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OUTCOME ANALYSIS OF SURGICAL MANAGEMENT OF ACETABULAM FRACTURE USING MODIFIED STOPPA APPROACH- OUR EXPERIENCE

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ABSTRACT

Introduction: Acetabular fractures are complex injuries that significantly impact hip joint function and mobility. The Modified Stoppa approach has emerged as an effective surgical technique for treating anterior acetabular fractures by providing excellent visualization and minimizing soft tissue damage. However, the outcomes of this technique vary among different patient populations and fracture types. This study evaluates the clinical, radiological, and functional outcomes of acetabular fracture fixation using the Modified Stoppa approach. **Methodology:** A prospective observational study was conducted on 40 patients with acetabular fractures treated using the Modified Stoppa approach. Surgical parameters, intraoperative blood loss, and perioperative complications were recorded. Radiological outcomes were assessed based on Matta's criteria, while functional recovery was evaluated using the Harris Hip Score (HHS). Postoperative complications and mobility status were also analyzed. **Results:** The mean time from injury to surgery was 5.26 ± 2.02 days, with an average operative duration of 148.64 ± 35.41 minutes. Anatomic reduction was achieved in 82.5% of patients, with imperfect and poor reductions observed in 15.0% and 2.5% of cases, respectively. The mean HHS was 85.93 ± 7.91, with 80% of patients achieving good to excellent outcomes. Full mobility was restored in 75% of patients, while 20% required assisted mobility. Major complications included deep vein thrombosis (7.5%), nerve injury (5.0%), and fixation failure (2.5%). **Conclusion:** The Modified Stoppa approach is an effective surgical technique for acetabular fractures, providing high rates of anatomic reduction and favorable functional outcomes. Early intervention, precise surgical techniques, and proper thromboprophylaxis contribute to improved patient recovery.

KEYWORDS : Acetabular fractures, Modified Stoppa approach, surgical fixation, Harris Hip Score, anatomic reduction, functional outcomes.

INTRODUCTION

The Modified Stoppa technique provides superior access to the pelvic ring and quadrilateral plate of the acetabulum, making it a widely adopted method for managing acetabular fractures. Since morbidity is higher in cases of unintentional reduction, the primary surgical goal is to achieve anatomic reduction with minimal complications, as nonanatomic reduction often leads to poor outcomes and may necessitate total hip replacement. [1,2] Several approaches exist, including Kocher-Langenbeck, iliofemoral, ilioinguinal, combined anterior/posterior, extended iliofemoral, transtrochanteric, modified Stoppa, and triradiate approaches. [3,4]

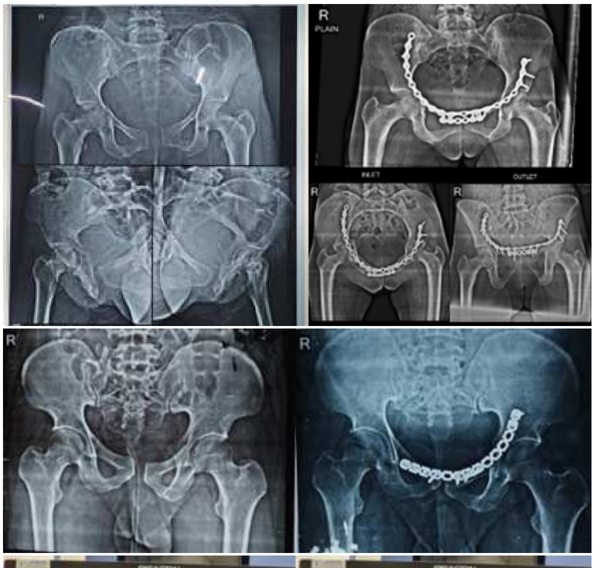
These are categorized as anterior, posterior, extensile, or mixed, with choice influenced by fracture configuration, soft tissue conditions such as Morel-Lavallée lesions, and surgeon expertise. [5] Introduced by Cole and Bolhofner in 1994, the Modified Stoppa technique gained popularity due to advantages such as reduction of anterior wall and column fractures, adequate pelvic ring exposure, avoidance of iliac vessels and femoral nerve, and applicability to anterior, posterior hemitransverse, and both-column fractures. [6,7] It also enables plating of the quadrilateral surface, supporting anatomic reduction. [8] Reported benefits include improved reduction, shorter operative times, and reduced blood loss. [9] Acetabular fractures, especially anterior column injuries, are challenging given the hip's role in weight bearing and mobility. The Modified Stoppa approach provides excellent visualization of the quadrilateral surface and pelvic brim, essential for stable fixation, though outcomes vary across patient groups. Nerve injury remains a concern, with an overall incidence of 7%, of which 2% are iatrogenic, most commonly linked to posterior column and wall fracture dislocations. [10] While anterior column fractures rarely damage nerves, the obturator nerve is at risk due to its proximity to the quadrilateral plate. [11] Obturator nerve injury may present as medial thigh paresthesia, sensory loss, or adductor weakness. [12] Although the Stoppa approach offers advantages over the ilioinguinal method, obturator nerve injury has been reported in 8–29% of cases, mainly in case reports and series, with limited understanding of underlying mechanisms. [13,14] This study therefore aims to evaluate the clinical and radiological outcomes of acetabular fractures managed with the Modified Stoppa technique, contributing to improved surgical practice and patient care.

MATERIAL AND METHODS

The study was conducted in the Department of Orthopaedics, M.L.N. Medical College, Prayagraj, over twelve months (2024–2025) as a prospective observational study. Forty patients were enrolled using non-probability convenience sampling after ethical approval and informed consent. Inclusion criteria were acetabular fractures in the weight-bearing region, displaced fractures ≥2 mm in non-weight-bearing areas, central fracture dislocations, isolated anterior or quadrilateral plate fractures, pubic diastasis with anterior column involvement, and young active patients requiring surgery. Exclusions included posterior wall fractures treated with the Kocher-Langenbeck approach, posterior pelvic ring injuries, open fractures, prior ipsilateral hip injury, bladder or urethral trauma, polytrauma requiring prolonged immobilisation, incomplete records, or loss to follow-up. Demographic data, mechanism of injury, associated trauma, Injury Severity Score, surgical timing, operative duration, blood loss, and perioperative complications were recorded. All patients underwent detailed clinical and neurological evaluation, followed by radiological assessment with pelvic anteroposterior and Judet views, CT scans, and 3D reconstructions. Fractures were classified using the Judet and Letournel system.

Preoperative low-molecular-weight heparin was administered unless contraindicated, and skin traction applied to reduce instability and prevent femoral head necrosis. Surgery was performed through a transverse Pfannenstiel incision two fingerbreadths above the symphysis pubis. The rectus abdominis was split along the linea alba to expose the transversalis fascia, and the bladder mobilised into the retropubic space of Retzius. Dissection continued laterally along the superior pubic ramus and pelvic brim. The corona mortis vessels were ligated to prevent bleeding, and external iliac vessels protected with retractors. Exposure extended posteriorly to the sacroiliac joint, and the obturator neurovascular bundle mobilised if required. For high anterior column fractures, an additional iliac crest window was created. Fracture reduction was achieved using Schanz screws, clamps, and ball spike pushers, and fixation performed with reconstruction plates and cortical screws in “J” or “C” configurations. Supplemental plates or lag screws were added for posterior column or quadrilateral involvement. Postoperatively, patients received antibiotics, antithrombotic therapy, and early mobilisation with restricted weight bearing. Radiological outcomes were assessed with X-rays and CT scans, while functional recovery was evaluated using the Harris Hip Score and the modified Merle d'Aubigné and Postel system. Patients were followed regularly, and statistical analysis correlated radiological reduction with functional outcomes.

Statistical Analysis:
A statistical program called SPSS version 26 (developed by SPSS Inc. in Chicago, Illinois, United States) was used to do the analysis after the data was entered into Microsoft Excel. The mean value, together with the standard deviation, was used to assess the continuous variables wherever it was necessary to do so. A statistical procedure known as the analysis of variance (ANOVA) was utilised in order to compare the means of different groups. We considered a p-value of less than 0.05 or 0.001 to be statistically significant.



RESULTS
The demographic analysis of the study population (n=40) showed a mean age of 38.5 ± 11.8 years, with the highest proportion in the 30–39 years group (25.0%). The study included 65.0% males and 35.0% females. The mean Injury Severity Score was 17.8 ± 5.9, consistent with moderate to severe trauma. Motor vehicle accidents were the most common mechanism (45.0%). [Table-1] The most common fracture pattern was anterior column with anterior wall and quadrilateral plate involvement, seen in 55.0%, while isolated anterior column fractures were found in 45.0%. [Figure-1] Associated injuries included limb trauma in 17.5%, head injuries in 12.5%, abdominal injuries in 10.0%, and others in 15.0%. [Figure-2] The main presenting symptom was pain in 95.0%, followed by swelling in 75.0%, inability to bear weight in 70.0%, deformity in 55.0%, and other complaints in 12.5%. [Figure-3] Radiological assessment showed significant improvement. In anterior column fractures, mean displacement reduced from 4.03 ± 1.22 mm preoperatively to 0.53 ± 0.35 mm postoperatively. In anterior column with wall and quadrilateral plate fractures, displacement decreased from 3.94 ± 1.03 mm to 0.32 ± 0.13 mm. [Table-2] The mean time to surgery was 5.25 ± 2.02 days, while mean operative duration was 148.4 ± 35.7 minutes. [Table-3] Radiological outcomes showed anatomic reduction in 82.5%, imperfect in 15.0%, and poor in 2.5%. [Table-4] Functional assessment revealed a mean Harris Hip Score of 85.93 ± 7.9. The Merle d'Aubigné score averaged 16.51 ± 2.26. [Table-5] Touch-down weight bearing was most common (52.5%), followed by partial (30.0%) and full weight bearing (17.5%), reflecting gradual recovery and healing progress. [Table-6] Postoperative complications are shown in Table-7. Mobility outcomes showed 75.0% regained full mobility, 20.0% required assistance, and 5.0% had no mobility. [Figure-4]

DISCUSSION
Acetabular fractures are complex injuries requiring precise reduction and fixation to restore hip function. The Modified Stoppa approach is increasingly preferred for its minimal soft tissue disruption and access to the anterior column, quadrilateral plate, and medial pelvis. Despite increasing adoption of the Modified Stoppa approach, data from Indian populations remain limited. Understanding patient demographics, fracture patterns, and outcomes in our setting is therefore essential for validating its clinical utility. In our study, the mean age was 38.5 ± 11.8 years, with most patients in the 30–39 years group (25.0%). Similar trends were noted by Khoshabi et al., (35.7 years), Kilinc et al., (40.1 years), and Paksoy et al., (36 years), confirming that these injuries mainly affect young to middle-aged adults. [15-17] Male predominance matched earlier reports, including Khoshabi et al., (71%) and the 3:1 ratio described by Paksoy et al., and Kilinc et al., [15-17] The mean ISS was 17.8 ± 5.9, comparable to Khoshabi et al., (16.2), reflecting high-energy trauma mechanisms. [15] Anterior column with anterior wall and quadrilateral plate fractures (55.0%) were most common, followed by anterior column (45.0%). Khoshabi et al., reported RTAs as the leading cause (52%), with falls (23%) also frequent, findings consistent with Kilinc et al., and Paksoy et al., (>50% RTAs), whereas Manap et al., found more fall-related cases (30%). [15-18] Verbeek et al., and Manap et al., observed both-column fractures as most common (48% and 46.3%) with similar T-type (13–14%) and transverse (15–17%) frequencies, underscoring the complexity of patterns treated by the Stoppa approach. [18,19] Associated injuries were frequent, with chest (17.5%), head (12.5%), and abdominal trauma (10.0%), similar to findings by Manap et al., and Verbeek et al., while Lee et al., emphasized perioperative challenges. [18-20] Pain was the predominant symptom (95.0%, n=38), followed by swelling (75.0%, n=30), inability to bear weight (70.0%, n=28), and deformity (55.0%, n=22), consistent with Khoshabi et al., and others, though the latter reported slightly lower weight-bearing difficulty (65% vs. 70%). [15-17] These findings highlight the need for timely diagnosis, pain management, and surgical stabilization. The Modified Stoppa and anterior-based approaches achieved effective anatomical reductions, particularly in both-column and anterior wall fractures. Paksoy et al., reported preoperative displacement of 4.5 mm in transverse and both-column fractures, similar to ours (4.53 mm and 4.28 mm), with comparable postoperative residual displacement (0.4–0.6 mm vs. 0.34–0.61 mm). [17] Manap et al., noted high preoperative displacement in T-type fractures (4.4 mm), comparable to our 4.32 mm, though their postoperative value (0.7 mm) was slightly higher than ours (0.53 mm), indicating better reductions in our cohort. [18] Lee et al., also observed reductions of 3.5–4.2 mm across fracture types, matching our results, with superior outcomes in anterior wall and column fractures (0.32 mm and 0.53 mm). [20] The mean time from trauma to surgery was 5.25 ± 2.02 days, comparable to Verbeek et al., (6.1 days). [19] Paksoy et al., highlighted poorer results with delays >7 days, supporting our optimal timing. [17] Thromboprophylaxis was given in 70.0%, drains used in 80.0%, with additional lateral windows in 30.0% and vertical midline incisions in 70.0%. Mean surgical duration was 148.43 ± 35.73 minutes, consistent with Kilinc et al., (140–160 minutes). [16] Tannast et al., warned that procedures >180 minutes increase blood loss and complications, reinforcing the advantage of our controlled timings. [2] Drains were removed at 3.25 ± 1.17 days, reducing infection risk; Lee et al., reported similar use (75–85%), while Paksoy et al., advised removal within 3–4 days,

consistent with our practice. [17,20] Overall, our surgical timing, duration, and technique align with prior studies, ensuring effective reduction and favorable outcomes. Blood loss was higher in bilateral fractures (640.42 ± 280.67 mL), with our average ranging 500–600 mL. Paksoy et al., reported 600–700 mL, consistent with ours (640.42 mL), confirming the high loss in acetabular surgeries due to deep exposure. [17] Kilinc et al., noted >750 mL with additional approaches, aligning with our higher values in bilateral cases. [16] Tannast et al., observed 1.2–1.5× greater loss in bilateral than unilateral fractures, paralleling our results (750.86 vs. 630.84 mL). [2] These findings reinforce the need for meticulous hemostasis, timely planning, and strategies like TXA or embolization in high-risk bilateral cases. Our study achieved high anatomic reduction (82.5%), with 15.0% imperfect and 2.5% poor reductions, demonstrating the effectiveness of the Modified Stoppa approach. Anderson et al., reported 85% and Zhou et al., 80%, both comparable. [21,22] Verbeek et al., found 10–20% imperfect reductions, consistent with our 15%. [19] Tannast et al., noted higher rates in complex fractures, explaining our results, while emphasized poor reductions with delayed surgery or comminution. [2] Functional recovery was favorable, with mean HHS 85.93 ± 7.91. Excellent-to-good outcomes were 80%, fair 12.5%, and poor 7.5%. Khoshabi et al., reported HHS 84.1 with 76.5% excellent-to-good, similar to ours. [15] Paksoy et al., found 75% with anterior approaches, though elderly patients had lower scores. [17] Manap et al., reported 14% fair outcomes, close to our 12.5%. [18] Poor outcomes (7.5%) matched Kilinc et al., (8–10%), often linked to older age, trauma severity, or complications. [16] Verbeek et al., further showed that poor reductions (>3 mm) lowered HHS, supporting our results. [19] The Modified Stoppa approach restored acetabular alignment and function, with fair or poor outcomes (20–30%) linked to imperfect reductions, delayed surgery, and complications. Mean HHS was 85.93 ± 7.96 and Merle d'Aubigné 16.51 ± 2.26, with excellent-to-good results in 80% (HHS) and 70% (Merle d'Aubigné). Khoshabi et al., reported HHS 84.1 with 76.5% excellent-to-good and noted nerve injuries as causes of poor recovery. [15] Kilinc et al., observed HHS 86.7 with 78% excellent-to-good, also consistent, with poor outcomes linked to infection, delayed surgery >7 days, and high-energy trauma. [16] Weight-bearing was conservative, with 52.5% TDWB, 30% PWB, and 17.5% FWB at six weeks. Manap et al., found similar rates (TDWB 55%, PWB 28%, FWB 17%), especially delayed in posterior column fractures. [18] Paksoy et al., reported TDWB 45%, PWB 40%, FWB 15%, indicating faster recovery with stable fixation, while comminuted fractures delayed progression. [17] Complications included bleeding (7.5%), nerve injury (5.0%), and vessel injury (5.0%). Khoshabi et al., reported bleeding 9.2%, Paksoy et al., noted 6.5%, and Kilinc et al., linked higher loss to delayed fixation. [15-17] Nerve injuries (5.0%) were similar to Khoshabi et al., (4.8%) and Kilinc et al., (5.5%), mainly obturator and femoral. [15,16] Vessel injuries (5.0%) aligned with Paksoy et al., (4.5%) and Kilinc et al., (4.0%). [16,17] Manap et al., reported higher bleeding (10.0%) and vessel injury (6.0%). [18] Overall, our complication rates parallel existing literature, underscoring bleeding and neurovascular risks. In our study of 40 patients with a Pfannenstiel incision, rectus abdominis paralysis (5.0%) and DVT (5.0%) were the most frequent complications. Obturator nerve palsy, infection, and hardware issues occurred in 2.5%, comparable to Paksoy et al., (6.8%) and Kilinc et al., (8.2%), underscoring the importance of early mobilization and thromboprophylaxis. [16,17] External iliac vein injury (2.5%) was similar to Verbeek et al., (2.0%), while deep infection (2.5%) aligned with Manap et al., (3.0%). [18,19] Fixation failure (2.5%) matched Khoshabi et al., (3.1%), and neuropraxia of the obturator nerve (5.0%) was consistent with Paksoy et al., (2.7%). [15,17] Hardware displacement into the acetabulum (2.5%) reflected Lee et al., (2.3%), emphasizing intraoperative fluoroscopy. [20] Functionally, 75.0% regained full mobility, consistent with Verbeek et al., and others [16,19] Assisted mobility was required in 20.0%, as reported by Paksoy et al., and Manap et al., due to stiffness and weakness. [17,18] No mobility in 5.0% was comparable to the 2–7% seen in earlier studies.

CONCLUSION

The Modified Stoppa approach proved to be an effective surgical technique for managing complex acetabular fractures, offering reliable fracture reduction and favorable functional recovery. Most patients regained mobility and quality of life, while complications such as bleeding, thromboembolism, and neurovascular injuries were consistent with existing literature and minimized by early intervention, careful technique, and thromboprophylaxis. Overall, this approach remains a safe and dependable option for achieving anatomical alignment and functional restoration in acetabular fracture surgery. Nevertheless, certain limitations must be acknowledged. This study is limited by its small sample size, single-institution design, focus on early outcomes, and lack of comparison with other surgical approaches. However, the findings support timely surgical intervention within the first week to optimise reduction and recovery. The Modified Stoppa approach showed favourable results, especially in complex fractures, and should be considered by surgeons. Careful preoperative planning is essential to minimise complications, while structured rehabilitation with progressive weight-bearing can enhance recovery and reduce stiffness.

Conflict Of Interest: None declared.

Funding: No external funding received.

Consent: Written informed consent was obtained from all participants.

Ethical Approval: Approval was granted by the institutional ethics committee in accordance with international guidelines.

Table: 1 Demographic And Injury Characteristics Of Enrolled Patients (n=40).

Parameter		Number [n=40]	Percentage (%)
Mean Age (years)		38.5 ± 11.8	
<20		4	10.0%
20-29		8	20.0%
30-39		10	25.0%
40-49		7	17.5%
50-59		6	15%
60+		5	12.5%
Gender	Male	26	65.0%
	Female	14	35.0%
Mean Injury Severity Score (ISS)		17.8 ± 5.9	
Mechanism of Injury	Motor Vehicle Accident	18	45.0%
	Fall from Height	10	25.0%
	Crush Injury	8	20.0%
	Other	4	10.0%

Table: 2 Comparison Of Preoperative And Postoperative Fracture Displacement.

Fracture Type	Preoperative Displacement (mm)	Postoperative Displacement (mm)	P-Value
Anterior Column	4.03 ± 1.22	0.53 ± 0.35	t=15.104 **p<0.0001***
Anterior column with Anterior Wall and quadrilateral plate	3.94 ± 1.03	0.32 ± 0.13	t=19.099 **p<0.0001***

Table: 3 Surgical Timing, Techniques, And Perioperative Parameters In Acetabular Fracture Fixation.

Surgical Parameter	Value (Mean ± SD) / n (%)
Mean Time from Trauma to Surgery (days)	5.25 ± 2.02
Mean Surgery Duration (minutes)	148.43 ± 35.73
Thromboprophylaxis Given	28 (70.0%)
Drain Used	32 (80%)
Drain Removal Time (days)	3.25 ± 1.17
Mean Time to Surgery (days)	5.26 ± 2.02
Surgery Time (minutes)	148.64 ± 35.41
Mean Blood Loss (mL)	640.42 ± 280.67
Bilateral Acetabulum Fractures Blood Loss (mL)	750.86 ± 240.79
Unilateral Acetabulum Fractures Blood Loss (mL)	630.84 ± 270.77

Table: 4 Radiological Outcomes Following Surgical Fixation Of Acetabular Fractures.

Radiological Outcome	NUMBER [n=40]	Percentage (%)
Anatomic Reduction	33	82.5%
Imperfect Reduction	6	15.0%
Poor Reduction	1	2.5%

Table: 5 Postoperative Functional Outcomes Assessed By Harris Hip And Merle D'aubigné Scores.

Clinical Score	Harris Hip Score	Merle d'Aubigné Score
Mean Score	85.93 ± 7.96	16.51 ± 2.26
Excellent n (%)	20 (50.0%)	18 (45.0%)
Good n (%)	12 (30.0%)	10 (25.0%)
Fair n (%)	5 (12.5%)	8 (20.0%)
Poor n (%)	3 (7.5%)	4 (10.0%)

Table: 6 Weight-bearing Status Of Patients At Six Weeks Post-surgery.

Postoperative Phase	Time (weeks, Mean ± SD)	Percentage (%)
Touch-Down Weight Bearing	21	52.5%
Partial Weight Bearing	12	30.0%
Full Weight Bearing	7	17.5%

Table: 7 Intraoperative And Postoperative Complications Observed During Surgery.

Complication		Number [n=40]	Percentage (%)
Intraoperative Complications	Bleeding	3	7.5%
	Nerve Injury	2	5.0%
	Vessel Injury	2	5.0%
Complications in Patients with Pfannenstiel Incision	Rectus Abdominis Paralysis	2	5.0%
	Obturator Nerve Palsy	1	2.5%
	Deep Vein Thrombosis (DVT)	2	5.0%
	Infection	1	2.5%
	Hardware Complications	1	2.5%

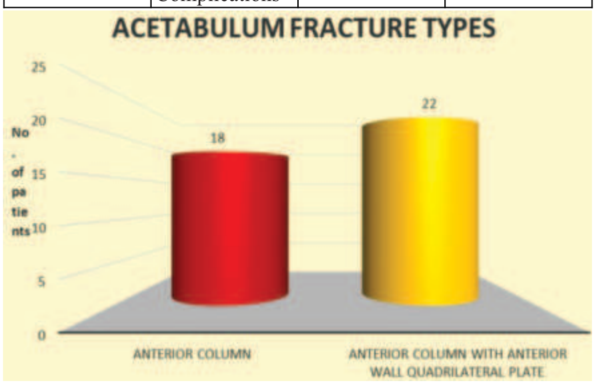


Figure: 1 Distribution Of Acetabular Fracture Types Among The Study Population.

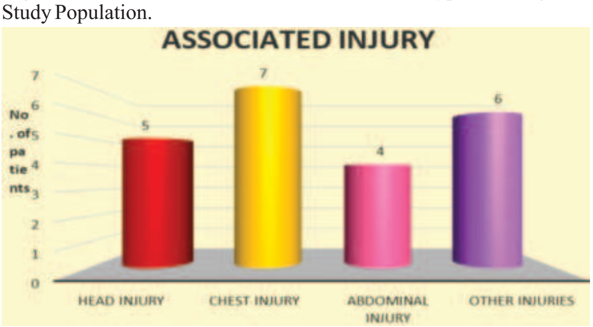


Figure: 2 Associated Injuries Observed In Patients With Acetabular Fractures.

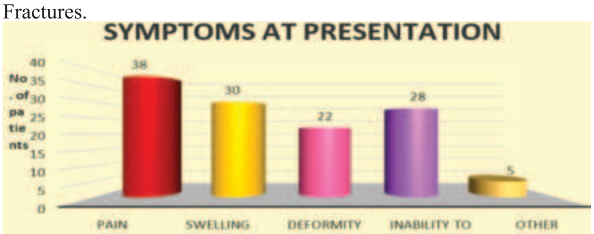


Figure: 3 Presenting Symptoms In Patients With Acetabular Fractures.

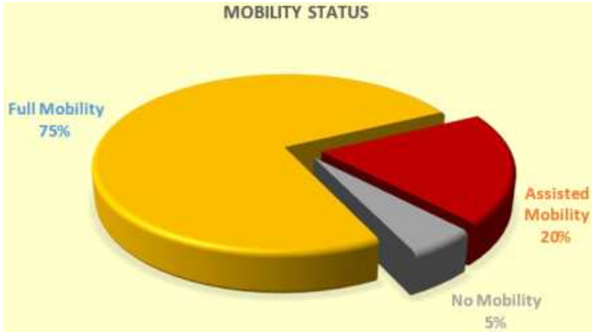


Figure: 4 Postoperative Mobility Status Of Patients.

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