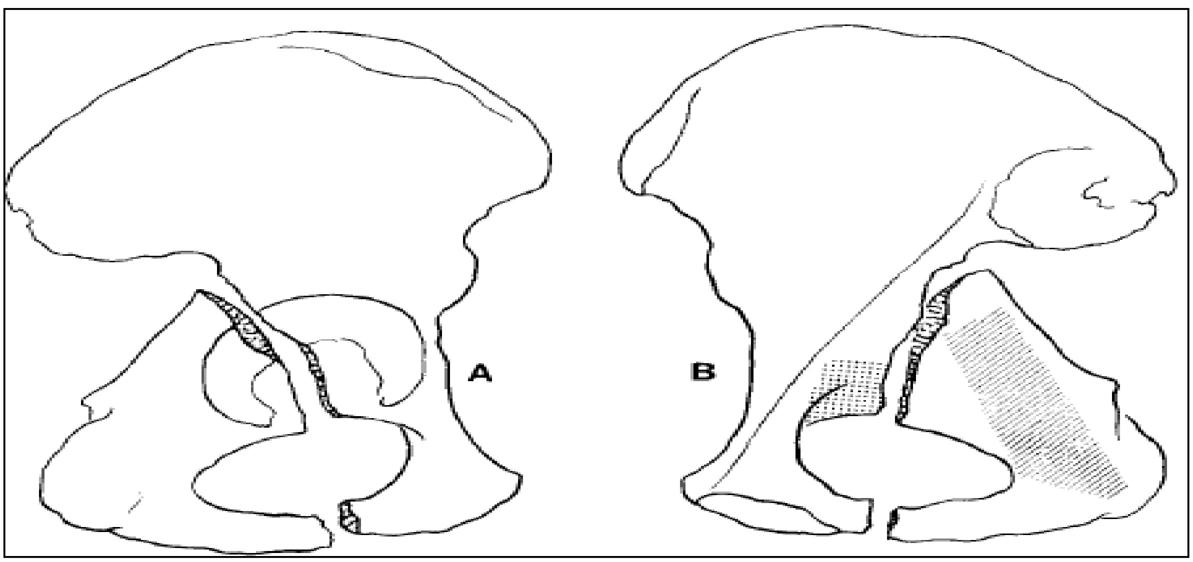
a.Obturator Oblique View showing a large posterior wall fragment (white arrowheads). b. Displacement of posterior wall fragments (white arrowheads) Adapted from *Evaluation of acetabular fractures with two- and three-dimensional CT. Martinez et al. 1992, RadioGraphics; 12:227–242*

ii. Posterior Column Fractures

These fractures constitute 4 % of all acetabular fractures.(12) A posterior column fracture typically detaches as one ischio-acetabular fragment, with disruption of the ilioischial line(34) and obturator ring disruption at the ischiopubic ramus. The posterior acetabular lip is disrupted, but the roof is usually spared. (34)

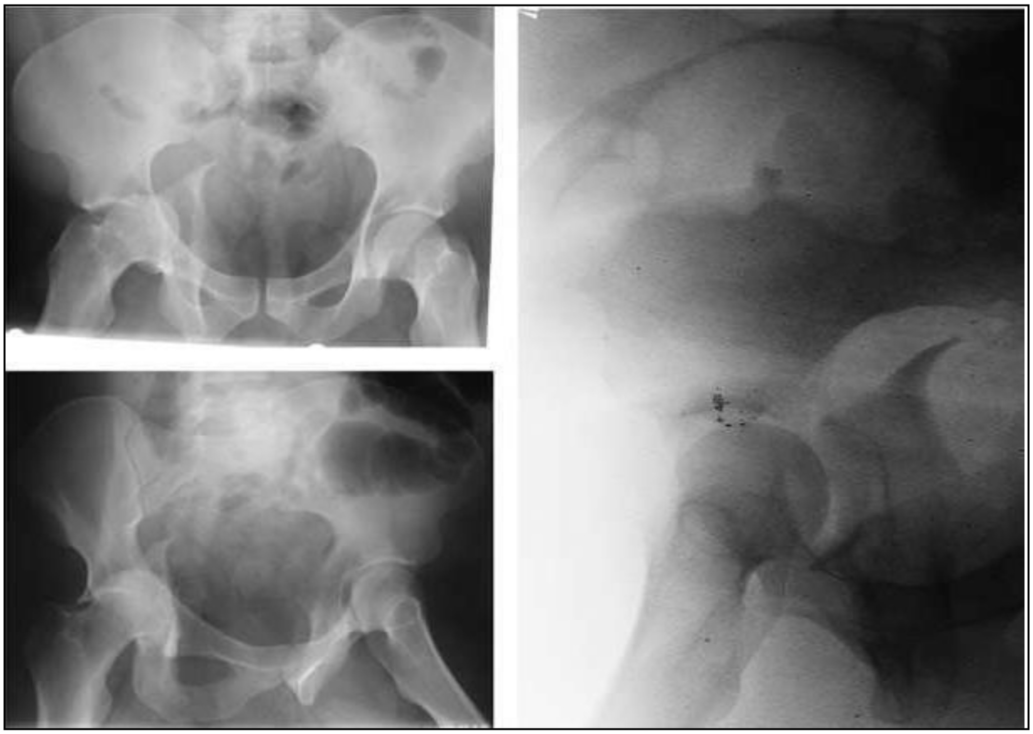
This is best viewed using an IOV, demonstrating a break in the ilioischial line at the greater sciatic notch. (34) An OOV will also demonstrate an intact iliopectineal line, but a disrupted obturator ring at the ischiopubic ramus.(45) The femoral head follows the posterior wall fragment posteromedially, with a risk of impingement of the superior gluteal neurovascular bundle. (45)

Figure 9: Posterior Column Fracture



A showing the intact iliopectineal line. In **B**, the lined are (posterior fragment) represents the ilioischial line radiologically, and the dotted area is the inner branch of the teardrop (anterior column) Adapted from *Acetabulum fractures: Classification and Management. Letournel E. 1980, Clin Orthop Relat Res.; 151:81–106*.

Figure 10: Anterior Pelvic and Iliac Oblique View of Posterior Column fracture



Disrupted ilioischial line. Adapted from *Rockwood & Greens Fractures in Adults. Philadelphia, Court-Brown, C., et al.: 2014, Lippincott Williams & Wilkins*.

iii. Anterior Wall Fractures

Anterior wall fractures make up only 2% of these fractures and involve separation of the anterior acetabular articular surface. (14) They may involve anterior displacement of the femoral head and involve the acetabular roof. (14) Radiologically, disruption of the iliopectineal line is seen on OOV, frequently with a trapezoidal fragment seen.(34)

Figure 11: Obturator Oblique View of Anterior Wall Fracture

Disrupted iliopectineal line, and trapezoidal anterior wall fragment. Adapted from *Rockwood & Greens Fractures in Adults. Philadelphia Court-Brown, C. et al.2014, Lippincott Williams & Wilkins*

iv. Anterior Column Fractures

Anterior column fractures make up 5% of acetabular fractures.(12) They involve disruption of the obturator ring at the ischiopubic ramus, and the iliopectineal line. (14)

Radiographically this is recognized as a discontinuity in the iliopectineal line on AP and OOV views, with undisturbed posterior acetabular. (34) The acetabular roof may be involved in high fractures.

On IOV, fracture extension into the iliac bone is noted, with an intact posterior column. This fracture pattern is divided into subtypes based on where the fracture exits on the iliac bone and may at the iliac crest, the ASIS, the Psoas gutter, or at the iliopectineal eminence.(46)

__Figure 12: Obturator Oblique View of Anterior Column fracture__

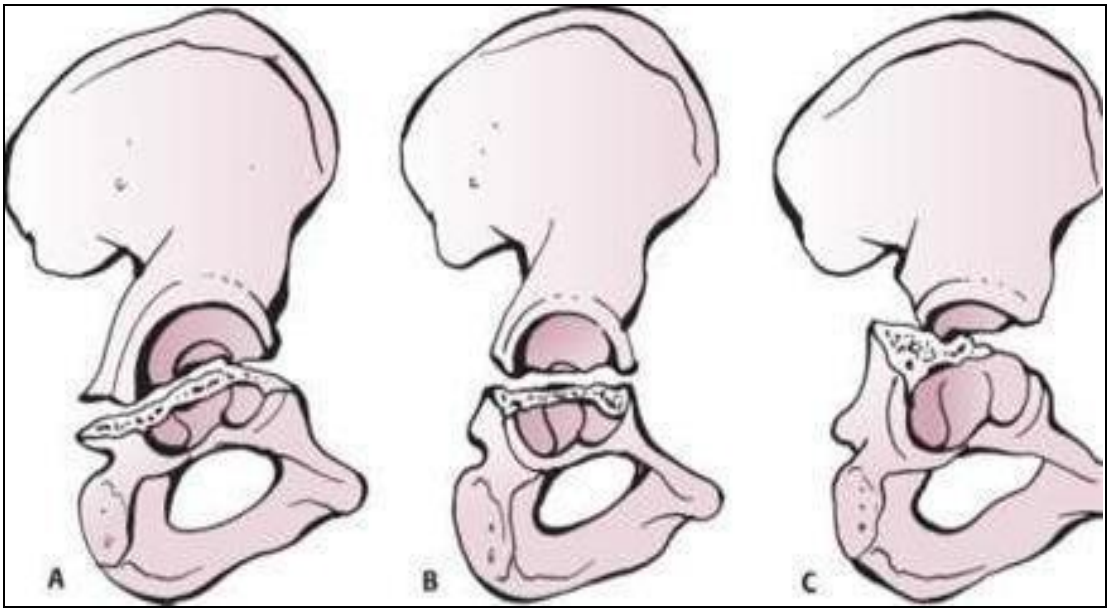
a. b.

a is OOV showing disrupted iliopectineal line and an ischiopubic ramus fracture. **b** is IOV showing intact posterior column and anterior fracture extension into the iliac wing. Adapted from *Rockwood & Greens Fractures in Adults. Court-Brown, C. et al.: 2014, Lippincott Williams & Wilkins Philadelphia*

v. Transverse Fractures

Transverse fractures make up 9% of acetabular fractures.(12) The fracture line is either oblique or horizontal, dividing both columns into a lower ischiopubic segment and an upper iliac segment. (14) The acetabulum may be fractured at three levels, these being juxtatectal (junction of roof and cotyloid fossa), transtectal (through the acetabular roof), or infratectal (below the acetabular roof, in the cotyloid fossa). (34)

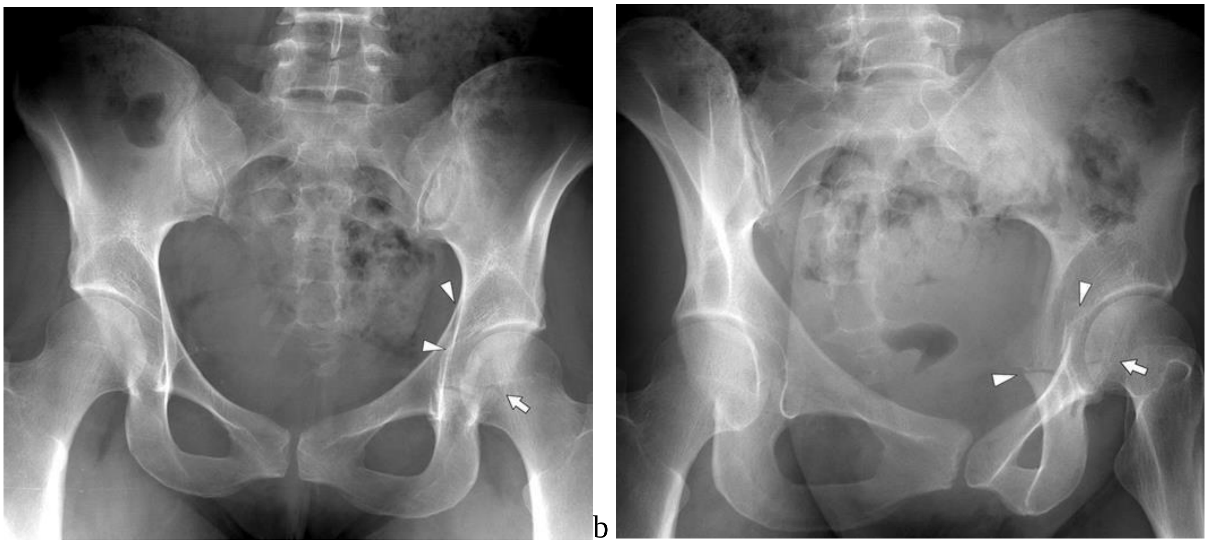
Figure 13: Types of Transverse Acetabular Fracture



A infratectal, **B** transtectal **C** juxtatectal Adapted from *Rockwood & Greens Fractures in Adults, Court-Brown, C. et al, 2014: Lippincott Williams & Wilkins Philadelphia.*

On AP radiography, ilioischial, iliopectineal and acetabular wall lines are interrupted, with the ischiopubic segment displaced medially. The obturator ring remains intact, as viewed on OOV. This fracture pattern is differentiated from an associated both column fracture in that both columns have a connection to the sciatic buttress.(47)

Figure 14: Anterior Pelvic and Iliac Oblique View of Transverse Acetabular Fracture



a b

a AP pelvic radiograph **b** is IOV pelvic radiograph, left transverse acetabular fracture. Arrowheads show disrupted iliopectineal and ilioischial lines, and the arrow points to the transverse fracture. Adapted from *Classification of Common Acetabular Fractures: Radiographic and CT Appearances. Durkee et al. October 2006, AJR: 187*

In OOV, the anterior column and iliopectineal line are disrupted, the obturator ring is intact and the ischiopubic segment is displaced. In IOV, ilioischial disruption at the greater sciatic notch is noted, and quadrilateral plate involvement is demonstrated.(46)

2.4.4 Associated Fracture Patterns

i. T – Shaped Fractures

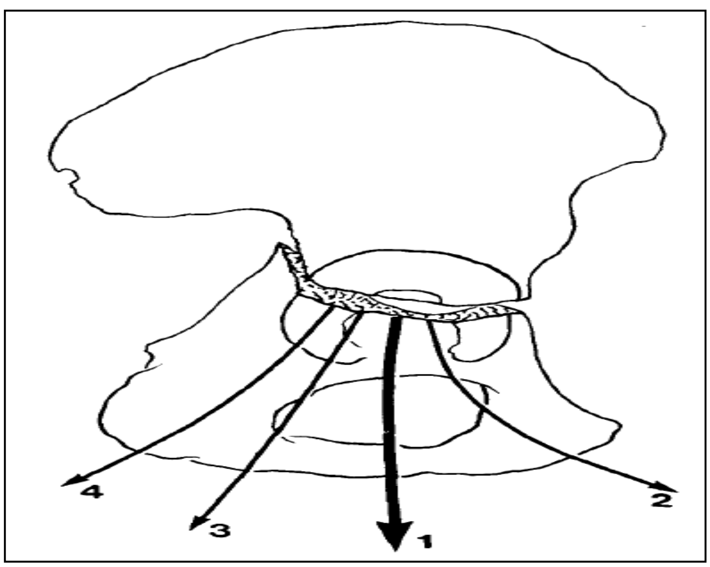
T-shaped fractures account for 6% of all acetabular fractures.(12) They involve a transverse acetabular fracture combined with an ischiopubic ramus fracture. The vertical fracture line may be oriented either anteriorly, vertical, or posteriorly [14]. The vertical component may be visualised on AP view. However, OOV gives the best view. (34)

The posterior aspect of the transverse component is clear in IOV, with an intact iliac wing. (34) Both ilioischial and iliopectineal lines are disrupted, as occurs in both column fractures. (14)

However, they are differentiated from the both column variety by not having fracture extension into the iliac wing(14), and by a segment of the articular surface being connected to the iliac wing.(46)

The fracture line may spare the obturator foramen and involve the ischium alone. Furthermore, the iliac component has an intact acetabular roof. (34) This fracture needs accurate identification, and delineation of the vertical fracture orientation because open reduction is challenging and usually requires both anterior and posterior approaches. (14) (34)T-shaped fractures have the least diagnostic accuracy of acetabular fractures despite CT imaging.(42) Posterior column with anterior hemitransverse and transverse with anterior wall fractures are considered T shaped fractures.(43)

Figure 15: T-Shaped Acetabular Fracture Variants



Transforaminal (1), obliquely forward (2) obliquely backward (3), or confined to the ischium (4). Adapted from *Acetabulum fractures: Classification and Management. Letournel E. 1980, Clin Orthop Relat Res.; 151:81–106*

ii. Posterior Column and Posterior Wall Fractures

These fractures constitute 3 % of acetabular fractures. (12) The dominant fragment is the posterior wall and is associated with posterior dislocation of the femoral head.(14) The posterior wall fragment may be comminuted, and usually has marginal impaction.

The posterior wall component is frequently incomplete and non-displaced and may be challenging to detect. (34)(47) As mentioned before, the posterior wall fragment is apparent on OOV, and posterior column fracture seen as ilioischial disruption is evident in IOV. (34)

Figure 16: Anterior Pelvic View of Posterior Column and Posterior Wall fracture

. Disrupted ilioischial line (black arrow), intact anterior column (arrowheads), posterior wall fragment (white arrow), and ischiopubic fracture line (variable). Adapted from *Rockwood & Greens Fractures in Adults. Court-Brown, C. et al. 2014: Lippincott Williams & Wilkins Philadelphia*

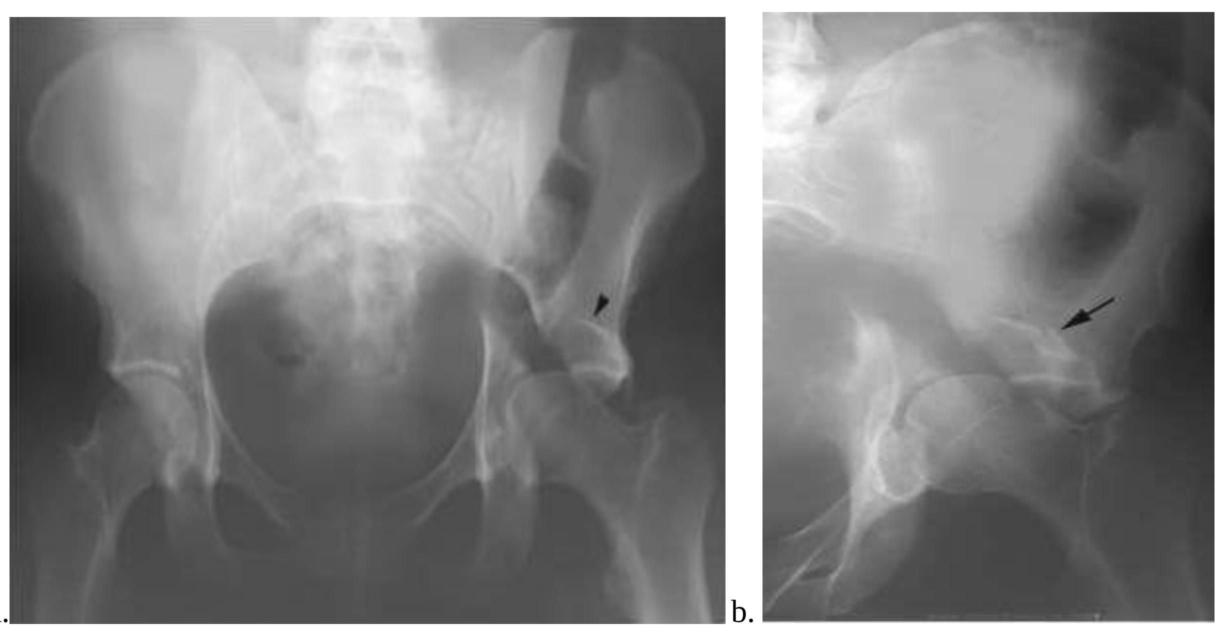
iii. Transverse and Posterior Wall Fractures

These fracture patterns make up 20% of acetabular fractures. (12) They are associated with posterior and central dislocation of the femoral head. (14) These more than other acetabular fractures have associated sciatic nerve injury and femoral head osteonecrosis. (12)

In OOV, the posterior wall fragment is appreciated, with the slope of the transverse fracture line assessed. The obturator ring remains intact. A rare variant has an ischiopubic fracture, making it a T-shaped fracture with a posterior wall fragment. (34) This variant has the poorest prognosis of all acetabular fractures.(46) There is no extension of the transverse fracture line into the iliac wing. Iliopectineal and ilioischial lines are disrupted. (14)

Figure 17: Radiographs showing a Transverse and Posterior Wall Fracture

a. b.



a is an AP pelvic radiograph showing ilioischial and iliopectineal line disruption, intact obturator ring, and medial femoral head dislocation. **b** is IOV confirming posterior wall disruption, and posterior wall superimposed on the iliac wing (black arrow). Adapted *Rockwood & Greens Fractures in Adults. Court-Brown, C. et al. 2014: Lippincott Williams & Wilkins Philadelphia*

iv. Anterior Column/Wall and Posterior Hemi-Transverse Fractures

This fracture pattern comprises 5% of acetabular fractures. (12) When the anterior fracture line is low or very low, this fracture may be confused with T-shaped fracture patterns. This fracture pattern is common in the elderly population.(47)

The anterior segment is frequently more displaced than the posterior, necessitating a posterior approach.(48) 75% are anterior column fractures, with the remainder affecting the anterior acetabular wall. The femoral head displaces anteriorly, and a segment of the acetabular roof and/or posterior wall remains connected to the iliac wing, differentiating it from both column fractures.(45) AP and OOV demonstrate iliopectineal line and teardrop disruption. The IOV shows the hemitransverse component extending posteriorly. (34)

Figure 18: Obturator Oblique View of Anterior and Posterior Hemitransverse Fracture

a b

a OOV showing iliopectineal line disruption, and anterior femoral head dislocation. **b** IOV illustrating iliopectineal line disruption. Adapted from *Rockwood & Greens Fractures in Adults. Court-Brown, C. et al. 2014: Lippincott Williams & Wilkins Philadelphia*

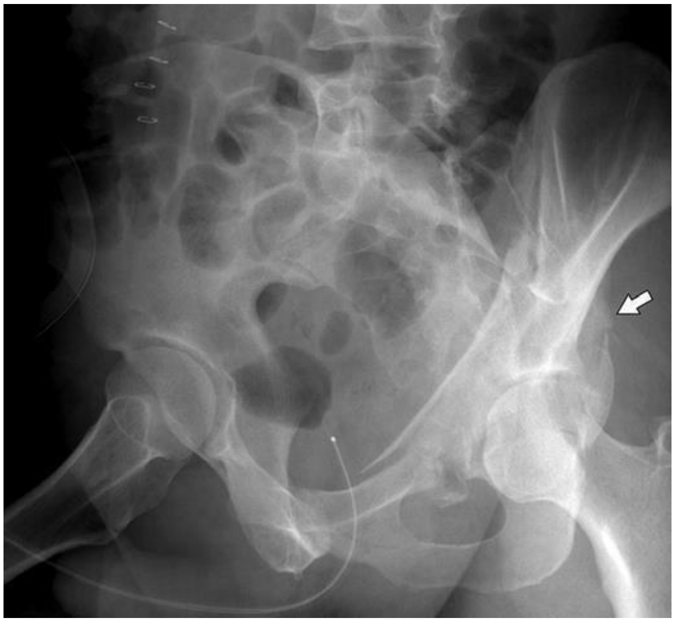
v. Both Column Fractures

Both column fractures comprise 19%, thus being the third most common fracture type. (12) The entire weight-bearing acetabulum is detached from the iliac wing. (14) The posterior component has two fracture lines, one from the greater sciatic notch that is met with a horizontally oriented fracture line running posterior-anterior. (34) The obturator ring is also disrupted at the ischiopubic junction. (14) Two variants have been described. The first has the anterior fracture line running parallel to the acetabular lip, ending at the anterior iliac edge. The second more common pattern has the anterior fracture line running superiorly to the iliac crest. (34) It is differentiated from T-shaped fractures in that the ilium is connected to the sacrum only by posterior aspects of the iliac wing. (34) The entire weight-bearing acetabulum is detached from the sciatic buttress, and the femoral head invariably displaces medially.(38)

The pathognomic 'spur' sign may be present, which represents the posterior displacement of the sciatic buttress of the iliac wing, thus separating the acetabulum from the axial skeleton.(13) The spur sign is best appreciated in OOV, the iliopectineal line is discontinuous, the sourcil is tilted, the ischiopubic ramus is fractured, and the spur if seen is pathognomic.

In IOV, the ilioischial line is disrupted, with a quadrilateral plate fracture separating the two columns.(45) Free rotation of the now separated columns enables them to move about the femoral head, maintaining the normal anatomic relationship, and is termed secondary congruence. This is the basis for non-operative management of these fractures as an option.(38)

Figure. 19: Obturator Oblique View Both Column Fracture with Spur Sign



Pathognomic ‘spur’ sign (white arrow). Adapted from *Classification of Common Acetabular Fractures: Radiographic and CT Appearances. Durkee et al. October 2006, AJR: 187.*

2.5 Acetabular Fracture Classification

2.5.1 The AO/OTA Acetabular Fracture Classification

The AO Group led by Mueller et al in 1990 developed a comprehensive classification in an attempt to standardize classification and is founded on Letournel’s classification.(49) The acetabulum is numbered 62: A, B, and C.(9) Many extra lesions may be present, affecting the prognosis.(49) Group A fractures are single /single column fractures, Group B is transverse fractures or its variants, and Group C fractures are both column fractures. All groups have subcategories (1, 2, and 3) resulting in 9 described fracture patterns.(50)

2.5.2 Harris - Coupe Classification of Acetabular Fractures

This is a Computer Tomography-based system where the anterior and posterior acetabular lips are described as walls, and the more medial acetabular parts (quadrilateral plate) are considered as columns.(51) In this classification system the anterior column description is restricted to the iliopectineal line and pelvic brim, thus being at the same level as the posterior column as described by Letournel.(34)

The Harris Classification divides acetabular fractures into Wall fractures (Category 0), Single column fractures (Category I) and Two-column fractures (Category II), and Floating Acetabulum (Category III). Category II is divided into 4 subcategories (A – D).(52) 2D and 3D CT is being employed more frequently in identifying these fractures.(53) Various authors believe Pelvic CT should standard imaging in acetabular fractures.(14,54,55)

2.5.3 Acetabular Fracture Classification for this Study

Of the fracture classification systems discussed, none is without its shortcomings. An ideal fracture classification system needs to be simple, reliable, valid, reproducible, and providing language that is clearly understood by all its users. It should guide management of the fracture, predict complications and prognosis. It should enable comparison across various centres for research purposes.(56)

The Letournel classification is topographical, taking into account a fracture line and its elements, and is, therefore, in theory, easy to understand.(57) Beule et al. and Visutipol et al. ascertained that the Letournel fracture classification is reproducible.(39,40) Hufner et al found low concordance with the gold standard in fracture classification among orthopaedic surgery residents, with an accurate fracture classification of only 11% compared with 61% for experienced orthopaedic surgeons or Hip surgery specialists.(36)

This justifies having both a resident and an orthopaedic consultant evaluating radiographs and giving a fracture classification, since the biggest factor determining accurate fracture classification is the observer's experience, with a high concordance with intraoperative findings in surgeons who regularly manage acetabular fractures.(39,40) With this protocol in place, the Letournel Classification has been chosen for this study.

2.6 Acetabular Fracture Complications

Complications following acetabular fractures are seen in both operative and non-operatively managed patients. Sciatic nerve injury with resultant foot drop may manifest as a direct result of posterior hip dislocation at the time of trauma. Furthermore, disruption to the medial circumflex femoral vessels has been associated with later development of femoral head avascular necrosis.

Non-operative management is sometimes carried out in patients with multiple comorbidities and reduced physiological reserve, especially the geriatric group. The use of skeletal traction is no longer preferred, with early mobilization being encouraged. This may be done from bed to wheelchair in the geriatric patients or non-weight bearing using crutches in able patients at 6 to 12 weeks post-injury. Patients immobilized for lengthy periods risk developing decubitus ulcers, hypostatic pneumonia, venous thrombosis, and deconditioning. (58)

Operative management has been the preferred mode of management for most acetabular fractures. In 1961, Rowe and Lowell undertook the first extensive study on management outcomes in both operatively and non-operatively managed acetabular fracture patients, with 93 patients seen and followed up for an average of 6 years. The fractures were described as posterior, inner wall, superior, non-displaced, or burst pattern. (59)

Despite not having clear anatomic landmarks to base the fracture patterns, outcomes were correlated with involvement of the weight-bearing dome/roof, state of the head of femur, joint congruency post-reduction, and joint stability at 1-year follow-up (59). Fractures affecting the weight-bearing dome had a poorer prognosis compared to those affecting other segments of the acetabulum. Furthermore, the radiographic and clinical picture at 1-year follow-up was strongly suggestive of long-term prognosis. (60)

As shall be discussed, operative management is the preferred treatment. However, complications from this modality include iatrogenic nerve injury, surgical site infection, thromboembolic events, heterotopic ossification, malunion and nonunion. (16)

The incidence of infection is approximately 2-5% (16). A 4.4% local wound infection incidence was determined in a meta-analysis by Giannoudis (21), with the risk increasing significantly in the presence of a Morel-Lavallé lesion, with a positive culture in more than 40% of patients. (55)

Iatrogenic sciatic nerve injury is most frequent in the posterior approach (Kocher-Langenbeck), with the peroneal division most frequently affected. Letournel reported a 6.3% postoperative incidence. (12) The incidence was 18.4% when skeletal traction with the knee extended and hip in slight flexion was the practice.(12) Middlebrooks et al reported a 2% incidence of sciatic nerve neuropraxia even after intraoperative visualization and isolation of the nerve.(61) Giannoudis' meta-analysis found an incidence of approximately 4.7%.(21)

It has been established that patients sustaining pelvic and acetabular fractures have an increased tendency to develop thromboembolic complications, such as pulmonary thromboembolism and deep venous thrombosis.(62) Giannoudis showed an incidence of 4.3% DVT or PE in his meta-analysis.(21)

Heterotopic ossification is a common occurrence reported in many series looking at acetabular ORIF. (52) Moderate to severe amounts of this may interfere with normal hip range of motion. The incidence has ranged from 7% (32) to 100%.(12) Ghalambor et al graded HO into grade 0 or 1 as seen on AP radiographs at 1-year follow-up, with Grade 0 encompassing no amount or minimal amounts of ectopic bone formation, and Grade 1 encompassing moderate and severe ectopic bone formation. (52) The four variables in the Ghalambor et al study that correlated significantly with Grade 1 HO were (1) The Iliofemoral surgical approach, (2) T-type fracture pattern, (3) Associated chest and abdominal injuries, and (4) multiple intraoperative findings indicative of severe injuries. There was a significant association between poor clinical outcomes at 1-year follow-up and Grade 1 HO.(52)

Avascular necrosis (AVN) has an incidence of 5.6%, according to Giannoudis et al. Patients experiencing a posterior femoral head dislocation were at a significantly increased risk of developing AVN (9.2%) compared to those without (5%).(21)

Post-traumatic osteoarthritis (OA) following acetabular fractures has an incidence of 19.7% as per Letournel’s findings, which correlates closely with Giannoudis et al's meta-analysis findings of 19.1%. They both elucidated a significant correlation between the quality of postoperative reduction and development of hip OA, with an incidence of 13.2% if the reduction was <2mm, and 43.5% incidence if > 2mm. (21)

2.7 Acetabular Fracture Outcomes

The treatment of these injuries continues to be challenging in sub-Saharan Africa and other developing regions, where non-operative methods are used due to the inaccessibility of surgical care.(63)

Oroko (64) in a 2-year retrospective case series of 11 operatively managed patients with pelvic and acetabular fractures reported good overall outcomes, based on the return to work status. No Objective scoring tool for hip function was utilized. Eliezer et al in a 4-year retrospective case series of 34 patients with acetabular fractures found good to excellent outcomes in operatively managed patients.(65) Functional outcome 1 year postoperatively was assessed using the Merle d'Aubigné Postel (MAP) score, EQ-5D, and Squat and Smile test scores, with good to excellent outcomes in 73.5% of patients.

There is limited objective insight into patient hip function after surgery or non-operative care in Kenya. No data is looking at factors contributing to functional outcome, and none correlating fracture patterns with functional outcome in Kenya.

Outcomes may be surgeon-dependent or independent, with independent factors being femoral head damage, injury mechanism, sciatic nerve injury, femoral head dislocation, associated injuries, fracture pattern, patient age, and comorbidities. Surgeon dependent factors include case selection, surgical timing, and quality of reduction and fixation (66).

Pre-existing conditions/states such as advanced age, high BMI, and presence of osteoporosis correlate with an increased fracture incidence and challenges in fracture reduction and fixation (67) Matta in a 2-year prospective study of 262 patients identified age as an independent risk factor for clinical outcome, with 81% of patients aged below 40year averaging good to excellent outcomes compared to 68% of patients 40 years or older. (16) Increasing fracture complexity as seen in the associated fracture patterns was associated with poorer rates of operative anatomical reduction (16).

High BMIs have been associated with increased postoperative complications and poorer outcomes, having an increased likelihood of increased intraoperative bleeding, developing deep venous thrombosis and wound infections. (68)

Posterior hip dislocation is controversial as a factor causing poorer outcomes, with various authors coming to different conclusions on the need for urgent reduction.(68) Absence of femoral head chondral damage, in conjunction with younger age and a simple fracture pattern, has been linked to good to excellent functional outcome scores.(67)

Clarke-Jenssen et al. showed that acetabular impaction and femoral head injury are the strongest predictors of failure after operative management. With the two factors present, native hip survival dropped to 0% at 3 years postoperatively in patients 60 years or older.(69)

Matta looked at 2 to 20-year survivorship of 816 operated hips. (70) The cumulative survivorship was 79%, with survivorship being preventing the need for a total hip replacement.

Identified in this study were independent risk factors of non-anatomical fracture reduction, age older than 40 years, post-operative hip incongruence, anterior hip dislocation, a posterior wall fracture, acetabular impaction, femoral chondral damage, use of the extended Iliofemoral approach, and initial fracture displacement of >20mm.(70)

The various fracture patterns have varying outcomes post-reduction. This, however, is not consistent across all studies. Zha et al assessed clinical outcomes in displaced acetabular fractures in the elderly, finding femoral head injury, quality of fracture reduction, and posterior wall comminution as the most important independent predictors of clinical outcome. (71)

Anatomic fracture reduction ensures reduced contact stress and diminishes the progression to post-traumatic osteoarthritis. Comminution of the posterior wall was associated with the early loss of reduction and fixation failure, leading to poorer functional outcomes. The femoral head injury resulted in generally poor functional outcomes despite anatomic acetabular reduction due to chondrocyte necrosis and femoral head necrosis resulting from the initial insult.(71)

Some investigators have suggested that fractures associated with quadrilateral plate involvement, posterior hip dislocation, and posterior wall marginal impaction are better managed with Total Hip Replacement (THR) at the outset.(72–74) This, however, may be confounded by a lower rate of anatomical fracture reductions in these studies.

Countering the notion that fracture patterns are of little consequence was Mattas study on operatively managed acetabular fractures, finding an anatomic reduction in 96% of elementary fracture patterns compared to 64% in associate fracture patterns, with all poor reductions occurring in associated fracture patterns. (16)

In particular, T-shaped with associated posterior wall fractures having the poorest outcomes, due to the associated articular cartilage damage and difficulty in surgical reduction.(16) This was echoed by Briffa et al in a 10-year follow-up study of 161 patients.(75) However, larger studies had revealed anterior wall fractures as having the poorest prognosis.(46,70) They frequently happen in osteopenic or osteoporotic bone, and are therefore harder to reduce anatomically, and are more prone to loss of reduction.(67)

Functional Status evaluation in acetabular fractures is done using the Merle d'Aubigné-Postel (MAP), the modified Merle d'Aubigné-Postel, and the Harris Hip Score (HHS).(76) MAP score was developed in 1954 for assessment of patients post hip arthroplasty using acrylic prosthesis(76) and was later used by Letournel and Judet in 1993 in assessing results post acetabular fracture treatment.(77)

Its components are assessment of pain, graded as no pain to intense and permanent. Mobility is assessed with hip range of motion, with normal range (Flexion exceeds 90°, abduction of 30) at one end, and hip ankylosis with a bad position at the extreme range. Ability to walk ranges from normal walking to none. These three categories have scores ranging from 0 to 6.

A modification of this score was proposed by Matta in 1986(32), in which the aforementioned categories were maintained, but scoring altered, ranging from 1 to 6, and added to a total score without weighting, thus a range of 3 to 18.

The Harris Hip Score,(78) has 4 components: Hip pain (44), hip function (47), range of motion (5), and absence of deformity (4), giving a maximum of 100 points.(76)

In a study comparing the aforementioned functional outcome tools, Stein et al followed up 661 patients. The study found overall correlation and agreement. The Spearman correlation coefficients between HHS and MAP was r = 0.82, between HHS and modified MAP, was r = 0.81, and between MAP and modified MAP was r = 0.89. Kappa agreement between HHS and MAP was 0.49, between HHS and modified HHS was 0.45, and between MAP and modified MAP was 0.55.(77)

These three tools have considerable ceiling effects, a scaling attenuation effect in which outcome scores are skewed towards the higher scores, limiting evaluation of changes in improvement in function over time (79,80) Despite this limitation, they remain the mainstay in evaluating hip function.

Tools used to measure functional outcomes need to be both reliable and valid.(81) Validity is defined as a tool's ability to assess what it is supposed to, whereas reliability is a tool's ability to provide results with minimal error.(81) The HHS has been shown to have good reliability, as demonstrated by Aliaa et al.(82) and is suitable for the evaluation of changes in hip function.(83) For these reasons, the HHS has been chosen for hip function evaluation in this study.

2.8 Conclusion on Literature Review

Acetabular fractures are complex, presenting a challenge in surgical management and rehabilitation to achieve optimal return to function and pain free ambulation. The varied presentation has a bearing on the quality of surgical reduction, and thus the affects hip joint mechanics. Investigating the factors that contribute to optimal hip function will help orthopaedists formulate better strategies for improved outcomes.

3.0 PATIENTS AND METHODS

3.1 Study Setting

The study was done in the A&E department, Orthopaedic Wards, and Fracture clinics at Kenyatta National Hospital, Nakuru County Referral Hospital, and Coptic Hospital.

Kenyatta National Hospital is the largest tertiary health institution in the country and East Africa, thus having a catchment for the whole nation. Nakuru County Referral hospital and Coptic Hospital are Level 5 hospitals. These institutions were selected due to their expertise and resources in handling acetabular fractures.

3.2 Study Design and Duration

A prospective consecutive cohort study, from December 2020 (proposal writing) to March 2022 (dissertation writing).

3.3 Study Population

Patients eighteen years and older of both genders presenting at KNH, NCRH, and Coptic Hospital during the study period, with acetabular fractures and providing informed written consent personally/next of kin, were included in the study.

3.3.1 Inclusion Criteria

1. Patients aged 18 years and older of either gender presenting with an acetabular fracture.
2. Patients admitted to the hospital in the preceding 48 hours.

3.3.2 Exclusion Criteria

3. Patients below 18 years of age
4. Radiographic evidence of pathological hip fracture
5. Radiographic evidence of a congenital hip anomaly

3.4 Sample Size Calculation

To determine the required sample of acetabular fractures patients for this the study, the Taro Yamane formula for known finite population will be employed and computed as follows:

$$n = \frac{N}{1 + Ne^2}$$

Where: n=sample size

N=population size=total number of acetabular fractures cases seen in the hospitals (Kenyatta National Hospital, Nakuru County Referral Hospital and Coptic Hospital) for 4 months (data collection duration)

e=margin of error (MoE) = 0.05

Therefore:

$$n = \frac{48}{1 + 48(0.05^2)}$$

$$n = 42$$

An additional 10% (4) samples will be added to account for attrition. Therefore, a sample size of **Forty-Six (46)** acetabular fractures patients were included into the study.

3.5 Sampling Procedure

Patients suspected of having a pelvic injury by exhibiting pelvic area pain, bruising, haematuria, limb-length discrepancy or polytrauma patients had requisite pelvic imaging done. The admitting doctor was required to request an AP pelvic x-ray radiograph and a pelvic CT scan (2 D axial, coronal, sagittal views, and 3D reconstruction) as is the standard practice for suspected pelvic fractures in the participating institutions. Patients satisfying the inclusion criteria were included by consecutive sampling.

All patients were assessed and admitted by the surgeon on call within 48 hours. The fracture classification was designated by the principal investigator and two consultant Orthopaedic surgeons aided by a classification algorithm (Appendix J). This was then input into the data collection sheet (Appendix A). Features that were determined from these radiological investigations were:

1. Fracture pattern as per the Letournel Classification.
2. Fracture displacement in millimeters (Greatest Displacement – axial/coronal views).
3. Presence of impaction on femoral head or acetabulum.
4. Presence of femoral head dislocation.

Early complications (within 2 weeks of injury) resulting directly from the injury or developing during inpatient care were input into the datasheet. This included:

1. Sciatic nerve injury immediate post-injury/iatrogenic – the Seddon Classification for peripheral nerve injuries shall be applied. (Appendix C)

2. Decubitus ulcers – the European Pressure Ulcer Advisory Panel (EPUAP) categories shall be applied. (Appendix H).
3. Venous Thromboembolism – classified as either Deep Venous Thromboembolism (Appendix D) or Pulmonary Embolism (Appendix F).
4. Hematoma – graded using the Subjective Hematoma Classification system (Appendix G).
5. Lower limb length discrepancy (Appendix I).

Data regarding management modalities was input into the datasheet, including:

1. Operative management
2. Non-operative management – criteria met or extenuating circumstances precluding surgery
3. Time to surgery (days).
4. Surgical approach.
5. Duration of hospital stay.

Socio-Demographic data was input into the datasheet shall and included:

1. Age
2. Sex
3. Occupation

The patient had the HHS documented in the HHS chart (Appendix 5.1) at 12 weeks post-management. Analysis of the scores was made and correlated with fracture pattern, time to surgery, demographic information, and management modality.

3.6 Data Collection Tools and Management

Data was collected using a structured questionnaire (Patient Data Collection Form) & Harris Hip Score Form. The collected data was reviewed for errors, double entered using Microsoft Excel for quality control, and analyzed using IBM SPSS version 26.

The completed data sheets (hard copy) were assessed for accuracy before data entry, and input into Microsoft Excel before transfer to SPSS version 26 for analysis. Additionally, once data entry was done, all cases were checked for double entry to ensure quality control and accuracy. The data set was checked for any logical or typographical errors.

Categorical data was presented as frequencies and percentages. Continuous data was presented as means and standard deviations. These results are presented in tabular and/or graphical format by hospital and case demographic characteristics or variables. Pearson's Chi-square test was used to assess associations between HHS and Age, Fracture displacement, Time to surgery, and Length of hospital stay.

Multiple regression analysis was employed, with the dependent variable being the HHS, and the patient Age, Fracture pattern, Fracture displacement, Sciatic Nerve Injury, and Time to surgery being the independent variables. This aided in determining the independent variables with a statistically significant effect on patient HHS.

3.7 Validation and Minimization of Errors

1. Validation of the research instruments involved having research records being reviewed by two different parties, the person collecting the data at the health institutions (Kenyatta National Hospital, Nakuru County Referral Hospital, and Coptic Hospital) and then the principal investigator who ensured that there is a commitment to the quality of the research.

2. Training and calibration of the research assistants was done by the principal investigator with the key goal being ensuring that the research assistants understood how the research must be conducted.

3.8 Quality Assurance Protocol

1. The case records were checked for completeness and accuracy before data entry.

2. Once data entry was done, all the questionnaires were checked for double entry to ensure accuracy.

3. Additionally, the dataset was checked for any logical or typographical errors.

3.9 Ethical Approval and Consent

I certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers was followed during this research. In particular, ethical permissions were sought from the Department of Orthopaedic Surgery, University of Nairobi as well as Kenyatta National Hospital, Ethics and Research Committee (KNH/UON-ERC).

All participants in this study were provided with written, informed consent documents in a language that they or their designated next of kin/guardian understood. A translator was sought in case of a language barrier while obtaining consent.

Approval to conduct the study was sought from the Department of Orthopaedic Surgery, University of Nairobi, as well as Kenyatta National Hospital, Ethics and Research Committee (KNH/UON-ERC). Data collection commenced once the approval was granted. Participants in this study or their next of kin were required to give written informed consent.

The consent sought enabled the principal investigator to take the patient's bio-data details as well as history related to the presenting illness. The chief investigator clarified to the participants the objective of this study. Participation in this study was purely voluntary, and as such, was made clear to the patients that they were free to participate or withdraw their participation at any point during the study without any explanation and consequences to their treatment. The study participants were informed that withdrawal of participation would not jeopardise their treatment or management in any way.

All information obtained was treated with the utmost confidentiality. All participants were allocated a study serial number linking them to their bio-database accessible only to the principal investigator. Patients' names were not used.

3.10 Study Limitations

1. Patient loss to follow-up: patient contacts were requested and they were contacted before expected review dates in good time (1 week).
2. Patient opting out of the study: patient education was performed at the enrollment stage.
3. Lack of standardized surgeon experience.

3.11 Study Delimitations

Comprehensive patient education before and during the study duration to limit patient dropout was conducted.

3.12 Dissemination of the Study Findings and Utility

The findings of the study will be disseminated in a three-tier fashion. One copy of the published The dissertation will be kept at the Department of Orthopaedic Surgery, University of Nairobi.

A second copy will be placed at the University Library. Copies shall also be shared with NCRH and Coptic Hospital. The highest level of sharing of the findings will be through publication in a peer-reviewed journal. It is hoped the study results are used to improve patient care, by bettering patient selection for the two management modalities to improve outcome measures. Furthermore, we hope to shed light on a need for improved referral policy, and public transport policy that enhances the safety of all road users.

4.0 RESULTS

A total of 46 patients were included in the study. Of the 46, 41 (89.1%) were males, and 5 (10.9%) were females (Figure 20). The age of the patients ranged from 18 – 72 years with a (Mean 34.9yrs ± 13.1yrs). A majority of the patients, 31 (67.4%) were treated at the Kenyatta National Hospital, 14 (30.4%) at NCRH and 1 (2.2%) at Coptic Hospital. The patients' Harris hip scores ranged from 51 – 95 with a mean score 76.6 (± 9.7).

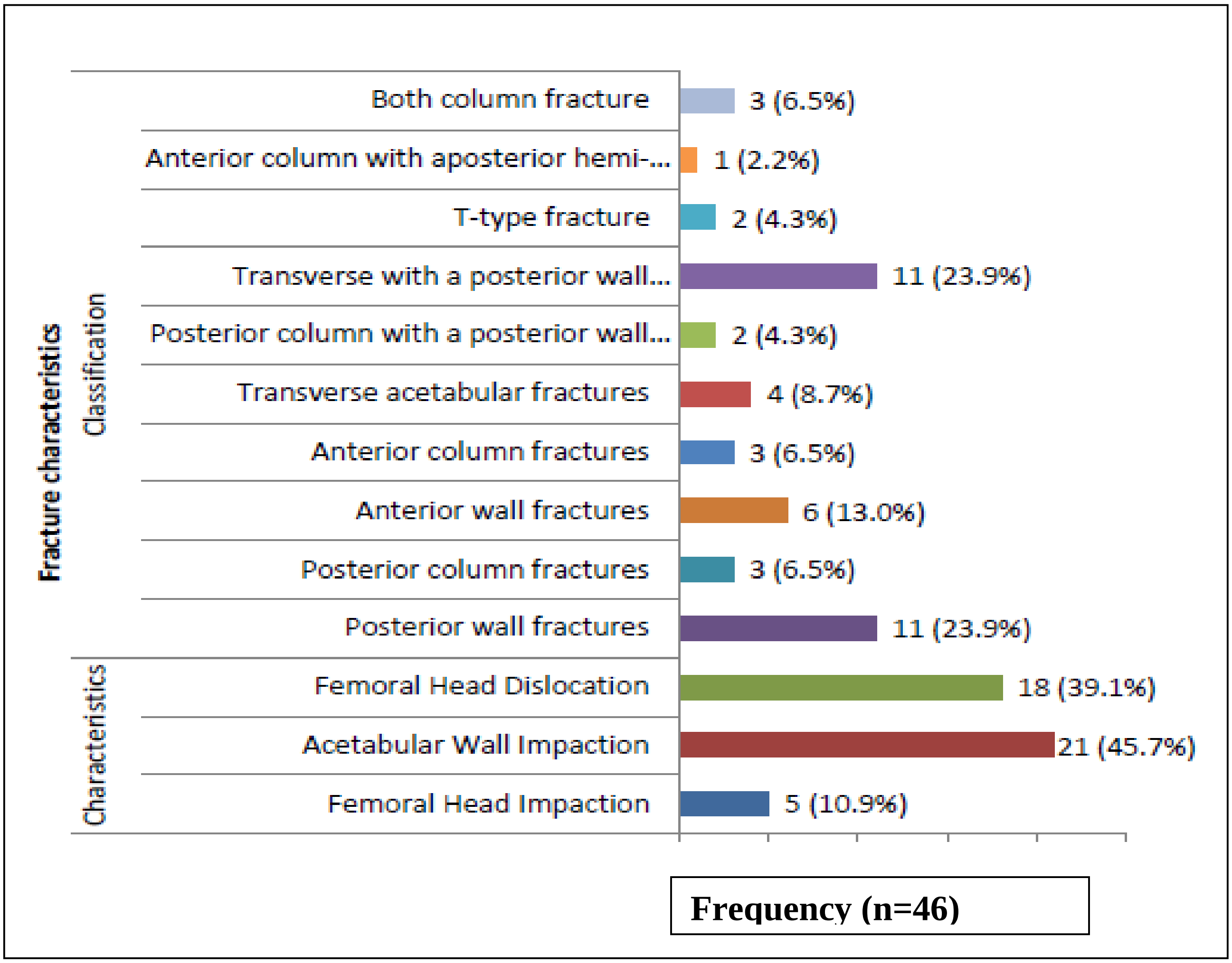
Table 2: Patient distribution by hospital

HOSPITAL	PATIENTS
KNH	31 (67.4%)
NCRH	14 (30.4%)
COPTIC HOSPITAL	1 (2.2%)

4.0 Fracture Patterns and Morphology

Fracture displacement ranged from 0 – 44 mm with a mean of 19.5mm (± 13.9mm). The most prevalent fracture patterns were posterior wall and transverse with posterior wall fractures each both having 11 (23.9%). Acetabular wall impaction was present in most of the cases (45.7%) (Figure 21).

Figure 20: Fracture patterns (Letournel's classification) and characteristics



4.1 Early Complications

Early complications were defined as sequelae of initial injury or in-patient care post-surgery or non-operative care complicating recovery and rehabilitation. Twenty-five patients had early complications (54.3%). The most frequent complication was lower limb length discrepancy that was seen in 21 patients (88% of complications). There were two cases of sciatic nerve injury and one patient who developed decubitus ulcers.

4.2 Fracture Management

For those operated on, it took anywhere between 1 and 41 days to be taken for surgery. The mean time to surgery was 16.5 days (± 12.3 days). Operative management was in 27 patients (58.7%), with 10 (37%) having Modified Stoppa and 17 (63%) having Kocher Langenbeck approaches. Non-operative management was employed in 19 (41.3%). The duration of hospital stay ranged from 1 to 132 days, with a mean duration 33.9 days (± 26.3 days)

A Fisher's Exact test showed a statistically significant association between Harris hip scores and operative management with majority of the patients having a fair Harris hip score (Table 4).

Table 3: Comparative Harris Hip Scores and operatively managed patients

		Harris hip score (Grading)							
		n (%)	Poor	Fair	Good	Excellent	Fisher's	*df*	*p*
	Total	46 (100)	5 (10.9)	24 (52.2)	10 (21.7)	7 (15.2)	19.185*	3	**<.001**
Operative	Yes	27 (58.7)	1 (2.2)	20 (43.5)	6 (13.0)	0			
management	No	19 (41.3)	4 (8.7)	4 (8.7)	4 (8.7)	7 (15.2)			

Fisher's Exact test was used.
*p<.05

4.3 Comparative Harris Hip Scores based on sex and employment status

Independent samples t and Analysis of Variance tests were applied to determine if there were differences in Harris hip score means between socio-demographic characteristics.
There were no outliers in the data, as assessed by inspection of the boxplot. Harris hip scores for each level of gender and occupation were normally distributed as assessed by Shapiro-Wilk test for normality (Table 5). Homogeneity of variance was not violated as assessed by Levene's test for equality of variances ($p > .05$). The differences in the mean Harris hip scores were not statistically significant (Table 6).

Table 4: Shapiro-Wilk test for normality of Harris hip scores and socio-demographic characteristics (n = 46)

Characteristics		*n*	Statistic	*df*	*p*
Sex	Male	41	0.950	41	.068
	Female	5	0.864	5	.242
Occupation	Employed	20	0.877	20	.061
	Self employed	18	0.950	18	.420
	Unemployed	8	0.925	8	.471

Shapiro-Wilk test was used for all variables.

Table 5: Comparative Harris hip score means by sex and occupation (n = 46).

					Levene's test				
Characteristics		n (%)	*M*	*SD*	*F*	*p*	Statistic	*df*	*p*
Sex	Male	41 (89.1)	76.3	9.3	2.650	.111	*t* = 0.589	44	.559
	Female	5 (10.9)	79.0	13.6					
Occupation	Employed	20 (43.5)	75.7	7.1	1.711	.193	*F* = 0.597	2, 43	.555
	Self employed	18 (39.1)	76.0	11.3					
	Unemployed	8 (17.4)	80.0	12.1					

Independent Samples t test was used for sex.
Analysis of Variance (ANOVA) was used for Occupation.

4.4 Comparative Harris Hip Scores based on fracture morphology

An Independent Samples t test was applied to determine if there were differences in Harris hip scores means among fracture characteristics. There were no outliers in the data, as assessed by inspection of the boxplot. Harris hip scores for each level of femoral head and acetabular wall impaction as well as femoral head dislocation were normally distributed as assessed by Shapiro-Wilk test for normality (Table 7). Homogeneity of variance was not violated (Levene's test). The differences in Harris hip scores means were non-statistically significant (Table 8).

Table 6: Shapiro-Wilk test for normality of Harris hip scores for fracture characteristics (n = 46)

Characteristics		*n*	Statistic	*df*	*p*
Femoral head	Yes	5	0.883	5	.323
Impaction	No	41	0.954	41	.094
Acetabular wall	Yes	21	0.941	21	.224
impaction	No	25	0.932	25	.097
Femoral head	Yes	18	0.913	18	.097
dislocation	No	28	0.954	28	.254

Shapiro-Wilk test for normality was used for all variables.

Table 7: Comparative Harris Hip Score means based fracture morphology (n = 46).

					Levene's test				
Characteristics		n (%)	*M*	*SD*	*F*	*p*	Statistic	*df*	*p*
Femoral head impaction	Yes	5 (10.9)	79.2	10.6	0.120	.731	*t* = 0.637	44	.527
	No	41 (89.1)	76.4	9.7					
Acetabular wall impaction	Yes	21 (45.7)	75.7	10.2	0.016	.901	*t* = 0.540	44	.592
	No	25 (54.3)	77.3	9.4					
Femoral head dislocation	Yes	18 (39.1)	75.9	7.1	3.972	.052	*t* = 0.374	44	.710
	No	28 (60.9)	77.0	11.2					

Independent Samples t test was used for all variables.

4.5 Comparative Harris Hip Scores based on fracture displacement and management

A Shapiro-Wilk test showed non-normality for fracture displacement (Statistic = 0.910, *df* = 46, $p = .002$), time to surgery (Statistic = 0.934, *df* = 34, $p = .041$) and duration of hospital stay (Statistic = 0.725, *df* = 46, $p < .001$).

Since fracture displacement, time to surgery and duration of hospital stay violated the normality assumption, Spearman's Rank-Order Correlation Coefficient (r_s) was applied. These showed a statistically significant correlation between Harris hip scores and fracture displacement and with duration of hospital stay (Table 9).

Table 8: Spearman's Rank-Order Correlation Coefficient (rs) tests for Harris hip scores (n = 46)

Harris hip scores	*n*	r_s	*p*
Fracture pattern	46	-.035	.817
Fracture displacement (mm)	46	-.489	**<.001**
Time to surgery (days)	34	-.172	.331
Duration of hospital stay (days)	46	-.333	**.024**

Spearman's Rank-Order Correlation Coefficient (r_s) test was used for all variables.

Since the Spearman's Rank-Order Correlation Coefficient (r_s) showed a statistically significant correlation between fracture displacement and Harris hip scores, a linear regression was run to predict Harris hip scores from fracture displacement. Fracture displacement statistically significantly predicted Harris hip scores (Table 10).

Table 9: Linear Regression model for Harris hip scores and fracture displacement (n = 46)

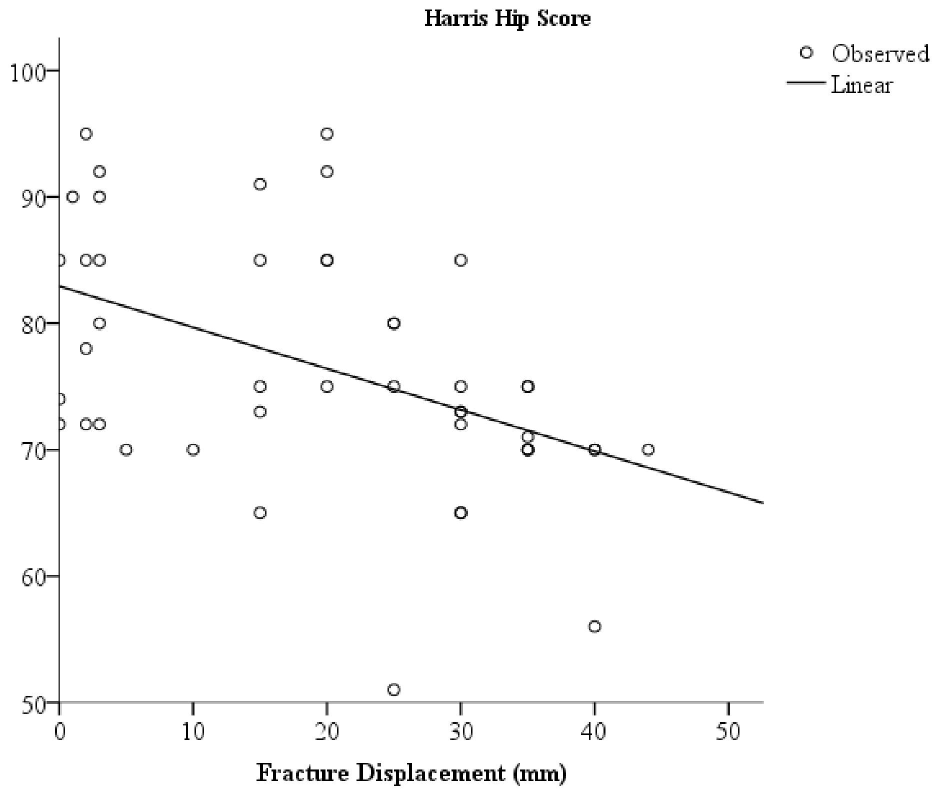
Model summary	*R*	R^2	Adjusted R^2	S.E. of Estimate	*p*
	.466	.217	.199	8.705	**<.001**
ANOVA	Sum of Squares	*df*	Mean Square	*F*	
Regression	923.081	1	923.081	12.181	
Residual	3334.224	44	75.778		
Total	4257.304	45			
Coefficients	*B*	S.E.	Beta	*t*	
Fracture displacement (mm)	-.326	.094	-.466	-3.490	
Constant	82.936	2.231		37.167	

Linear regression model was used for all variables.

The model presents the regression equation as:

Figure 21: Plot for Harris hip scores and Fracture displacement (mm) linear regression

Harris hip scores = 82.936 – 0.326(Fracture displacement).


Harris Hip Score
Observed
Linear
100
90
80
70
60
50
0
10
20
30
40
50
Fracture Displacement (mm)

Since the Spearman's Rank-Order Correlation Coefficient (r_s) showed a statistically significant correlation between Harris hip scores and duration of hospital stay, a linear regression was run to predict duration of hospital stay from Harris hip scores. Harris hip scores statistically significantly predicted duration of hospital stay (Table 11).

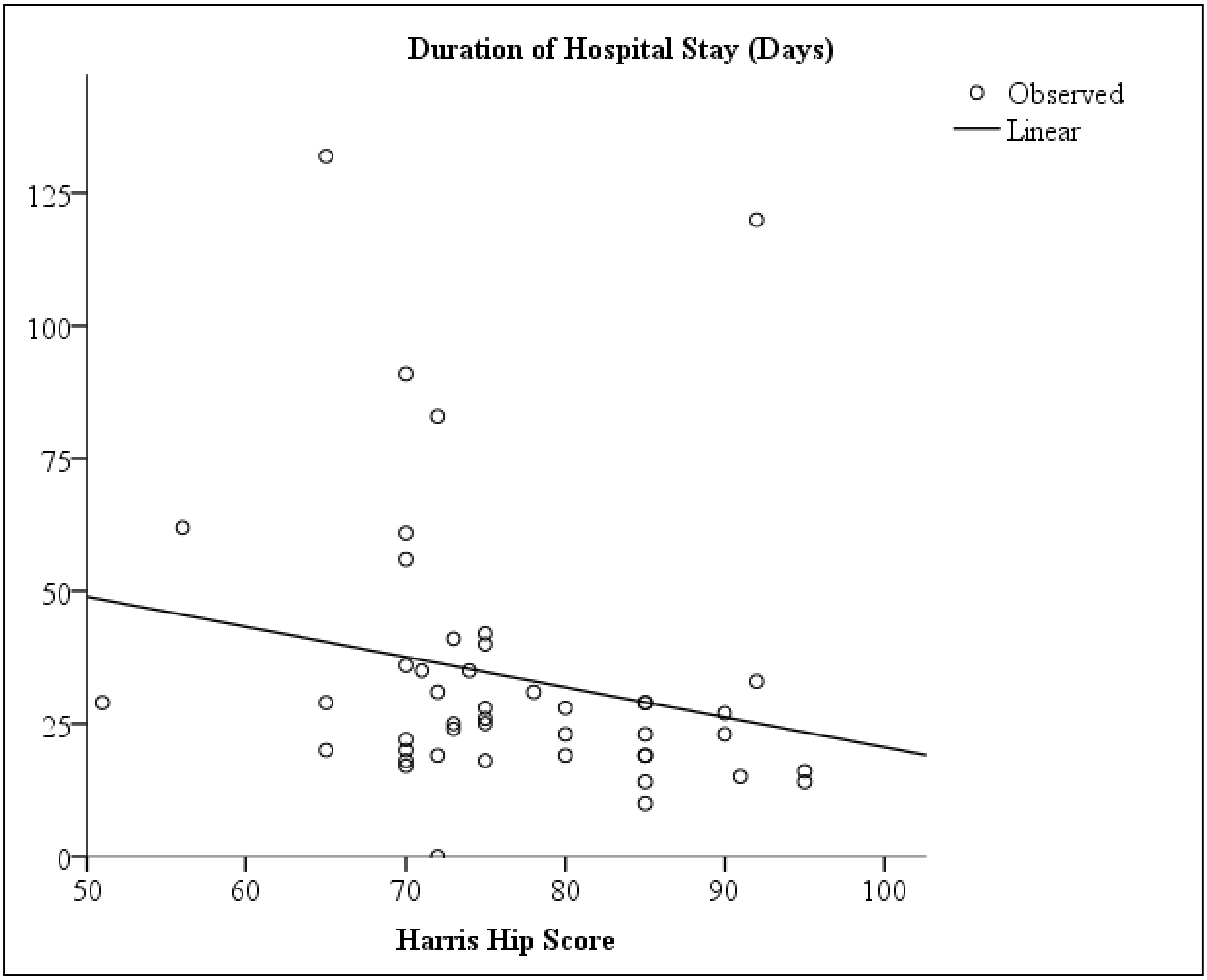
Table 10: Linear Regression model for duration of hospital stay (days) and Harris hip scores (n = 46)

Model summary	*R*	R^2	Adjusted R^2	S.E. of Estimate	*p*
	.210	.044	.022	26.030	.162
ANOVA	Sum of Squares	*df*	Mean Square	*F*	
Regression	1371.118	1	1371.118	2.024	
Residual	29812.817	44	677.564		
Total	31183.935	45			
Coefficients	*B*	S.E.	Beta	*t*	
Harris hip scores	-.568	.399	-.210	-1.423	
Constant	77.299	30.785		2.511	

The model presents the regression equation as:

Duration of hospital stay (days) = 77.299 – 0.568 (Harris hip scores)

Figure 22: Plot for duration of hospital stay (days) and Harris hip scores linear regression



5.0 DISCUSSION

Acetabular fractures frequently result from high-energy trauma (1,2) and are primarily caused by road traffic accidents, with rates ranging between 40% (8), and 76% (9). Mutiso et al found 87 per cent of pelvic fractures occur due to motor vehicle accidents (4). The focus of this study was to describe fracture patterns, early complications and outcomes, in order to better inform patient management by identifying the important parameters that may influence function, which is the ultimate goal of patient care. Oroko (64) in a 2-year retrospective study looked at pelvic and acetabular outcomes. The study had no outcome measure tool, except return to work status. Eliezer et al assessed functional outcome 1-year post acetabular fracture management using the Merle d'Aubigné Postel (MAP) score, EQ-5D, and Squat and Smile test, the only study to our knowledge in the East African region using objective scoring criteria. We aimed to perform a study looking at early outcomes due to the challenges of reliable long term patient follow-up, with loss to follow-up and dependable patient data storage acting as impediments to credible and complete results. There may be utility of early outcome scores to guide management.

Previous Kenyan studies have shown a preponderance of young, male victims involved in motor vehicle accidents. Okemwa et al (2008) showed an 81% male predominance of road traffic fatalities (90). The proportion of patients were predominantly male (89.1% of patients), and young (mean 34.9 years). These findings are similar to those in a Brazilian study by Marcelo et al (91). This may be due to patterns of road transportation use and occupational exposure, with women involved in occupations less prone to high energy injuries. Posterior wall fractures were among the two most common fracture patterns. However, duration of hospital stay differed greatly, with the Marcelo study having a mean duration of 14.4 days, compared to 33.9 days in this study. This may be attributed to constraints on theatre availability or sub-optimal patient optimization due to concomitant injuries in our setting. A larger proportion in the Marcelo study underwent operative management compared to this study (90% versus 58.7%). This may be due to timely access to theatre services. Complication rates were higher in the current study. Our predominant early complication was limb length discrepancy, compared to infection in the Marcelo study. With a significant number of patients in the current study experiencing non-operative or delayed operative care, limb length inequality was likely to occur. Conversely, infection rates would be the predominant complication in a setting where management is predominantly operative, as seen in the Marcelo study (91).

Similarly, in a Swedish study by Lundin et al (92), 58% of acetabular fractures were male. However, more patients in our study (58.7%) underwent surgical management in comparison to the Swedish study (15%). The main goal of acetabular fixation being restoration of joint congruency and integrity of the weight bearing surface (sourcil), one possible explanation for this difference may be the degrees of displacement necessitating reduction, testament to the fracture mechanism and energy involved. Melhem et al in a retrospective French epidemiological study (93) found a higher mean age of patients with this acetabular fractures (66yrs), as well as a male predominance (61%). Surgical fixation rates were similar to those of the Swedish study by Lundin et al (91) of 14.33%.

Patterns based on the Letournel classification showed an equal incidence of posterior wall and transverse with posterior wall fractures as the two predominant (23.9%). This is similar to Letournel's series (24.7%) (34) for posterior wall, and those by Letournel and Judet for transverse with posterior wall (20%) (12), in whose series this was the second most frequent fracture pattern after posterior wall fractures. This study had also found anterior wall fractures as the third most common fracture pattern, compared to the Letournel series that had associated both column in this position (12). Briffa et al (75) in a 10-year follow-up study found associated both column as the most frequent fracture pattern (67%), followed by posterior wall (41%).The differences may be attributed to the number of patients in the current study, with a larger study potentially showing agreement.

Limb length discrepancy was the predominant complication, with 21patients affected. This is a complication not widely addressed in the literature. It may be due to significant fracture displacements at the time of injury, subsequent inadequate reductions, or flexion contracture at the hip. This study found an incidence of 8% for post-operative sciatic nerve injury, compared to 6.3% in the Letournel series (12). Briffa et al (75) had an overall incidence of 12% sciatic nerve injury (both iatrogenic and immediate post injury). Other investigators have reported lower rates, with Giannoudis et al demonstrating 4.7% (21) and Middlebrooks et al 2% (61). This may be indicative of sciatic nerve stretch intraoperatively occurring during fracture reduction. These injuries are predominantly neuropraxias that resolve within 3 or so months.

The average HHS in this study was 52.2 (Fair), with a statistically significant correlation between operatively managed patients and higher scores. This is comparable to Chan et al (94) in a 1-year prospective study of operatively managed patients demonstrating an average HHS of 66.8 (fair). This suggests that early HHS may be useful in determining near and long-term functional outcomes. There was no statistically significant relationship between HHS and demographics of sex and occupation. Similarly, no association was demonstrated between HHS and fracture characteristics of head and wall impaction, as well as dislocation. This is likely due to the fact that the score was performed early, as these factors have been found to have an impact on eventual hip function (69) and suggests that HHS should perhaps be performed later. There was no correlation between HHS and fracture pattern. This contrasts with Matta (16), who found higher outcome scores in elementary fracture patterns. Briffa et al (75) reported poor outcomes in T-type fractures.

However, the findings from these authors were not early (10-year follow-up for the Briffa et al study) and longer term studies in our setting would have to be undertaken to observe any agreement or deviations from these investigators. This study found a negative correlation between fracture displacement and HHS scores, with poorer scores associated with high initial displacement at the time of injury. This is consistent with a study by Meena et al (95) and Iqbal et al (96) that demonstrated initial fracture displacement being a factor influencing hip function scoring. The mean follow-up was 3.95 years. It is therefore significant that this parameter can predict functional outcome at a much earlier time as seen in the current study. Similarly, Ziran et al (68) also demonstrated poorer functional outcomes in fractures with an initial displacement of greater than 20mm.

There were higher Harris hip scores in the operatively managed patients, with most (52.2%) having a fair Harris hip score. This is due to the fact that anatomic fracture reduction ensures reduced contact stress, has congruency that enables pain free ambulation and diminishes the progression to post-traumatic osteoarthritis (71).

There was a negative correlation between length of hospital stay and HHS. This has not been demonstrated in the literature looking at functional outcomes by other investigators. Our findings may be attributed to polytrauma patients requiring other surgeries, thus compromising overall rehabilitation and return to normal ambulation. There was no correlation in this study between HHS and duration to surgery, despite this being a finding in by other investigators (9) (16) (50) (96). This may be due to the lower numbers in this study compared to those demonstrating a correlation. Studies in our setting carried out on a larger scale may demonstrate agreement with other authors.

5.1 Study limitations

1. This was a multicenter study with the participating institutions having different resources and theatre availability, influencing time to surgery and therefore length of hospital stay.
2. The patients undergoing operative management with received care from surgeons with varying levels of experience, therefore possibly influencing functional outcomes.
3. Some patients had multiple injuries, thus lengthening their length of hospital stay and thus confounding the outcome measure.

6.0 CONCLUSION

Acetabular fractures are a challenge to manage, with concerns for future hip function and the likelihood of post traumatic arthritis necessitating total hip replacement surgery. Operative management is best suited for displaced fractures, with non-operative care reserved for those with minimal displacement or those unfit for surgery. A majority of patients underwent surgical fixation (58.7%), indicative of the severity of injury and fracture displacement necessitating operative care. Of note is the poorer HHS in patients with initially large fracture displacement, and longer hospital stay. Higher HHS were seen in operatively managed patients. The HHS performed early showed agreement with scores done a year after surgery, suggesting that early scoring may help predict future functional outcomes.

6.1 Recommendations

Acetabular fractures have the potential for sequelae that hamper activities of daily living, with pain and disability. They pose a risk for the development of post traumatic arthritis of the hip joint, that may necessitate total hip arthroplasty. Measures to ensure anatomical reduction, early surgery, reduced length of hospital stay, and operative management for displaced fractures should be undertaken, which include prioritization of these patients for surgery, and increasing the pool of expertise able to tackle these complex fractures. Educating road users of all cadres and other occupations at risk on safe and considerate road use and workplace safety is paramount to reducing the occurrence of these high energy injuries.

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8.0 APPENDICES

A. Data Collection Sheet

PATIENT DEMOGRAPHICS

LINK LOG	
HOSPITAL	
AGE	
SEX	M / F
OCCUPATION	

HARRIS HIP SCORE

At 12 Weeks	

FRACTURE CHARACTERISTICS

1. Fracture Classification	
2. Fracture Displacement	___________mm
3. Femoral Head Impaction	YES__________/NO_____________
4. Acetabular Wall Impaction	YES__________/NO_____________
5. Femoral Head Dislocation	YES__________/NO_____________

EARLY COMPLICATIONS

COMPLICATION	YES	NO
1. Sciatic nerve injury (immediate post injury)		
2. Sciatic nerve injury (iatrogenic)		
3. Decubitus ulcers		
4. DVT and PE		
5. Hematoma		
6. Lower Limb Length Discrepancy		

FRACTURE MANAGEMENT

1. Operative Management	**YES______**	**NO________**
2. Surgical Approach		
3. Time To Surgery	____________DAYS	
4. Non-Operative Management – Criteria Met Or Extenuating Circumstances Precluding Surgery.		
5. Duration Of Hospital Stay	____________DAYS	

B. Hojaji

VITAMBULISHI VYA WAGONJWAKIPIMO CHA KIUNO CHA HARRIS

Inapotimia Wiki 12	

KITAMBULISHI KWA MTANDAO	
HOSPITALI	
UMRI	
JINSIA	KIUME / KIKE
KAZI	

SIFA ZA VIUNGO VILIVYOVUNJIKA

1. Uainishaji Wa Kuvunjika	
2. Upana wa Kuvunjika	___________milimita
3. Kubanwa kwa mfupa upande wa mguu	NDIO___________/LA______________
4. Kubanwa kwa mfupa upande wa kiuno	NDIO___________/LA______________
5. Kujitenga kwa Kiuno	NDIO___________/LA______________

MATATIZO YANAYOJITOKEZA MAPEMA

UTATA	NDIO	LA
1. Jeraha kwa mshipa wa sayatik (muda mfupi baada ya jeraha kuu)		
2. Jeraha kwa mshipa wa sayatik (unaosababishwa na daktari)		
3. Vidonda upande wa kulalia		
4. Kuganda kwa damu kwa mishipa ya miguu na ya kifua		
5. Mseto wa damu		
6. Tofauti kati ya urefu wa miguu		

MATIBABU YA WALIOVUNJIKA KIUNO

1. Kufanyiwa upasuaji	**NDIO_______**	**LA________**
2. Namna ya upasuaji		
3. Muda kabla ya upasuaji kutekelezwa	____________SIKU	
4. Matibabu bila upasuaji, na sababu .		
5. Muda wa kulazwa	____________SIKU	

C. Seddon Classification (84)

TYPE	EXAMINATION FINDINGS
Neuropraxia	Sensory dysfunction, normal motor, Negative Tinnel’s sign, recovery days to weeks
Axonotemesis	Incomplete motor and/or sensory dysfunction, positive Tinnel's sign at the injury site, slow recovery/incomplete
Neurotmesis	Complete motor and sensory dysfunction, positive Tinnel's sign at the injury site, recovery only in surgical intervention

D. Peripheral Deep Venous Thrombosis (Dvt) Criteria – WELLS SCORE (85)

Wells score

Clinical characteristics	Score
Active cancer	+1
Paralysis or plaster immobilisation	+1
Bed rest >3 days or major surgery <4 weeks	+1
Localised tenderness along the distribution of the deep venous system	+1
Entire leg swollen	+1
Calf swelling >3 cm when compared with asymptomatic leg	+1
Pitting oedema	+1
Collateral superficial veins (non-varicose)	+1
Previously documented deep vein thrombosis	+1
Alternative diagnosis at least as likely as deep vein thrombosis	−2
Clinical probability	
Unlikely	<2
Likely	≥2

E. Harris Hip Score (82)

Harris Hip Score

Patient ID:
Study Hip: ☐ Left ☐ Right
Examination Date (DD/MM/YY): / /
Subject Initials: |____|____|____|
Hospital:

Pain *(check one)*

☐ None or ignores it (44)

☐ Slight, occasional, no compromise in activities (40)

☐ Mild pain, no effect on average activities, rarely moderate pain with unusual activity; may take Paracetamol (30)

☐ Moderate Pain, tolerable but makes concession to pain. Some limitation of ordinary activity or work. May require Occasional pain medication stronger than Paracetamol (20)

☐ Marked pain, serious limitation of activities (10)

☐ Totally disabled, crippled, pain in bed, bedridden (0)

Limp

☐ None (11)

☐ Slight (8)

☐ Moderate (5)

☐ Severe (0)

Support

☐ None (11)

☐ Cane for long walks (7)

☐ Cane most of time (5)

☐ One crutch (3)

☐ Two canes (2)

☐ Two crutches or not able to walk (0)

Distance Walked

☐ Unlimited (11)

☐ 1.2 km (8)

☐ 400 – 600 m (5)

☐ Indoors only (2)

☐ Bed and chair only (0)

Sitting

☐ Comfortably in ordinary chair for one hour (5)

☐ On a high chair for 30 minutes (3)

☐ Unable to sit comfortably in any chair (0)

Enter public transportation

☐ Yes (1)

☐ No (0)

Stairs

☐ Normally without using a railing (4)

☐ Normally using a railing (2)

☐ In any manner (1)

☐ Unable to do stairs (0)

Put on Shoes and Socks

☐ With ease (4)

☐ With difficulty (2)

☐ Unable (0)

Absence of Deformity (All yes = 4; Less than 4 =0)

Less than 30° fixed flexion contracture	☐ Yes	☐ No
Less than 10° fixed abduction	☐ Yes	☐ No
Less than 10° fixed internal rotation in extension	☐ Yes	☐ No
Limb length discrepancy less than 3.2 cm	☐ Yes	☐ No

Range of Motion (*indicates normal)*

Flexion (*140°) ________

Abduction (*40°) ________

Adduction (*40°) ________

External Rotation (*40°) ________

Internal Rotation (*40°) ________

Range of Motion Scale

211° - 300° (5)	61° - 100 (2)
161° - 210° (4)	31° - 60° (1)
101° - 160° (3)	0° - 30° (0)

Range of Motion Score __________
Total Harris Hip Score __________

F. Classification of Pulmonary Embolism (86)

Massive PE ***(also known as high-risk PE)***	- Sustained hypotension (systolic blood pressure <90 mm Hg), not due to arrhythmia, hypovolemia, sepsis, or left ventricular dysfunction, and either lasting for at least 15 minutes or necessitating the administration of inotropes OR - Pulseless ness OR - Persistent profound bradycardia (heart rate < 40 bpm) plus findings of shock
Submassive PE ***(also known as intermediate-risk PE)***	- Right ventricular dysfunction OR myocardial necrosis AND - Absence of systemic hypotension (systolic blood pressure >90 mm Hg)
Low-risk PE	- Absence of hypotension, shock, right ventricular dysfunction, and myocardial necrosis

G. Subjective Hematoma Classification (87)

HEMATOMA GRADE
1. ABSENT
2. MILD
3. MODERATE
4. SEVERE

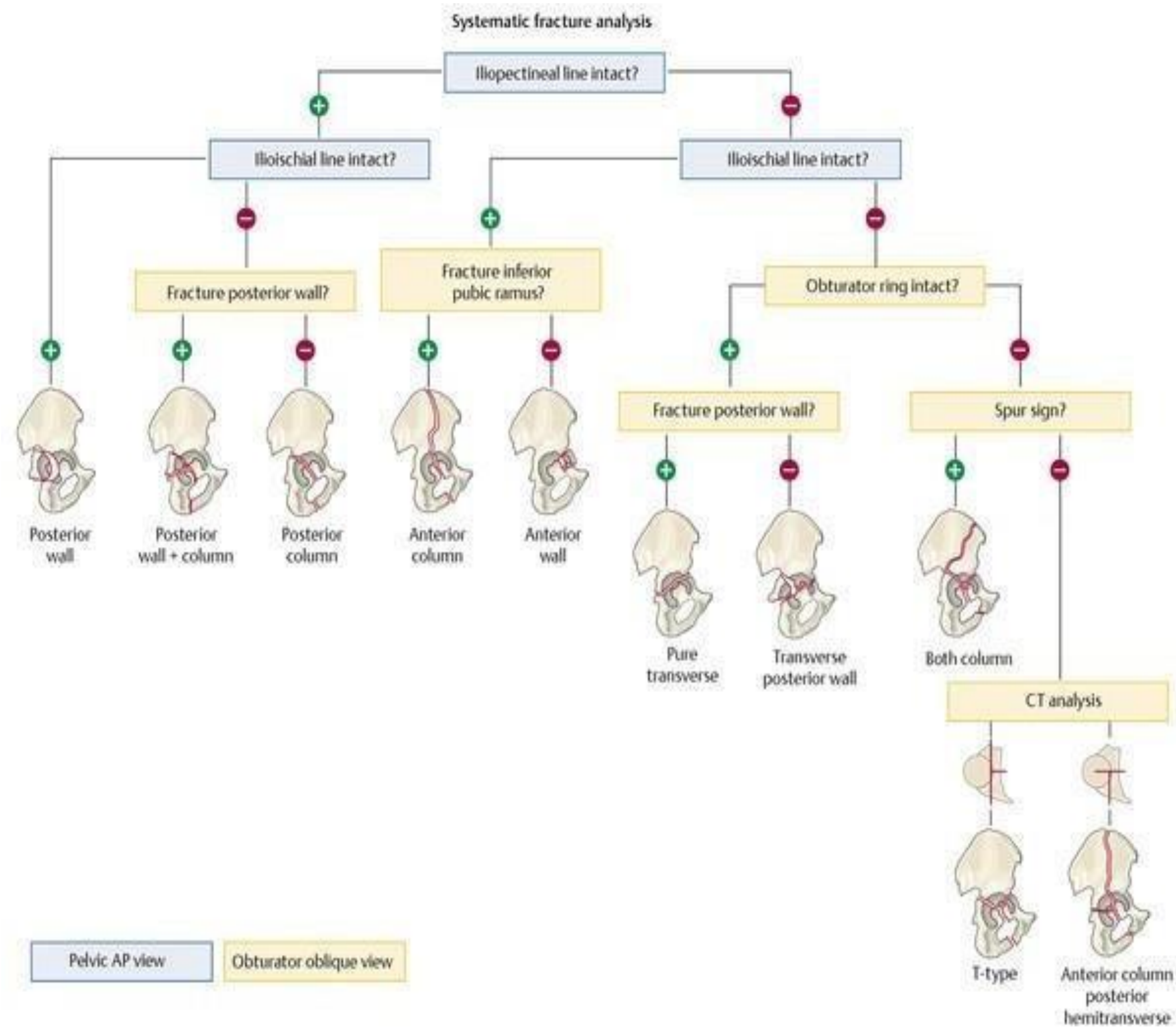
H. European Pressure Ulcer Advisory Panel (Epuap) Categories (88)

Grade	Description
I	Non-blanchable erythema of intact skin
II	Partial-thickness skin loss involving epidermis, dermis or both
III	Full-thickness skin loss involving damage to or necrosis of subcutaneous tissue that may extend down to, but not through, underlying fascia
IV	Full-thickness skin loss with extensive destruction, tissue necrosis, or damage to muscle, bone or supporting structures

I. Lower Limb Length Discrepancy Classification(89)

MILD	**< 3cm**
MODERATE	**3cm – 6cm**
SEVERE	**>6cm**

J. Acetabular Fracture Classification Algorithm (100)



K. Consent Form

RESEARCH TITLE

STUDY PATTERN AND OUTCOME MEASURES OF ACETABULAR FRACTURES SEEN AT KENYATTA NATIONAL HOSPITAL, NAKURU COUNTY AND REFERRAL HOSPITALAND COPTIC HOSPITAL

Principal Investigator:

Dr Samora Onsare Maranya

Department of Orthopaedic Surgery

University of Nairobi

STUDY DESCRIPTION

This is a study looking at objective outcome measures in patients sustaining acetabular fractures seen at KNH, NCRH, and Coptic Hospital. Your participation will involve divulging your personal demographic information concerning age, occupation, occupation, as well as your progress during the study.

The study aims to describe the acetabular fracture that you have sustained, complications that may be suffered during your hospital stay, and a serial evaluation of your hip function upon your discharge.

Your participation in this study will be kept in confidence and your actual name will not be used in this study. Confidentiality will be maintained by limiting access to your personal information and concealing your identity by assigning a code to your file.

Participation in this study is wholly voluntary, and you withdraw at any point if you so wish. You shall benefit from participating in this study by having close monitoring of your injury and complications should they arise. There are no risks in getting involved in this study. Study findings shall not be used for any monetary gain.

Your care shall not be compromised nor shall you be discriminated against if you decide to pull out from this study at any point. If you require any clarification, the primary investigator may be reached via the contacts provided on the consent certificate/form

L. Consent Certificate

I certify that the study has been fully explained to me and I am willing to participate in it.

Participant's Signature (or thumbprint)……………………….

Date……………………………………………

I confirm that I have clearly explained to the participant the nature of the study and the contents of this consent form in detail and the participant has decided to participate voluntarily without any coercion or undue pressure.

Investigator's Signature……………………………….. Date…………………………..

Witness Signature.. Date..

For any enquiries, please contact:

1. Dr. Samora Onsare Maranya,
    a. Principle investigator
    b. Mobile number: 0714 074 261
    c. E-mail: onsare254@gmail.com

    OR
2. Dr. Kirsteen Ondiko Awori,
    a. Senior lecturer, Department of Orthopaedic Surgery, University of Nairobi.
    b. Mobile number: 0722 812 499
    c. Email: kawori@uonbi.ac.ke

    OR
3. Dr Ezekiel Oburu
    a. Lecturer, Department of Orthopaedic Surgery, University of Nairobi.
    b. Mobile number: 0708 728 060
    c. Email: oburue@uonbi.ac.ke

    OR
4. Kenyatta National Hospital/University of Nairobi Ethics and Research Committee
    College of Health Sciences, University Of Nairobi
    P.O. Box 19676-00202
    Nairobi
    Telephone: 020-2726300 Ext 44355/+254202726300-9
    Email: uonknh_erc@uonbi.ac.ke

M. Fomu Ya Idhini

Msimamizi wa kanuni:

Dk Samora Onsare Maranya

Idara ya Upasuaji wa Mifupa

Chuo Kikuu cha Nairobi

MAELEZO YA UTAFITI

Huu ni utafiti unaoangalia hatua za matokeo ya lengo kwa wagonjwa wanaovunjika mifupa ya kiuno inayoonekana katika KNH, NCRH na Hospitali ya Coptic. Ushiriki wako utajumuisha kutoa maelezo yako ya kibinafsi kuhusu umri wako, kazi unayoifanya, na pia maendeleo yako wakati wa utafiti.

Utafiti huo unakusudia kuelezea kuvunjika kwa kiuno ambayo umeendelea nayo, shida ambazo zinaweza kukuandama wakati wa kukaa kwako hospitalini, na tathmini ya mfululizo ya utendaji wako wakati wa kurudi nyumbani

Ushiriki wako katika utafiti huu utahifadhiwa kwa siri na jina lako halisi halitatumika katika utafiti huu. Usiri utadumishwa kwa kupunguza ufikiaji wa habari yako ya kibinafsi, na kuficha utambulisho wako kwa kupeana nambari kwenye faili yako.

Kushiriki katika utafiti huu ni kwa hiari kabisa, na unajiondoa wakati wowote ikiwa unataka. Utafaidika kwa kushiriki katika utafiti huu kwa kuwa na ufuatiliaji wa karibu wa jeraha lako na shida zinapotokea. Hakuna hatari katika kushiriki katika utafiti huu. Matokeo ya utafiti hayatatumika kwa faida yoyote ya kifedha.

Utunzaji wako hautavurugwa wala hautabaguliwa ikiwa utaamua kujiondoa kutoka kwa utafiti huu wakati wowote. Ikiwa unahitaji ufafanuzi wowote, mchunguzi wa msingi anaweza kufikiwa kupitia anwani zilizotolewa kwenye cheti / fomu ya idhini

N. Cheti Cha Idhini

Sahihi ya mshiriki..Tarehe..

Ninathibitsha yakwamba nimetoa maelezo sahihi kwa mhusika kuhusu huu utafiti na yale yote yaliyomo kwa ustadi, naye mhusika ametoa uamuzi wa kushiriki bila ya kushurutishwa.

Sahihi ya mchunguzi………………………………Tarehe………………………

Sahihi ya Shahidi…………………………………...Tarehe……………………..

Ukiwa na maswali yoyote kuhusu utafiti huu, wasiliana na:

1. Dkt. Samora Onsare Maranya,
   a. Mchunguzi mkuu
   b. Simu ya rununu: 0714 074 261
   c. Barua Pepe: onsare254@gmail.com

AU

2. Dkt. Kirsteen O. Awori,
   a. Mhariri Mkuu Idara ya Anatomia ya Binadamu, Chuo Kikuu cha Nairobi.
   b. Simu ya rununu: 0722 812 499
   c. Barua Pepe: kawori@uonbi.ac.ke

AU

3. Dkt. Ezekiel Oburu
   a. Mhariri, Idara ya Upasuaji wa Mifupa, Chuo Kikuu cha Nairobi.
   b. Simu ya rununu: 0708 728 060
   c. Barua Pepe: oburue@uonbi.ac.ke

AU

4. Hospitali ya Kitaifa ya Kenyatta /Chuo Kikuu cha Nairobi,Kamati ya Maadili na Utafiti Chuo cha Sayansi za Afya, katika Chuo Kikuu cha Nairobi

   Sanduku la posta 19676-00202 Nairobi

   Simu: +254202726300-9 Ext 44355

   Barua pepe: uonknh_erc@uonbi.ac.ke

   Appendix A: Ethics Review Committee

O. ERC Certificate

UNIVERSITY OF NAIROBI
FACULTY OF HEALTH SCIENCES
P O BOX 19676 Code 00202
Telegrams: varsity
Tel:(254-020) 2726300 Ext 44355

KNH-UON ERC
Email: uonknh_erc@uonbi.ac.ke
Website: http://www.erc.uonbi.ac.ke
Facebook: https://www.facebook.com/uonknh.erc
Twitter: @UONKNH_ERC https://twitter.com/UONKNH_ERC

KENYATTA NATIONAL HOSPITAL
P O BOX 20723 Code 00202
Tel: 726300-9
Fax: 725272
Telegrams: MEDSUP, Nairobi

Ref: KNH-ERC/A/434

12th November 2021

Dr. Samora Onsare Maranya
Reg. No.H58/7195/2017
Dept. of Orthopaedic Surgery
Faculty of Health Sciences
University of Nairobi

12 NOV 2021

Dear Dr. Onsare

RESEARCH PROPOSAL: PATTERNS, COMPLICATIONS AND EARLY FUNCTIONAL OUTCOMES OF ACETABULAR FRACTURES AT THREE URBAN HOSPITALS IN KENYA (P658/08/2021)

This is to inform you that KNH-UoN ERC has reviewed and approved your above research proposal. Your application approval number is **P658/08/2021.** The approval period is 12th November 2021 – 11th November 2022.

This approval is subject to compliance with the following requirements;

i. Only approved documents including (informed consents, study instruments, MTA) will be used
ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by KNH-UoN ERC.
iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to KNH-UoN ERC 72 hours of notification
iv. Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to KNH-UoN ERC within 72 hours
v. Clearance for export of biological specimens must be obtained from relevant institutions.
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.
vii. Submission of an executive summary report within 90 days upon completion of the study to KNH-UoN ERC.

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) https://research-portal.nacosti.go.ke and also obtain other clearances needed.

Yours sincerely

PROF. M.L. CHINDIA
SECRETARY, KNH-UON ERC

c.c. The Dean-Faculty of Health Sciences, UoN
The Senior Director, CS, KNH
The Chairperson, KNH- UoN ERC
The Assistant Director, Health Information, KNH
The Chair, Dept. of Orthopaedic Surgery, UoN
Supervisors: Dr. Kirsteen Ondiko Awori, Dept. of Human Anatomy, UoN
Dr. Ezekiel Oburu,Dept.of Orthopaedic Surgery, UoN

P. KNH Study Registration Certificate

KNH/R&P/FORM/01

KENYATTA NATIONAL HOSPITAL
P.O. Box 20723-00202 Nairobi

Tel.: 2726300/2726450/2726565
Research & Programs: Ext. 44705
Fax: 2725272
Email: knhresearch@gmail.com

Study Registration Certificate

1. Name of the Principal Investigator/Researcher
   DR. SAMERIA MARANYA.
2. Email address: onsare254@gmail.com Tel No. 0714074261
3. Contact person (if different from PI).......
4. Email address: .... Tel No. ....
5. Study Title
   PATTERNS, COMPLICATIONS AND EARLY FUNCTIONAL OUTCOMES OF ACETABULAR FRACTURES AT THREE URBAN HOSPITALS IN KENYA.
6. Department where the study will be conducted DEPARTMENT OF SURGERY, ORTHOPAEDICS
   (Please attach copy of Abstract)
7. Endorsed by KNH Head of Department where study will be conducted.

   Name Dr. Okumu .... Signature [signature] Date 15/12/2021

   KENYATTA NATIONAL HOSPITAL OFFICE OF THE HOD ORTHOPAEDICS 15 DEC 2021 P.O. Box 20723-00202, NAIROBI

8. KNH UoN Ethics Research Committee approved study number P655/08/2021
   (Please attach copy of ERC approval)
9. I DR. SAMORIA MARANYA commit to submit a report of my study findings to the Department where the study will be conducted and to the Department of Medical Research.

   Signature [signature] Date 1/12/2021.

10. Study Registration number (Dept/Number/Year) Orthopaedics /36 /2021
    (To be completed by Medical Research Department)
11. Research and Program Stamp ______

KENYATTA NATIONAL HOSPITAL 15 DEC 2021 P.O. Box 20723-00202 NRB Research Resource Centre

All studies conducted at Kenyatta National Hospital **must** be registered with the Department of Medical Research and investigators **must commit** to share results with the hospital.

Q. NACOSTI Approval

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION

Ref No: 896024

Date of Issue: 22/April/2022

RESEARCH LICENSE

This is to Certify that Dr.. Samora Onsare Maranya of University of Nairobi, has been licensed to conduct research in Nairobi on the topic: PATTERNS, COMPLICATIONS AND EARLY FUNCTIONAL OUTCOMES OF ACETABULAR FRACTURES AT THREE URBAN HOSPITALS IN KENYA for the period ending : 22/April/2023.

License No: NACOSTI/P/22/16987

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Website: www.nacosti.go.ke

R. Originality Report

PATTERNS, COMPLICATIONS AND EARLY FUNCTIONAL OUTCOMES OF ACETABULAR FRACTURES IN THREE URBAN HOSPITALS IN KENYA

by Dr. Maranya

Submission date: 29-Apr-2022 05:43PM (UTC+0300)
Submission ID: 1823875223
File name: PATTERNS.docx (1.98M)
Word count: 12542
Character count: 72283

PATTERNS, COMPLICATIONS AND EARLY FUNCTIONAL OUTCOMES OF ACETABULAR FRACTURES IN THREE URBAN HOSPITALS IN KENYA

ORIGINALITY REPORT

15%	9%	11%	3%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Emile Letournel, Robert Judet. "Fractures of the Acetabulum", Springer Science and Business Media LLC, 1993 Publication	1%
2	erepository.uonbi.ac.ke Internet Source	1%
3	Meir H. Scheinfeld, Akiva A. Dym, Michael Spektor, Laura L. Avery, R. Joshua Dym, Derek F. Amanatullah. "Acetabular Fractures: What Radiologists Should Know and How 3D CT Can Aid Classification", RadioGraphics, 2015 Publication	1%
4	Navid Ziran, Gillian L. S. Soles, Joel M. Matta. "Outcomes after surgical treatment of acetabular fractures: a review", Patient Safety in Surgery, 2019 Publication	1%
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