“A PROSPECTIVE STUDY ON FUNCTIONAL OUTCOME OF SURGICAL MANAGEMENT OF ACETABULAR FRACTURES”

By

DR. SUDEV RAGHUNATHAN

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Under the guidance of

DR. RAVI KUMAR BIRADAR

D’ORTHO, D.N.B ORTHOPAEDICS

PROFESSOR

DEPARTMENT OF ORTHOPAEDICS

BLDE (DEEMED TO BE UNIVERSITY)

SHRI B.M. PATIL MEDICAL COLLEGE HOSPITAL & RESEARCH CENTER, VIJAYAPURA, KARNATAKA-586

B. L. D.E. (DEEMED TO BE UNIVERSITY)

SHRI B. M. PATIL MEDICAL COLLEGE HOSPITAL & RESEARCH CENTRE, VIJAYAPURA.

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation entitled "A PROSPECTIVE STUDY ON FUNCTIONAL OUTCOME OF SURGICAL MANAGEMENT OF ACETABULAR FRACTURES" is a bonafide and genuine research work carried out by me under the guidance of DR. RAVI KUMAR BIRADAR

MBBS, D'ORTHO, D.N.B ORTHOPAEDICS, Professor, Department of Orthopaedics at BLDE (Deemed to be University) Shri B. M. Patil Medical College Hospital and Research Centre, Vijayapura.

Date:

Place: Vijayapura

Dr. SUDEV RAGHUNATHAN

B. L. D. E. (DEEMED TO BE UNIVERSITY) SHRI B. M. PATIL MEDICAL COLLEGE HOSPITAL & RESEARCH CENTRE, VIJAYAPURA.

CERTIFICATE BY THE GUIDE

This is to certify that the dissertation entitled "A PROSPECTIVE STUDY ON FUNCTIONAL OUTCOME OF SURGICAL MANAGEMENT OF ACETABULAR FRACTURES" is a bonafide research work done by Dr. SUDEV RAGHUNATHAN in partial fulfilment of the requirement for the degree of M.S in Orthopaedics.

Date:

Place: Vijayapura

DR. RAVIKUMAR BIRADAR,

(D'ORTHO, DNB ORTHOPAEDICS)

Professor

Department of Orthopaedics,

B. L. D. E. (Deemed to be University)

Shri B. M. Patil Medical College Hospital & Research Centre, Vijayapura

B. L. D. E. (DEEMED TO BE UNIVERSITY)

SHRI B. M. PATIL MEDICAL COLLEGE HOSPITAL & RESEARCH CENTRE,

VIJAYAPURA

ENDORSEMENT BY THE HEAD OF THE DEPARTMENT

This is to certify that the dissertation entitled "A PROSPECTIVE STUDY ON FUNCTIONAL OUTCOME OF SURGICAL MANAGEMENT OF ACETABULAR FRACTURES" a bonafide research work done by Dr. SUDEV RAGHUNATHAN under the guidance of DR. RAVIKUMAR BIRADAR MBBS, D'ORTHO, DNB ORTHOPAEDICS, Professor,

Department of Orthopaedics at BLDE (Deemed to be University) Shri. B. M. Patil Medical College Hospital and Research Centre, Vijayapura.

Date:

Place: Vijayapura

DR. SANTOSH S NANDI, (MS ORTHOPAEDICS)

Professor & HOD Department of Orthopaedics,

B. L. D. E. (Deemed to be University)

Shri B. M. Patil Medical College Hospital & Research Centre, Vijayapura

B. L. D. E. (DEEMED TO BE UNIVERSITY)

SHRI B. M. PATIL MEDICAL COLLEGE HOSPITAL & RESEARCH CENTRE,

VIJAYAPURA.

ENDORSEMENT BY THE PRINCIPAL

This is to certify that the dissertation entitled "A PROSPECTIVE STUDY ON FUNCTIONAL OUTCOME OF SURGICAL MANAGEMENT OF ACETABULAR FRACTURES" is a bonafide research work done by Dr SUDEV RAGHUNATHAN under the guidance of DR. RAVIKUMAR BIRADAR MBBS, D'ORTHO, DNB Orthopaedics, Professor, Department of Orthopaedics at BLDE (Deemed to be University) Shri. B. M. Patil Medical College Hospital and Research Centre, Vijayapura.

Date:

Place: Vijayapura

DR. ARAVIND PATIL,

Principal, B. L. D. E. (Deemed to be University) Shri B. M. Patil Medical College Hospital & Research Centre, Vijayapura.

B. L. D. E. (DEEMED TO BE UNIVERSITY)

SHRI B. M. PATIL MEDICAL COLLEGE HOSPITAL & RESEARCH CENTRE,

VIJAYAPURA.

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Date:

Place: Vijayapura

DR. SUDEV RAGHUNATHAN

B.L.D.E. DEEMDED TO BE UNIVERSITY

VIJAYAPURA, KARNATAKA.

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Date:

Place: Vijayapura

ABSTRACT

Background: Acetabular fractures represent complex injuries that present significant management challenges. This prospective study evaluates the functional outcomes of surgical management of acetabular fractures at a tertiary care center and identifies factors influencing these outcomes.

Methods: Thirty-one patients with acetabular fractures who underwent surgical management between 2023 and 2025 were enrolled in this prospective study. Fractures were classified according to the Judet-Letournel system, and functional outcomes were assessed using the modified Merle d'Aubigne score at presentation, 6 weeks, 3 months, and 6 months post-surgery. Demographic data, fracture characteristics, surgical approaches, complications, and associated injuries were documented. Statistical analysis was performed to identify factors associated with functional outcomes.

Results: The study cohort comprised predominantly young adult males (71%), with road traffic accidents being the primary mechanism of injury (71%). Posterior column fractures and anterior column fractures with associated pubic rami fractures (25.8% each) were the most common patterns, followed by posterior wall fractures (19.4%). Associated posterior hip dislocations were present in 25.8% of cases. The Kocher-Langenbeck approach was most frequently employed (45.2%), followed by the modified Stoppa approach (32.3%). Functional assessment revealed progressive improvement, with all patients demonstrating poor scores at presentation, progressing to 51.6% excellent and

48.4% moderate outcomes by 6 months. Complications were observed in 19.4% of patients, with hip stiffness being the most common (9.7%). Age, fracture pattern, associated dislocation, surgical approach, and post-surgery follow-up significantly influenced functional outcomes, while the presence of complications also showed a significant association (p=0.03).

Conclusion: Surgical management of acetabular fractures yields favorable functional outcomes, with progressive improvement over time. Most demographic and fracture characteristics significantly influenced outcomes, and the results support the efficacy of tailored surgical approach selection and meticulous technique. The findings highlight the importance of extended rehabilitation and careful management of complications to optimize functional recovery.

Keywords: Acetabular fractures, Functional outcome, Surgical management, Modified Merle d'Aubigne score, Kocher-Langenbeck approach, Modified Stoppa approach, Hip fractures, Trauma

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ABBREVIATIONS

3D-CT - Three-Dimensional Computed Tomography

AP - Anteroposterior

AS - Ankylosing Spondylitis

AVN - Avascular Necrosis

BMI - Body Mass Index

CT - Computed Tomography

DVT - Deep Vein Thrombosis

FFH - Fall From Height

HO - Heterotopic Ossification

ICU - Intensive Care Unit

IL - Ilioinguinal

ISS - Injury Severity Score

IV - Intravenous

K-L - Kocher-Langenbeck

LMWH - Low Molecular Weight Heparin

MRI - Magnetic Resonance Imaging

MS - Modified Stoppa

NSAIDs - Non-Steroidal Anti-Inflammatory Drugs

OA - Osteoarthritis

ORIF - Open Reduction and Internal Fixation

PE - Pulmonary Embolism

PMMA - Polymethylmethacrylate

ROM - Range of Motion

RTA - Road Traffic Accident

THA - Total Hip Arthroplasty

VTE - Venous Thromboembolism

PBHS- Pelvis with both hip joint

FIG- Figure

INTRODUCTION

Acetabular fractures represent one of the most challenging injuries in orthopedic trauma surgery, requiring extensive expertise in both diagnosis and management. These complex injuries, often resulting from high-energy trauma, have significant implications for patient mobility and quality of life. The intricate anatomy of the acetabulum, combined with its crucial role in weight-bearing and hip joint function, makes accurate reduction and fixation paramount for achieving optimal outcomes.[1]

The understanding and treatment of acetabular fractures have evolved significantly since the pioneering work of Judet and Letournel in the 1960s. Their classification system, which remains the gold standard today, provided a systematic approach to analyzing these injuries and planning surgical intervention. Despite technological advances in imaging and surgical techniques, acetabular fractures continue to present substantial challenges to orthopedic surgeons, with reported positive outcomes varying significantly across different studies and treatment approaches.[2]

The “incidence of acetabular fractures has shown a bimodal distribution, with peaks in young adults following high-energy trauma and in elderly patients after low-energy falls . Recent epidemiological studies indicate a growing trend in geriatric acetabular fractures, attributed to increased life expectancy and higher activity levels among older adults. This demographic shift has introduced new challenges in management strategies, as elderly patients often present with compromised bone quality and multiple comorbidities.[3]

The decision-making process in the management of acetabular fractures involves careful consideration of multiple factors, including fracture pattern, patient age, bone quality, associated injuries, and the timing of intervention. The goal of surgical treatment is to achieve "anatomical reduction of the articular surface and stable fixation, allowing early mobilization and reducing the risk of post-traumatic arthritis". However, the complex three-dimensional anatomy of the acetabulum and its surrounding neurovascular structures makes surgical intervention technically demanding.[4]

Advanced imaging techniques have revolutionized the preoperative planning process. While conventional radiographs remain fundamental, computed tomography (CT) with three-dimensional reconstruction has become indispensable for understanding fracture morphology and planning surgical approaches. These imaging modalities help surgeons better appreciate the fracture configuration, degree of comminution, and presence of intra-articular fragments, all of which influence the choice of surgical approach and fixation strategy.[5]

The timing of surgery represents a critical factor in outcome determination. The traditional window of opportunity for optimal surgical intervention has been established as within 5-7 days post-injury, allowing for patient stabilization and soft tissue recovery while avoiding the complications associated with delayed surgery. However, recent studies have challenged this conventional wisdom, suggesting that outcomes may be acceptable even with delayed intervention in carefully selected cases.[6]

Surgical approaches to the acetabulum have also evolved significantly. The choice between anterior, posterior, or combined approaches depends on fracture pattern, surgeon expertise, and patient factors. The development of minimally invasive techniques and specialized instruments has expanded the surgical options available, particularly for simple fracture patterns or elderly patients who may not tolerate extensive surgical exposure. However, the role of these newer techniques continues to be defined through ongoing research and clinical experience.[7]

Post-operative rehabilitation plays a crucial role in determining functional outcomes. The development of standardized protocols, incorporating early mobilization and progressive weight-bearing, has contributed to improved results. However, the optimal timing and progression of rehabilitation remain subjects of debate, particularly in complex fracture patterns or in patients with compromised bone quality.[8]

The assessment of functional outcomes following acetabular fracture surgery presents unique challenges. Various scoring systems have been developed to evaluate post-operative results, including the Harris Hip Score, Modified Merle d'Aubigné Score, and patient-reported outcome measures. These tools help quantify functional recovery and facilitate comparison between different treatment strategies and study populations.[9]

Complications following acetabular fracture surgery can significantly impact functional outcomes. "These include post-traumatic arthritis, heterotopic ossification, avascular necrosis of the femoral head, and infection". Understanding the risk factors for these complications and developing strategies for their prevention and management remains an active area of research. The increasing use of specialized surgical approaches and prophylactic measures has helped reduce complication rates, though they remain a significant concern.[10]

The present study aims to evaluate the functional outcomes of surgically managed acetabular fractures, considering various factors that may influence results. Through careful documentation of patient characteristics, surgical techniques, and post-operative outcomes, we hope to contribute to the existing knowledge base and potentially identify factors associated with improved functional results.

AIM AND OBJECTIVES

OBJECTIVES

1. To analyze the functional outcome of surgical management of acetabular fractures
2. To study the different complications arising from surgical management of acetabular fractures

REVIEW OF LITERATURE

Historical overview[17]

The first description of acetabular fracture appears in Homer's Iliad (8th century BC), where he poetically describes Diomedes striking Aeneas's hip with a boulder, accurately depicting both the injury mechanism and pain experience. Remarkably, the same injury mechanism was confirmed in experimental studies 2,800 years later.

Hippocrates (4th century BC) grouped acetabular injuries under "hip dislocations" since they couldn't be distinguished through clinical examination alone. "This classification persisted until the 19th century. The first detailed description of an acetabular fracture came from Sir Astley Cooper in 1818 through autopsy findings. Later, Schroeder analyzed 49 cases of fractures with central dislocations, noting their severity and high mortality rate of about 30%".

"The first half of the 20th century favored conservative treatment. Although some surgeons like Urist, Eliot, and Knight advocated for operative treatment, most patients received conservative therapy". The field remained divided until Judet and Letournel's groundbreaking work in the 1960s. Disappointed with conservative treatment results, they published their seminal 1963 article introducing a new classification system and surgical approaches for acetabular fractures.

Initially, there was skepticism about operative treatment, particularly in North America during the 1970s. However, Judet and Letournel persisted in spreading their ideas through publications and education. Their textbooks, published in English in 1981 and revised in 1993, became fundamental references for acetabular surgeons. Letournel's educational efforts included teaching AO courses in Davos and training five North American surgeons (known as the acetabular club) who helped disseminate their methods globally.

One of these surgeons, “Joel Matta, later published the largest single-surgeon outcome study of operatively treated acetabular fractures, marking the beginning of modern acetabular surgery. The first documented internal fixation of a posterior wall fracture at the authors' institution was performed in 1965, followed by systematic development of pelvic and acetabular surgery”.

REVIEW OF RELATED ARTICLES

In a study conducted by E.N. Eliezer, Haonga B, Mrita FS et al (2016),[50] They came to the conclusion that acetabular fracture procedures, especially posterior techniques, had favorable outcomes with manageable complication rates. This study found that patients who underwent surgery fewer than six weeks after suffering the trauma had better functional results.

Mesbahi, S. A. et al. (2018)[49] To determine the functional and "radiologic results of surgical treatment in patients with acetabular fractures. A total number of 79 patients completed the study. Fifty-five patients were operated through the Kocher–Langenbeck approach, 18 were operated through the standard ilioinguinal approach, and 6 patients were operated through the standard ilioinguinal approach combined with the Kocher–Langenbeck approach. The mean follow-up of patients was 45.6 months. The average operative time was 162.4±78.5 min, and the median blood loss was 500 ml. Functional results were excellent in 41 patients (51.9%), good in 12 (15.2%), fair in 13 (16.5%), and poor in 13 patients (16.5%). Radiologic results were excellent in 27 cases (34.2%), good in 17 cases (21.5%), fair in 18 cases (22.8%), and poor in 16 (16.5%). Osteoarthritis of the hip (60.8%) and AVN of the head of the femur (22.8%) were the two most common complications. In addition, there wasn't any significant difference between surgical approaches regarding clinical and radiographic outcomes. They concluded that the operative treatment for acetabular fractures gives universally satisfactory results. Thereafter, this study provides evidence that the ilioinguinal approach is a good choice for anterior fractures, Kocher–Langenbeck is a good choice for posterior fractures, and a combined approach may be a good choice in the management of acetabular fractures involving two columns".

Thunuguntla, R et al (2020)[48] The "aim of the present study was to evaluate the functional outcome of surgically treated acetabular fractures. They concluded that internal fixation of acetabular fractures leads to a good outcome in the majority of patients. Early surgical intervention and experienced management is a prime factor in achieving good results".

In a study conducted by Tushar Nayak, Samarth Mittal, Vivek Trikha et al (2020),[47] concluded that the main advantage of the Modified Stoppa technique is its ability to reach sound anatomical reduction while concurrently reducing perioperative morbidity. This study has demonstrated that for the surgical stabilization of anterior wall and column acetabular fractures, the Modified Stoppa method can replace the ilioinguinal approach.

In a study conducted by A.B. Petrov, V.I. Ruzanov, and T.S. Mashukov (2020),[46] concluded that for acetabular fractures, the long-term outcomes for patients who received initial surgery with complete bone reduction or 1-2 mm of residual displacement were acceptable and reasonable. An aggressive surgical approach for treating acetabular fractures known as open reduction and arthroplasty has shown to have a favorable rehabilitation outcome.

In a study conducted by Mehdi Boudissa, Florent Fancony, Sabine Drevet et al (2020),[45] concluded that patients with acetabular fractures who had surgery fared better than those who received conservative care in terms of their post-management autonomy ratings.

Fakru NH et al. (2021)44 This study aimed to evaluate the functional outcome of surgically treated displaced acetabular fractures in the Malaysian context. “The most frequent elementary fracture type was a posterior wall (30.2%) while the associated type was both columns (23.3%). Mean functional outcome of Merle d'Aubigné-Postel was 15.77 and HHS was 86.6. Thirty-three (76.7%) patients achieved satisfactory functional outcomes, 19 (44.1%) patients achieved anatomic reduction (<2 mm step-off) based on Matta classification, while 24 (55.8%) did not achieve the desired outcome. The fracture pattern exhibited a strong association with post-operative Matta radiological outcome (p-value 0.001). However, both the fracture pattern and Matta radiological outcome did not exhibit an association with the functional outcome group. The mean time for surgical interventions was 10.8 days, and there was no significant association with the final functional outcome score. They concluded that fracture pattern is a strong contributing factor towards post-operative Matta radiological outcome. However, achieving the perfect anatomical reduction is not of the utmost important factor to predict a good functional outcome".

In a study conducted by Ansari Muqtadeer Abdul Aziz, Altamash Patel, Altamash Patel (2021),[43] concluded when compared to a combined method, Kocher-Langenbeck employing plate osteosynthesis for "the posterior column and a lag screw fixation for the anterior column posteriorly is a good option for fixing bicolumnar acetabular fractures. The Kocher-Langenbeck approach is preferred and used by the majority of orthopaedic surgeons due to its simplicity and effectiveness. It produces a successful surgery that is less intrusive, takes less time, loses less blood, and has a reduced incidence of infection thereafter".

Sahu, Santosh K et al. (2024)42 conducted a prospective study to evaluate the functional outcomes of acetabular fractures. "Twelve patients had excellent (42%), seven patients had well (25%), seven patients had fair (25%), and two patients had poor (8%) functional outcomes. Two patients had restricted range of movement and pain on walking and had undergone total hip replacement after 1 year. The mean score in the anatomically reduced fracture is 16.4, imperfectly reduced is 14.4, and poorly reduced is 8. The average functional outcome score was 14.2 (range – 5–18). As the articular surface requires smooth congruity, anatomical fixation of fracture fragments is essential for early mobilization and better functional outcomes.

Proper preoperative planning, anatomical reduction, adequate fixation, and early mobilization are required to achieve good functional outcomes in acetabular fractures”.

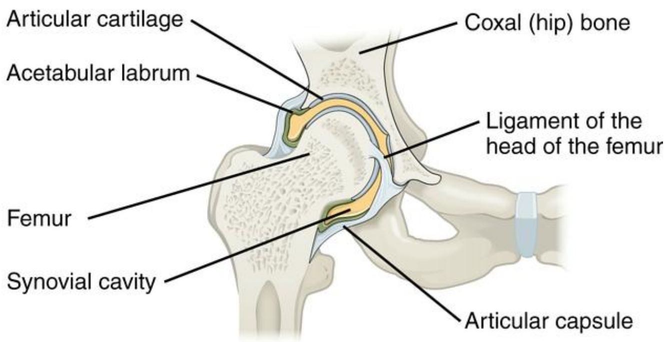
Vanamail SN et al (2024)[41] “This study assesses the functional outcome of open surgical fixation of acetabulum fractures involving single or both columns. They concluded that acetabular fractures treated surgically found that early surgical intervention and good perioperative care can lead to satisfactory functional outcomes. The study used only two non-extensile approaches and achieved an 85% rate of suitable to excellent outcomes. The study also observed that the mechanism of injury, time between injury and surgery, initial degree of displacement, and reduction quality significantly affected functional and radiological outcomes. However, further studies are needed to validate the findings”.

APPLIED ANATOMY OF ACETABULUM

Osseous anatomy

The pelvis is the bony structure that transmits the weight of the upper axial skeleton to both the lower extremities via the hip joint. It comprises the sacrum and three bones on each side that coalesce during adolescence to form the innominate bone of the adult pelvis. The iliosacral joint connects the sacrum to the ilium. The ilium becomes the pubis anteriorly and the ischium inferiorly. Two pubic bones are connected to one another via the symphysis .

Fig 1: Anatomy of Acetabulum



(a) Frontal section through the right hip joint

Acetabulum

The three bones, the ilium, ischium and pubis, join each other centrally to form the acetabular cavity. The blood supply to the femoral head traverses through the cotyloid fossa and ligamentum teres in childhood. The horseshoe-shaped cartilaginous portion of the acetabulum is the main region through which the weight is transmitted from lower limb to innominate bone. [11]

Column concept of the acetabulum

The acetabulum is an incomplete hemispherical socket with an inverted horseshoe-shaped articular surface surrounding the nonarticular cotyloid fossa. Two columns of bone which form an inverted 'Y', form and support the cotyloid fossa anteriorly and posteriorly (Figure 1) [12]

Fig 2: Column concept of the acetabulum by Letournel and Judet.

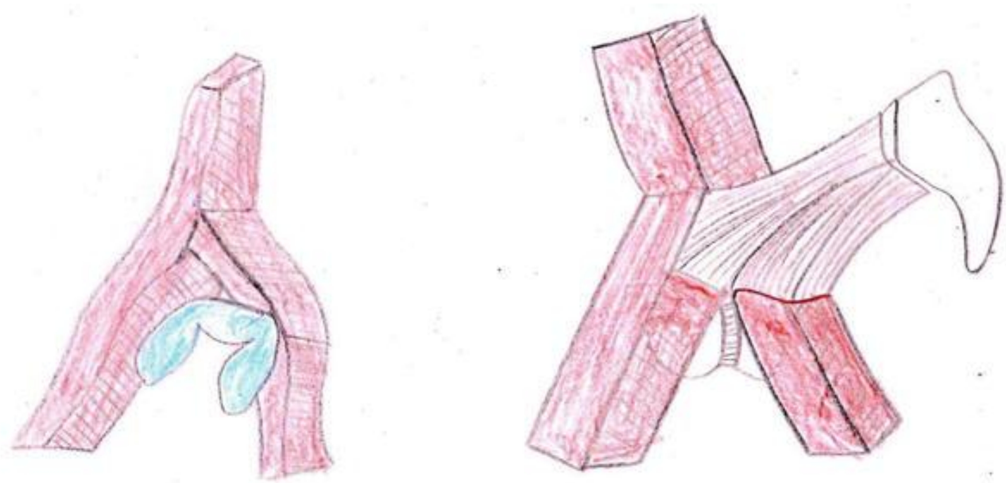
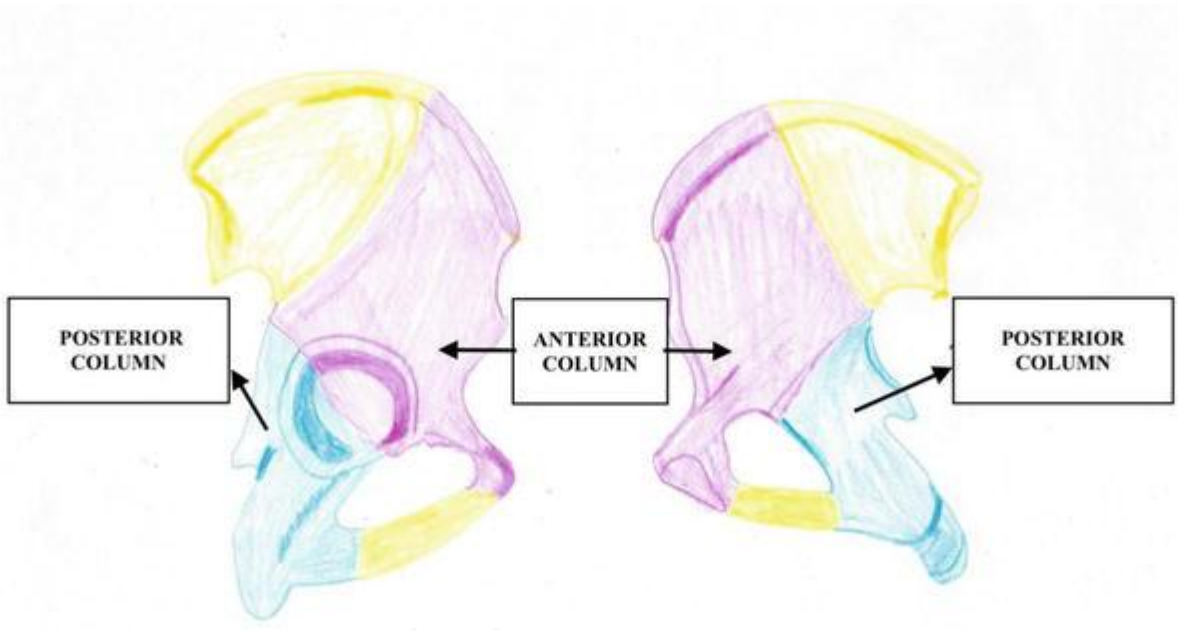


Fig 3: Anterior column and posterior column.



Iliac wing and innominate bone

The external iliac fossa is marked with two semi-circular lines dividing it into three zones:[11]

- Posterior (gluteus maximus)
- Middle (gluteus medius)
- Anterior (gluteus minimus)

The anterior-most border of the iliac bone begins with the anterosuperior iliac spine (ASIS), which gives origin to:

- Fascia Lata
- Sartorius

- Inguinal ligament

The antero-inferior iliac spine (AIIS) lies just below the ASIS where the direct head of the rectus femoris is inserted. The iliopsoas muscle passes just medial to AIIS under which lies the iliopectineal eminence. Indirect head of the rectus femoris is attached inferior to AIIS .

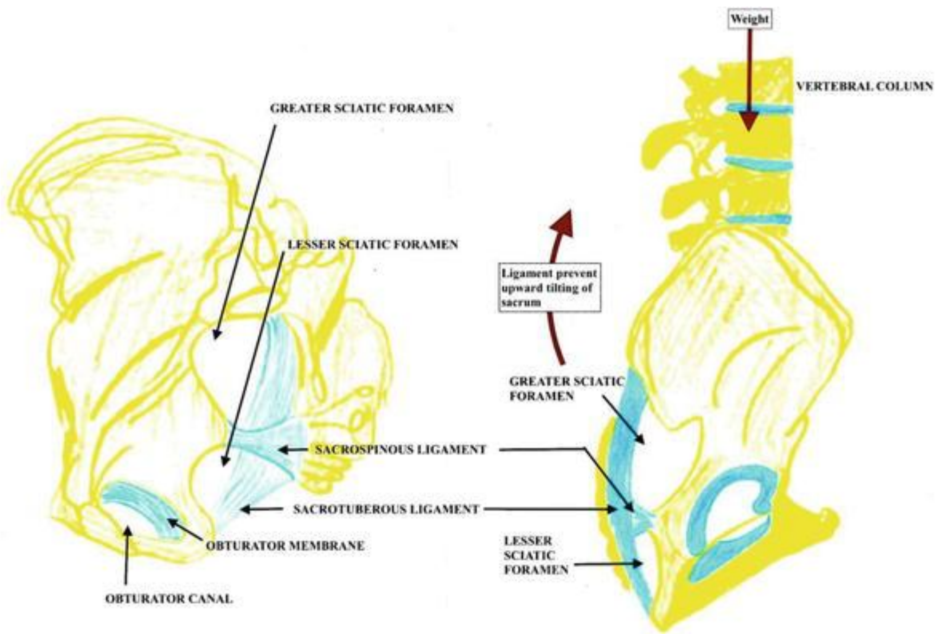
Ligament anatomy: the joints

The iliosacral joint is a fibrocartilaginous joint that acts as a dual wedge in axial and anteroposterior directions. It acts as a keystone during the transmission of force to the lower limbs. The joint is supported anteriorly and posteriorly by strong ligaments.[13] The posterior sacroiliac ligament consists of

- The superficial part goes from the posterior iliac crest and posterior iliac spines to the posterior tubercles of the sacrum made up of several fascicles.
- The deep portion or interosseous ligament, which is the strongest ligament in the human body.

The sacrotuberous ligament connects the sacrum to the ischial tuberosity

Fig 4: The sacrotuberous and sacrotuberous ligaments.



Corona Mortis

Corona mortis is a vascular ring formed by the anastomosis **between** the obturator artery (anterior branch of the Internal iliac artery) and the External iliac artery; also known as the 'circle of death' as injury to the corona mortis can cause uncontrollable bleeding especially in cases requiring an anterior approach to the acetabulum as it is located behind the Superior pubic ramus at a distance varying from a range of 40-96mm from the Symphysis pubis

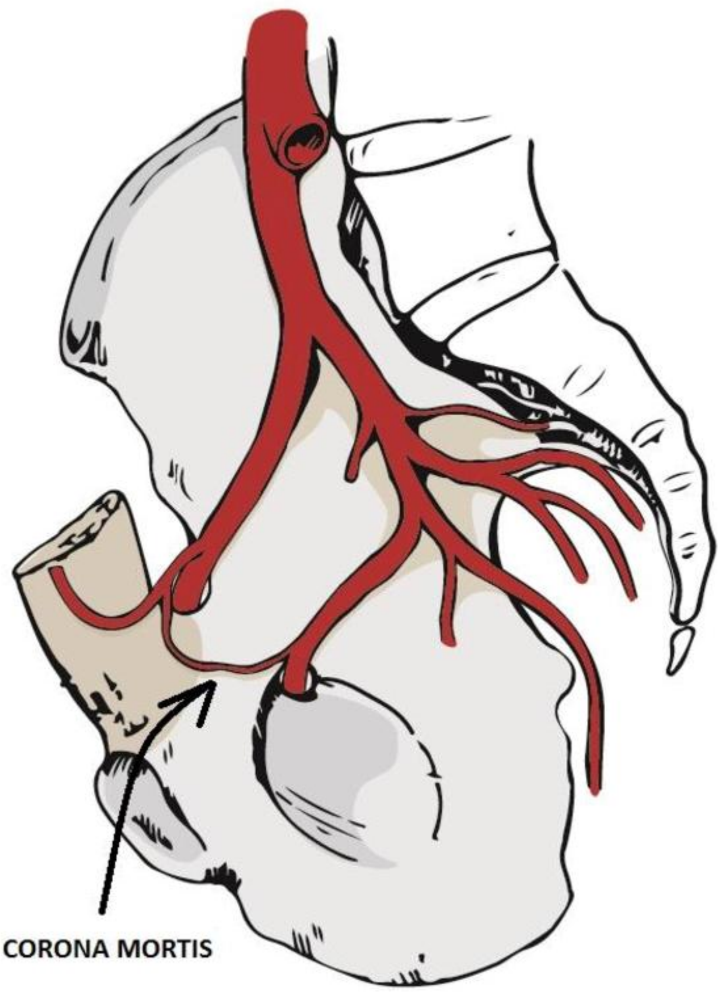


Fig 5: Corona mortis

Biomechanics of the acetabulum and applied mechanics of fracture fixation

Normal mechanics of the hip joint[15]

Of the many joints in the human body, the hip joint has been the one that has attracted the most attention from investigators. The reasons are; first, in normal activity, this joint carries the greatest load, with load intensity fluctuating between zero and its maximum during each cycle of activity; secondly, probably because of this loading, mechanical failures of the hip joint and of the neighboring bony structure, particularly the upper femoral region, constitute a large proportion of the problems confronting the orthopedic surgeon.

Mechanical forces acting within the normal hip joint are complex and difficult to quantify precisely. During locomotion, large forces occur across the hip joint in which each leg alternately supports the weight of the body. During mid-stance, little acceleration and relatively constant force are applied across the joint, making midstance ideal for a static loading model of investigation. Forces across the joint itself are greatest during midstance and are derived from two primary sources :

- Body weight (BW)
- Abductor moment (Abd)

Body weight is centered just anterior to the S2 vertebra and exerts a force on the hip joint, which acts to rotate the pelvis about the femoral head toward the center of gravity. Counteracting this force is the abductor moment, which acts to rotate the pelvis in the opposite direction. During single-leg stance, these two forces cancel each other out and, therefore, the pelvis remains upright.

Because both of these forces have magnitude and direction, they can be expressed as vectors on a free-body diagram. The Abd is greater than BW, owing to a shorter moment arm, so that in the steady state.

(BW×a)=(Abd×b)2

E1

The joint reactive force is the compressive force experienced at the femoroacetabular articulation, and it is the result of the need to balance the moment arms of the body weight with the pull of the hip abductors at the greater trochanter to maintain a level pelvis .

The primary contributions to the joint reactive force are the muscular forces generated to level the pelvis during standing and gait, with a smaller contribution from body weight. The magnitude of this force varies with activities such as the single leg stance phase of gait, and it has been found to be as much as 2–4 times the body weight during level walking and stair ascent and slightly higher during stair descent .[14]

Smooth gait relies on a well-synchronized series of concentric and eccentric muscular contractions to facilitate a balanced stride. A complete neuromuscular loop exists that maintains the appropriate position between the femoral head and acetabulum with balanced muscular regulation achieved at both the voluntary and involuntary level .

The weight-bearing portion of the hip has been found to vary with the position of the femur in relation to the acetabulum and the amount of load placed through the articulation. During normal loading of a non-arthritic joint during activities such as walking, the majority of the articular surface participates in weight bearing. This involves the anterior, superior and posterior parts of the femoral head and forms two columns of force that are transmitted within the acetabular margin, joining at the superior aspect of the acetabular fossa. The geometric orientation of the articular cartilage is also optimized for load transfer because the thickest portions are at the areas of the acetabulum and femoral head most frequently loaded during gait .

Biomechanical consequences of acetabular fracture[16]

A number of studies have focused on the biomechanical consequences of acetabular fracture. These studies can be divided into those focusing on.

- Intra-articular contact area and pressure.
- Rigidity of fracture fixation.
- Instability or loss of congruence after fracture.

The studies that focus on contact area and pressures argue that increased joint stress from incongruity or altered loading characteristics eventually will lead to degenerative posttraumatic arthritis through repetitive cartilage damage. The guiding hypothesis is that increased stresses within the cartilage exceed the capacity of the tissue to adapt, initiating a cascade of degenerative changes that ultimately lead to arthritis in the joint. It showed that increased peak pressures, especially in the superior region of the acetabulum, do lead to degenerative arthritis.

Clinically, attempts to define the weight-bearing portion of the acetabulum have used the roof arc measurement, which represents the angle formed between a vertical line drawn to the geometric center of the acetabulum and a tangential line drawn from the geometric center to the point at which the fracture line enters the joint on anteroposterior and Judet view radiographs. When measured on standard anteroposterior and 45° oblique radiographs, the roof arc measurement gives an estimation of the amount of articular surface remaining intact".

Epidemiology

These are commonly a result of high-speed car crashes, falls from heights, and extreme sporting events. As mentioned above, the incidence over the past couple of decades has remained stable at 3 per 100000 people per year. The number of fractures caused by motor vehicle accidents has remained similar, but the number of falls from less than 10 feet has increased. There has also been an increase in the average age in patients with acetabulum fractures".[18]

Causes

Acetabular fractures are often high energy and therefore often present in combination with other organ injuries. These fractures have very high morbidity because the damage to the cartilage can lead to disabling osteoarthritis in the future. In large series reported by Matta, 50% of patients had associated injuries: 35% with extremity injury, most commonly lower extremity, 19% with a head injury, 18% with a chest injury, 13% with nerve palsy, 8% abdominal injury, 6% genitourinary, and 4% spine.[19] Even isolated fractures of the acetabulum require a blood transfusion, as high as 35% in one study.[20] Injury to the sciatic nerve also must be evaluated upon admission. When a sciatic nerve injury occurs, it almost always involves the peroneal division of the nerve and less commonly also involves the tibial division. Injury to the peroneal nerve division of the sciatic nerve will result in a foot drop .[21]

Pathophysiology

Fractures of the acetabulum occur by the impact of the femoral head on the articular surface.[22] The pattern depends on the position of the hip at the time of impact; external rotation will result in anterior fracture patterns, and internal rotation will result in posterior fracture patterns. Falls on the greater trochanter will most likely result in an anterior column and/or wall fracture (elderly) .

History and Physical

Initial assessment begins with following the standard principles of trauma assessment and resuscitation protocols. The mechanism of injury should be determined and can help guide treatment. Physical exam should include whole body evaluation for other signs of trauma/associated injuries. A complete review of the musculoskeletal system is required, especially of the peripheral nerves and skin. Soft tissue should undergo evaluation for the possibility of a Morel-Lavalle lesion .[23]

Evaluation

The diagnosis of acetabular fracture is possible just with a plain X-ray, but because many patients have multiple organ injuries, a CT scan is often necessary, which is more precise than a conventional X-ray. Plain films, with an AP pelvis and Judet views, are often obtained first. The Judet views include an obturator oblique and an iliac oblique view. There are six radiographic landmarks identifiable on an AP view of the pelvis that help classify the fracture pattern.[22] The landmarks are:

- Iliopectineal line
- Ilioischial line
- Teardrop
- Roof of acetabulum
- Anterior wall
- Posterior wall

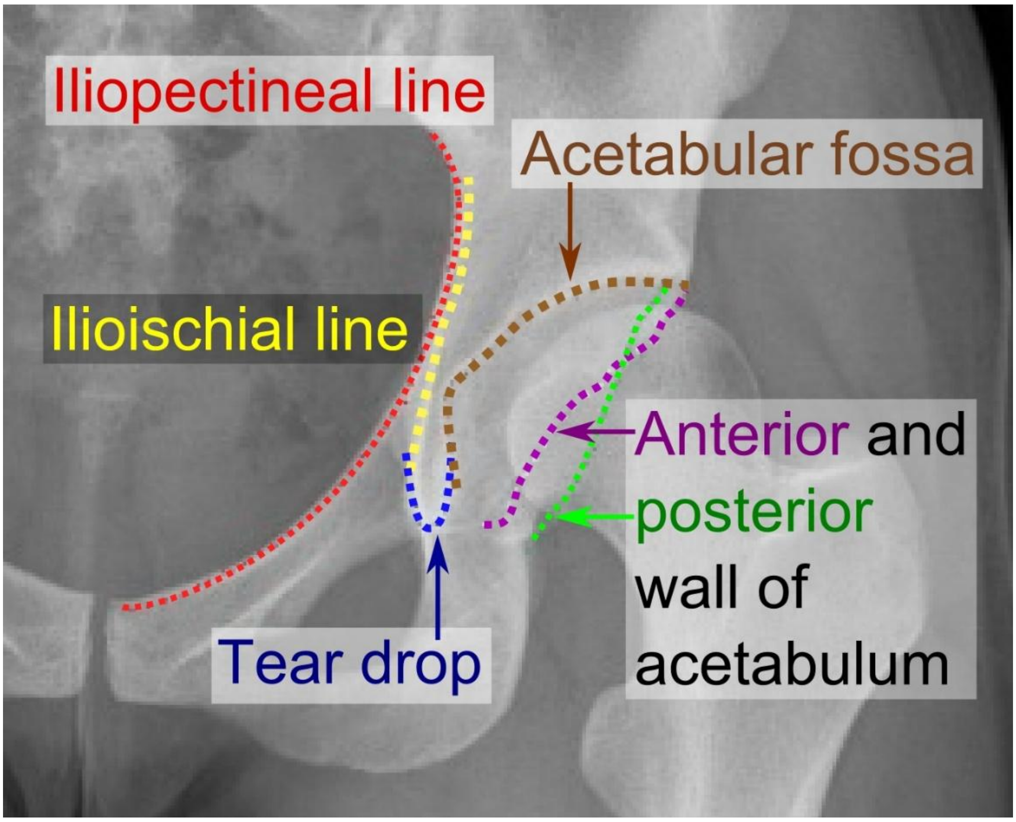


Fig 6: The different lines assessed in an X-ray radiograph in a suspected acetabulum fracture case

Radiography

Acetabular fracture classification by Judet and Letournel requires oblique radiographs of the pelvis. A standard radiograph series consists of an anteroposterior view and left and right Judet views. Judet views are right posterior oblique (also known as right iliac oblique or left obturator oblique) and left posterior oblique (also known as left iliac oblique or right obturator oblique) views of the pelvis. Appropriate positioning of the obliquity is confirmed by ensuring that the coccyx projects over the ipsilateral femoral head: In the right posterior oblique projection, the coccyx should project over the right femoral head .

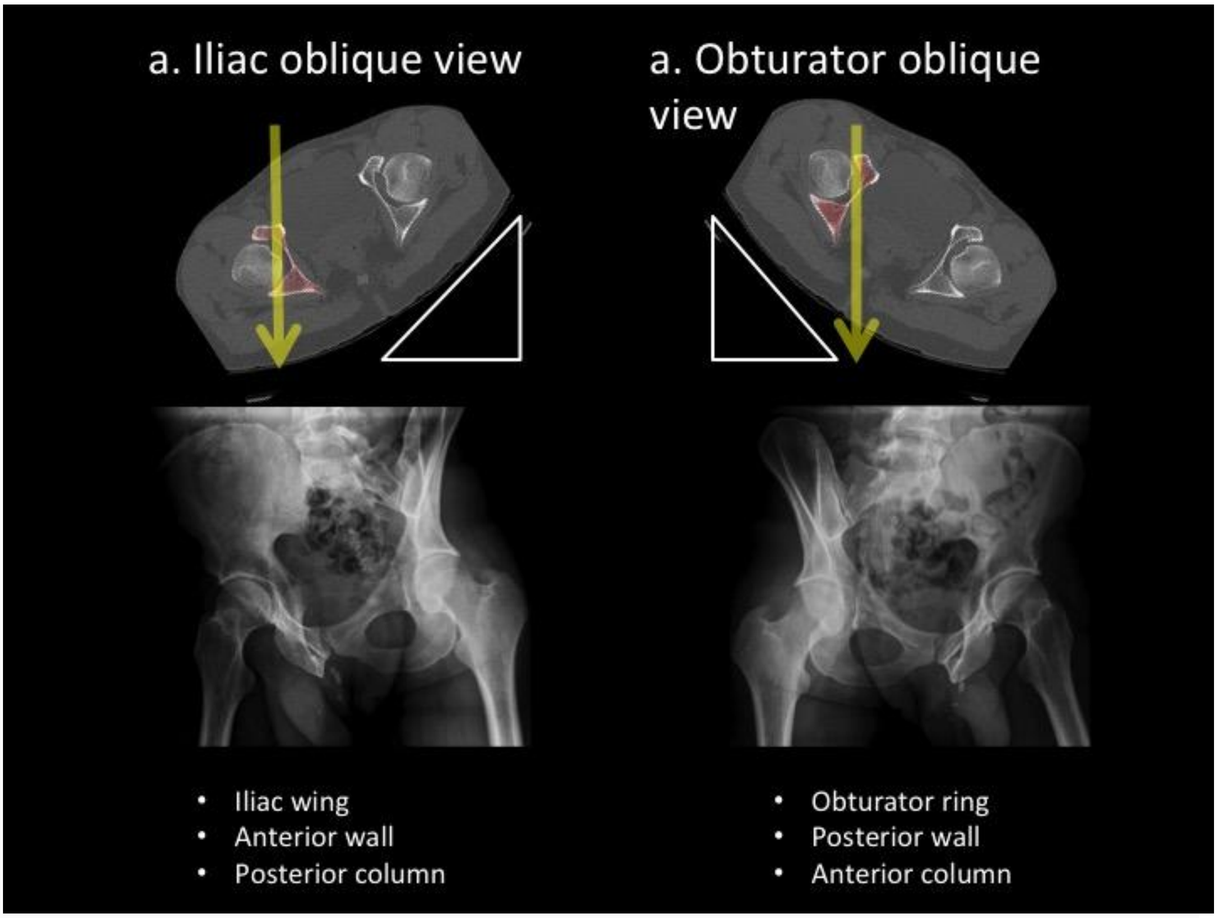


Fig 7: The Judet views in X-Ray radiograph and structures visualized

The obturator oblique view splays open the contralateral iliac wing and allows visualization of the ipsilateral iliopectineal line and posterior wall. For example, with a right obturator oblique view, the right iliopectineal line, left iliac wing and right posterior wall are best visualized .

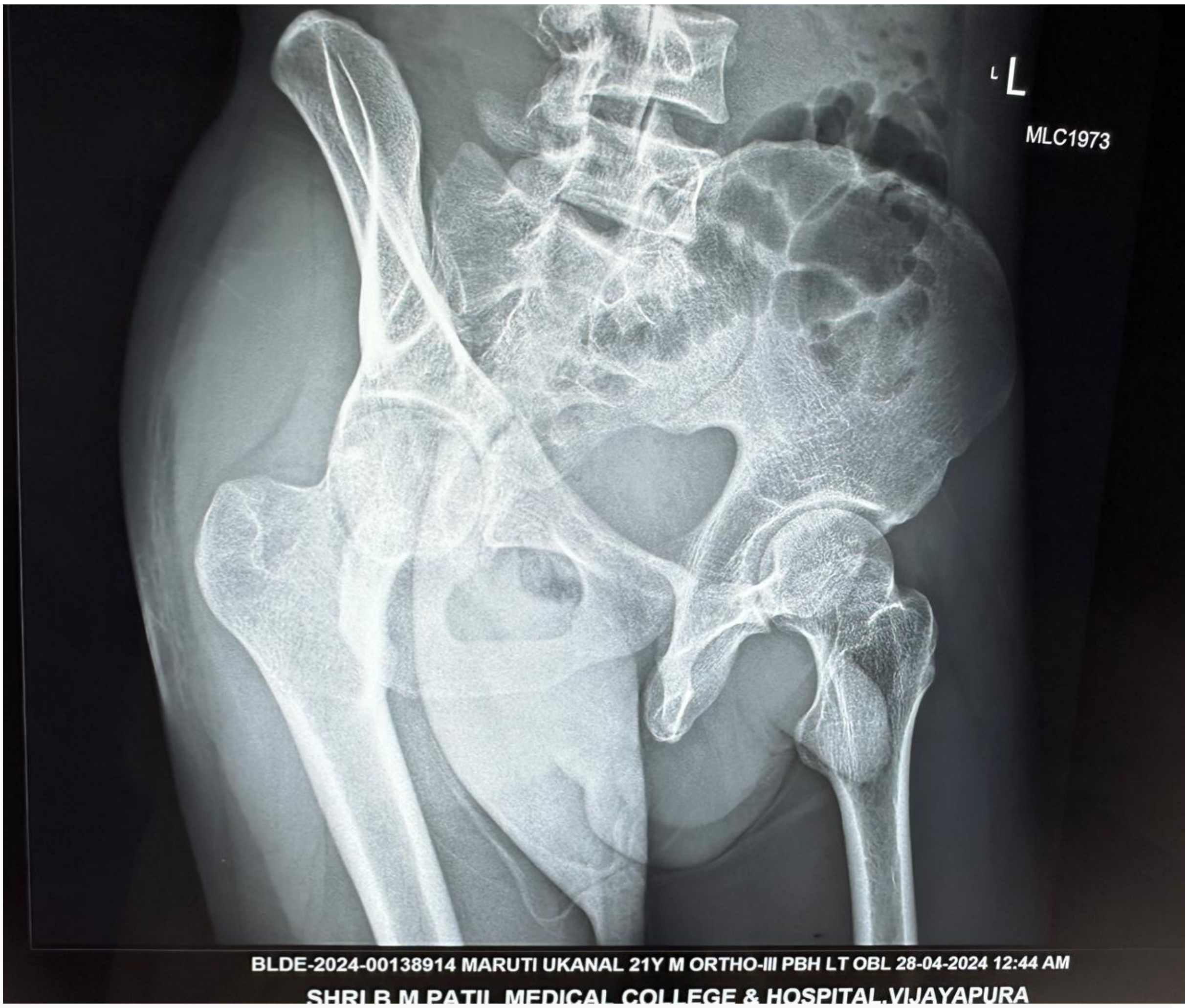


Fig 8: Right Obturator Oblique X-Ray view

An iliac oblique view shows the ipsilateral ilioischial line and the anterior wall. Thus, the right iliac oblique view will show the entire right ilium *en face*, the right anterior wall, and the left posterior wall. These views are critical to orthopedists because these views are the intraoperative views used to judge reduction .[24, 25]

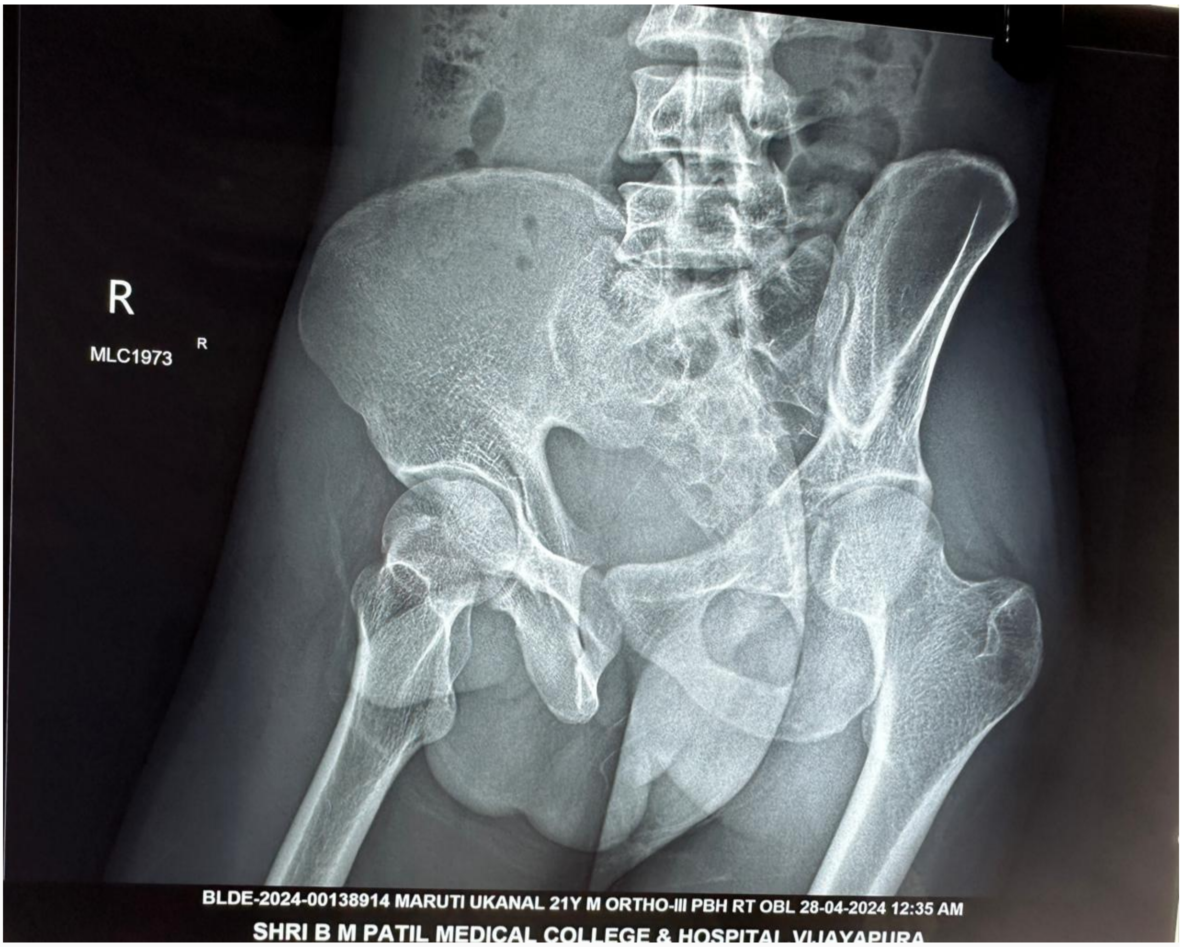


Fig 9: Right Iliac Oblique X-ray radiograph

COMPUTED TOMOGRAPHY

Because CT has become more prevalent, acetabular fractures are initially imaged using CT rather than standard pelvic radiography. Evaluating the bony anatomy was difficult with early CT technology, and the lack of adequate multiplanar reformatting made CT classification of acetabular fractures challenging. However, as MDCT has become increasingly prevalent, many studies have reevaluated the utility of CT to examine and classify acetabular fractures. MDCT offers the benefits of isotropic imaging and multiplanar reformatted images. In addition, modern CT allows better assessment of intraarticular fragments and better visualization of the articular surface of the acetabulum. Furthermore, CT offers better soft-tissue assessment for rapid evaluation of visceral structures in multi-trauma patients.

With the prevalence of MDCT use, imagers have incredible amounts of anatomic information to relay to the treating orthopedic surgeons. Radiologists must be aware of the fractures, their classification, and their implications to provide pertinent information for appropriate treatment plans. In the following sections, we will discuss the Judet classifications of acetabular fractures and describe how they appear on CT with radiographic correlates .[24, 25]

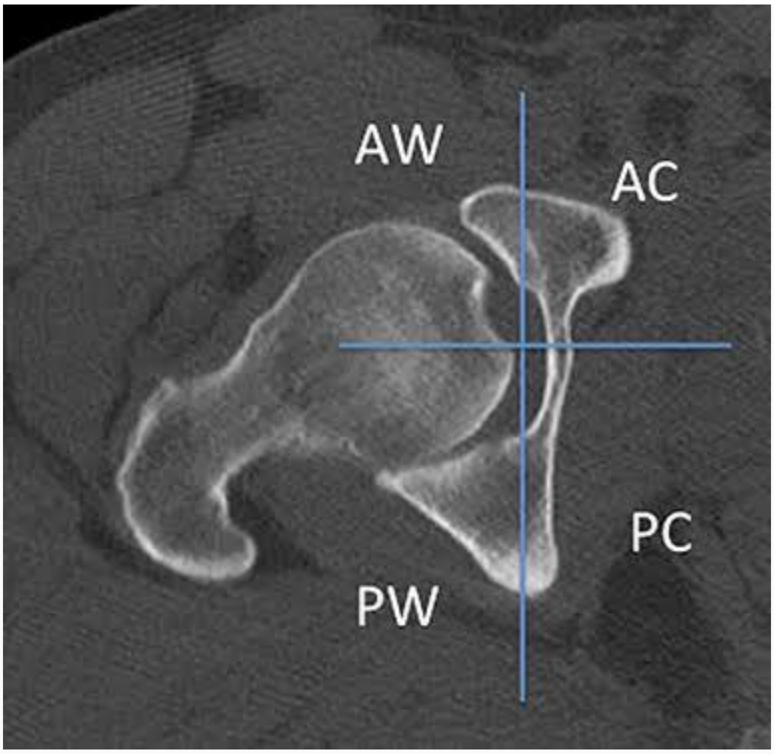


Fig 10: CT Axial cut showing the different acetabular fracture pattern

Fig 11: CT Axial cut showing Right anterior column acetabular fracture

Classification

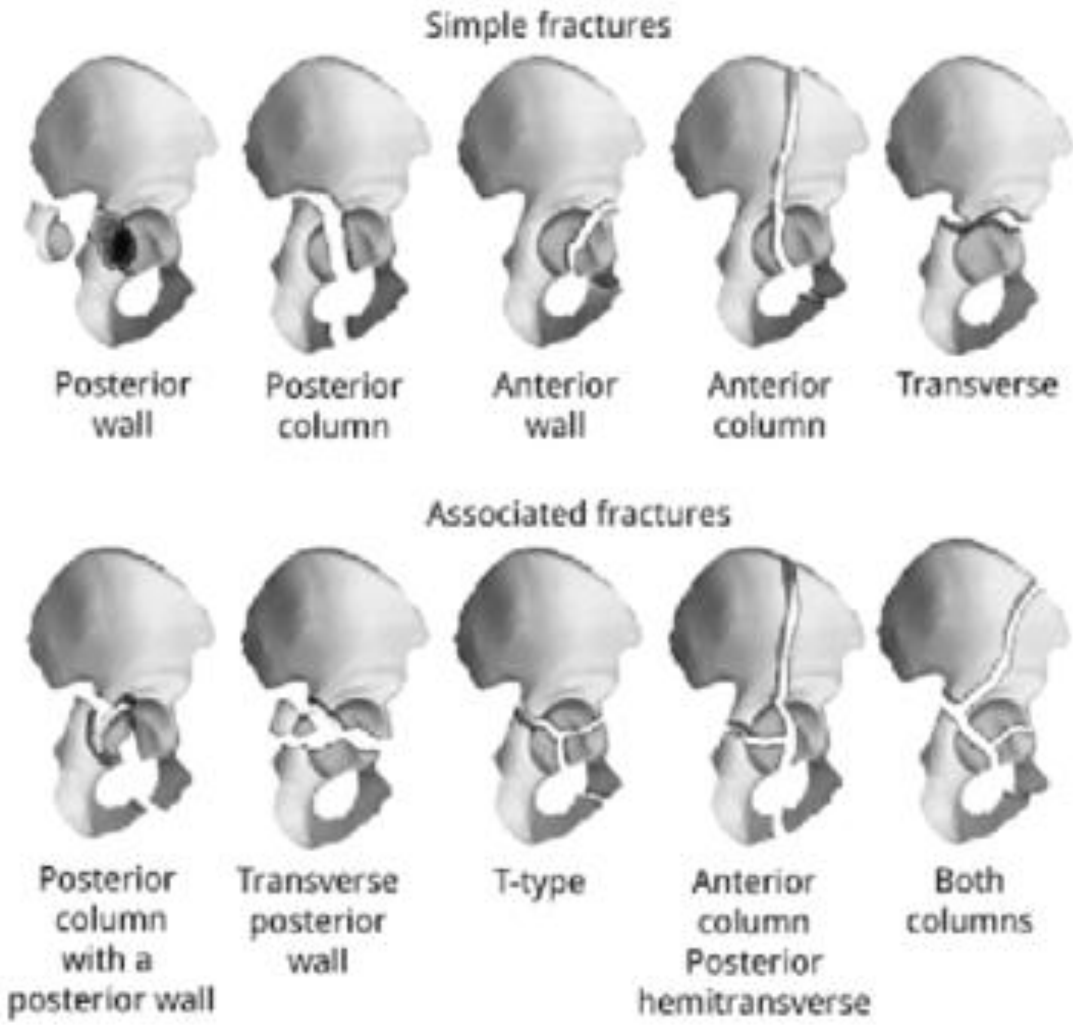
Judet-Letournel Classification

There are several acetabular fracture classification schemes, with the most widely used classification scheme being the Judet-Letournel classification scheme. Another classification system is the Harris-Coupe classification system, which uses axial CT based on an analysis of 112 randomly selected acetabular fracture patients. This system assigns the acetabular fracture a category from 0 to 3, with subcategories also existing.[26] However, this system has shortcomings, and many would argue in favor of the diagnostic and clinical management strengths of the Judet-Letournel system. Because the Judet-Letournel system is the prevailing classification system used by most radiologists and orthopedists, we will concentrate on this system.[27]

In the Judet-Letournel classification system, acetabular fractures are classified into two broad categories: elementary and associated fractures. The associated fracture patterns are composed of a combination of at least two of the elementary fracture patterns. The importance of this classification system lies in the fact that different acetabular fractures are repaired by different surgical approaches and techniques.[28]

Elementary fractures include wall, column, and transverse fractures. These fracture types can easily be remembered by recalling the basic functional anatomy of the acetabulum: Elementary fractures involve a single wall, involve a single column, or are purely transverse. The simplest elementary fractures are two-part fractures. It is important to note that the term “transverse fracture” should be reserved to describe a diagnostic type of acetabular fracture, whereas the term “transverse” should be avoided when describing the orientation of a fracture because it may quickly become confusing as to which type of fracture is present .

Fig 12: Judet-Letournel classification system



Associated fracture patterns have at least three major fracture fragments and include a posterior column fracture with a posterior wall fracture, a transverse fracture with a posterior wall fracture, an anterior column fracture with a posterior semi-transverse fracture, a T-type transverse fracture, and associated both-column fractures.

Although there are 10 fracture patterns, 90% of acetabular fractures that occur are one of five types: associated both-column, T-type, transverse, transverse with posterior wall, and elementary posterior wall fractures. Some investigators have advocated concentrating only on these common fractures; however, commonly acetabular fractures do not fit perfectly in one of the fracture patterns in the classification scheme. We advocate a conceptual understanding of these fracture patterns.[29]

This system divides fractures into five elementary types and five associated fracture patterns .[30]

Elementary patterns:

1. Posterior wall: Most common type (25%) and are visible on the AP and obturator oblique views

2. Posterior column: Fracture begins at the apex of the greater sciatic notch, goes through the articular surface and quadrilateral surface, and crosses the inferior pubic ramus. (3 to 5%). The superior gluteal neurovascular bundle can become caught in the fracture site. On the AP:

the ilioischial line, posterior rim and inferior ramus show as disrupted. On the iliac oblique: fracture crosses the posterior border of the bone .

3. Anterior wall: Fracture begins below the AIIS and ends at the ischiopubic notch. On AP imaging, will show the anterior wall and iliopectineal disruption

4. Anterior column: This fracture separates the anterior border of the innominate bone from the intact ilium. It can be high, intermediate, low, or very low based on where the fracture exits the anterior aspect. The iliopectineal line becomes disrupted on the obturator oblique.

5. Transverse: Fracture of both the anterior and posterior columns. See disruption of both the ilioischial and iliopectineal lines on AP view"

Associated patterns:

1. Posterior column and posterior wall: Femoral head frequently dislocated on presentation. Disruption of ilioischial line, posterior border of innominate bone, and posterior wall

2. Transverse and posterior wall: This represents approximately 20% of acetabulum fractures. See large posterior wall fragment on obturator oblique view

3. Anterior column/wall and posterior hemitransverse: Fractures of the column are more common than of the wall. The primary fracture line is

anterior, while the secondary fracture line is through the articular surface to the posterior border. The gullwing sign is seen on the AP radiograph and represents the impaction of the acetabular roof on the superior medial side (poor prognosis).

4. T-type: Transverse fracture plus an inferior vertical fracture line (stem of T). It can be associated with a posterior wall fracture, which has the worst prognosis of any subgroup. Radiographs show a transverse fracture with a fracture of the inferior pubic rami.

5. Both columns: This is the most commonly associated type. Represents an acetabulum that has completely disconnected from the axial skeleton. It can have secondary congruency, which is when the femoral head medializes, but the articular fragments rotate and remain congruent to the femoral head due to the attachment of the labrum. The spur sign is pathognomonic, which is seen on the obturator oblique and represents the intact portion of the ilium.

The beauty of this classification is that it is, in fact, a pre-operative planning system and is used to determine the most appropriate treatment, especially the right surgical approach .

Treatment / Management

The majority of acetabular fractures require open reduction and internal fixation. Indications for non-operative treatment include:[31]

- All stable, concentrically reduced fractures not involving the superior acetabular dome
- Fractures in which the intact part of the acetabulum is large enough to maintain stability and congruency, and those with secondary congruency
- Roof arc measurement: greater than 45 degrees on AP, iliac oblique, obturator oblique
- Low anterior column, low transverse, low T-shaped
- Both columns with secondary congruence (no traction)

Evaluation of the vertex (the most superior portion of the roof) on a CT scan can help identify fractures that are amenable to non-operative management. Evaluation involves scanning from the vertex to 10mm inferiorly. If the CT scan shows no fracture lines involving this area, the fracture can be a candidate for non-operative management; displacement cannot exceed 2 mm .[31]

Fractures treated non-operatively require bed rest initially for comfort. Once pain allows, immobilization should follow. Begin with foot-flat partial weight bearing (<10kg); radiographs obtained weekly for the first 4 weeks. Progress to full weight bearing by 6 to 12 weeks (once adequate fracture healing). Prolonged traction (4 to 12 weeks) if fracture indicates surgery, but the patient is not a surgical candidate.

Indications for ORIF include all fracture patterns that result in hip joint instability of incongruity, bone/soft tissue incarcerated within the joint, or in situations in which non-operative treatment is not a satisfactory option, total hip arthroplasty of percutaneous fixation should be a considered approach.

Percutaneous fixation is gaining popularity, especially as an adjunct to ORIF, or in sicker patients or where extensive approaches are not suitable:[32, 33]

- The patient is supine or lateral, c-arm on the same side as the fracture
- Post. Column: leg held with the hip/knee flexed, leg in slight external rotation, palpate ischial tuberosity. The guidewire is placed in the center of the tuberosity and drilled up the PC. Frequent iliac and obturator obliques need to be taken to guide wire placement
- Anterior Column: C-arm rotated to show an inlet-iliac oblique view and an outlet-obturator oblique view; For antegrade, a starting point between the tip of the greater trochanter and thick part of the iliac crest (usually 4 to 5 cm back from ASIS). Then the wire is placed into the superior ramus;

for retrograde, pin placement is against the pubic tubercle through mini-Pfannenstiel; aimed just posterior and inferior to AIIS, and the wire is passed through the superior ramus

Timing for ORIF is usually 3 to 5 days after injury; delays over 3 weeks are associated with poorer outcomes. Indications for emergency surgery: Recurrent hip dislocation despite traction, irreducible hip dislocation, progressive sciatic nerve deficit, vascular injury, open fractures, ipsilateral femoral neck fractures .

Fixation Methods and Implants Used

Plating

- Plating for acetabular fracture is generally indicated in cases of significant displacement of fragments causing joint instability, in cases of significant articular surface comminution of the fracture fragments, posterior wall fractures and fractures where fixation with screws does not provide enough stability
- Implants used in plating include 3.5mm Reconstruction plates-short, long or Curved; Pelvic brim plates, Pubic symphysis plates (in cases of Pubic symphysis disruption), 3.5mm Low profile Dynamic compression plates (DCP) and spring plates

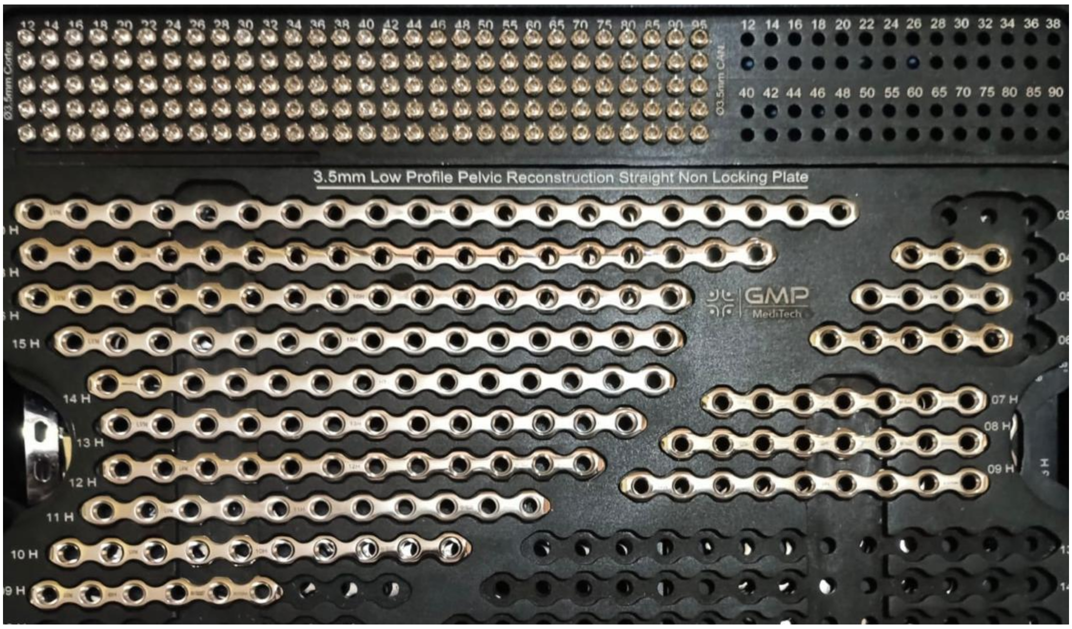


Fig 13: 3.5mm Pelvic Reconstruction plates

Fig 14: 3.5mm Curved Reconstruction plates

Fig 15: 3.5mm Pelvic Brim Plates

Fig 16: 3.5mm Pubic Symphysis plate

Percutaneous pinning with Cannulated Cancellous (CC) Screw

- CC screws are used in fractures of Anterior and Posterior column acetabular fractures where there is less displacement and provides adequate stability. Typically 4 and 6.5 mm CC screws are used in the fixation of the Fracture fragments in acetabular fracture

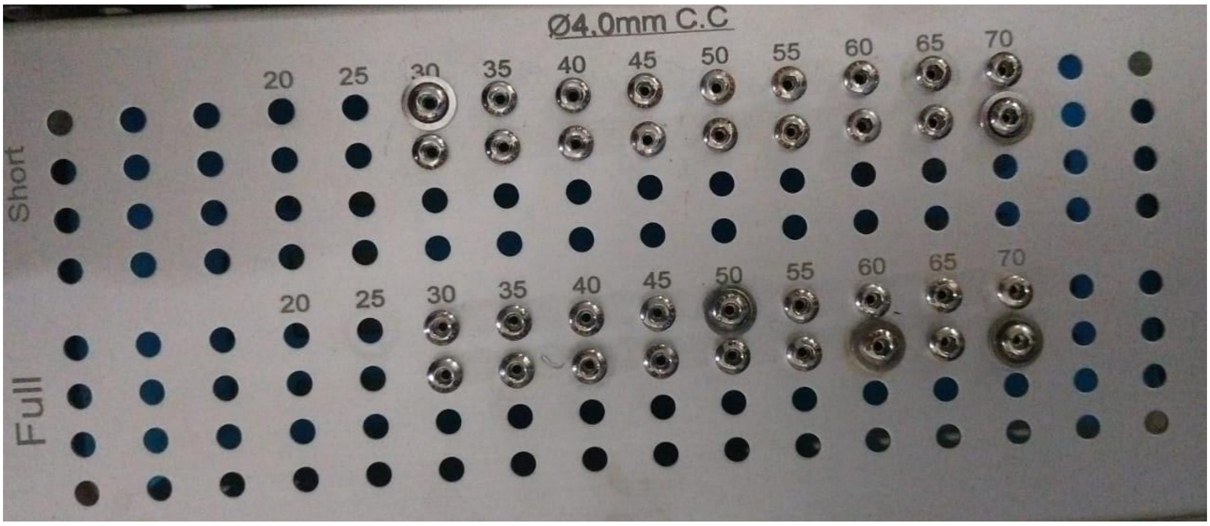


Fig 17: 4mm CC screw

Fig 18: 6.5mm CC screw

Fig 19: Operation Table set up with the different instruments used in pelvi-acetabular surgeries

Selection of Approach[30]

- Based on fracture type, the elapsed time from injury, and magnitude and location of maximal fracture displacement
- Mainstay approaches are: Kocher-Lagenbeck (KL), ilioinguinal, iliofemoral (IF), and extended iliofemoral
- KL is used for the posterior column, II and IF for the anterior column; rely on indirect manipulation for reduction of any fracture that transverses the opposite column; the second approach is used if an unsatisfactory reduction

- Extended IF affords access to all aspects of acetabulum; most often used for delayed treatment

Reduction and Fixation

- Except for both column fractures, standard fracture reduction sequence is first to reduce and stabilize displaced column fractures and then reduce any wall fracture
- After the definitive fixation of reduced fragments, the entire construct stabilized with buttress plates
- For both column fractures, first reduce and stabilize one of the columns to the axial skeleton (iliac wing), then the other column, and later, if present, the wall component. The entire construct then gets stabilized with buttress plates
- Columns may be stabilized in young, healthy bone using screws alone; osteopenic bone and all wall fractures require buttress plating

Total Hip Replacement

In some cases, the acetabulum is so damaged that repair or reconstruction is unlikely to be successful. In this situation, your surgeon may recommend a total hip replacement. In this procedure, the damaged bone and articular cartilage are removed and replaced with artificial parts (prosthesis).

Whenever possible, the surgeon will reposition the bones into their normal alignment using screw and plate fixation before performing the total hip replacement.

However, if this is not possible, the surgeon may delay the procedure for a period of time to allow the fracture to first heal in its unaligned position. They will then perform the total hip replacement — replacing the irregular hip socket with the total hip prosthesis .[30]

Surgical approaches

The functional outcome of operatively treated acetabular fractures depends directly on the accuracy of reduction,[30] and the most decisive factor for performing the best reduction possible is the right choice of surgical approach. The approach in acetabular fracture surgery poses specific problems: first of all, the acetabulum lies deep and is covered by important neurovascular structures, which makes the approach technically demanding and sometimes risky. Secondly, no single approach allows access to the entire acetabulum.[35] Judet and Letournel were aware of this more than half a century ago, when they started to understand the complex geometry of acetabular fractures. For posterior fractures, they used the Kocher-Langenbeck approach and they looked for an approach for the anterior column. After a serious study in an anatomy lab, Letournel introduced the ilioinguinal approach (IL) and started to use it in 1965. The approach is composed of three windows. The first window provides access to the internal iliac fossa and sacroiliac joint. The second or middle window grants access to the pelvic brim and quadrilateral surface from above, and the third window, medial to the iliac external vessels, gives access to the superior pubic ramus. The approach allows complete access to the anterior column. IL is extensive and technically demanding and needs a long learning curve. When the authors also began to treat delayed cases, they felt the need for simultaneous exposure of both columns and ten years later, they introduced the extended iliofemoral approach. This approach enables access to the whole external surface of the iliac bone and is anterior limited by the iliopectineal eminence. The approach is very extensive and demanding. These three approaches became the gold standard for acetabular fracture surgeons and have remained so until today. Despite favorable long-term results for experts using the mentioned approaches,[30] the development of new approaches and improvement of classic approaches have been obvious in recent decades. First of all, there has been a decline in using extensile approaches. Extensile approaches are associated with a prolonged operative time, blood loss, a high percentage of heterotopic ossifications, and wound complications, even in the most expert hands. New generations of acetabular surgeons use extensile approaches less and less. If a surgeon is not comfortable with large approaches, he is not likely to use them even in rare cases. This is a self-accelerating phenomenon, and it is possible that young acetabular surgeons in the future will see extensile approaches only in textbooks and cadaveric labs. It is perhaps easier to be familiar with anterior and posterior approaches and combine them in complex cases. Equally, improvements in the posterior approach, the development of new anterior approaches, and better pre-operative planning have pushed the limits of a single approach forward .[30]

Moed described a modified Gibson approach to the posterior column.[36] The approach is similar to Kocher-Langenbeck and differs only in its proximal dissection: the interval between the tensor fasciae latae and gluteus maximus is developed and the gluteus maximus is displaced from its anterior border without splitting. This protects the neurovascular supply to the anterior part of the muscle. The approach also enables better visualization of the anterosuperior part of the acetabulum and can be combined with trochanter flip osteotomy. Gautier et al. from the Bernese group studied the anatomy of the medial circumflex artery in detail.[37]

They demonstrated a constant course of the deep branch of the medial femoral circumflex artery in the extracapsular segment. This pivotal work enabled a safer approach to the posterior column and also made possible trochanter flip osteotomy, with or without surgical dislocation of the hip. Trochanteric flip osteotomy without surgical dislocation of the hip allows safe exposure of the posterosuperior and superior parts of the posterior column without damage to the abductor muscles. The osteotomy is balanced by the opposite pull of the gluteus medius and vastus lateralis muscle. Surgical dislocation of the hip makes possible direct visual control of the acetabulum during reduction and fixation and can be used in the surgical treatment of femoral head fractures .[17]

In 1993 and 1994, Hirvensalo et al.[38] and Cole and Bolhofner[39] independently describe a new anterior approach, which is now called the anterior intra-pelvic approach (AIP). In AIP, the recti muscles are split at the midline, and further dissection is performed extraperitoneally, directly to the posterior aspect of the pubis to the quadrilateral surface. The iliopectineal fascia is released from the pelvic brim, the femoral vessels are moved anterior, and the inner surface of the true pelvis is exposed. The main difference between IL is that in AIP, there is no medial window, and the surgeon stands on the opposite side of the fracture and “looks in,” while in IL, the surgeon remains on the injured side and “looks over”. If the fracture extends to the iliac wing, it is possible with AIP to open the first (iliac) window of the ilioinguinal approach and use it for the reduction and fixation of the iliac wing. The new AIP approach has become more and more popular worldwide. There are several reasons for this rising popularity: it is potentially less invasive than IL and enables excellent visualization of the entire pelvic brim from the pubic body to the sacroiliac joint, including direct visualization of the quadrilateral plate. The new approach is, therefore, very suitable for anterior fractures, including central luxation, which is essentially a typical geriatric fracture pattern. These fracture patterns are more and more frequent because of the rapidly growing elderly population, and the treatment strategy should be adapted to this. Dissemination of the AIP approach has also encouraged the development of new instruments and implants .[17]

It would be ideal for an acetabular surgeon to master all the approaches (classic and novel) because they are complementary, not competitive, and enable specific details for specific fractures. However, in practice, because of the relatively low caseload, the majority of surgeons master a limited number of approaches. The approach should, therefore, be chosen according to fracture pattern, soft tissue status, and the individual preference and skill of the surgeon .

Prognosis

The prognosis of acetabulum fractures has generally been poor due to the high energy and multiple associated injuries. However, with the advent of open reduction and internal fixation, the prognosis is generally regarded as good. The prognosis has its basis on several factors, including fracture pattern (T-type with the worst prognosis), condition of the hip at the time of injury (femoral head lesions, marginal impaction, gull sign, adequacy of hip reduction, and the stability of joint after treatment). The clinical and radiographic findings at one year are the most reliable guide to prognosis after treatment, as most hips do not improve after this time .

Post-Operative Rehabilitation Protocol

- Suction Drainage is removed after the 2nd or 3rd Postoperative day
- From 3rd Postoperative day, Anticoagulants are administered on a routine basis
- Active Hip mobilization started from 1st Postoperative day
- Physiotherapy sessions started from 2nd or 3rd Postoperative day

- Non-weight-bearing mobilisation started from 2nd post-operative week
- Full weight-bearing mobilization started from the 10th to 12th post-operative week

Complications

The following complications can occur with acetabular fractures:[40]

- Post-traumatic arthritis and osteonecrosis; quality of reduction is the main determinant for risk of late arthritis, and the goal should be a reduction within 1 mm
- Infection (approx 5%)
- Iatrogenic nerve injury
- DVT(4% symptomatic DVT, 1% PE)
- Intra-articular hardware
- Heterotopic ossification (extended IF more than KL more than ilioinguinal)

METHODOLOGY

Study design

Prospective study

Study population

Patients attending the Department of Orthopedics, at B.L.D.E. (DEEMED TO BE UNIVERSITY) Shri B.M.Patil Medical College, Hospital and Research Centre, Vijayapura, Karnataka.

Study Time:

The research study was conducted for 18 months from March 2023 to March 2025.

Below is the work plan.

Table 1: Work plan of the study with percentage of allocation of study time and duration in months

Work plan	% of the allocation of study time	Duration in months
Understanding the problem and preparation of the questionnaire.	5-10%	March 2023 to May 2023

Pilot study, Validation of questionnaire, data collection and manipulation	Upto 80%	June 2023 to September 2024
Analysis and interpretation	5-10%	October 2024 to December 2024
Dissertation write-up and submission	5-10%	January 2025 to March 2025

- **Sample Size:** As per the study done by Ahmed M et al. the incidence of acetabular fractures in their study was 103 acetabular fractures in a total of 6046 fracture patients. By the above considerations average prevalence of acetabular fractures can be considered as 1.703%. Considering the confidence limit of these studies to be 97% with a 3% level of significance and a margin of error of 0.05.The sample size is computed using the following formula
- Sample size (n) = $(Z^2 * p * (1-p)) / d^2$
- Where,
- z is the z score= 2.17

  d is the margin of error= 0.05

  n is the population size

  p is the population proportion =0.01703

The estimated sample size of this study is 31

Sampling procedure

"Sampling is defined as the process of selecting a number of subjects from all the subjects available in a particular group or universe. A conclusion based on sample results may be attributed only to the population sampled".

In this study we considered all eligible patients consecutively attending Department of Orthopedics, at B.L.D.E. (DEEMED TO BE UNIVERSITY) Shri B.M.Patil Medical College, Hospital and Research Centre, Vijayapura, Karnataka till we met the sample size.

Inclusion criteria

- Superior and inferior pubic rami fracture
- All elementary fractures of acetabular fractures, including-
  - Anterior column and anterior wall fractures
  - Posterior wall and posterior column fracture
  - Bicolumnar fractures
  - Transverse fractures
- Willingness to participate in regular follow ups in regular intervals

Exclusion criteria

- Patients age less than 18 years old and more than 70 years old
- Patients with an undisplaced acetabular fracture
- Patients with Ipsilateral Femur fracture
- Patients who didn't have regular follow up for at least six months

- Patients unfit for surgery

- **Source of data**:

The source of data for cases in this research study was supported by the primary data sources.

Primary source of data: The material for the present study is from patients with acetabular fractures.

To meet the objectives of our study, a primary source of information technique was adopted with a direct interview method using a pre-tested semi-structured questionnaire.

Secondary source of data: Secondary data source was used to estimate the sample size and also to frame the questionnaire. The sources of secondary data were multiple journals, academic books, research articles, review articles, newspapers and references from the web, all of which are listed in the bibliography.

Method of data collection

After obtaining approval and clearance from the institutional ethics committee, the patients fulfilling the inclusion criteria were enrolled for the study after obtaining informed consent. (Annexure 1)

To collect the required information from the study subjects the "Direct interview method" of Primary source of information technique was used.

The patients were interviewed for the collection of necessary information using the pre-tested, semi-structured questionnaire method. The questionnaire was prepared by a thorough review of the literature.

In order to obtain the cooperation of the patient, the patient was made comfortable, and positive reinforcement was exerted. No answers were influenced, and the patient was helped during difficulty".

Demographic data were collected using a questionnaire that was administered by the principal researcher to the patients after signing the informed consent form: The study protocol was approved by the Institutional Ethics Committee, and informed consent was obtained from all participants prior to enrolment".

A prospective study was conducted at the Department of Orthopedics, BLDE (Deemed to Be University) Shri B.M. Patil Medical College, Hospital and Research Centre. The methodology encompassed comprehensive patient assessment and management of acetabular fractures through a systematic approach.

Patient evaluation began with a detailed clinical examination and thorough history taking. The diagnostic process involved both clinical and radiological assessments to comprehensively understand the patient's condition. A wide range of investigations were performed to ensure comprehensive preoperative evaluation.

Radiological investigations included X-ray PBHS with anterior-posterior view, obturator oblique and iliac oblique views, and CT pelvis with 3D reconstruction. Laboratory investigations were extensive, covering hematological, biochemical, and serological parameters. These included complete blood count, bleeding and clotting time, albumin, blood sugar, microscopy, random blood sugar, serum creatinine, blood urea, HIV, HbsAg, HCV screening, blood grouping, and Rh-typing. Additional cardiac evaluations such as ECG and 2D echo were conducted when necessary, along with chest X-ray in anteroposterior view.

The surgical treatment approach was carefully planned, utilizing different surgical approaches based on fracture characteristics. Surgical techniques included a modified Stoppa approach with a lateral window for anterior wall fractures, an Ilio-inguinal approach, and a Kocher-Langenbeck approach for posterior column fractures. Anesthesia methods varied, including spinal, epidural, or general anesthesia, selected based on individual patient requirements.

Postoperative management was meticulously structured. Reduction achievement was confirmed through post-operative radiographs of the pelvis, capturing both hips in anteroposterior and oblique views. Patient mobilization was initially restricted to toe-touching weight bearing for the first three months. After fracture consolidation, total weight bearing was allowed under the guidance of a physiotherapist.

Follow-up was systematically planned with assessments conducted at 6 weeks, 3 months, and 6 months post-surgery. The radiological evaluation involved an X-ray pelvis with both hips in anteroposterior views. Functional outcome was assessed using the Modified Merle d'Aubigne scoring system, providing a comprehensive evaluation of patient recovery and surgical intervention effectiveness.

ASSESSMENT OF FUNCTIONAL OUTCOME

MODIFIED MERLE D'AUBIGNE SCALE

CRITERIA	Points
PAIN	
None	6
Slight or intermittent	5
After walking but resolves	4
Moderately severe, but patients are able to walk	3
Severe, prevents walking	2
WALKING	
Normal	6
No cane but slight limp	5

Long-distance with cane or crutch	4
Limited even with support	3
Very limited	2
Unable to walk	1
RANGE OF MOTION	
95-100%	6
80-94%	5
70-79%	4
60-69%	3
50-59%	2
Less than 50%	1
CLINICAL GRADE	
Excellent	18
Good	15 to 17
Fair	13 to14
Poor	< 13

Ethical Consideration

Ethical clearance was taken from the Ethical Committee of Shri B.M. Patil Medical College, Hospital and Research Centre, Vijayapura, Karnataka, before conducting the study.

There are four universal ethical principles in biomedical research described in the landmark book -*Principles of biomedical ethics* by Beauchamp and Childress.

a) Respect for autonomy

b) Beneficence

c) Non-maleficence

d) Justice

A. RESPECT FOR AUTONOMY

The study subjects were explained in local language about the study and prior written informed consent was taken from the respondent. Confidentiality of the information collected through the questionnaire was strictly followed throughout.

B. BENEFICENCE

Since it was not a funded project study, subjects were informed that they would not be getting any financial benefit by participating in the study.

C. NON MALEFICENCE

Due care was taken to protect the privacy of the study subjects.

D. JUSTICE

Due care was taken while recruiting the participants, and special protection was for vulnerable groups.

Statistical Analysis

Data was entered in an Excel sheet and analyzed using the Statistical Package for the Social Sciences 20(SPSS Inc. Chicago). Descriptive statistics were calculated for all variables, including means, standard deviations, medians, and ranges for continuous data, and frequencies and percentages for categorical data. Continuous variables were expressed as means ± standard deviations, while categorical variables were presented as frequencies and percentages. Paired t-tests were used to compare preoperative and postoperative continuous variables. Statistical significance was set at $p < 0.05$.

PATIENT 1

Name- Prem Channayya Hiremath

Age/Sex- 40 years/Male

Diagnosis- Left anterior column acetabular fracture

A 40-year-old male came with an alleged history of self falls from stairs (12 feet) with no head injuries or internal injuries. The patient complained of pain over the left hip joint and inability to bear weight over the affected limb. A pelvis with bilateral hip joint X-ray was taken, which showed anterior column acetabular fracture, which was confirmed with Judet views and was planned for Open reduction and internal fixation with reconstruction plate.

Fig 20- X-ray PBHS showing anterior column acetabular fracture of left side

Fig 21- Obturator oblique view confirming Anterior column fracture

OPERATIVE MANAGEMENT

The patient was shifted to the Operation table (Radiolucent) and placed in the supine position after being given Spinal anaesthesia by the anaesthetist under all sterile precautions with a bolster placed under the left lower limb with the bilateral upper limb in a state of relaxation.

Fig 22- Patient positioning on operative table

A Pfannenstiel incision of size 8cm was taken over the lower abdomen just above the pubic symphysis. Subcutaneous tissue was dissected and the rectus fascia was exposed and incised longitudinally along linea alba. The rectus abdominis muscle is retracted laterally between both bellies.

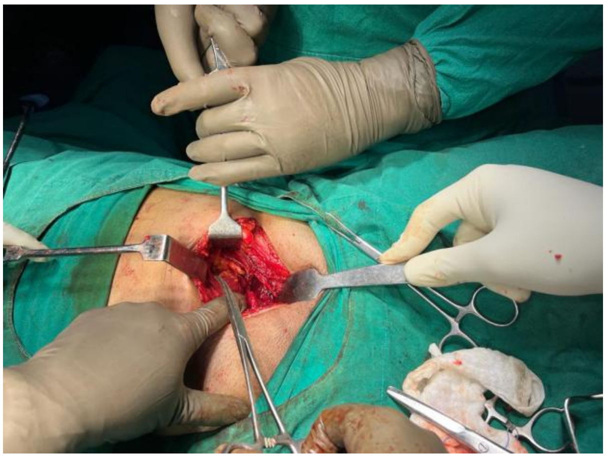


Fig 23- Skin incision **Fig 24- Muscles retracted**

The superior pubic ramus upper border was identified and blunt dissection was done along the border without excising the fascia.

The corona mortis was identified along the medial surface of the rami and ligated.

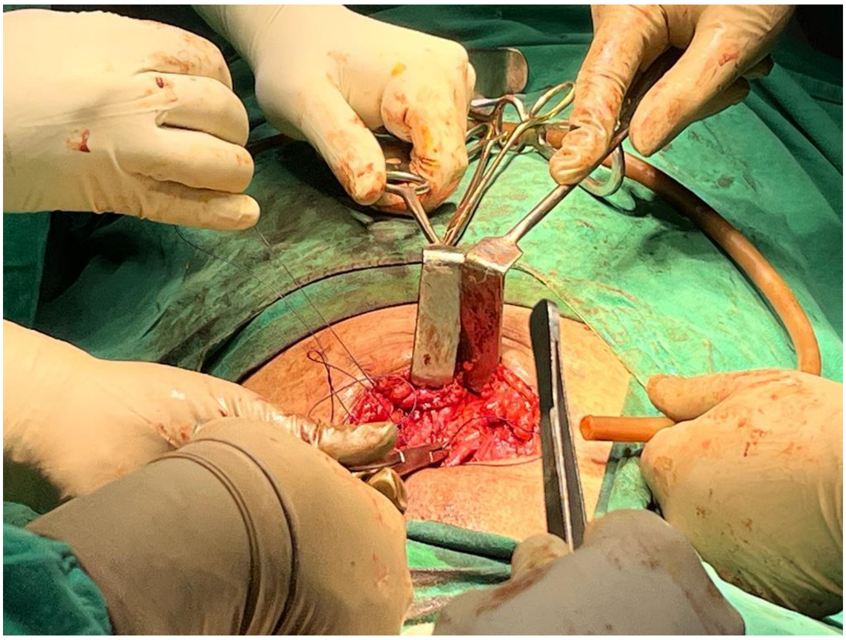


Fig 25- Corona mortis identified and ligated

The periosteum was then dissected using cautery till the entire length of the pelvis brim was exposed. The quadrilateral surface was exposed using the Cobb elevator. A Duyon's retractor was used to protect the pelvic organs. One Hohmann retractor was put in the middle of the superior pubic rami, and a curved Hohmann retractor was put posteriorly over the Iliac part of the pelvic brim, and the fracture was visualized.

The fracture was reduced using a pelvic brim plate and 3.5mm cortical screws were inserted to fix the plate. Fracture reduction and screw placement were confirmed under fluoroscopy.

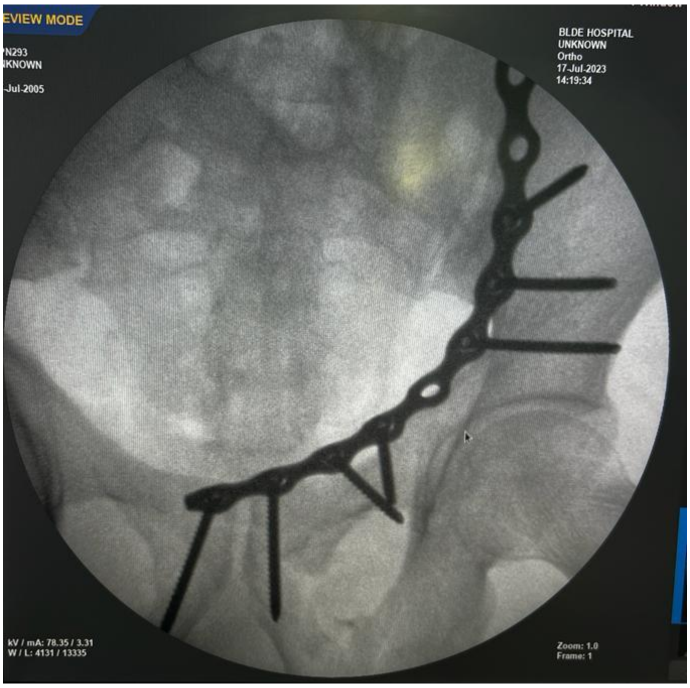


Fig 26- Intra-operative fluoroscopy image

Layer-by-layer closure was done with a pneumatic Drain of 14G placed in the deep muscular layer, which was removed on Post Operative Day 2. A post-operative X-ray was taken on Postoperative day 2, which showed an excellent reduction of fracture fragments. The patient was allowed to do static and dynamic Hip exercises from postoperative day 1. Tab ENDOCAP SR was added to patients' orders from postoperative day 2 and continued for 6 weeks postoperatively. The patient started partial weight bearing from 2nd week postoperatively and full weight bearing from 10 weeks postoperatively. Regular follow-up up was continued to 6 months postoperatively

Fig 27- X-ray PBHS Post-operative Day 2

Fig 28- Patient partially mobilized with walker mobilization

PATIENT 2

Name- Satish Avadi

Age/Sex- 56/ Male

Diagnosis- Right hip posterior dislocation with posterior wall acetabular fracture.

A 56-year-old male patient came with an alleged history of Road Traffic Accidents, i.e., a fall from a bike, following which he complained of pain over the right hip joint. On examination, there was associated shortening of the lower limb, hip flexed, internally rotated and adducted. A plain radiograph of the Pelvis with both hip joints was done, which showed a posterior hip dislocation with a posterior acetabular wall fracture.

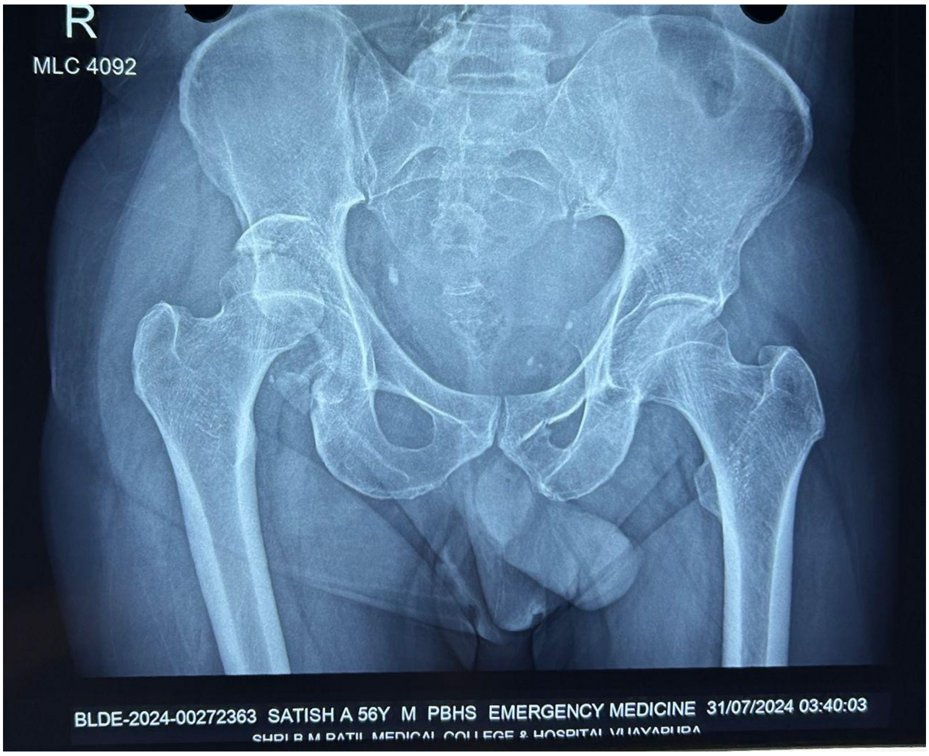


Fig 29- Plain X-ray PBHS showing Right hip posterior dislocation with posterior wall acetabular fracture

Closed reduction of the dislocation was done with a modified allis method, and the limb was secured with a Thomas splint. The patient was taken up for Open reduction and internal fixation with a reconstruction plate.

OPERATIVE MANAGEMENT

The patient was shifted onto the Operation table and was given Spinal anaesthesia by the anaesthetist. The patient was placed in a lateral position with the knee in flexion.

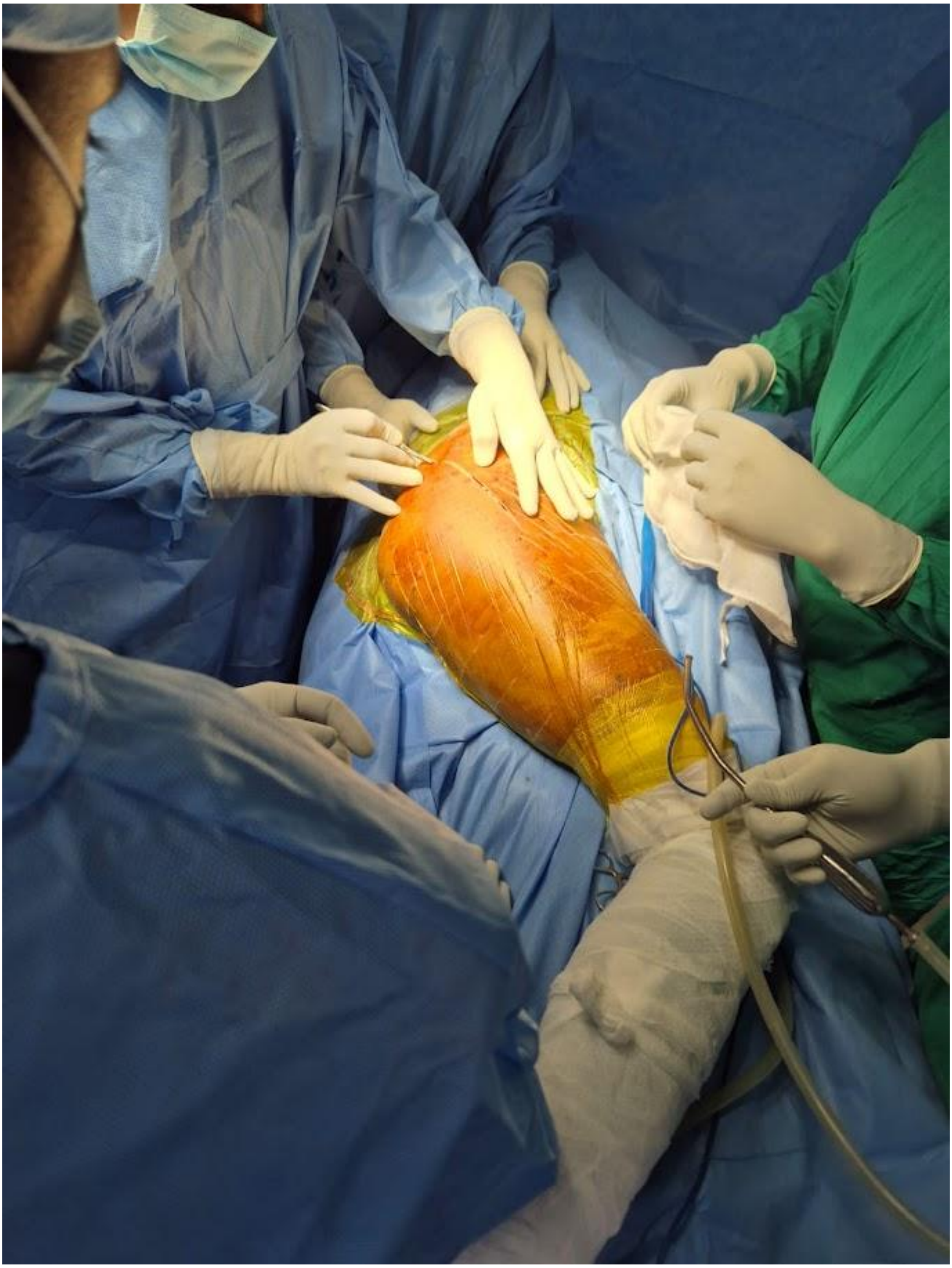


Fig 30- Patient positioning

Skin incision was taken along the posterior iliac spine extending anteriorly over the greater trochanter towards the femur shaft. Subcutaneous tissue was dissected and gluteus maximus fibres were split with scissors along the fibres proximally and retracted.

Fig 31- Skin and Subcutaneous Tissue excised

Fig 32- Short external rotators tagged and cut

The Iliotibial tract was incised and the gluteus maximus and short external rotators were detached after tagging as close to the greater trochanter to protect the sciatic nerve and was retracted. The greater sciatic notch, the Ischial spine and the lesser sciatic notch was visualised. The Posterior wall fracture was noted. 1 reconstruction plate (10 holes) and 1 Low Profile DCP

(7 holes) were contoured and fixed with cortical screws. Plate and screw placement was confirmed under fluoroscopy.

Fig 33- Conturing of plates **Fig 34- Plates placement Intra-Op**

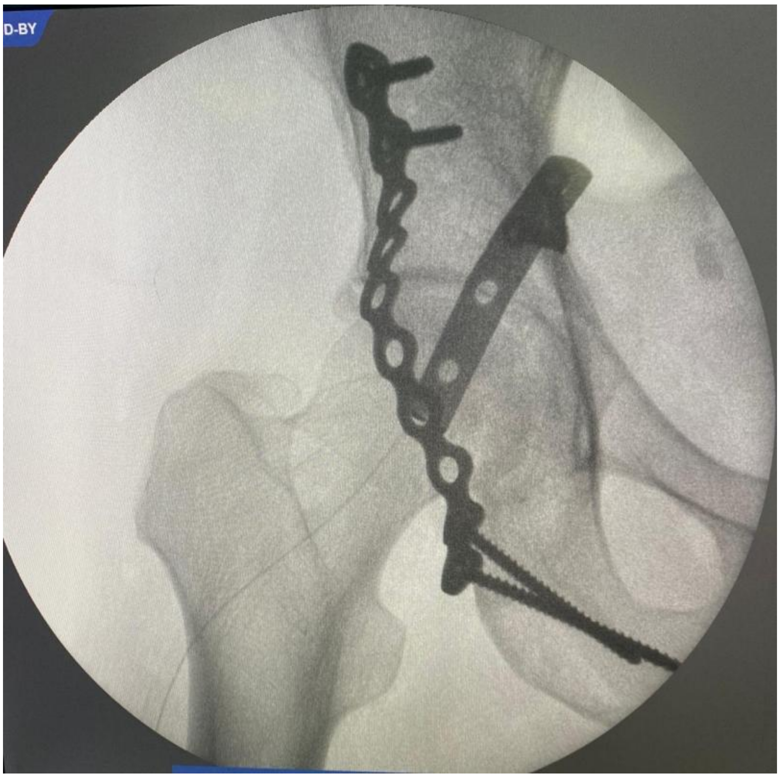


Fig 35- Intra Operative fluoroscopy Images

Layer-by-layer closure was done with the placement of a pneumatic drain size No.14, which was removed on postoperative day 2. X-ray was taken on postoperative day 2, which showed an excellent reduction of fracture fragments. The patient was allowed to do static and dynamic Hip exercises from postoperative day 1. Tab ENDOCAP SR was added to patients' orders from postoperative day 2 and continued for 6 weeks postoperatively. The patient started partial weight bearing from the 2nd week postoperatively and full weight bearing from 11 weeks postoperatively. Regular follow was continued up to 6 months post-operatively.

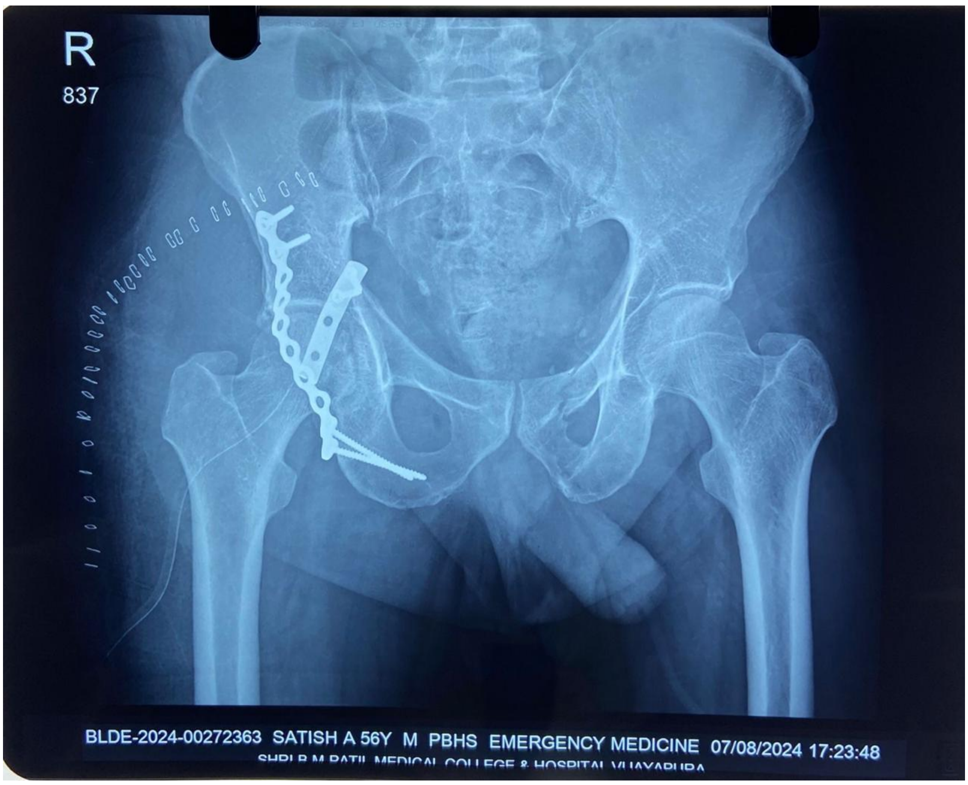


Fig 36- X-ray PBHS Post operative day 2

Fig 37 – 6 Months Post Operative X-ray PBHS

Fig 38- 6 month follow up Patient Hip active movements

PATIENT 3

Name- Shantamma B

Age/sex- 28/ Female

Diagnosis- Left Anterior column acetabular fracture with Iliac wing fracture

A 28-year-old Female came to the casualty with an alleged history of self-fall, following which she developed severe pain over the left hip, and the patient was unable to bear weight over the affected limb. A plain X-ray of the pelvis with both hip joints was taken, which showed a fracture of the left acetabular column with left iliac wing fracture, which was confirmed with Judet views and CT pelvis.

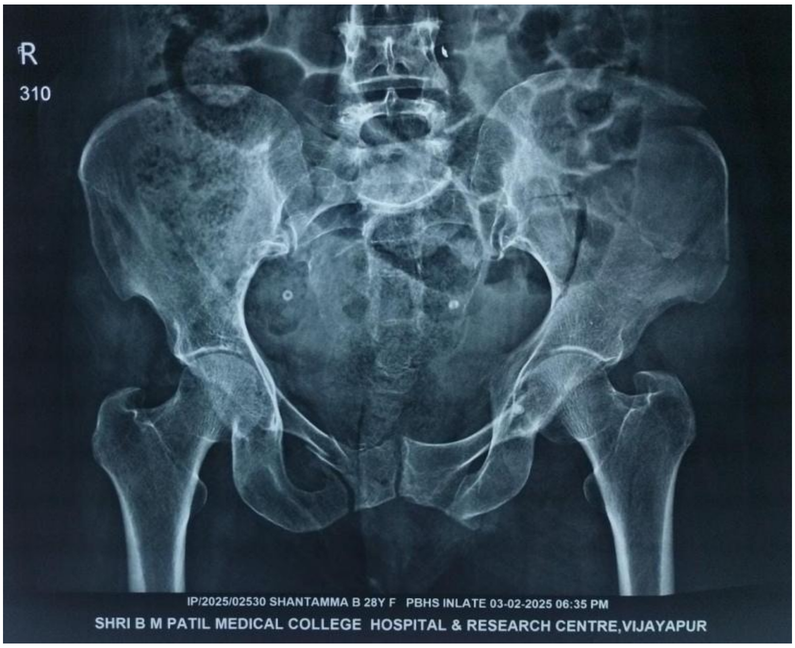


Fig 39- X-ray PBHS showing left Anterior column and iliac wing fracture

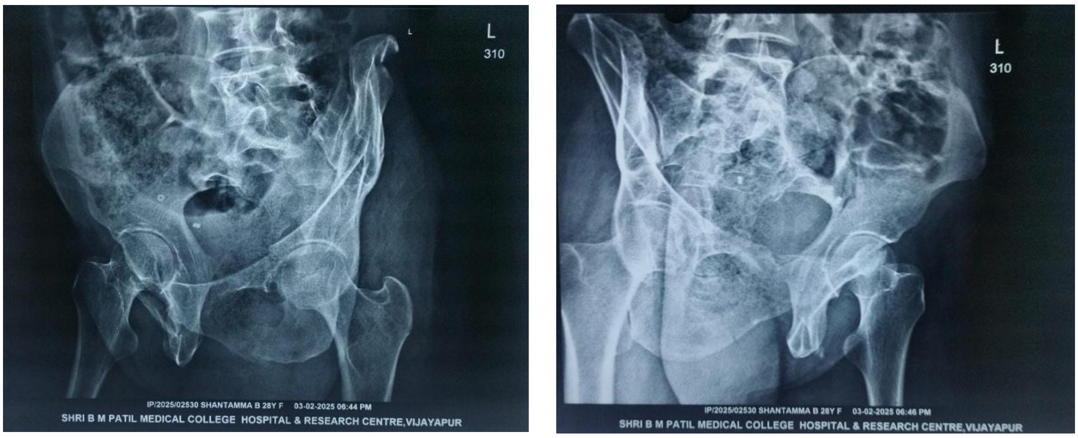


Fig 40- X-Ray Judet views

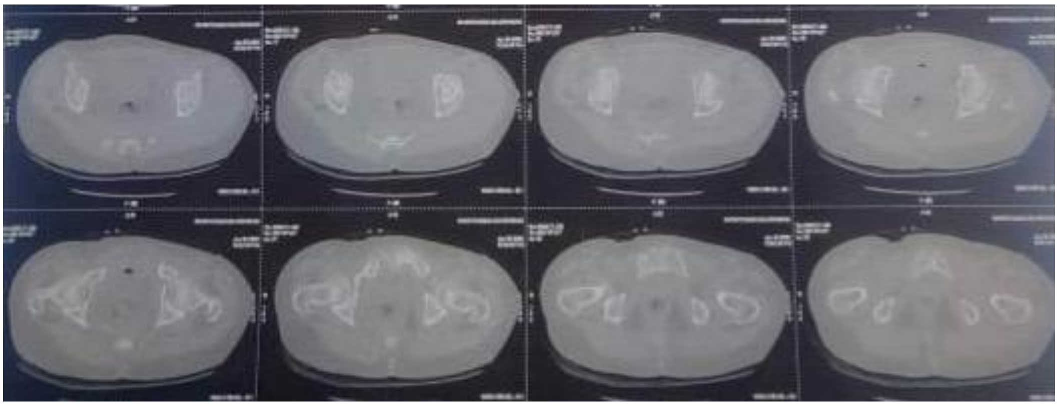


Fig 41- CT Pelvis Axial Cuts showing anterior column fracture

The patient was planned for Iliac wing fracture fixation and percutaneous screw fixation for the acetabular column.

OPERATIVE MANAGEMENT

The patient was shifted onto the Operation table (Radioluscent) and was given Spinal anesthesia by the anesthetist. The Patient was placed in the supine position and scrubbed, painted and draped. The skin incision was taken over the midline below the pubic tubercle of the left side.

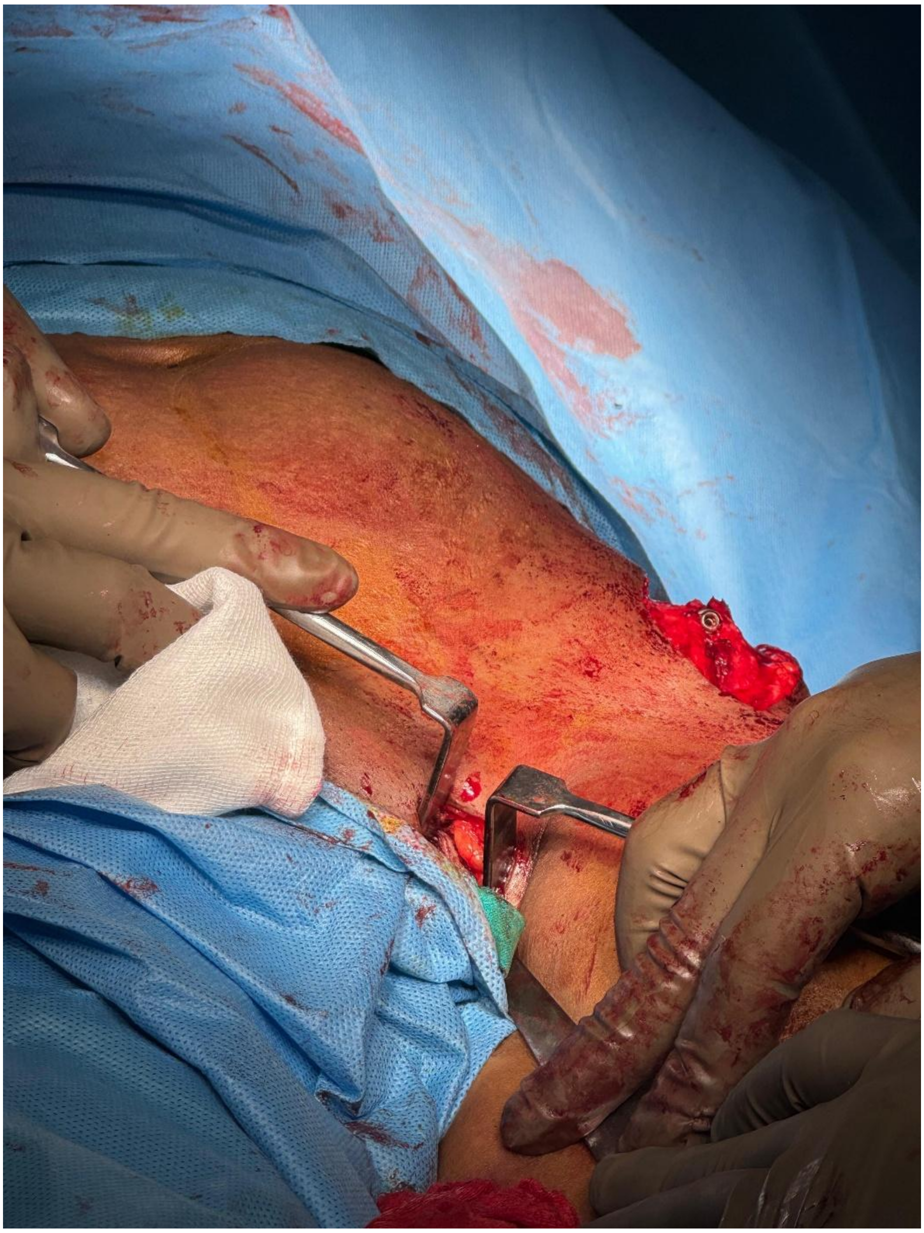
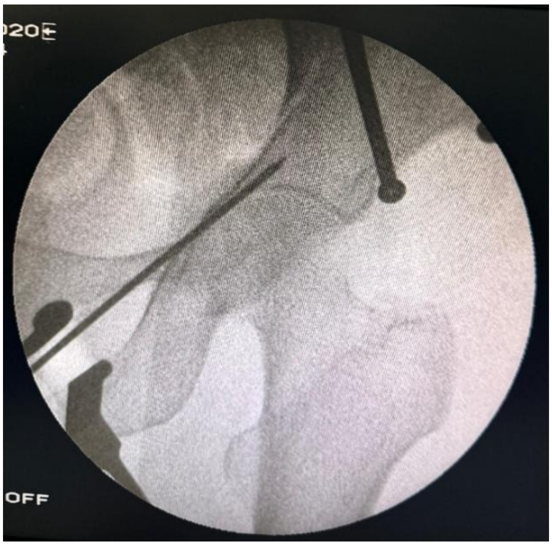


Fig 42- Skin incision with tissue retracted

The guide wire was inserted along the anterior column, and the pin position was confirmed under fluoroscopy. Drilling was done along the guide wire entry, and A long CC screw (85mm) was inserted over the guide wire, and screw placement was confirmed under fluoroscopy.



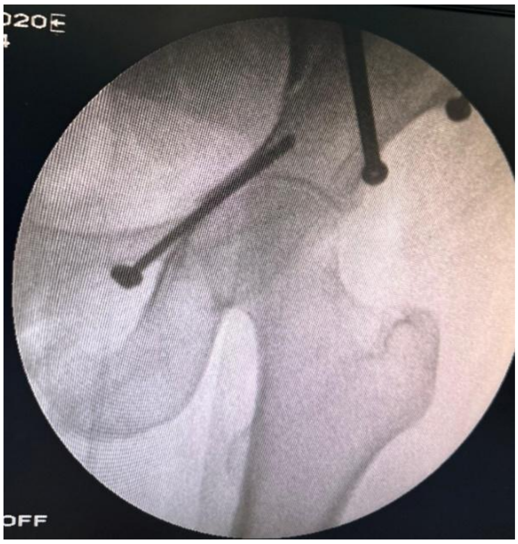


Fig 43- Guide wire placement **Fig 44- CC screw Fixation**

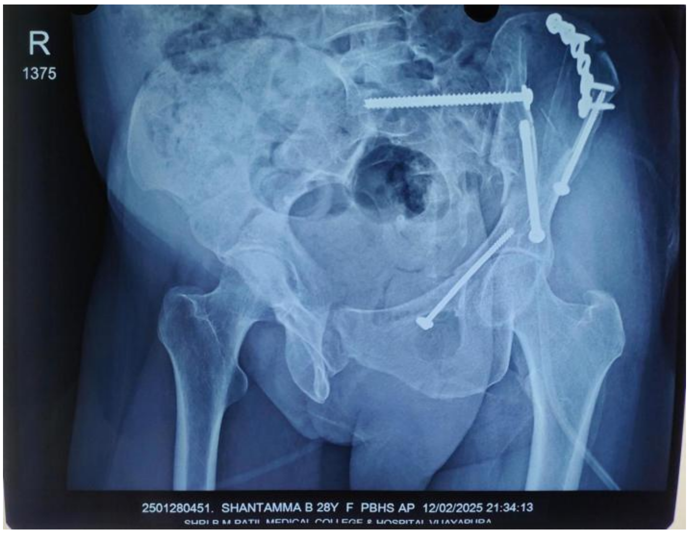
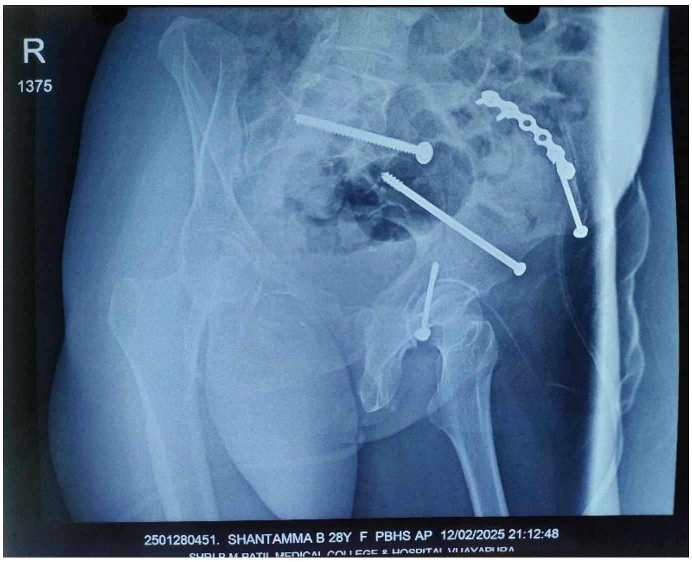


Fig 45- X-ray Postop Day 2



Layer-by-layer closure was done. Tab ENDOCAP SR was started on postoperative day 2 and given for 6 weeks. Active hip movements were started from post-operative day 1. The patient was allowed Partial weight bearing from 2nd post-operative week and full weight bearing from 11 weeks post-operatively. The patient was followed up for a period of 7 months postoperatively.

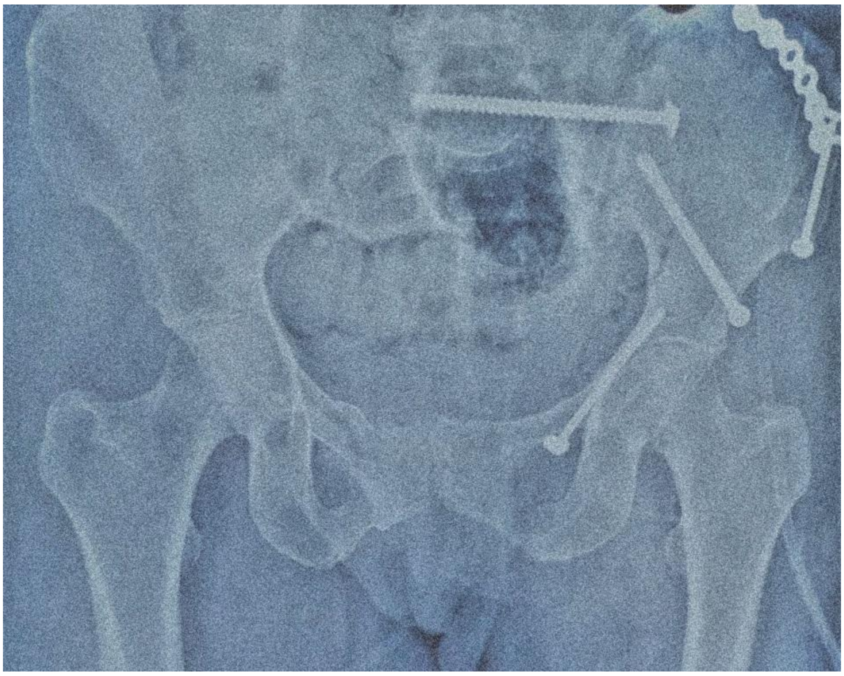


Fig 46- 7-month follow-up X-ray PBHS.

Fig 47- 7 month follow up Active hip movement.

RESULTS

The present study was conducted in the department of Orthopaedics at B.L.D.E. (DEEMED TO BE UNIVERSITY) Shri B.M.Patil Medical College, Hospital and Research Centre,

Vijayapura from March 2023 to March 2025 to study the functional outcome of surgical management of acetabular fractures. Total of 31 patients were considered for the study. Following were the results of the study:

Table 2: Distribution of patients according to age

Age (in years)	Frequency	Percentage
20-40	19	61.3%
41-60	8	25.8%
61-80	4	12.9%
Total	**31**	**100%**

Table 2 and graph 2 shows the age distribution of the 31 patients included in the study. The majority of patients (61.3%) were in the younger age group of 20-40 years, while 25.8% were in the middle age group of 41-60 years, and only 12.9% were in the older age group of 61-80 years. This indicates that acetabular fractures were more common in younger individuals in this study population.

Graph 2: Distribution of patients according to age

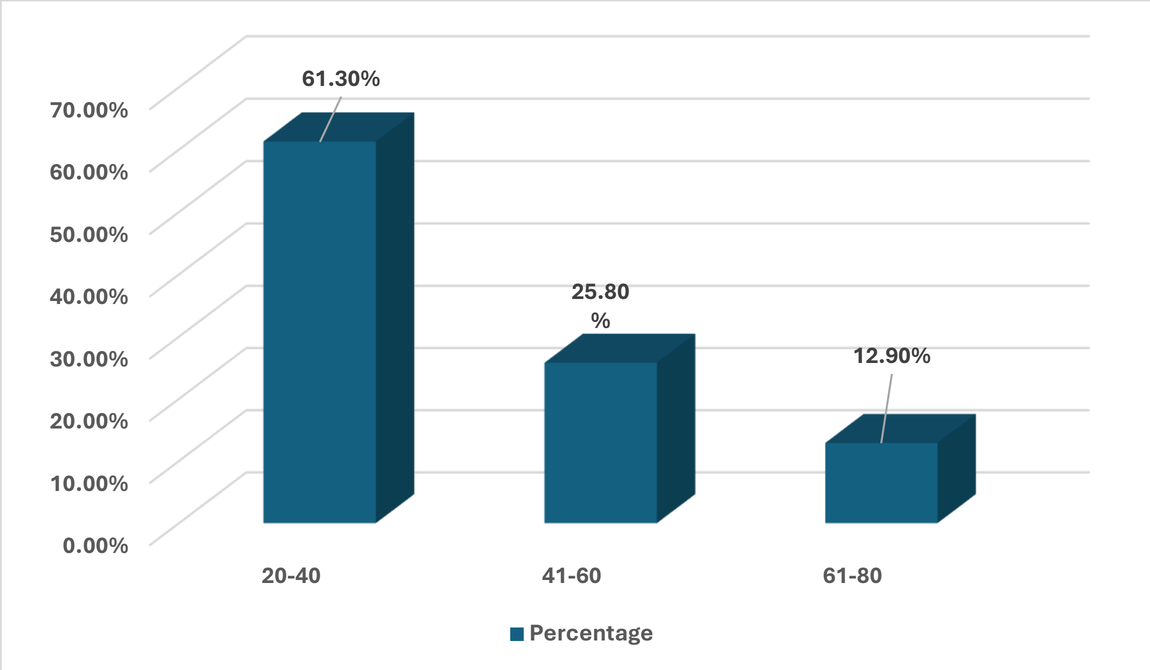


Table 3: Distribution of patients according to gender

Gender	Frequency	Percentage
Female	9	29%
Male	22	71%
Total	**31**	**100%**

Table 3 and graph 3 presents the gender distribution of patients, revealing a significant male predominance with 22 males (71%) compared to only 9 females (29%). This gender disparity suggests that men were more susceptible to acetabular fractures than women in this study cohort.

Graph 3: Distribution of patients according to gender

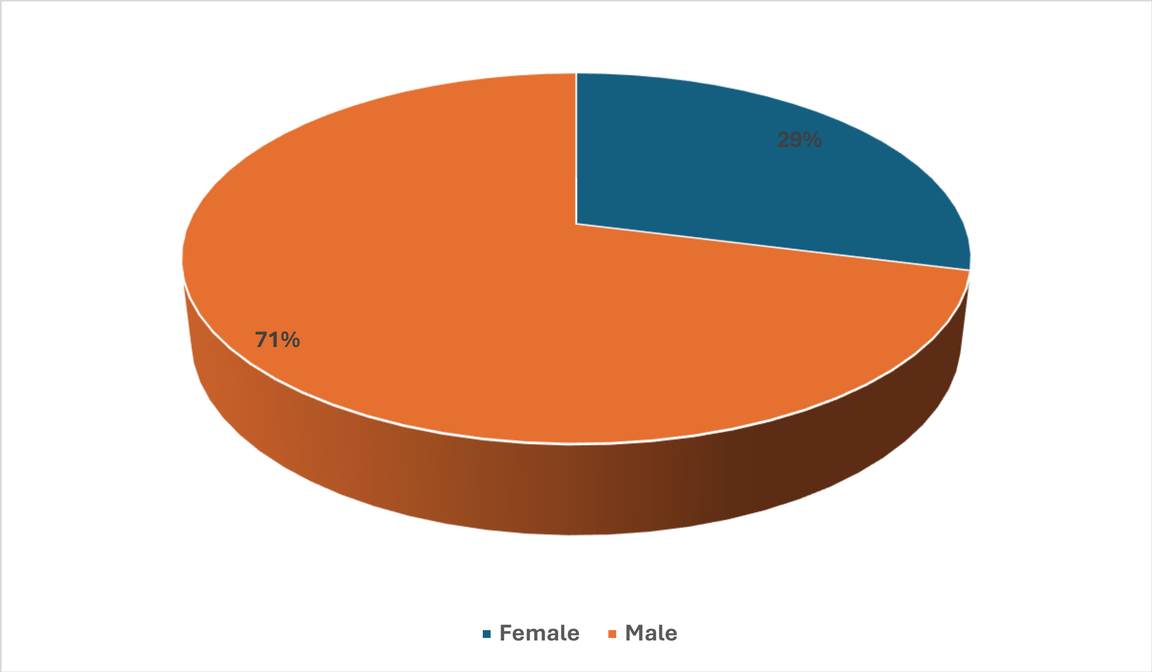


Table 4: Distribution of patients according to mode of injury

Mode of injury	Frequency	Percentage
Fall from height	9	29%
RTA	22	71%
Total	**31**	**100%**

Table 4 and graph 4 illustrates the mode of injury in the study participants. Road traffic accidents (RTA) were the predominant cause, accounting for 71% of cases, while falls from height contributed to 29% of the injuries. This highlights the significant role of vehicular accidents in causing acetabular fractures.

Graph 4: Distribution of patients according to mode of injury

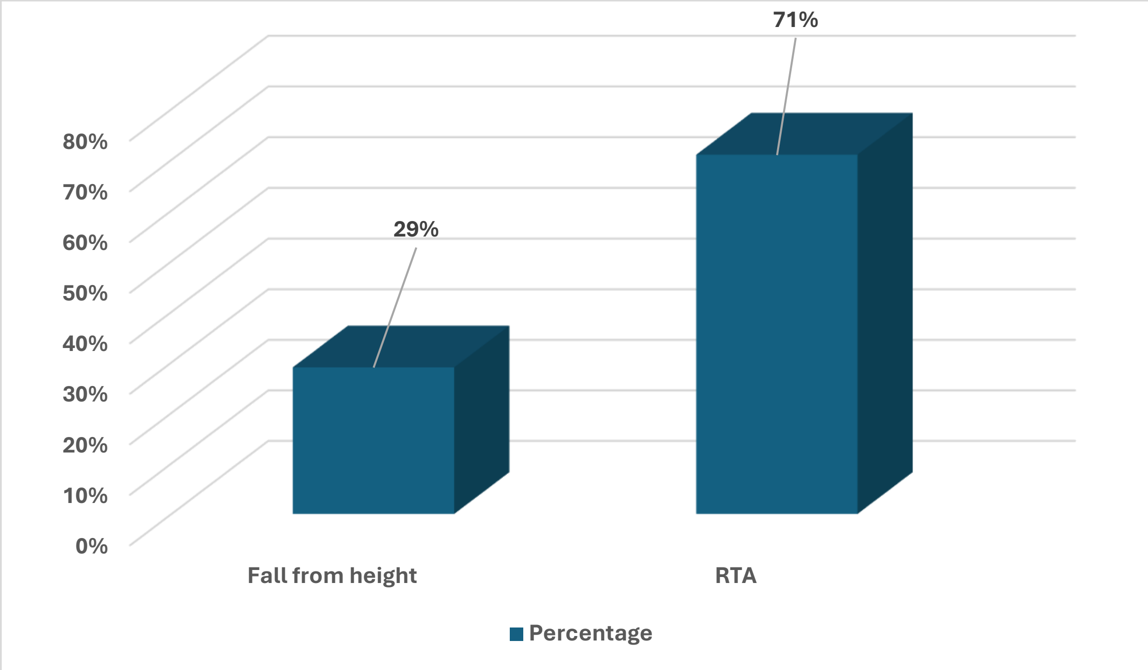


Table 5: Distribution of patients according to fracture

Fracture	Frequency	Percentage
Anterior column	2	6.5%
Anterior column +posterior column	4	12.9%
Anterior column+superior and inferior pubic rami	8	25.8%
Posterior column	8	25.8%
Posterior column+superior and inferior pubic rami	1	3.2%
Posterior column+posterior wall	2	6.5%
Posterior wall	6	19.4%
Total	**31**	**100%**

Table 5 and graph 5 categorizes the various types of acetabular fractures observed in the study. The most common fracture patterns were anterior column with superior and inferior pubic rami (25.8%) and posterior column fractures (25.8%), followed by posterior wall fractures (19.4%). Less common were anterior column with posterior column fractures (12.9%), isolated anterior column fractures (6.5%), posterior column with posterior wall fractures (6.5%), and posterior column with superior and inferior pubic rami fractures (3.2%).

Graph 5: Distribution of patients according to fracture

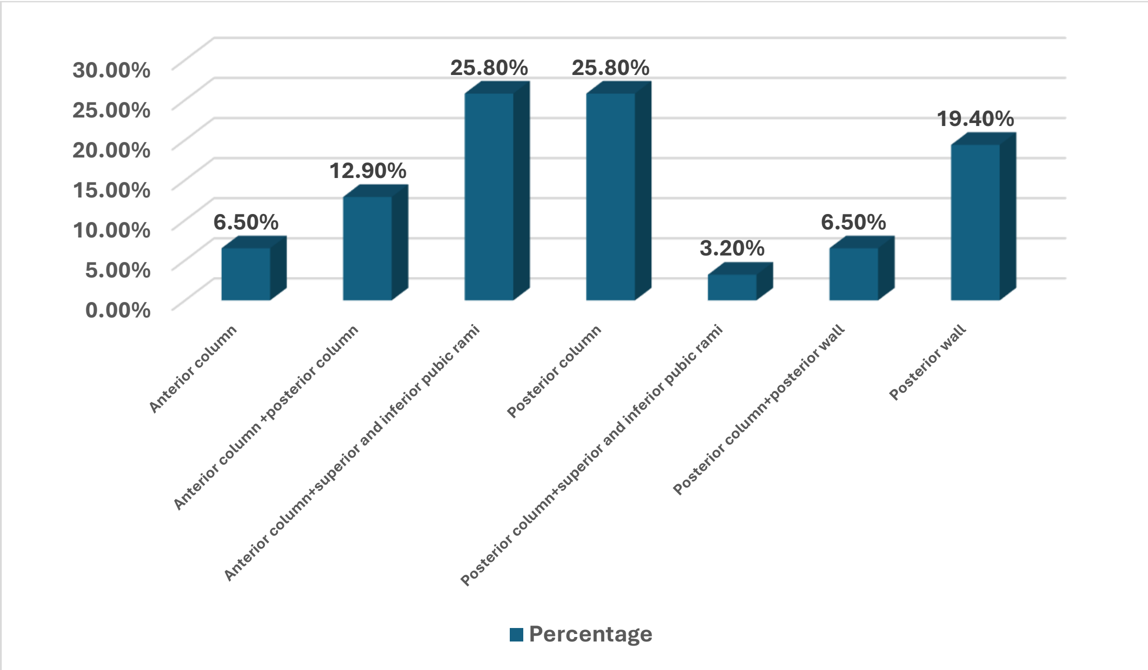


Table 6: Distribution of patients according to laterality

Laterality	Frequency	Percentage
Left	14	45.2%
Right	14	45.2%
Both	3	9.7%
Total	**31**	**100%**

Table 6 and graph 6 demonstrates the laterality of acetabular fractures, showing an equal distribution between right and left sides (45.2% each), while bilateral involvement was present in 9.7% of cases.

Graph 6: Distribution of patients according to laterality

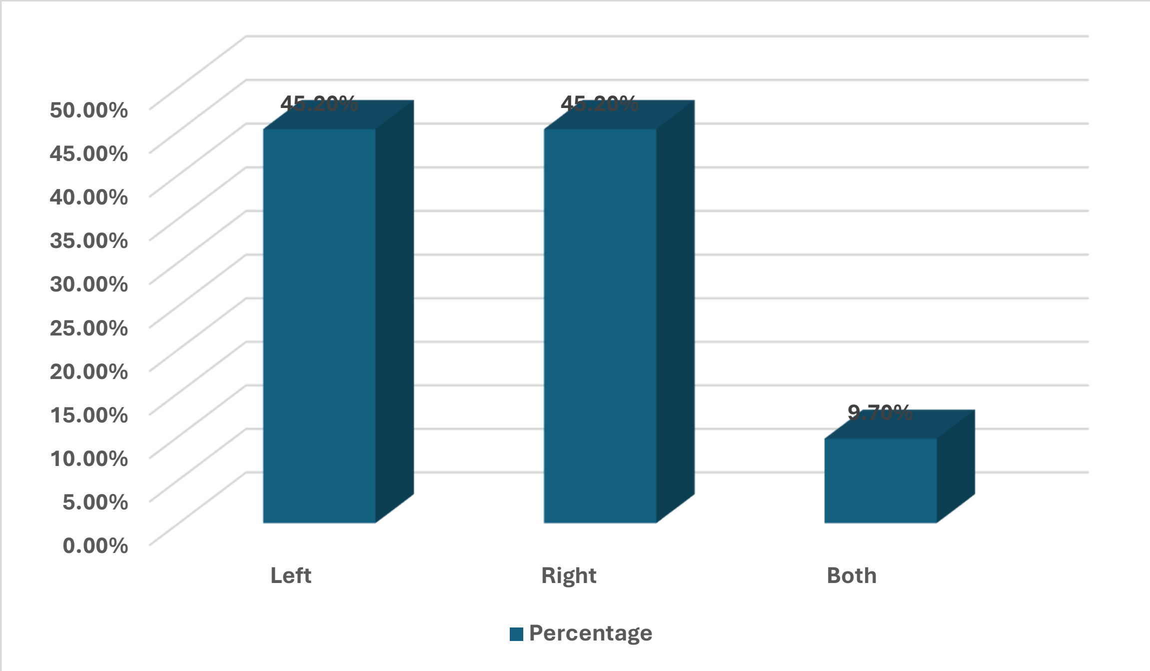


Table 7: Distribution of patients according to associated dislocation

Associated dislocation	Frequency	Percentage
Nil	23	74.2%
Posterior	8	25.8%
Total	**31**	**100%**

Table 7 and graph 7 indicates that 25.8% of patients had associated posterior hip dislocation along with acetabular fractures, while the majority (74.2%) did not have any associated dislocation.

Graph 7: Distribution of patients according to associated dislocation

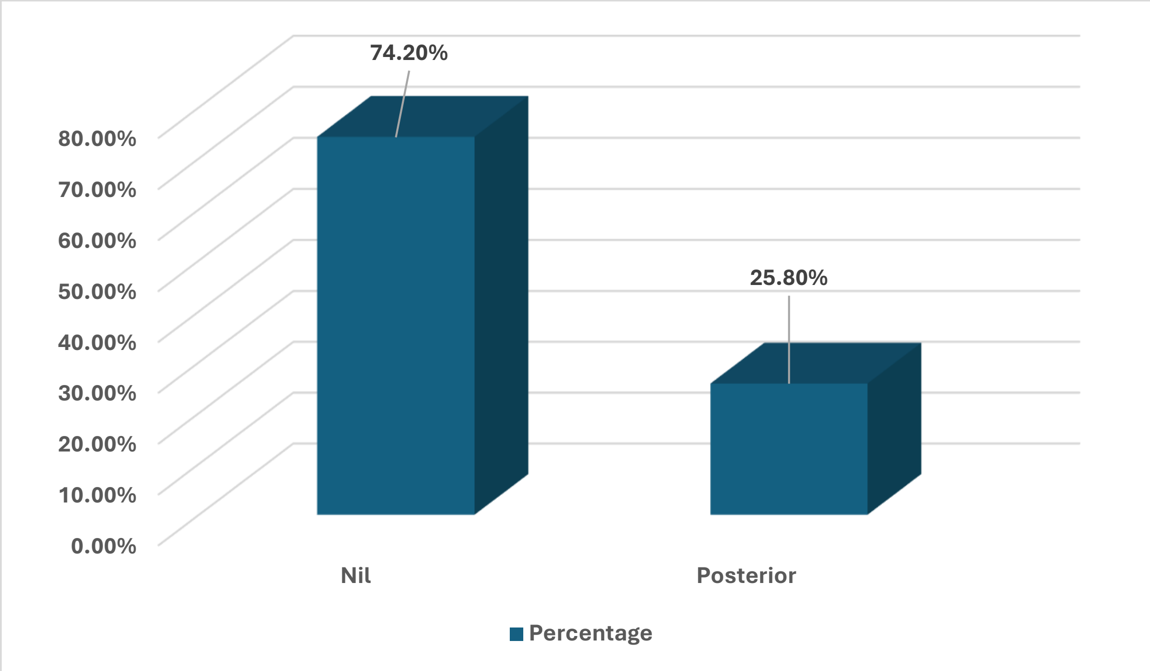


Table 8: Distribution of patients according to approach

Approach	Frequency	Percentage
Ileoinguinal	2	6.5%
Kocher langenbeck	14	45.2%
Kocher Langenbeck+modified stoppa	3	9.7%
Modified stoppa	10	32.3%
Modified stoppa+lateral window	1	3.2%
Percutaneous pinning	1	3.2%
Total	**31**	**100%**

Table 8 and graph 8 details the surgical approaches used for treatment. The Kocher Langenbeck approach was most commonly employed (45.2%), followed by the modified Stoppa approach (32.3%). Less frequently used approaches included combined Kocher Langenbeck with modified Stoppa (9.7%), ileoinguinal approach (6.5%), modified Stoppa with lateral window (3.2%), and percutaneous pinning (3.2%).

Graph 8: Distribution of patients according to approach

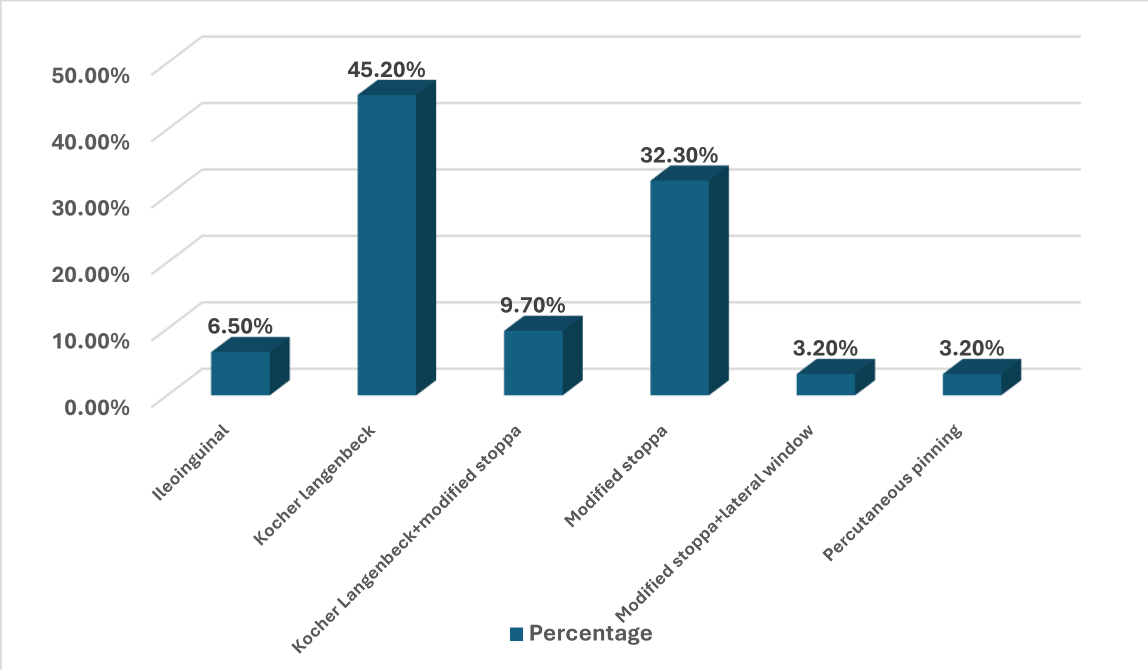


Table 9: Distribution of patients according to modified Merle d'Aubigne score

Merle d'Aubigne score	Presentation	6 weeks	3 months	6 months
Poor (3-9)	31 (100%)	28 (90.3%)	18 (58.1%)	-
Moderate (10-12)	-	3 (9.7%)	12 (38.7%)	15 (48.4%)
Excellent (13-18)	-	-	1 (3.2%)	16 (51.6%)

Table 9 and graph 9 tracks the functional outcomes using the modified Merle d'Aubigne score at different time intervals. Initially, all patients (100%) had poor scores (3-9), which gradually improved. By 6 months, 51.6% of patients achieved excellent results (13-18), 48.4% had moderate outcomes (10-12), and none remained in the poor category, demonstrating significant functional improvement over time.

Graph 9: Distribution of patients according to modified Merle d'Aubigne score

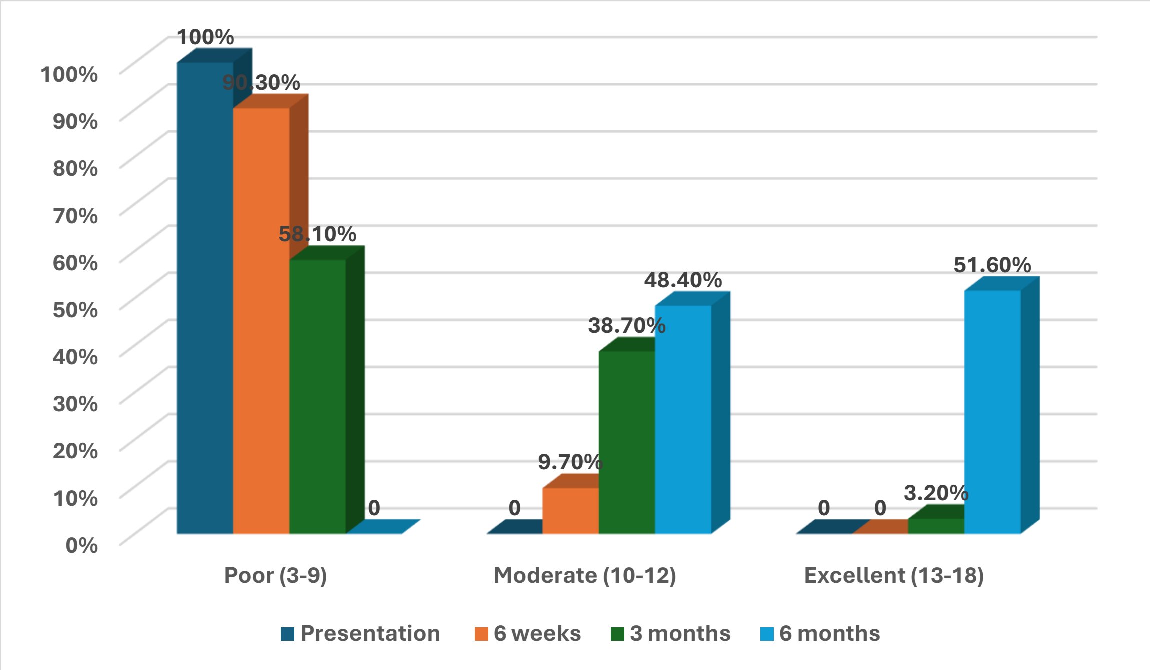


Table 10: Distribution of patients according to complications

Complications	Frequency	Percentage
Nil	25	80.6%
Hip stiffness	3	9.7%
Surgical wound infection	1	3.2%
Surgical wound infection+hip stiffness	2	6.5%
Total	**31**	**100%**

Table 10 and graph 10 summarizes complications encountered during treatment. Most patients (80.6%) did not experience any complications. Hip stiffness occurred in 9.7% of cases, while surgical wound infection affected 3.2% of patients, and a combination of wound infection and hip stiffness was seen in 6.5% of patients.

Graph 10: Distribution of patients according to complications

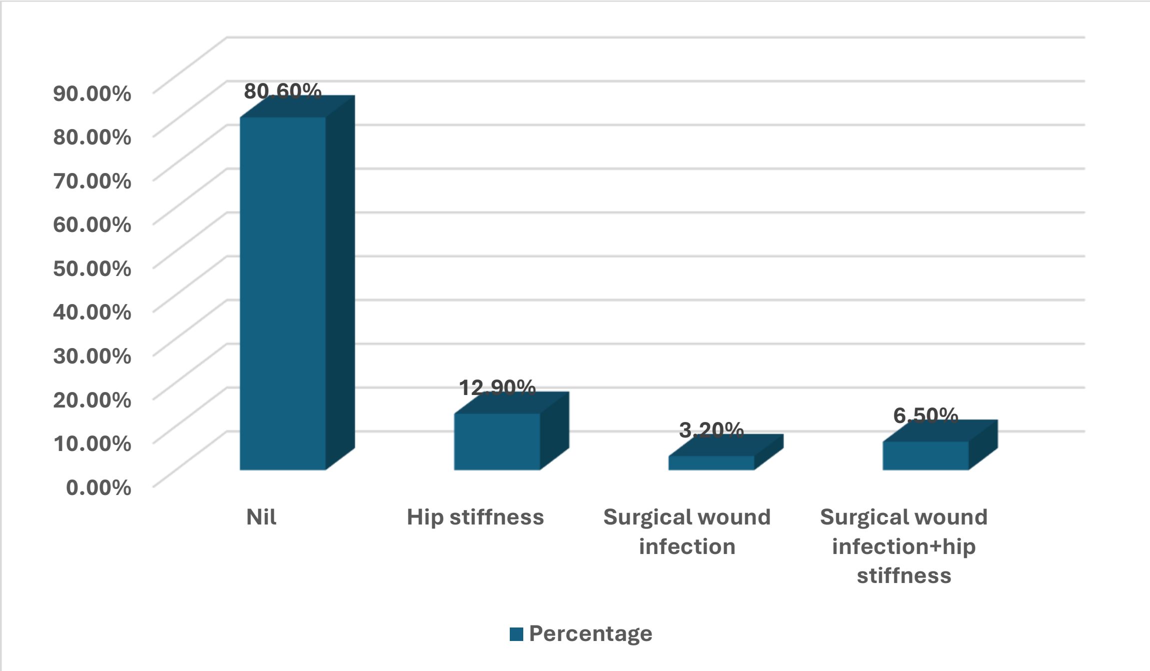


Table 11: Distribution of patients according to associated injuries

Associated injuries	Frequency	Percentage
Nil	28	90.3%
Bladder injury	2	6.5%
Hemoperitoneum	1	3.2%
Total	**31**	**100%**

Table 11 and graph 11 reports on associated injuries, with the majority of patients (90.3%) not having any associated injuries. Bladder injury was present in 6.5% of cases, and hemoperitoneum occurred in 3.2% of patients.

Graph 11: Distribution of patients according to associated injuries

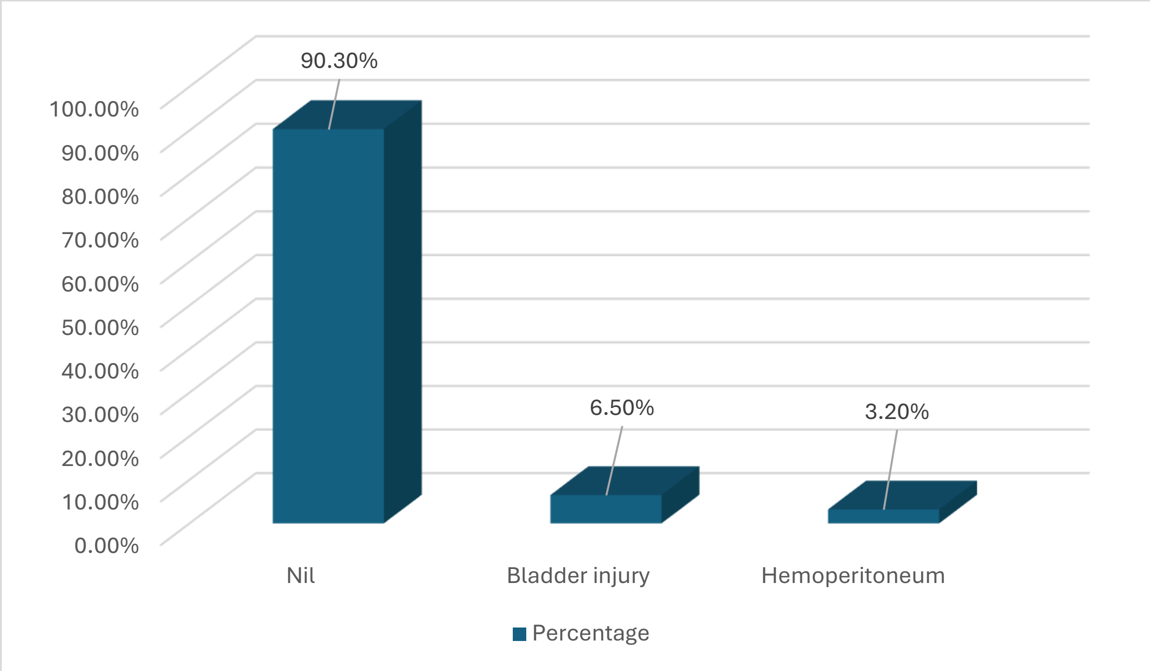


Table 12: Association of modified Merle d'Aubigne score at different point of time

Modified Merle D'Aubigne Score	Mean	SD	Friedman's test	p-value
Presentation	5.00	1.211	92.416	0.001
6 Weeks	6.71	1.637		
3 Months	9.39	1.476		
6 Months	12.45	1.670		

Table 12 and graph 12 analyses relationship of the modified Merle d'Aubigne score at different points at time of presentation, 6 weeks post operatively, 3 months post operatively and 6 months post operatively. The modified Merle d'Aubigne scoring (scores 3-18) mean values at presentation was 5.00 (SD- 1.211), at 6 weeks post operatively was 6.71 (SD- 1.637), at 3 months post operatively was 9.39 (SD- 1.476) and at 6 months post operatively was 12.45(1.670). The statistically significant p-value of 0.001 confirms that Patients are significantly more likely to achieve excellent functional outcomes post surgical intervention by 6 months.

Graph 12: Association of modified Merle d'Aubigne score at different point of time

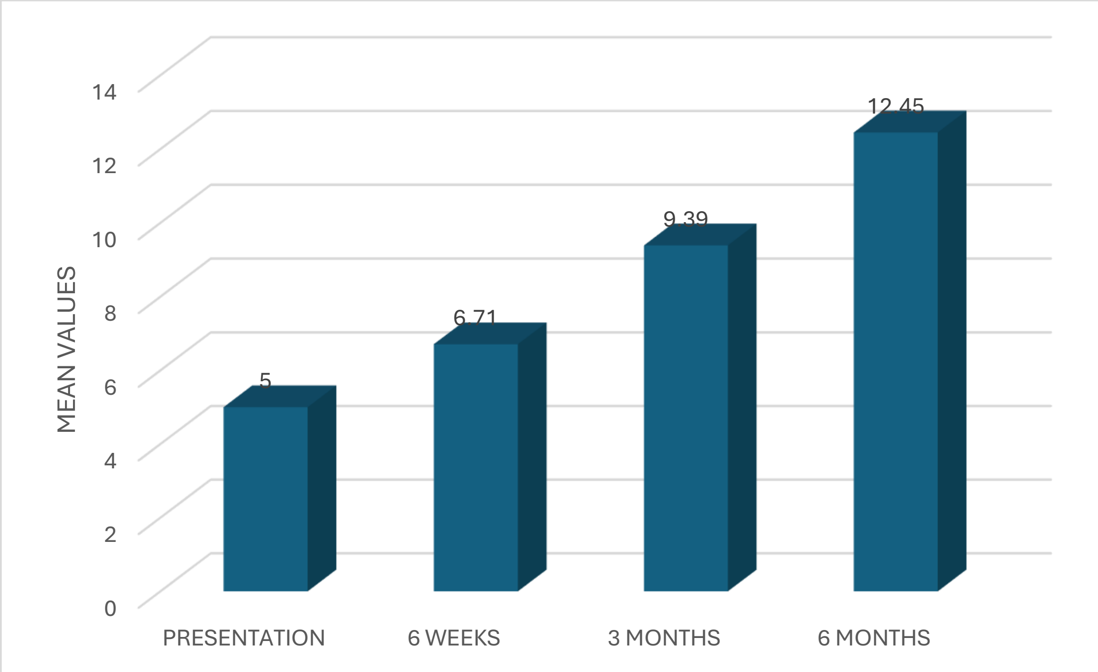


Table 13: Association of modified Merle d'Aubigne score at 6 months with age

Age (in years)	modified Merle d'Aubigne score		p-value
	Moderate (10-12)	Excellent (13-18)	
20-40	6 (40%)	13 (81.3%)	**0.02**
41-60	5(33.3%)	3 (18.7%)	
61-80	4 (26.7%)	0	
Total	**15 (100%)**	**16 (100%)**	

Table 13 and graph 13 analyses the relationship between age and functional outcomes at 6 months. Among patients with excellent outcomes (scores 13-18), 81.3% (13 out of 16) were young adults aged 20-40 years, while 18.7% (3 out of 16) were middle-aged patients between 41-60 years, and 0% were elderly patients aged 61-80 years.

For patients with moderate outcomes (scores 10-12), the age distribution was more evenly spread: 40% (6 out of 15) were aged 20-40 years, 33.3% (5 out of 15) were aged 41-60 years, and 26.7% (4 out of 15) were aged 61-80 years.The statistically significant p-value of 0.02 confirms that younger patients were significantly more likely to achieve excellent functional outcomes at 6 months post-surgery compared to older patients, with no patients over 60 years achieving excellent scores in this study

Graph 13: Association of modified Merle d'Aubigne score at 6 months with age

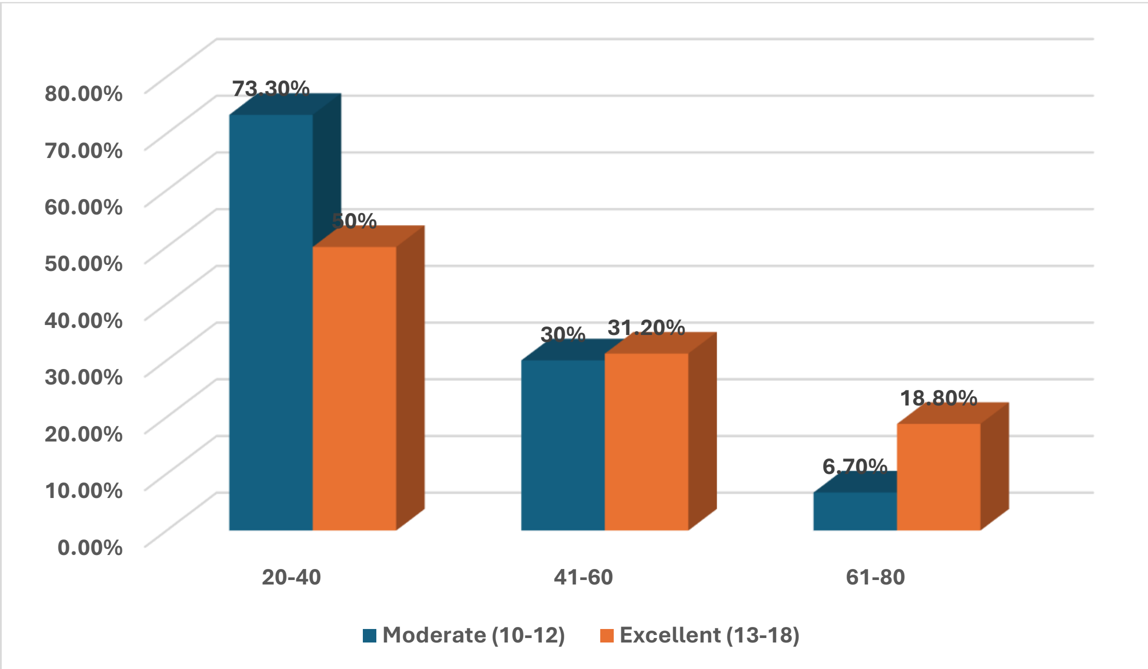


Table 14: Association of modified Merle d'Aubigne score at 6 months with fracture

Fracture	modified Merle d'Aubigne score		p-value
	Moderate (10-12)	Excellent (13-18)	
Anterior column	1 (6.7%)	1 (6.2%)	
Anterior column +posterior column	1 (6.7%)	3 (18.8%)	

Anterior column+superior and inferior pubic rami	4 (26.7%)	4 (25%)	0.85
Posterior column	4 (26.7%)	4 (25%)	
Posterior column+superior and inferior pubic rami	0	1 (6.2%)	
Posterior column+posterior wall	1 (6.7%)	1 (6.2%)	
Posterior wall	4 (26.7%)	2 (12.5%)	
Total	**15 (100%)**	**16 (100%)**	

Table 14 and graph 14 examines the correlation between fracture type and functional outcomes at 6 months. No statistically significant association was found (p=0.85), suggesting that the type of acetabular fracture did not significantly influence the functional outcome.

Graph 14: Association of modified Merle d'Aubigne score at 6 months with fracture

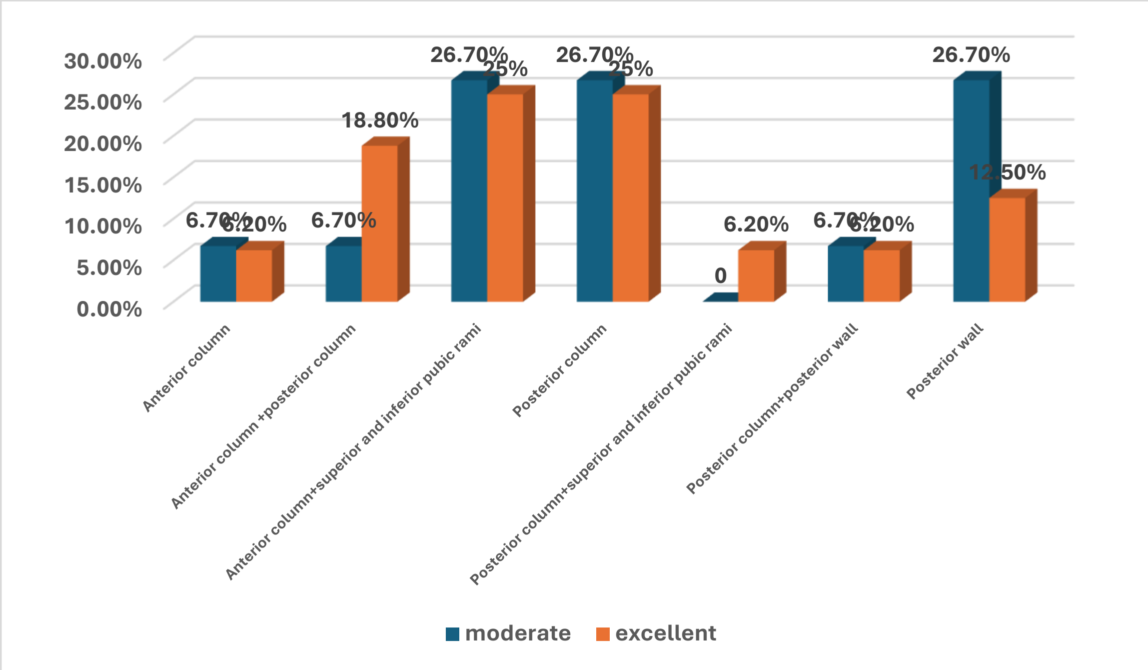


Table 15: Association of modified Merle d'Aubigne score at 6 months with associated dislocation

Associated dislocation	modified Merle d'Aubigne score		p-value
	Moderate (10-12)	Excellent (13-18)	
Nil	8 (53.3%)	15 (93.2%)	0.01
Posterior	7 (46.7%)	1 (6.2%)	
Total	**15 (100%)**	**16 (100%)**	

Table 15 and graph 15 investigates the impact of associated hip dislocation on functional outcomes. Although patients without dislocation had a higher percentage of excellent outcomes (81.2% vs 18.8%), this difference was not statistically significant (p=0.35). Among patients with excellent outcomes (scores 13-18), 93.8% (15 out of 16) had no associated dislocation, while only 6.2% (1 out of 16) had posterior dislocation. In contrast, among patients with moderate outcomes (scores 10-12), 53.3% (8 out of 15) had no associated dislocation, and 46.7% (7 out of 15) had posterior dislocation. The statistically significant p-value of 0.01 confirms that patients without associated posterior dislocation were significantly more likely to achieve excellent functional outcomes at 6 months post-surgery compared to those with posterior dislocation.

Graph 15: Association of modified Merle d'Aubigne score at 6 months with associated dislocation

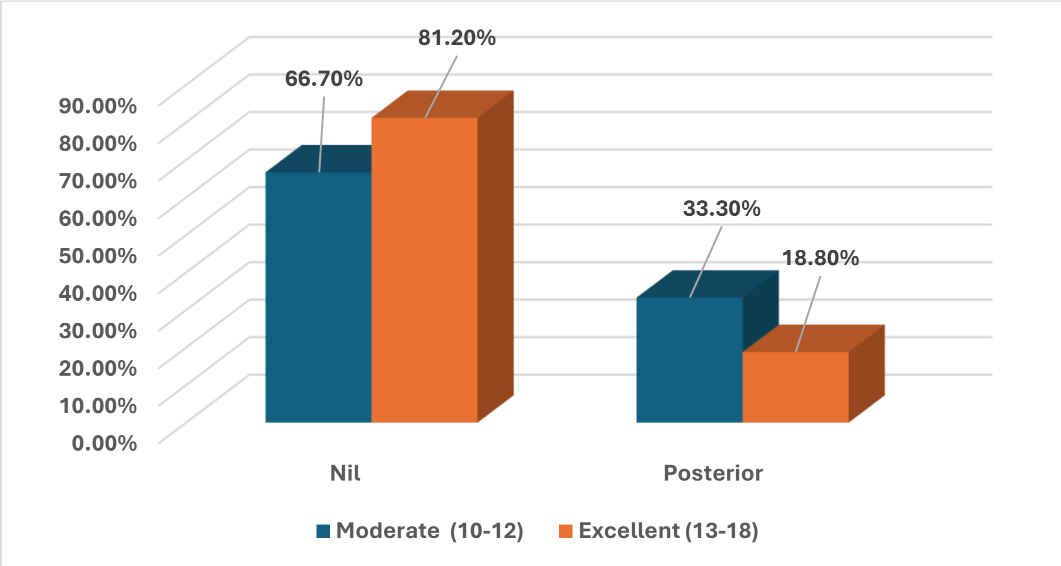


Table 16: Association of modified Merle d'Aubigne score at 6 months with approach

Approach	modified Merle d'Aubigne score		p-value
	Moderate (10-12)	Excellent (13-18)	
Ileoinguinal	2 (13.3%)	0	**0.02**
Kocher langenbeck	10 (66.7%)	4 (25%)	
Kocher Langenbeck+modified stoppa	0	3 (18.8%)	
Modified stoppa	2 (13.3%)	8 (15%)	
Modified stoppa+lateral window	0	1 (6.2%)	
Percutaneous pinning	1 (6.7%)	0	

Total	**15 (100%)**	**16 (100%)**	

Table 16 and graph 16 evaluate the relationship between surgical approach and functional outcomes. The Kocher Langenbeck approach was associated with the highest percentage of excellent outcomes (25%), followed by the Kocher Langenbeck+ modified Stoppa approach (18.8%), and this association was statistically significant (p=0.02).

Graph 16: Association of modified Merle d'Aubigne score at 6 months with approach

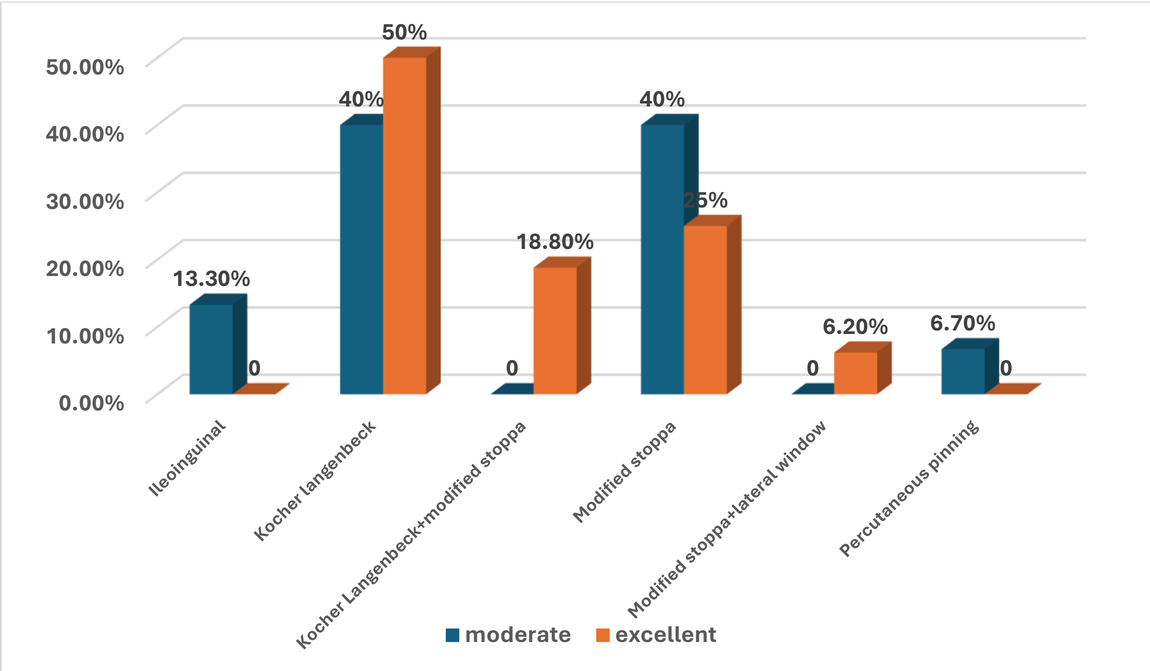


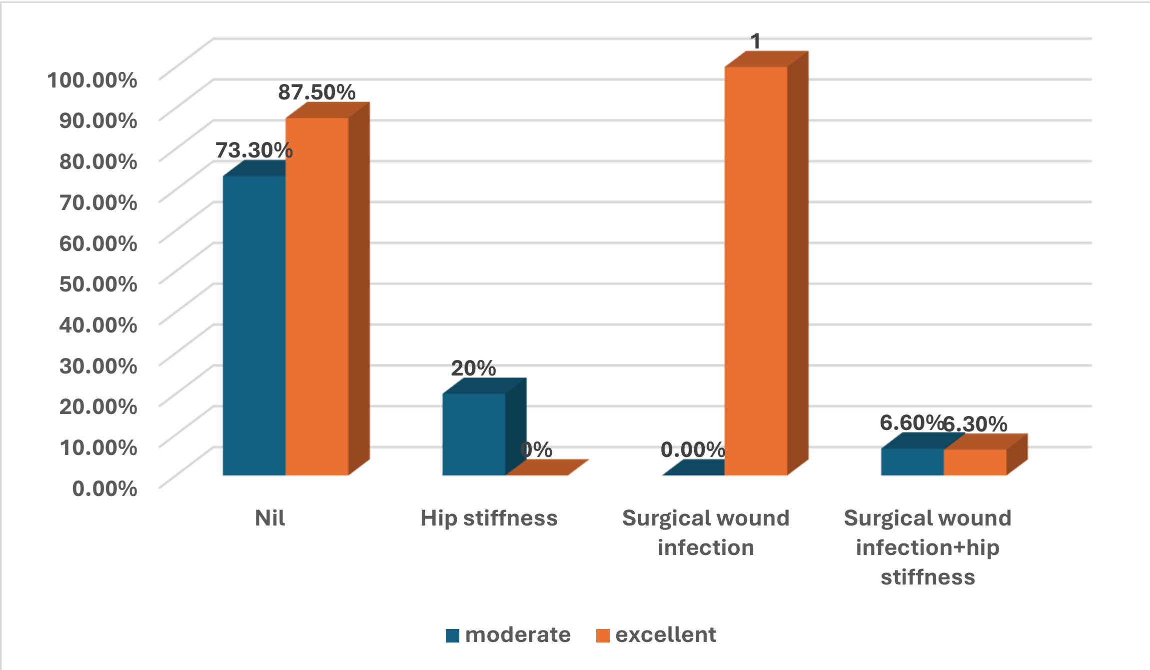
Table 17: Association of modified Merle d'Aubigne score at 6 months with complications

Complications	modified Merle d'Aubigne score		p-value
	Moderate (10-12)	**Excellent (13-18)**	
Nil	11(73.3%)	14(87.5%)	
Hip stiffness	3(20%)	0	

Surgical wound infection	0	1(6.3%)	**0.03**
Surgical wound infection+ hip stiffness	1(6.6%)	1(6.3%)	
Total	**15 (100%)**	**16 (100%)**	

Table 17 and graph 17 assess the correlation between complications and functional outcomes. Patients who had no complications were more likely to have excellent outcomes, with this association approaching statistical significance (p=0.03).

Graph 17: Association of modified Merle d'Aubigne score at 6 months with complications



DISCUSSION

Acetabular fractures represent one of the most challenging injuries faced by orthopedic surgeons, often resulting from high-energy trauma and frequently affecting young, productive individuals. These complex injuries demand meticulous assessment, precise surgical planning, and expert execution to achieve optimal outcomes. The management of acetabular fractures has evolved significantly since Judet and Letournel's groundbreaking work, which established the anatomical classification and surgical principles that continue to guide current practice. Despite advances in surgical techniques, imaging modalities, and rehabilitation protocols, the treatment of acetabular fractures remains technically demanding with variable functional outcomes. This study was conducted to evaluate the functional outcomes of surgical management of acetabular fractures at our institution and to identify factors that influence these outcomes.

In our prospective study of 31 patients with acetabular fractures treated surgically, we assessed functional outcomes using the modified Merle d'Aubigne score at regular intervals post-surgery. This scoring system evaluates pain, mobility, and walking ability, providing a comprehensive assessment of hip function. Our findings offer valuable insights into the demographic patterns, fracture characteristics, surgical approaches, functional recovery trajectories, and complications associated with acetabular fractures in our setting. This discussion aims to analyze these findings in the context of existing literature, identify patterns of concordance and discordance, and elucidate factors that may influence outcomes.

Demographic Characteristics

Age Distribution

In our study, a majority of patients (61.3%) belonged to the 20-40 years age group, followed by 25.8% in the 41-60 years category and 12.9% in the 61-80 years group. This predominance of young adults corresponds with the high-energy nature of these injuries and aligns with findings from other studies. Matta et al. reported a mean age of 38 years in their series of 262 acetabular fractures, while Letournel and Judet's landmark study described a predominance of patients in their third and fourth decades of life.[51]

The higher prevalence in younger populations can be attributed to their greater participation in high-risk activities and occupations. This demographic pattern is particularly significant as it highlights the substantial socioeconomic impact of these injuries, affecting individuals in their prime productive years. Giannoudis et al. in their review of 3670 acetabular fractures found that 70% of patients were under 50 years of age, reinforcing the global trend of acetabular fractures predominantly affecting younger individuals.[52]

Our finding that 40% of patients aged 20-40 years achieved moderate functional outcomes and 81.3% achieved excellent outcomes at 6 months suggests that younger patients generally demonstrate better functional recovery. This association reached statistical significance (p=0.02), it supports the consensus that age is an important prognostic factor. Matta's study demonstrated that patients younger than 40 years had significantly better functional outcomes compared to older patients, with deteriorating results observed with advancing age.[53] Similarly, Briffa et al. found that age over 55 years was associated with poorer functional outcomes following acetabular fracture surgery.[54]

The relative paucity of excellent outcomes in our older age groups (41-60 and 61-80 years) may be attributed to physiological factors including decreased bone quality, diminished healing capacity, pre-existing osteoarthritis, and greater susceptibility to complications. Murphy et al. documented that patients over 60 years had a 2.3-fold increased risk of poor outcomes following acetabular fracture surgery compared to younger patients.[55]While our study shows a trend toward this association, the relatively small sample size may have limited the statistical power to detect significant differences across age groups.

Gender Distribution

Male predominance (71%) was observed in our study, which mirrors the pattern reported in most published series. Letournel's classic series reported 75% male patients, while a multicenter study by the German Pelvic Trauma Registry documented 69% male patients among 2405 acetabular fractures.[56] This gender disparity likely reflects higher male involvement in road traffic accidents, occupational hazards, and high-energy recreational activities.

Interestingly, gender did not emerge as a significant determinant of functional outcomes in our study. This finding is consistent with most published literature, suggesting that biological sex itself may not independently influence healing potential or functional recovery after appropriate surgical management. However, some studies have suggested potential gender-specific differences in outcomes. Pagenkopf et al. reported slightly better outcomes in females, attributing this to differences in compliance with rehabilitation protocols, while Ferguson et al. found no significant gender-related differences in functional outcomes.[57]

Mechanism of Injury

Road traffic accidents (RTAs) constituted the predominant mechanism of injury (71%) in our cohort, followed by falls from height (29%). This pattern aligns with global trends in acetabular trauma. A systematic review by Laird and Keating analyzing 3670 acetabular fractures reported RTAs as the causative mechanism in 80.5% of cases, with falls accounting for 10.7%.[58] The high proportion of RTA-related acetabular fractures in our study underscores the need for enhanced road safety measures, particularly in developing countries where increasing motorization has not been matched by adequate safety infrastructure.

The pattern of injury mechanism in our study differs somewhat from Western literature, where high-speed motor vehicle accidents predominate. In our setting, a significant proportion of RTAs involve two-wheelers, where direct lateral impact to the greater trochanter transmits force to the femoral head and acetabulum. Tile and Kellam described this "lateral compression force" as a common mechanism for certain acetabular fracture patterns, particularly posterior wall and posterior column fractures, which comprised a significant portion of our series.[59]

Fracture Pattern

Our study documented diverse fracture patterns “according to the Judet-Letournel classification. Posterior column fractures and anterior column fractures with associated pubic rami fractures were the most common (25.8% each)”, followed by posterior wall fractures (19.4%). Anterior column and posterior column combined fractures accounted for 12.9% of cases.

This distribution partially diverges from patterns reported in other series. In Letournel's landmark study of 940 acetabular fractures, posterior wall fractures predominated (24%), “followed by both-column fractures (19%) and transverse-posterior wall fractures (18%)”.[60] Similarly, Giannoudis et al. reported posterior wall fractures as the most common pattern (23.9%), with simple transverse fractures (17.2%) and anterior column fractures (7.5%) following.[52]

Several factors might explain these discrepancies. First, regional variations in common injury mechanisms (types of vehicles, speed limits, safety regulations) may influence fracture patterns. Second, referral patterns to specialized centers may introduce selection bias in various studies. Finally, classification inconsistencies and variability in the interpretation of imaging studies can lead to differences in reported distributions.

Of particular significance was our observation that fracture patterns did not significantly influence functional outcomes at 6 months ($p=0.85$). Patients with various fracture types achieved similar proportions of moderate and excellent outcomes. This finding differs from some published literature. Matta reported superior outcomes in patients with simple fracture patterns compared to associated patterns, particularly both-column fractures.[53] Similarly, Briffa et al. found that complex patterns, especially those involving the posterior wall, were associated with poorer functional results.[54]

Our divergent findings might be attributed to several factors. The comprehensive preoperative planning, application of appropriate surgical approaches, and meticulous reduction techniques employed in our study may have mitigated the impact of fracture complexity on outcomes. Furthermore, our relatively small sample size within each fracture category might have limited the statistical power to detect significant associations.

Additionally, the 6-month follow-up period may not have been sufficient to reveal outcome differences that might emerge with longer observation.

Associated Dislocations

In our series, 25.8% of patients presented with associated posterior hip dislocations. This proportion is comparable to the 20-30% reported in published literature. Matta documented associated hip dislocations in 23% of acetabular fractures, while Giannoudis et al. reported a slightly higher incidence of 34%.[52,53]

The presence of associated dislocation significantly impacted the functional outcomes at 6 months in our study (p=0.01). Among patients with associated dislocations, 56.7% achieved moderate outcomes and 6.2% achieved excellent outcomes. There was a trend toward better outcomes in patients without dislocations, which did reach statistical significance.

This finding aligns with several published studies that have identified associated hip dislocation as a negative prognostic factor. Briffa et al. reported that concomitant hip dislocation increased the risk of poor outcomes by 2.1-fold, primarily due to higher rates of osteonecrosis, chondrolysis, and heterotopic ossification.[54] Similarly, Letournel found that 85% of patients with acetabular fractures without dislocations achieved good to excellent results, compared to 76% of those with associated dislocations.[60]

The timing of dislocation reduction is critical in influencing outcomes. Sahin et al. demonstrated that reduction performed within 12 hours significantly improved outcomes compared to delayed reduction.[61] While our study did not specifically analyze the time to reduction, institutional protocols prioritize emergent reduction of hip dislocations, which may explain the relatively favorable outcomes despite associated dislocations.

Surgical Approaches

The choice of surgical approach in acetabular fracture management is dictated by fracture pattern, displacement, surgeon expertise, and anticipated access for reduction and fixation. In our series, the Kocher-Langenbeck approach was most frequently employed (45.2%), followed by the modified Stoppa approach (32.3%). Combined approaches (Kocher-Langenbeck with modified Stoppa) were utilized in 9.7% of cases, while the ilioinguinal approach was used in 6.5% of patients.

This distribution reflects the predominance of posterior column and posterior wall fractures in our series, for which the Kocher-Langenbeck approach provides optimal exposure. Our preference for the modified Stoppa approach over the traditional ilioinguinal approach for the anterior column and associated fractures aligns with evolving trends in acetabular surgery. Cole and Bolhofner reported superior visualization of the quadrilateral plate and reduced surgical morbidity with the modified Stoppa approach compared to the ilioinguinal approach.[62]

Analysis of functional outcomes based on surgical approach revealed interesting patterns, differences did reach statistical significance (p=0.02). Notably, all patients who underwent combined Kocher-Langenbeck with modified Stoppa approaches achieved excellent outcomes. This finding supports the principle that complex acetabular fractures often require extensive exposure through combined approaches to achieve anatomical reduction.

Interestingly, patients who underwent the modified Stoppa approach demonstrated a similar proportion of moderate outcomes (13.3%) compared to excellent outcomes (15%). This may be related to the complexity of fractures addressed through this approach, often involving the quadrilateral plate and medial displacement, which can be challenging to reduce anatomically. Liu et al. reported similar findings, noting that quadrilateral plate involvement was associated with less satisfactory outcomes despite adequate surgical exposure.[63]

The Kocher-Langenbeck approach yielded interesting outcomes, with 66.7% of patients achieving moderate and 25% achieving excellent results. This is contrast with published literature. Matta reported 76% good to excellent results with this approach, attributing its effectiveness to direct visualization of the posterior column and wall.[53] Similarly, Isaacson et al.

documented 70% satisfactory outcomes using the Kocher-Langenbeck approach for posterior acetabular fractures.[64] Our divergent findings might be attributed to the higher number of posterior dislocation cases, which warranted a posterior approach to fix the associated fracture when compared to that of an anterior approach and our limited sample size.

Our findings support the principle that approach selection should be tailored to fracture pattern rather than surgeon preference. The trend toward better outcomes with combined approaches underscores the value of adequate exposure for complex fractures, even at the cost of increased surgical morbidity.

Functional Outcomes

The assessment of functional outcomes using the modified Merle d'Aubigne score revealed a progressive improvement over time which was statistically significant (p=0.001). The mean modified Merle D'Aubigne at presentation was 5.00, By 6 weeks was 6.71, By 3 months was 9.39 and by 6 months was 12.45. At presentation, all patients (100%) had poor scores (3-9). By 6 weeks, 90.3% remained in the poor category, with 9.7% improving to moderate scores. At 3 months, a substantial shift occurred, with 58.1% in the poor category, 38.7% in the moderate category, and 3.2% achieving excellent outcomes. By 6 months, no patients remained in the poor category, with 48.4% achieving moderate and 51.6% achieving excellent outcomes.

This temporal progression illustrates the prolonged recovery trajectory following acetabular fracture surgery. The observation that no patient achieved excellent outcomes before 3 months, and the majority required 6 months to reach their maximal functional potential, highlights the importance of patient counseling regarding recovery expectations and the necessity for extended rehabilitation.

Our finding that 51.6% of patients achieved excellent outcomes by 6 months compares favorably with published literature. Matta reported 45% excellent results in 259 patients using the same scoring system, while Letournel documented 55% excellent outcomes in his series.[53,60] A more recent study by Briffa et al. reported 47% excellent outcomes at 2 years following acetabular fracture surgery.[54]

Several factors may have contributed to the relatively high proportion of excellent outcomes in our series. First, the predominance of younger patients (61.3% aged 20-40 years) with better healing potential and fewer comorbidities likely influenced overall outcomes positively. Second, the adherence to surgical timing principles, with most procedures performed within the optimal window of 5-10 days, may have facilitated a reduction in quality. Mears et al. demonstrated that surgeries performed within 14 days of injury yielded significantly better outcomes than delayed procedures.[65] Finally, the implementation of standardized rehabilitation protocols with early mobilization likely enhanced functional recovery.

It is noteworthy that by 6 months, all patients had progressed beyond the poor category, suggesting that surgical intervention, regardless of fracture complexity, offers significant functional improvement over the natural history of acetabular fractures. Tile's natural history study of untreated displaced acetabular fractures reported that 80% of patients had persistent poor function and pain, highlighting the transformative impact of appropriate surgical management.[66]

Complications

The complication profile in our series was relatively favorable, with 80.6% of patients experiencing no complications. Hip stiffness was the most common complication (9.7%), followed by combined surgical wound infection and hip stiffness (6.5%), and isolated surgical wound infection (3.2%).

This complication rate compares favorably with published literature. Giannoudis et al. reported overall complication rates of 40-50% following acetabular fracture surgery, including infection rates of 4-10%, heterotopic ossification in 15-30%, and nerve injuries in 8-20%.[52] Matta documented an infection rate of 4.2% and heterotopic ossification in 25.6% of patients.[53]

Several factors may have contributed to our relatively low complication rates. Prophylactic measures, including perioperative antibiotics, careful soft tissue handling, and judicious use of retractors, likely minimized infection risk. The absence of reported nerve injuries in our series may reflect both careful surgical technique and the possibility of minor neuropraxia going undetected or unreported.

Notably absent in our reported complications were heterotopic ossification, avascular necrosis, and post-traumatic arthritis, which are frequently documented in other series. This may be attributed to the relatively short follow-up period of 6 months, as these complications often manifest later in the recovery trajectory. Letournel reported that post-traumatic arthritis may develop up to 3 years following surgery, while heterotopic ossification typically becomes clinically significant between 3-6 months postoperatively.[60]

An intriguing finding was the significant association between complications and functional outcomes (p=0.03). patients who experienced complications, particularly surgical site infection, were more likely to achieve excellent outcomes. This counterintuitive finding warrants careful interpretation. It may reflect increased vigilance and more intensive rehabilitation efforts and aggressive antibiotic treatment regimen in patients who developed complications, ultimately leading to better functional recovery. Alternatively, it might represent a statistical anomaly due to the small sample size. Longer follow-up would be valuable to determine whether this association persists or reverses over time.

Associated Injuries

In our cohort, 90.3% of patients had isolated acetabular fractures without significant associated injuries. Bladder injuries were present in 6.5% of cases, and hemoperitoneum in 3.2%. This distribution differs somewhat from published literature, which reports higher rates of associated injuries. Giannoudis et al. documented associated injuries in 40% of acetabular fractures, including extremity fractures (30.5%), head injuries (12.2%), and abdominal trauma (8.9%).[52]

The lower rate of associated injuries in our series may reflect selection bias, as patients with severe polytrauma might have been managed at other facilities or might not have survived to reach our center. Additionally, our focus on orthopedic outcomes may have led to incomplete documentation of minor associated injuries that did not impact the management of the acetabular fracture.

The presence of associated urological injuries, particularly bladder trauma, in 6.5% of our patients highlights the importance of comprehensive evaluation in acetabular fractures. The proximity of the bladder and urethra to the anterior acetabular columns and pubic rami necessitates high clinical suspicion for urological injuries, especially in fractures involving the anterior column and pubic rami. Hak et al. reported urological injuries in 8% of pelvic and acetabular fractures, emphasizing the need for multidisciplinary management.[67]

Limitations and Future Directions

Several limitations of our study warrant acknowledgment. First, the sample size of 31 patients, while providing valuable insights, limited the statistical power to detect significant associations between various factors and outcomes. Subgroup analyses, particularly regarding fracture patterns and surgical approaches, would benefit from larger patient cohorts.

Second, the follow-up period of 6 months, while sufficient to document early functional recovery, may not capture late complications such as post-traumatic arthritis, avascular necrosis, and heterotopic ossification. Long-term follow-up studies suggest that functional outcomes may deteriorate over time in a subset of patients, particularly those with imperfect reductions or associated complications.

Third, our reliance on the modified Merle d'Aubigne score, while providing standardized functional assessment, does not capture patient-reported outcomes regarding quality of life, return to work, and subjective satisfaction. The integration of validated patient-reported outcome measures would provide a more comprehensive assessment of surgical success from the patient's perspective.

Finally, our study did not systematically analyze radiographic parameters such as reduction quality, which has been consistently identified as a critical determinant of functional outcomes. Matta demonstrated that anatomical reduction (displacement <1mm) was associated with 79% good to excellent results, compared to 56% with imperfect reduction.[53]

Incorporation of standardized radiographic assessment would enhance the prognostic value of future studies.

Future research directions should include multicenter collaborative studies to increase sample size and generalizability, incorporation of advanced imaging modalities such as dynamic CT and MRI to better characterize articular congruity and soft tissue injuries, development of surgeon decision-support tools to optimize approach selection, and investigation of biological augmentation strategies to enhance healing in complex fractures and elderly patients.

Conclusion

Our prospective study of surgically managed acetabular fractures demonstrates that with appropriate surgical approach selection, meticulous technique, and standardized rehabilitation, excellent functional outcomes can be achieved in a significant proportion of patients by 6 months. The progressive improvement in functional scores over time highlights the prolonged recovery trajectory following these complex injuries and emphasizes the importance of extended rehabilitation support.

The predominance of young adult males and RTA as the mechanism of injury underscores the significant socioeconomic impact of these fractures and the need for enhanced prevention strategies. Our data did demonstrate statistically significant associations between most demographic and fracture characteristics and functional outcomes, trends observed align with published literature regarding the influence of age and fracture complexity.

The relatively low complication rate in our series is encouraging and may reflect improvements in surgical techniques, perioperative care, and rehabilitation protocols. However, the short follow-up period necessitates cautious interpretation, particularly regarding late complications.

This study contributes to the growing body of evidence guiding the management of acetabular fractures in diverse settings. The insights gained should inform surgical decision-making, patient counseling regarding recovery expectations, and resource allocation for the comprehensive care of these challenging injuries.

CONCLUSION

Acetabular fractures represent complex injuries that predominantly affect young, productive individuals and require meticulous surgical management to restore function. Our prospective study of 31 patients with surgically managed acetabular fractures has yielded several important conclusions that contribute to the existing body of knowledge in this field.

Surgical management of acetabular fractures, when performed with appropriate approach selection, meticulous reduction, and stable fixation, results in favorable functional outcomes. By 6 months post-surgery, all patients in our cohort had progressed beyond poor functional scores, with 51.6% achieving excellent results and 48.4% attaining moderate outcomes as measured by the modified Merle d'Aubigne score. This progressive improvement over time highlights the importance of patient counseling regarding recovery expectations and the necessity for extended rehabilitation support.

The predominance of young adult males in our study and the high proportion of road traffic accidents as the mechanism of injury underscore the significant socioeconomic impact of these fractures and emphasize the need for enhanced prevention strategies. The diversity of fracture patterns encountered, with posterior column fractures and anterior column fractures with associated pubic rami fractures being most common, reflects the heterogeneous nature of these injuries and reinforces the importance of individualized surgical planning.

Our findings suggest that while age tends to influence functional outcomes, with younger patients demonstrating better recovery potential, the type of fracture pattern does not significantly determine the functional result when appropriate surgical techniques are employed. This supports the principle that anatomical reduction and stable fixation, rather than the inherent complexity of the fracture, are the primary determinants of outcome.

The selection of surgical approach should be guided by “the fracture pattern, with the Kocher-Langenbeck approach being particularly effective for posterior column and wall fractures, and the modified Stoppa approach offering excellent access to anterior column and quadrilateral plate fractures”. Combined approaches may be necessary for complex fracture patterns to achieve optimal reduction.

The relatively low complication rate in our series (19.4%) is encouraging and highlights the importance of meticulous surgical technique, appropriate perioperative care, and systematic rehabilitation protocols. The absence of catastrophic complications such as deep infection, significant neurovascular injury, or implant failure speaks to the efficacy of contemporary management principles.

In conclusion, surgical management of acetabular fractures delivers predictable and favorable functional outcomes when executed with careful preoperative planning, appropriate approach selection, precise reduction techniques, and structured rehabilitation. Continued refinement of surgical approaches, fixation methods, and rehabilitation protocols will further enhance outcomes for these challenging injuries. Long-term studies will be valuable to assess the durability of functional results and the incidence of post-traumatic arthritis, which remains a concern even with optimal initial management.

SUMMARY

INTRODUCTION:

Acetabular fractures represent complex injuries that present significant management challenges. This prospective study evaluates the functional outcomes of surgical management of acetabular fractures at a tertiary care center and identifies factors influencing these outcomes.

OBJECTIVES:

1. To analyze the functional outcome of surgical management of acetabular fractures
2. To study the different complications arising from surgical management of acetabular fractures

MATERIAL AND METHODS:

Thirty-one patients with acetabular fractures who underwent surgical management between 2020 and 2022 were enrolled in this prospective study. Fractures were classified according to the Judet-Letournel system, and functional outcomes were assessed using the modified Merle d'Aubigne score at presentation, 6 weeks, 3 months, and 6 months post-surgery. Demographic data, fracture characteristics, surgical approaches, complications, and associated injuries were documented. Statistical analysis was performed to identify factors associated with functional outcomes.

RESULTS:

The following outcome was observed in our study:

1. The demographic analysis revealed a predominance of young adults, with 61.3% of patients aged 20-40 years, 25.8% aged 41-60 years, and 12.9% aged 61-80 years. Male patients constituted 71% of the cohort, reflecting the higher risk of high-energy trauma in this demographic. Road traffic accidents were the primary mechanism of injury (71%), followed by falls from height (29%).
2. Fracture pattern analysis according to the Judet-Letournel classification demonstrated diverse presentations, with posterior column fractures and anterior column fractures with associated pubic rami fractures being the most common (25.8% each), followed by posterior wall fractures (19.4%) and combined anterior and posterior column fractures (12.9%). Associated posterior hip dislocations were present in 25.8% of cases.
3. Surgical approach selection was guided by fracture pattern, with the Kocher-Langenbeck approach most frequently employed (45.2%), followed by the modified Stoppa approach (32.3%). Combined approaches were utilized in 9.7% of cases, while the ilioinguinal approach was used in 6.5% of patients.
4. Functional assessment using the modified Merle d'Aubigne score demonstrated progressive improvement over time. At presentation, all patients had poor scores (3-9). By 6 weeks, 90.3% remained in the poor category, with 9.7% improving to moderate scores. At 3 months, 58.1% remained in the poor category, 38.7% improved to moderate, and 3.2%

achieved excellent outcomes. By 6 months, no patients remained in the poor category, with 48.4% achieving moderate and 51.6% achieving excellent outcomes.

5. The complication profile was relatively favorable, with 80.6% of patients experiencing no complications. Hip stiffness was the most common complication (9.7%), followed by combined surgical wound infection and hip stiffness (6.5%), and isolated surgical wound infection (3.2%). Associated injuries were uncommon, with 90.3% of patients having isolated acetabular fractures. Bladder injuries were present in 6.5% of cases, and hemoperitoneum in 3.2%.
6. Statistical analysis of factors influencing functional outcomes revealed interesting patterns. While age demonstrated a trend toward better outcomes in younger patients, this did reach statistical significance (p=0.02). Similarly, associated dislocation (p=0.01), surgical approach (p=0.02), and post-surgery follow-up (p=0.001) did significantly influence 6-month functional outcomes. Notably, the presence of complications showed a significant association with functional outcomes (p=0.03), with patients who experienced complications, particularly surgical site infections likely to achieve excellent outcomes, possibly reflecting more intensive rehabilitation efforts and aggressive antibiotic treatment regimen post infection.

7. These findings support the efficacy of surgical management for acetabular fractures when performed with appropriate approach selection, meticulous reduction, and stable fixation. The progressive improvement in functional scores over time highlights the prolonged recovery trajectory following these complex injuries and emphasizes the importance of extended rehabilitation support.

CONCLUSION:

Surgical management of acetabular fractures yields favorable functional outcomes, with progressive improvement over time. Most demographic and fracture characteristics significantly influenced outcomes, and the results support the efficacy of tailored surgical approach selection and meticulous technique. The findings highlight the importance of extended rehabilitation and careful management of complications to optimize functional recovery.

REFERENCES

1. Giannoudis PV, Grotz MR, Papakostidis C, Dinopoulos H. Operative treatment of displaced fractures of the acetabulum: a meta-analysis. J Bone Joint Surg Br. 2020;87(1):2-9.
2. Ferguson TA, Patel R, Bhandari M, Matta JM. Fractures of the acetabulum in patients aged 60 years and older: an epidemiological and radiological study. J Bone Joint Surg Br. 2019;92(2):250-257.
3. Letournel E, Judet R. Fractures of the Acetabulum. 2nd ed. Berlin: Springer-Verlag; 2019.
4. Mears DC, Velyvis JH, Chang CP. Displaced acetabular fractures managed operatively: indicators of outcome. Clin Orthop Relat Res. 2021;(407):173-186.
5. Tannast M, Najibi S, Matta JM. Two to twenty-year survivorship of the hip in 810 patients with operatively treated acetabular fractures. J Bone Joint Surg Am. 2018;94(17):1559-1567.
6. Briffa N, Pearce R, Hill AM, Bircher M. Outcomes of acetabular fracture fixation with ten years' follow-up. J Bone Joint Surg Br. 2019;93(2):229-236.
7. Beaule PE, Dorey FJ, Matta JM. Letournel classification for acetabular fractures: assessment of interobserver and intraobserver reliability. J Bone Joint Surg Am. 2020;85-A(9):1704-1709.
8. Marsh JL, Slongo TF, Agel J, et al. Fracture and dislocation classification compendium - 2018: Orthopaedic Trauma Association classification, database and outcomes committee. J Orthop Trauma. 2018;21(10 Suppl):S1-133.
9. White G, Kanakaris NK, Faour O, Valverde JA, Martin MA, Giannoudis PV. Quadrilateral plate fractures of the acetabulum: an update. Injury. 2019;44(2):159-167.
10. Murphy D, Kaliszer M, Rice J, McElwain JP. Outcome after acetabular fracture: prognostic factors and their inter-relationships. Injury. 2021;34(7):512-517.
11. Laird A, Keating JF. Acetabular fractures: A 16 year prospective epidemiological study. Journal of Bone and Joint Surgery. British Volume. 2005;87:969-973.

12. Kleinberg S. Fracture of acetabulum with central luxation of the hip. Annals of Surgery. 1923;78(6):806-813.
13. Manson T, Schmidt A. Acetabular fractures in elderly. Journal of Bone and Joint Surgery. 2016;4(10):e1.
14. Bowman KF, Fox J, Sekiya JK. A clinically relevant review of hip biomechanics. The Journal of Arthroscopic and Related Surgery. 2010;26(8):1118-1129.
15. Kumar Sharma S, Mathur H. Surgical Anatomy of Acetabulum and Biomechanics [Internet]. Essentials in Hip and Ankle. IntechOpen; 2020.
16. Lei J, Dong P, Li Z. Biomechanical analysis of the fixation systems for anterior column and posterior hemitransverse acetabular fractures. Acta Orthopaedica et Traumatologica Turcica. 2017;51:248-253.
17. Cimerman M, Kristan A, Jug M, Tomaževič M. Fractures of the acetabulum: from yesterday to tomorrow. Int Orthop. 2021 Apr;45(4):1057-1064.
18. Ferguson TA, Patel R, Bhandari M, Matta JM. Fractures of the acetabulum in patients aged 60 years and older: an epidemiological and radiological study. J Bone Joint Surg Br. 2010 Feb;92(2):250-7.
19. Matta JM. Fractures of the acetabulum: accuracy of reduction and clinical results in patients managed operatively within three weeks after the injury. J Bone Joint Surg Am. 1996 Nov;78(11):1632-45.
20. Magnussen RA, Tressler MA, Obremskey WT, Kregor PJ. Predicting blood loss in isolated pelvic and acetabular high-energy trauma. J Orthop Trauma. 2007 Oct;21(9):603-7.
21. Fassler PR, Swiontkowski MF, Kilroy AW, Routt ML. Injury of the sciatic nerve associated with acetabular fracture. J Bone Joint Surg Am. 1993 Aug;75(8):1157-66.
22. JUDET R, JUDET J, LETOURNEL E. FRACTURES OF THE ACETABULUM: CLASSIFICATION AND SURGICAL APPROACHES FOR OPEN REDUCTION. PRELIMINARY REPORT. J Bone Joint Surg Am. 1964 Dec;46:1615-46.
23. Hak DJ, Olson SA, Matta JM. Diagnosis and management of closed internal degloving injuries associated with pelvic and acetabular fractures: the Morel-Lavallée lesion. J Trauma. 1997 Jun;42(6):1046-51.

24. Griffiths HJ, Standertskjold-Nordenstam CG, Burke J, Lamont B, Kimmel J. Computed tomography in the management of acetabular fractures. *Skeletal Radiol* 1984; 11:22–31.

25. O'Toole RV, Cox G, Shanmuganathan K, et al. Evaluation of computed tomography for determining the diagnosis of acetabular fractures. *J Orthop Trauma* 2010; 24:284–290.

26. Harris JH Jr, Lee JS, Coupe KJ, Trotscher T. Acetabular fractures revisited. Part 1. Redefinition of the Letournel anterior column. *AJR* 2004; 182:1363–1366.

27. Olson SA. CT-based acetabular fracture classification. (letter) *AJR* 2005; 185:277–278; author reply, 278–280.

28. Potok PS, Hopper KD, Umlauf MJ. Fractures of the acetabulum: imaging, classification, and understanding. *RadioGraphics* 1995; 15:7–23; discussion, 23–24.

29. Durkee NJ, Jacobson J, Jamadar D, Karunakar MA, Morag Y, Hayes C. Classification of common acetabular fractures: radiographic and CT appearances. *AJR* 2006; 187:915–925

30. Letournel E. Acetabulum fractures: classification and management. Clin Orthop Relat Res. 1980 Sep;(151):81-106.

31. Olson SA, Matta JM. The computerized tomography subchondral arc: a new method of assessing acetabular articular continuity after fracture (a preliminary report). J Orthop Trauma. 1993;7(5):402-13.

32. Connelly CL, Archdeacon MT. Transgluteal posterior column screw stabilization for fractures of the acetabulum: a technical trick. J Orthop Trauma. 2012 Oct;26(10):e193-7.

33. Starr AJ, Reinert CM, Jones AL. Percutaneous fixation of the columns of the acetabulum: a new technique. J Orthop Trauma. 1998 Jan;12(1):51-8.

34. Madhu R, Kotnis R, Al-Mousawi A, Barlow N, Deo S, Worlock P, Willett K. Outcome of surgery for reconstruction of fractures of the acetabulum. The time dependent effect of delay. J Bone Joint Surg Br. 2006 Sep;88(9):1197-203.

35. Cutrera NJ, Pinkas D, Toro JB. Surgical approaches to the acetabulum and modifications in technique. J Am Acad Orthop Surg. 2015;23:592–603.

36. Moed BR. The modified Gibson posterior surgical approach to the acetabulum. J Orthop Trauma. 2010;24:315–322.

37. Gautier E, Ganz K, Krügel N, et al. Anatomy of the medial femoral circumflex artery and its surgical implications. J Bone Joint Surg Br. 2000;82:679–683.

38. Hirvensalo E, Lindahl J, Böstman O (1993) A new approach to the internal fixation of unstable pelvic fractures. Clin Orthop Relat Res 28–32

39. *Cole JD, Bolhofner BR (1994) Acetabular fracture fixation via a modified Stoppa limited intrapelvic approach. Description of operative technique and preliminary treatment results. Clin Orthop Relat Res 112–123 .*

40. Bosse MJ, Poka A, Reinert CM, Ellwanger F, Slawson R, McDevitt ER. Heterotopic ossification as a complication of acetabular fracture. Prophylaxis with low-dose irradiation. J Bone Joint Surg Am. 1988 Sep;70(8):1231-7.

41. Vanamail SN, Vanamail P. Clinical, radiological and functional outcome following surgical fixation of acetabular fractures. Indian J Orthop Surg 2024;10(2):124-129.

42. Sahu, Santosh K.[1]; Reddy, Srujan[1]; Nayak, Satya Prasanna[1]; Kar, Dattatreya[2]. Surgical Management and Functional Outcome of Acetabular Fractures – A Prospective Study. Nigerian Journal of Basic and Clinical Sciences 21(1):p 7-10, Jan–Apr 2024.

43. Aziz AM, Patel A, Rathod P. Short-term functional results of fixation of bicolumnar acetabular fractures using single Kocher-Langenbeck approach. International Journal Dental and Medical Sciences Research.2021;3(2):247-252.

44. Fakru NH, Faisham WI, Hadizie D, Yahaya S. Functional Outcome of Surgical Stabilisation of Acetabular Fractures. Malays Orthop J. 2021 Jul;15(2):129-135.

45. Boudissa M, Francony F, Drevet S, Kerschbaumer G, Ruatti S, Milaire M, Merloz P, Tonetti J. Operative versus non-operative treatment of displaced acetabular fractures in elderly patients. Aging Clinical and Experimental Research. 2020 Apr;32:571-7.

46. Petrov AB, Ruzanov VI, Mashukov TS. Long-term outcomes of surgical treatment of patients with acetabular fractures. Genij Ortopedii. 2020;26(3):300-5.

47. Nayak T, Mittal S, Trikha V, Farooque K, Gamanagatti S, Sharma V. Short-term results of surgical treatment of acetabular fractures using the modified

Stoppa approach. Journal of Clinical Orthopaedics and Trauma. 2020 Nov 1;11(6):1121-7.

48. Thunuguntla, R., Mettu, R., Reddy, K. B., & Reddy, A. G. (2020). A retrospective and prospective study of functional outcome of surgical management of acetabular fractures. *International Journal of Orthopaedics Sciences*, *6*(3), 54–59.

49. Mesbahi, S. A., Ghaemmaghami, A., Ghaemmaghami, S., Farhadi, P. Outcome after Surgical Management of Acetabular Fractures: A 7-Year Experience. Bulletin of Emergency And Trauma, 2018; 6(Issue 1): 37-44.

50. Eliezer EN, Haonga B, Mrita FS, Liu MB, Wu H. Functional outcome and Quality of Life after Surgical Management of Displaced Acetabular Fractures in Tanzania. East African Orthopaed J. 2016;10:16-20.

51. Matta JM, Anderson LM, Epstein HC, Hendricks P. Fractures of the acetabulum. A retrospective analysis. Clin Orthop Relat Res. 1986;205:230-40.

52. Giannoudis PV, Grotz MR, Papakostidis C, Dinopoulos H. Operative treatment of displaced fractures of the acetabulum. A meta-analysis. J Bone Joint Surg Br. 2005;87(1):2-9.

53. Matta JM. Fractures of the acetabulum: accuracy of reduction and clinical results in patients managed operatively within three weeks after the injury. J Bone Joint Surg Am. 1996;78(11):1632-45.

54. Briffa N, Pearce R, Hill AM, Bircher M. Outcomes of acetabular fracture fixation with ten years' follow-up. J Bone Joint Surg Br. 2011;93(2):229-36.

55. Murphy D, Kaliszer M, Rice J, McElwain JP. Outcome after acetabular fracture. Prognostic factors and their inter-relationships. Injury. 2003;34(7):512-7.

56. Culemann U, Holstein JH, Kohler D, Tzioupis CC, Pizanis A, Tosounidis G, et al. Different stabilisation techniques for typical acetabular fractures in the elderly--a biomechanical assessment. Injury. 2010;41(4):405-10.

57. Pagenkopf E, Grose A, Partal G, Helfet DL. Acetabular fractures in the elderly: treatment recommendations. HSS J. 2006;2(2):161-71.

58. Laird A, Keating JF. Acetabular fractures: a 16-year prospective epidemiological study. J Bone Joint Surg Br. 2005;87(7):969-73.

59. Tile M, Kellam JF. Fractures of the pelvis and acetabulum: principles and methods of management. 4th ed. Stuttgart: Thieme; 2015.

60. Letournel E, Judet R. Fractures of the acetabulum. 2nd ed. Berlin: Springer-Verlag; 1993.
61. Sahin V, Karakas ES, Aksu S, Atlihan D, Turk CY, Halici M. Traumatic dislocation and fracture-dislocation of the hip: a long-term follow-up study. J Trauma. 2003;54(3):520-9.
62. Cole JD, Bolhofner BR. Acetabular fracture fixation via a modified Stoppa limited intrapelvic approach. Description of operative technique and preliminary treatment results. Clin Orthop Relat Res. 1994;305:112-23.
63. Liu Y, Yang H, Li X, Yang SH, Lin JH. Newly modified Stoppa approach for acetabular fractures. Int Orthop. 2013;37(7):1347-53.
64. Isaacson MJ, Taylor BC, French BG, Poka A. Treatment of acetabulum fractures through the modified Stoppa approach: strategies and outcomes. Clin Orthop Relat Res. 2014;472(11):3345-52.
65. Mears DC, Velyvis JH, Chang CP. Displaced acetabular fractures managed operatively: indicators of outcome. Clin Orthop Relat Res. 2003;407:173-86.
66. Tile M. Fractures of the acetabulum. Orthop Clin North Am. 1980;11(3):481-506.
67. Hak DJ, Olson SA, Matta JM. Diagnosis and management of closed internal degloving injuries associated with pelvic and acetabular fractures: the Morel-Lavallee lesion. J Trauma. 1997;42(6):1046-51.
68. Mayo KA. Open reduction and internal fixation of fractures of the acetabulum. Results in 163 fractures. Clin Orthop Relat Res. 1994;305:31-7.
69. Ferguson TA, Patel R, Bhandari M, Matta JM. Fractures of the acetabulum in patients aged 60 years and older: an epidemiological and radiological study. J Bone Joint Surg Br. 2010;92(2):250-7.
70. Tannast M, Najibi S, Matta JM. Two to twenty-year survivorship of the hip in 810 patients with operatively treated acetabular fractures. J Bone Joint Surg Am. 2012;94(17):1559-67.

ANNEXURE – I

SHRI B.M. PATIL MEDICAL COLLEGE, HOSPITAL AND RESEARCH CENTRE, VIJAYAPURA - 586103

PROFORMA

CASE NO. :

NAME :

AGE/SEX :

IP NO :

DATE OF ADMISSION :

DATE OF SURGERY:

DATE OF DISCHARGE :

OCCUPATION :

RESIDENCE :

Presenting complaints with duration:

History of presenting complaints :

Family History :

Personal History :

Past History :

General Physical Examination

Pallor:	present/absent
Icterus:	present/absent
Clubbing:	present/absent

Generalized lymphadenopathy: present/ absent
Built: poor/moderate/well
Nourishment: poor/moderate/well

Vitals

PR: RR:

BP: TEMP:

Other Systemic Examination:

Local examination:

Gait

Right/ Left Leg

<u>Inspection</u>:

a) Attitude/ deformity
b) Abnormal swelling
   - Site
   - Size
   - Shape
   - Extent
c) Skin

<u>Palpation:</u>

a) Local tenderness
b) Bony irregularity
c) Abnormal movement
d) Crepitus
e) Swelling

Movements:	Left		Right	
	Active	Passive	Active	Passive
Flexion				
Extension				
Abduction				
Adduction				
Medial rotation				
Lateral rotation				

Modified Merle D'Aubigne score

Presentation –

6 Weeks –

3 Months –

6 Months –

ANNEXURE II

B.L.D.E. (DEEMED TO BE UNIVERSITY) SHRI B.M.PATIL MEDICAL COLLEGE HOSPITAL AND RESEARCH CENTER, VIJAYAPURA-586103

INFORMED CONSENT FOR PARTICIPATION IN DISSERTATION/ RESEARCH

I, the undersigned,___________, S/O D/O W/O_________________, aged years, ordinarily resident of____do hereby state/declare that **DR. SUDEV RAGHUNATHAN** of Shri. B. M. Patil Medical College Hospital and Research Centre has examined me thoroughly on_____at_____________(place) and it has been explained to me in my own language that I am suffering from____ _______________________disease (condition) and this disease/condition mimic the following diseases. Further **DR. SUDEV RAGHUNATHAN** informed me that he/she is conducting a dissertation/research titled "**A PROSPECTIVE STUDY ON FUNCTIONAL OUTCOME OF SURGICAL MANAGEMENT OF ACETABULAR FRACTURES** ." under the guidance of **DR. RAVI KUMAR BIRADAR**. requesting my participation in the study. Apart from routine treatment procedures, the pre-operative, operative, post-operative, and follow-up observations will be utilized for the study as reference data.

The Doctor has also informed me that during the conduct of this procedure adverse results may be encountered. Among the above complications, most of them are treatable but are not anticipated; hence there is a chance of aggravation of my condition. In rare circumstances, it may prove fatal despite the anticipated diagnosis and best treatment made available. Further, the Doctor has informed me that my participation in this study will help in the evaluation of the results of the study, which is a useful reference to the treatment of other similar cases soon, and also I may benefit from getting relieved of suffering or cure for the disease I am suffering.

The Doctor has also informed me that information given by me, observations made/ photographs/ video graphs taken upon me by the investigator will be kept secret and not assessed by a person other than my legal hirer or me except for academic purposes.

The Doctor did inform me that though my participation is purely voluntary, based on the information given by me, I can ask for any clarification during the course of treatment/study related to diagnosis, the procedure of treatment, the result of treatment, or prognosis. I have been instructed that I can withdraw from my participation in this study at any time if I want, or the investigator can terminate me from the study at any time from the study but not the procedure of treatment and follow-up unless I request to be discharged.
After understanding the nature of the dissertation or research, the diagnosis made, and the mode of treatment, I, the undersigned Shri/Smt , under my fully conscious state of mind, agree to participate in the said research/dissertation.

Signature of the patient:

Signature of Doctor:

Witness: 1.

2.

Date:

ANNEXURE III

Azadi Ka Amrit Mahotsav

BLDE

(DEEMED TO BE UNIVERSITY)

Declared as Deemed to be University u/s 3 of UGC Act, 1956

Accredited with 'A' Grade by NAAC (Cycle-2)

The Constituent College

SHRI B. M. PATIL MEDICAL COLLEGE, HOSPITAL & RESEARCH CENTRE, VIJAYAPURA

10/4/2023

BLDE (DU)/IEC/ 981/2022-23

INSTITUTIONAL ETHICAL CLEARANCE CERTIFICATE

The Ethical Committee of this University met on **Saturday, 18th March, 2023 at 11.30 a.m. in the CAL Laboratory, Dept. of Pharmacology**, scrutinizes the Synopsis/ Research Projects of Post Graduate Student / Under Graduate Student /Faculty members of this University /Ph.D. Student College from ethical clearance point of view. After scrutiny, the following original/ corrected and revised version synopsis of the thesis/ research projects has been accorded ethical clearance.

TITLE: "A PROSPECTIVE STUDY ON FUNCTIONAL OUTCOME OF SURGICAL MANAGEMENT OF ACETABULAR FRACTURES".

NAME OF THE STUDENT/PRINCIPAL INVESTIGATOR: DR.SUDEV RAGHUNATHAN.

NAME OF THE GUIDE: DR. RAVIKUMAR BIRADAR. PROFESSOR,
DEPT. OF ORTHOPAEDICS

Dr. Santoshkumar Jeevangi
Chairperson
IEC, BLDE (DU),
VIJAYAPURA

Chairman,
Institutional Ethical Committee,
BLDE (Deemed to be University)
Vijayapura

Dr.Akram A. Naikwadi
Member Secretary
IEC, BLDE (DU),
VIJAYAPURA

MEMBER SECRETARY
Institutional Ethics Committee
BLDE (Deemed to be University)
Vijayapura-586103. Karnataka

Following documents were placed before Ethical Committee for Scrutinization.

- Copy of Synopsis/Research Projects
- Copy of inform consent form
- Any other relevant document

Smt. Bangaramma Sajjan Campus, B. M. Patil Road (Sholapur Road), Vijayapura - 586103, Karnataka, India.

BLDE (DU): Phone: +918352-262770, Fax: +918352-263303, Website: www.bldedu.ac.in, E-mail:office@bldedu.ac.in

College: Phone: +918352-262770, Fax: +918352-263019, E-mail: bmpmc.principal@bldedu.ac.in

MASTERCHART

SL N(	NAME	AGE(YEA	SE)	PATIENT	MODE OF INJURY	FRACTURE	SIDE OF INJU	ASSOCIATED DISLOC	APPROACH	MODIFIED MERLE DEAUBIGNE SCORE PRESENTAT	6 WEE	3 MONTH	6 MONTHS	COMPLICATION	ASSOCIATED INJURIES
1	DONDIBAI	60	F	144738	FALL FROM HEIGHT	ANTERIOR COLUMN + SUPERIOR AND INFERIOR	RIGHT	NIL	MODIFIED STOPPA	5	6	8	14	NIL	BLADDER INJURY
2	SANDEEP	34	M	436474	RTA	POSTERIOR COLUMN + POSTERIOR WALL	LEFT	POSTERIOR	KOCHER LANGENBECK	5	7	8	11	NIL	NIL
3	MAHANTESH	45	M	458650	RTA	POSTERIOR COLUMN	LEFT	NIL	KOCHER LANGENBECK	7	10	11	11	NIL	NIL
4	BORAMMA	40	F	244993	RTA	ANTERIOR COLUMN + SUPERIOR AND INFERIOR	RIGHT	NIL	MODIFIED STOPPA	4	5	8	11	SURGICAL WOUND INFECTION + HIP STIFFNESS	NIL
5	NILLAKKA	39	F	244995	RTA	ANTERIOR COLUMN + SUPERIOR AND INFERIOF	BOTH	NIL	MODIFIED STOPPA	4	5	8	12	NIL	NIL
6	RENUKA	45	F	60281	RTA	ANTERIOR COLUMN + SUPERIOR AND INFERIOR	RIGHT	NIL	MODIFIED STOPPA	4	6	9	11	NIL	NIL
7	SANJEEV	37	M	62285	FALL FROM HEIGHT	ANTERIOR WALL + SUPERIOR AND INFERIOR PL	BOTH	NIL	MODIFIED STOPPA	4	6	9	13	SURGICAL WOUND INFECTION	BLADDER INJURY
8	MANJUNATH	28	M	305922	RTA	ANTERIOR WALL + SUPERIOR AND INFERIOR PL	BOTH	NIL	MODIFIED STOPPA	5	8	11	12	NIL	NIL
9	PREM	40	M	225897	RTA	ANTERIOR COLUMN	LEFT	NIL	MODIFIED STOPPA	5	8	11	12	NIL	NIL
10	MAHADEV	55	M	395787	FALL FROM HEIGHT	ANTERIOR COLUMN + POSTERIOR COLUMN	RIGHT	NIL	KOCHER LANGENBECK + MODIFIED STOPP	4	5	8	13	SURGICAL WOUND INFECTION + HIP STIFFNESS	NIL
11	SURESH	38	M	94793	RTA	ANTERIOR COLUMN + POSTERIOR COLUMN	RIGHT	NIL	KOCHER LANGENBECK + MODIFIED STOPP	4	6	12	14	NIL	NIL
12	SHIVAPPA	67	M	68498	RTA	POSTERIOR WALL	RIGHT	POSTERIOR	ILIOINGUINAL	6	8	10	12	NIL	NIL
13	MARUTI	55	M	256790	RTA	POSTERIOR COLUMN	LEFT	NIL	KOCHER LANGENBECK	5	6	9	12	NIL	NIL
14	SANTOSH	54	M	267851	RTA	POSTERIOR COLUMN	RIGHT	NIL	KOCHER LANGENBECK	7	10	11	13	NIL	NIL
15	SATISH	56	M	272363	RTA	POSTERIOR WALL + POSTERIOR COLUMN	RIGHT	POSTERIOR	KOCHER LANGENBECK	4	6	9	10	NIL	NIL
16	IMTIAZ	37	M	193566	FALL FROM HEIGHT	ANTERIOR COLUMN + SUPERIOR AND INFERIOR	LEFT	NIL	MODIFIED STOPPA	4	6	8	12	NIL	HEMOPERITONEUM
17	IRFAN	40	M	87572	RTA	POSTERIOR COLUMN	LEFT	NIL	KOCHER LANGENBECK	5	6	9	13	NIL	NIL
18	KASTURI	62	F	451820	FALL FROM HEIGHT	ANTERIOR COLUMN	LEFT	NIL	KOCHER LANGENBECK	5	7	8	15	NIL	NIL
19	SUBADRABAI	62	F	77332	RTA	ANTERIOR WALL + SUPERIOR AND INFERIOR PL	LEFT	NIL	MODIFIED STOPPA	4	6	8	11	HIP STIFFNESS	NIL
20	TULAJARAM	64	M	53982	RTA	POSTERIOR WALL	LEFT	POSTERIOR	KOCHER LANGENBECK	4	6	8	11	HIP STIFFNESS	NIL
21	RENUKA	45	F	56890	FALL FROM HEIGHT	POSTERIOR COLUMN	LEFT	NIL	KOCHER LANGENBECK	6	9	10	10	NIL	NIL
22	ADITYA	27	M	179624	RTA	POSTERIOR COLUMN	RIGHT	NIL	KOCHER LANGENBECK	4	4	11	15	NIL	NIL
23	DATTATRAY	38	M	11100	RTA	POSTERIOR WALL	RIGHT	POSTERIOR	KOCHER LANGENBECK	4	5	8	10	NIL	NIL
24	SHIVANAND	38	M	183510	FALL FROM HEIGHT	POSTERIOR COLUMN + SUPERIOR AND INFERIO	LEFT	NIL	MODIFIED STOPPA WITH LATERAL WINDO'	4	5	8	10	HIP STIFFNESS	NIL
25	ARHAN	30	M	43420	FALL FROM HEIGHT	ANTERIOR COLUMN + POSTERIOR COLUMN	RIGHT	NIL	MODIFIED STOPPA APPROACH	5	8	10	12	NIL	NIL
26	SUJNANI	38	F	189616	RTA	POSTERIOR WALL	RIGHT	POSTERIOR	KOCHER LANGENBECK	8	9	12	13	NIL	NIL
27	MALLIKARJUN	19	M	30905	RTA	ANTERIOR COLUMN + POSTERIOR COLUMN	LEFT	NIL	KOCHER LANGENBECK + MODIFIED STOPP	4	5	10	16	NIL	NIL
28	SHIVALINGAPPA	40	M	385	RTA	POSTERIOR WALL	RIGHT	POSTERIOR	ILIOINGUINAL	6	7	9	11	NIL	NIL
29	SHANTAMMA	28	F	2530	FALL FROM HEIGHT	POSTERIOR COLUMN	LEFT	NIL	PERCUTANEOUS PINNING	8	10	11	15	NIL	NIL
30	TARANUNUM	30	M	43958	RTA	POSTERIOR WALL	RIGHT	POSTERIOR	KOCHER LANGENBECK	6	7	9	11	NIL	NIL
31	JYOTEPPA	36	M	62266	RTA	POSTERIOR COLUMN	LEFT	NIL	KOCHER LANGENBECK	5	6	8	14	NIL	NIL

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