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HIP FRACTURES IN ADULTS

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REVIEW ARTICLE

Complications Associated with Hip Fractures

Abstract

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Hip fractures in the elderly are a major public health concern, associated with high rates of morbidity and mortality. This review synthesizes the extensive spectrum of complications following hip fracture surgery, categorizing them into medical, anesthetic, and surgical types. Medical complications are prevalent and multifactorial; cardiac events, including myocardial injury, are a leading cause of death, often predicted by elevated troponin and NT-proBNP levels. Postoperative delirium and cognitive dysfunction are common neurological complications, while venous thromboembolism remains a significant risk despite routine thromboprophylaxis. Other frequent issues include pulmonary infections, anemia, acute kidney injury, urinary tract infections, and pressure sores. Anesthetic complications, such as intraoperative hypotension and bone cement implantation syndrome, add to the perioperative risk. Surgically, complications vary by fracture type, ranging from fixation failure, non-union, and avascular necrosis in femoral neck fractures to implant cut-out and malunion in intertrochanteric and subtrochanteric fractures. Overall mortality remains high (14-36%), driven by non-modifiable and modifiable risk factors like advanced age, cardiac disease, and surgical delays. A comprehensive, multidisciplinary approach focusing on preoperative optimization, meticulous surgical technique, and proactive postoperative management is essential to mitigate these complications and improve patient outcomes.

KEYWORDS

Hip Fractures; Postoperative Complications; Aged; Fracture Fixation; Arthroplasty, Replacement, Hip; Venous Thromboembolism; Delirium; Mortality

Introduction

Most of hip fracture patients are aged over 65 years and have preexisting comorbidities.[1] These comorbidities are often associated with various complications and influence the treatment out come, mainly increasing the risk of morbidity and mortality, length of hospital stay and treatment costs. The complications after non operative management of hip fractures are pressure sores, pneumonia, thromboembolic disease and urinary tract infection in addition to nonunion and malunion.[2] The general complication and complications related to surgery continue to rise in first four months postoperatively. Most of the postoperative complications occur within first few days of surgery. According to Goh et al, the reoperation rates at 120 days is almost double than 30 days after surgery (1% risk of re-operation at 30 days and 2% at 120 days).[3] The cephalo-medullary implants are associated with higher risk of peri-implant fracture and reoperation as compared to sliding hip screws, and patients with total hip arthroplasty have higher risk of

dislocation and DVT as compared to hemiarthroplasty.[3] Although the risk of mortality is decreasing, the overall complication rate remains high. The common cause of mortality after surgical management of hip fractures are cardiac complications, thromboembolism and sepsis. The patients are at risk of developing complication even after discharge from the hospital which shows the importance of high-quality hospital and community level care.[3]

This article discusses the possible medical, anesthetic and surgery related complications, their risk factors and recommendation for prevention and treatment.

Complications

Cognitive and Neurological

Post-operative confusion and cognitive complications are more common in elderly patients. They are categorized into three types: postoperative cognitive dysfunction (POCD), post-operative delirium (POD), and dementia.[1,4]

Postoperative cognitive dysfunction (POCD) occurs in approximately 10% of patients who undergo hip fracture surgery. POCD is usually mild and patients can usually manage activities of daily living. The pathophysiology of POCD is not clear. The mechanism of POCD may be multifactorial and may be related to preoperative comorbidities, cognitive reserve, effect of anesthetic drugs and perioperative events.

Postoperative delirium (POD) occurs in 13.5% to 33% of all hip fracture surgeries.[1] Patients of POD may present in 3 forms: hyperactive, hypoactive and mixed form. Hyperactive patients are irritable, restless and sometimes harmful to staffs. Hypoactive patients are calm, less mobile and find difficulty in communication. It is usually confused with depression and fatigue.[1]

The cause of POD is multifactorial. Age, previous alcohol abuse, impaired cognitive function before surgery, type of anesthetic drugs used, infection, urinary tract infection or fluid and electrolyte imbalance are possible causes of POD.[1] Regional anesthesia with nerve blocks causing less use of sedatives decreases the possibility of POD.[5] Postoperative oxygen saturation <95% is associated with increased risk of POD so supplemental oxygen should be continued at least for 2 days post-surgery. The use of sedatives and anticholinergic drugs should be avoided. Some medications like low dose of haloperidol are effective in preventing POD.[1]

Cardiac

The common cause of mortality during hospital stay in elderly patients with hip fractures are cardiac failure and myocardial infarction.[6] 30-60% of perioperative complications in noncardiac surgeries are due to cardiac events. Myocardial infarction, acute heart failure or cardiovascular death are considered major postoperative adverse cardiac events (MACE).[6] Several studies have shown that preoperative increase in brain natriuretic peptide (specially NT-proBNP) either alone or in association with increased level of troponin I helps in predicting the increased risk of MACE.[7]

Hip fracture increases the additional stress to already compromised cardiac function thus increasing the risk of cardiac failure. The possible risk factors include age ≥70 years, hypertension, anemia, hypoalbuminemia, duration of surgery >120 minutes.[8]

Fracture resulting in pain, bleeding, inflammation and hypercoagulation precipitates injury to the myocardium.[9] The incidence of myocardial infarction in patients with hip fracture ranges from 35% to 42%.[6] The risk factors in such patients are age, male gender, pre-existing cardiovascular disease and surgical delay.[6] Study by Borges et al found 1 in 5 patients of hip fractures had myocardial injury which was diagnosed by elevated troponin I. Mortality was 3 times higher in patients with elevated troponin I versus normal troponin I (22.6% in elevated troponin I versus 8.7% in normal troponin I) when managed via standard treatment strategy.[7] When the patients with elevated troponin I are treated via accelerated approach, the cardiac stress is minimized and hence decrease the risk of mortality. Since cardiac symptoms are not obvious in such patients, troponin I should be measured preoperatively to identify these group of patients.[9]

Vascular

Deep Vein Thrombosis (DVT) is a common complication after hip fracture which occurs due to hypercoagulable states and immobilization. The incidence of preoperative DVT is 8%-34.9% and may be as high as 62% if surgery is delayed.[10] Delayed surgery, hypoproteinemia, three or more comorbidities and d-dimer level >1.59mg/dl are predictors of preoperative DVT.[10] Female gender, advanced age, delayed presentation after injury, delayed surgery, kidney disease, BMI >28kg/m^2, type of hip fracture, anemia, history of coronary heart disease, dementia, pulmonary disease, smoking, ASA class III and IV, high level of fibrinogen and CRP, albumin level <35g/l are risk factors of preoperative DVT.[10] These risk factors should be identified and modifiable risk factors should be optimized.

The incidence of DVT after hip fracture surgery without thromboprophylaxis is as high as 50%.[11] The fatal pulmonary embolism (PE) is more likely to occur due to inherent physiological factors, fracture type, required surgery and combination of all of these. The incidence of pulmonary embolism is 1.4% to 7.5% of all patients within 3 months of hip fracture.[1] So thromboprophylaxis should be used routinely in elderly patients with hip fracture because they reduce risk of DVT by 60%.[1] There are several pharmacological thromboprophylaxis available which includes aspirin, unfractionated heparin (UFH), low-molecular weight heparin (LMWH), direct oral anticoagulants (DOAC) and warfarin. There is no clear guideline regarding use of these agents. Several studies describe the superiority of one agent over another.

Ahmed et al performed a meta-analysis to study the safety and efficacy of DOAC, LMWH, UFH, aspirin and warfarin and they suggested comparable efficacy and safety of these agents. The choice should depend on other factors like patient tolerance, adherence, and preference, route of drug administration, drug availability and cost.[11]

The incidence of venous thromboembolism (VTE) which includes DVT and PE; is decreasing with routine use of the thromboprophylaxis. This is under reported in literatures according to some studies. Phillipe et al performed a retrospective study which showed 4.7±0.5% risk of VTE at 3 months in a cohort of patients in which 98.8% had received thromboprophylaxis (87% had received LMWH for 35 days). Mortality was double in VTE group as compared to group without VTE. This explains the PE as possible cause of death in this group of patients. [12]

Pulmonary

Postoperative pulmonary complications (PPCs) are defined as pulmonary abnormalities that result in identifiable disease or dysfunction and adversely impact the patients' clinical course.[1] The common PPCs are atelectasis, pneumonia, exacerbation of chronic lung disease, respiratory failure and acute respiratory distress syndrome.[1,13] Almost 4% of patients with hip fracture surgery suffer from PPCs and half of them are severe.[13] The possible risk factors of PPCs are advanced age (>60 years), poor general health status, smoker, current respiratory infection, chronic obstructive pulmonary disease (COPD), uncontrolled asthma, obstructive sleep apnea and other chronic lung diseases like interstitial lung disease, neuromuscular disease, chest wall deformity or pulmonary artery hypertension.[13] Lung expansion techniques including deep breathing exercises and spirometry, prophylaxis for venous thromboembolism and regional anesthesia with minimal analgesics decrease the risk of PPCs.[13]

Postoperative Pneumonia (POP) is the most common and devastating complication after hip fracture with incidence of 4-15%.[14] The risk factors for POP are male sex, advanced age, ASA scale≥3, anemia, COPD, coronary heart disease, arrythmia, congestive heart failure, chronic kidney disease, cerebrovascular accident, time from injury to surgery, delayed surgery >48 hours after admission or injury, lower partial pressure of oxygen in arterial blood and high BUN and alanine aminotransferase.[14] Although most of the risk factors are nonmodifiable, they should be identified so that preventive strategies can be applied in high-risk patients.

Endocrine and Metabolic

Metabolic syndrome (MetS) is a cluster of medical conditions that, despite the controversy over its multiple definitions, involves components of obesity, dyslipidemia, hypertension, hypoalbuminaemia, and increased fasting blood glucose levels.[15] Malnutrition, which is prevalent among the elderly population, is even more frequent among patients hospitalized for hip fractures, with rates ranging from 20% to 70%. Patients with protein-caloric malnutrition have higher medical and surgical complication rates (including pressure scars and perioperative infections), lower functional capability, and a higher mortality.

Gastrointestinal

The Gastro-intestinal Complications following a hip fracture in elderly patients with pre-existing health issues include bleeding and complications from malnutrition and metabolic disorders.[1] Delays in surgery, such as those due to fluid imbalance or existing GI bleeding, can also exacerbate these problems.

Common postoperative GI complications include dyspepsia, abdominal distension, reflexes ileum and constipations. Postoperative GI stress ulcer and secondary bleeding are well known medical complication, especially in patients with a history of previous gastroduodenal ulcers.[16]Gastrointestinal bleeding can be prevented by avoiding NSAIDs, and wise use of pump inhibitors, antacids and adequate hydration in order to minimize the morbidity and mortality.

Urinary

The most common postoperative urinary complications are urinary retention, urinary tract infections and acute kidney injuries (12-61%). [16]

Lower rates of urinary retention were noticed in patients under intermittent catheterization immediately after surgery or their catheter removed the next morning after surgery.[17] This is the reason why earlier removal of catheter is advised, though the evidence is already limited. [16]

Urinary tract infections, an important delirium risk factor, are the leading cause of nosocomial infection in patients with hip fractures (12% to 61%).[16] UTI itself is found to be responsible for prolonged hospital stay (additional 2.5days) and higher mortality rate. [18] Indwelling catheters should preferably be removed within 24h after its insertion as it is the single most important risk factor for postoperative infection.[19]

Some literatures have mentioned the incidence of acute kidney injuries (AKI) among aging patients undergoing arthroplasty for femoral neck fractures ranging from 16 to 24%.[19] Three mechanisms proposed responsible for the development of AKI include prerenal, renal (intrinsic), or postrenal (post obstructive) failure. Hypovolemia is supposed to be the leading cause of prerenal AKI. Acute tubular necrosis (prolonged dehydration or hemorrhage at perioperative period), pulmonary embolism, acute myocardial infarction, heart failure, anesthetic agents, and sepsis are the other prerenal causes of AKI. The renal AKI can occur due to renal artery occlusion (embolism or thrombus), drugs (aminoglycosides, amphotericin B, NSAIDs, Proton-pump inhibitors, radiocontrast agents) and pyelonephritis.[20]

The age of the patient, emergency surgery or longer preparation time are the other predisposing factors. The timely treatment and accurate monitoring are required to minimize the risk of permanent kidney damage.[19] AKI is a mostly transient but frequent complication after hip fracture surgery that is associated with increased length of hospital stay, treatment cost, mortality and morbidity.

Hematological

The perioperative anemia, an important factor connected to adverse consequences; is a very common perioperative scenario with the prevalence ranging from 24% to 44%, being even higher if considered only the postoperative period (51-87%). [21]
It is associated with other medical complications and increased hospitalization duration, rate of readmission and death. The risk factors include age, inadequate pre-fracture functional level, cardiovascular or pulmonary diseases, low haemoglobin, fracture type, anesthetic type (neuraxial anesthesia and associated sympathetic blockade reduces intraoperative bleeding even under normotensive conditions), length of surgery, and the degree of intraoperative bleeding.[22] Values of haemoglobin concentration <=10g/Dl at admission are independent predictor of increased mortality at 30 days in patients with hip fractures. [23]

Miscellaneous

Pressure sore is another complication after hip fractures and 35% occur within first week of hospitalization. The risk factors are age, malnutrition, smoking and other comorbidities. The use of foam or alternating pressure mattresses along with aggressive nursing care and good nutrition helps in prevention of pressure sores.[1]

Anesthesia Related

Anesthesia related complications during hip fracture surgery can be influenced by patient comorbidities, delay in admission, and surgical technique. Common anaesthetic complications are intraoperative hypotension (IOH) and postoperative nausea and vomiting (PONV). Other concerns involve delirium in older patients and less common but serious issues like bone cement induced complications.
Arterial hypotension is reported in 15%-33% of patients and usually occurs during the first 20 minutes after spinal anesthesia. But hypotension may occur during other types of anesthesia because patients are usually in hypovolemia due to fracture induced blood loss, ingestion of diuretics, or inappropriate fluid intake resulting from immobility or dementia.[1]
Bone cement implantation syndrome (BCIS) is a complication associated with the implantation of PMMA and is a significant cause of intraoperative mortality and morbidity. Although the syndrome is poorly understood and has no standard definition, its clinical presentation is mostly characterized by hypoxia, systemic hypotension, pulmonary hypertension, cardiac arrhythmias, loss of consciousness, and eventually cardiac arrest. [24] The cardiopulmonary complications of BCIS can be reduced by modern cementing techniques, appropriate anaesthesia interventions,, adequate patient preparation and avoiding use of cement.[1] (Table 1)

Surgery Related

Various factors, such as inadequate planning, improper positioning of the patient, soft tissue handling, inadequate reduction, and poor choice of implant, can cause surgery related complications during and after hip fracture surgery. These complications can vary depending on whether the fracture is intracapsular or extracapsular.

Surgery Related Complications of Femoral Neck Fractures:

Fixation failure and non-union are common failure modes following displaced or undisplaced femoral neck fracture fixation. Internal fixation may fail because of many factors, including inadequate reduction, poor implant selection or position, non-union, osteonecrosis, and infection. The incidence of non-union and/or fixation failure requiring revision surgery is between 30% and 50% for displaced fractures. The incidence of non-union in patients under the age of 60 years was 10% for displaced fractures and 5% in undisplaced fractures. This meta-analysis also reported fixation failure in 9.7% of cases.[25]
Operative failure and non-union may be salvaged with a valgus osteotomy, converting shear into compressive forces (Figure 1). Failures following operative fixation include mechanical issues like screw cut-out (where the screw tip exits the bone), varus collapse (medial angulation), "Z-effect" (sliding of the two head-neck implants: one shifts forward toward the joint with the other shifts backward, which results in a "Z" appearance). Its frequency is 5% to 10%.[26] (Figure 2)
In select groups of patients who may be high-risk for osteosynthesis failure, arthroplasty, usually a hemiarthroplasty, may be recommended. Complications associated with arthroplasty include acetabular erosions and thigh pain, which are more common in hemiarthroplasties (bipolar, Austin-Moore prosthesis), (Figure 3) whereas dislocation, aseptic loosening, and subsidence are more commonly seen with total hip arthroplasty.[27,28] (Figure 4 and 5)
Avascular necrosis (AVN) of the femoral head following femoral neck fractures may be related to delay in surgery and osteosynthesis, the overall incidence is 15–25 %. [29–31] Non-union of femoral neck fractures is mainly due to precarious blood supply, synovial bathing, and non-anatomical reduction, emphasizing the need to reduce these fractures anatomically before osteosynthesis.
The risk of infection is lower with internal fixation than with arthroplasty, as might be expected. In comparative studies, infection rates following internal fixation range from 0% to 10% compared with arthroplasty infection

Table 1. Medical Complications

System	Complication	Incidence	Recommendation
Cognitive and Neurological	Post Operative Cognitive Dysfunction (POCD)	10%	Identification and optimization of high-risk patients
	Post Operative Delirium (POD)	13.5%-33%	Avoid sedatives and anticholinergic drugs Supplemental Oxygen at least 2 days after surgery
Cardiac	Myocardial Ischemia/Infarction/ Failure	35%-42%	Identification of high-risk patient Avoid delay and treat via accelerated approach
Vascular	DVT (without Thromboprophylaxis)	50%	Thromboembolism Prophylaxis Early Mobilization
	DVT (with Thromboprophylaxis)	5%	
	PE	1.4%-7.5%	
Pulmonary	Postoperative Pulmonary Complications (PPCs)	4%	Lung Expansion Exercise (Deep Breathing Exercises/Spirometry) Thromboembolism Prophylaxis Regional Anesthesia
Endocrine-Metabolic	Malnutrition	20%-70%	Preoperative Nutritional Supplements
Gastrointestinal (GI)	Postoperative GI Ulcers/ Bleeding	1.90%	Avoid NSAIDs Use Proton Pump Inhibitors, Antacids, Adequate Hydration
	Dyspepsia, Reflexes Ileum, Constipation, Abdominal Distention	-	
Urinary	Urinary Retention	-	Intermittent Catheterization, Early Removal Early Catheter Removal Adequate Fluid Resuscitation Avoid Nephrotoxic drugs Treat Comorbidities
	Urinary Tract Infection	12%-61%	
	Acute Kidney Injury	16%-24%	
Hematological	Anemia	24%-44%	Maintain Hemoglobin level above 10mg/dl
Miscellaneous	Pressure Sores	7%-9%	Foam or Alternative Pressure Mattress Aggressive Nursing Care Good Nutritional Supplement
	Arterial Hypotension	15%-33%	Fluid Resuscitation Vasopressor
	Bone Cement Implantation Syndrome (BCIS)	15.4%-46.7%	Oxygen Administration Fluid Resuscitation Inotropes to support Cardiac Function Vasopressor to manage hypotension

DVT Deep Vein Thrombosis; *PE* Pulmonary Embolism; *NSAIDs* Non-steroidal Anti-Inflammatory Drugs

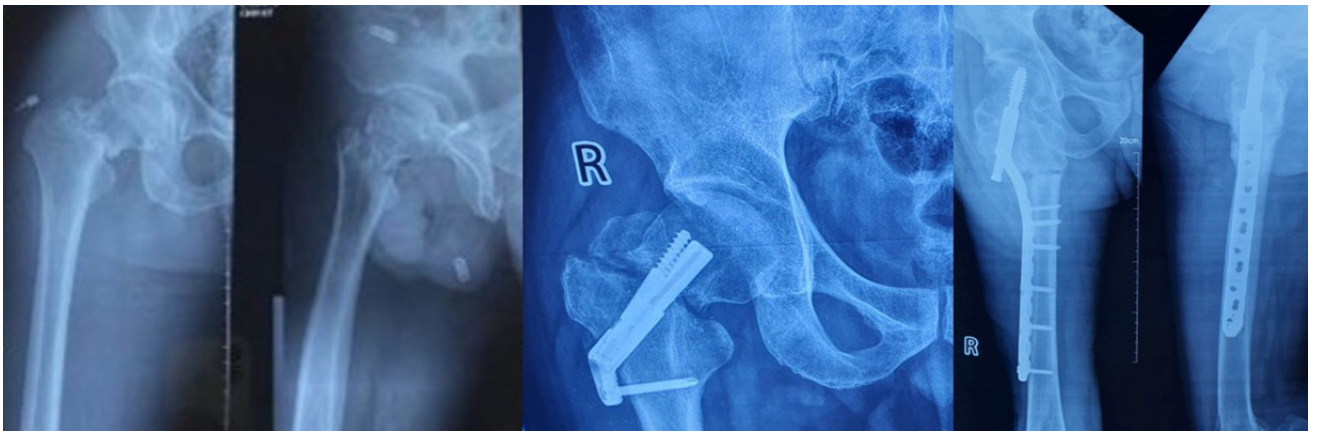

Figure 1 Non-Union of Neck of Femur managed by Valgus Osteotomy and Fixation

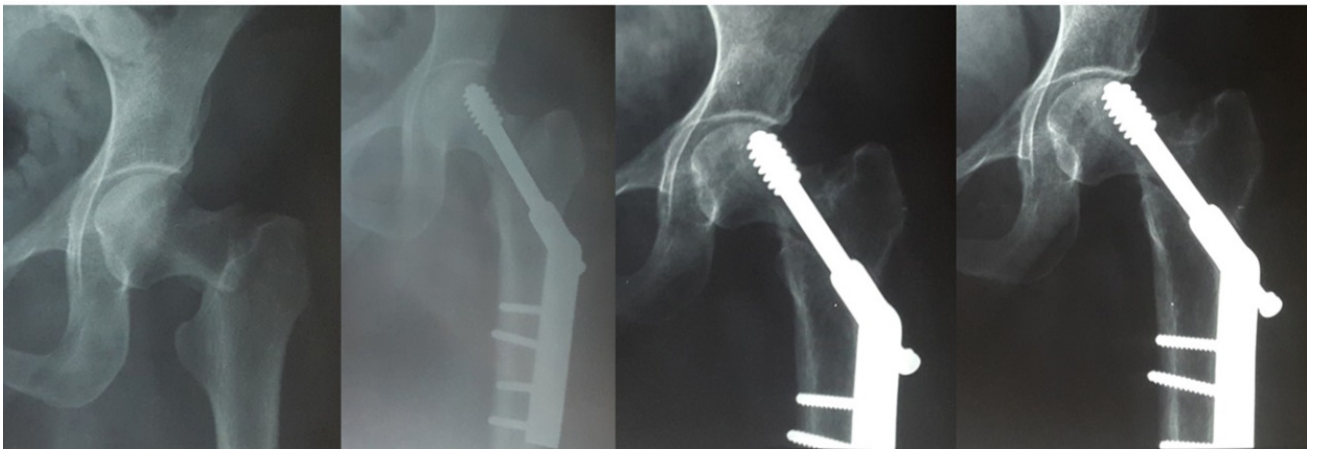

Figure 2 Lag Screw cut out and Varus collapse after Neck of Femur Fracture fixed with DHS

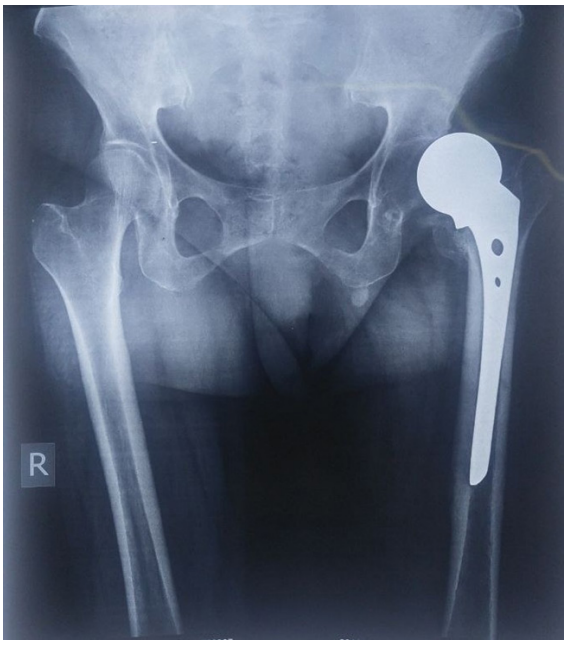

Figure 3 Loosening and subluxation of an Austin Moore hemiarthroplasty. The patient presented with anterior thigh pain and difficulty in weight bearing

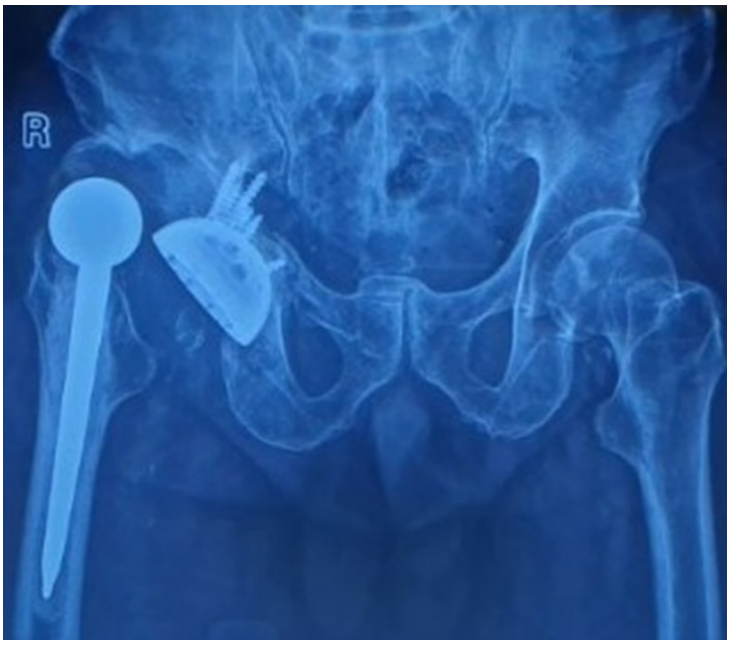

Figure 4 Dislocation after Hybrid Total Hip Replacement

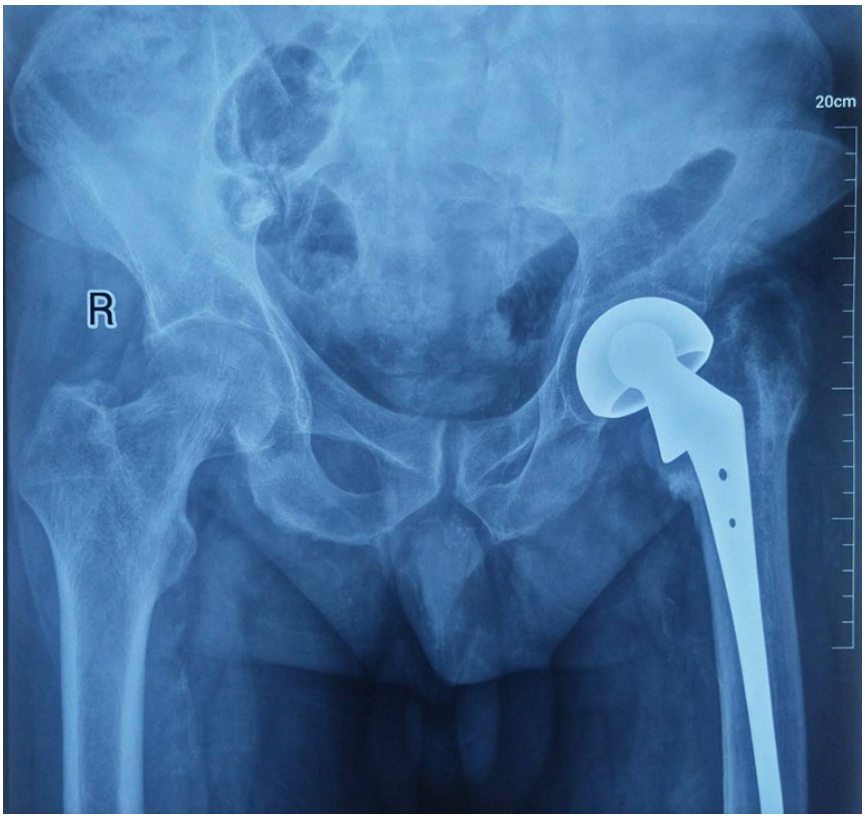

Figure 5 Subsidence after Bipolar Hemiarthroplasty

rates of 0% to 18%.[32] Xiaopo Liu et al. have highlighted that operating time >107 min, serum albumin <41.6 g/L, BMI >26.6 kg/m^2, and age >79 years are risk factors for postoperative surgical site infection.[33]

Surgical Complications of Intertrochanteric Fractures:

Implant cut-out is the most frequently reported complication of surgical fixation of intertrochanteric fractures. Cut-out is linked to insufficient fracture reduction and improper lag screw location. A cut-out rate of 10% to 15% has been reported in the past, but contemporary data indicate an incidence of 2% to 3%[34] and with the best surgical methods, a figure is as low as 1%[35]. The greatest predictor of future screw cut-out is the distance to the positioning of the lag screw in the femoral head. So, the tip-apex distance should be maintained during fixation and monitored during subsequent follow ups. Parker et al found an increased incidence of femoral shaft fracture at the tip of the implant when using an intramedullary device.[36] Fractures around or below an extramedullary plate, such as a sliding hip screw, are uncommon, with an incidence of approximately 0.1%. Reverse oblique intertrochanteric fractures if fixed with extramedullary device are associated with failure rate of 36% compared to only 5% for intramedullary device.[1]

Excessive screw sliding is another common complication that occurs due to fracture collapse and impairs postoperative mobilization. (Figure 6) The screw sliding >187mm affects postoperative mobility.[1] Non-union is uncommon in intertrochanteric fracture rather leads to varus malunion causing limb shortening and abductor insufficiency.

Wound sepsis is rare after the fixation of an intertrochanteric fracture. Deep wound sepsis is the most devastating complication and occurs in about 1% of patients. Minimally invasive surgery, avoiding lengthy surgery, exposing the fracture, and taking preventative antibiotics can lower the frequency.[37]

Surgical complications of Subtrochanteric fractures:

Malunion can cause a varus alignment of the proximal femur, leading to decreased abductor efficiency due to the greater trochanter's proximal position. Non-union rates in subtrochanteric fractures vary but are typically higher than in intertrochanteric fractures. Rates have been reported to be as high as 20% or

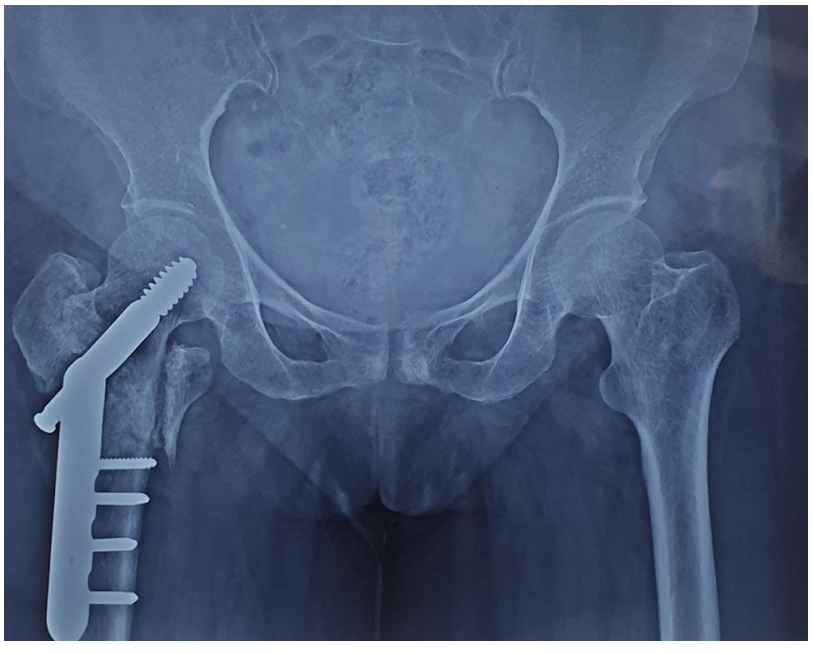

Figure 6 Excessive sliding of lag screw after DHS fixation

Table 2. Surgical Complications

Complication	Incidence	Intervention/ Recommendation
Avascular necrosis	15%- 25%	Early Surgery (within 24 hrs) Aim for Anatomical Reduction and rigid fixation Avoid varus & rotational malposition
Cut - out	Up to 15%	Keep Tip Apex Distance (TAD) < 25mm Avoid superior position of lag screw in the femoral head Aim for the postero-inferior or central screw in the femoral head Aim for proper fracture reduction
"Z-effect" after PFN fixation	5% - 10%	The relative length of the antirotation screws and the inferior lag screw is crucial Avoid fixation of the fracture at a cervico-diaphysial angle of <125^0
Peri-implant fracture at the tip of PFN	1% - 3%	Avoid wedging in the anterior cortex Use Longer PFN Use of a new generation nail with a splinter at the end to reduce stress risers
Non-union	10-35% (Neck of femur) <2% (Intertrochanteric) 20-32% (Subtrochanteric)	Valgus restoration with anatomical reduction and stable fixation Use of primary bone grafting
Malunion	10-30% (Neck of femur) 1-2% (Intertrochanteric) 10-15% (Subtrochanteric)	Avoid Varus positioning Avoid distraction at fracture site Restore length, alignment & rotation Avoid the wrong entry point during PFN
Dislocation	0.2% - 5%	Meticulous capsular repair Optimal combined anteversion
AVN	15% - 25%	Early fixation <24 hours Anatomical fixation

PFN Proximal Femoral Nail; *AVN* Avascular Necrosis

more, with one meta-analysis specific to atypical femoral fractures showing a 15% non-union rate in subtrochanteric cases.[38] So anatomical reduction and stable fixation along with primary bone graft is recommended. (Table 2)

Mortality

The mortality after hip fracture in patients aged 65 years and older ranges between 14% to 36%.[1] Studies have shown that age, gender, fracture type, walking capacity, activities of daily living, mental state and cognitive impairment are the possible non-modifiable risk factors.[39] Dementia, chronic obstructive pulmonary disease (COPD), chest infection, heart failure, anemia, abnormal renal function test and malignancy are other common risk factors of increased mortality.[1] Among them the two common causes of mortality within 30 days are heart failure (65%) and chest infection (43%).[1]

Non operative management of hip fractures increases the risk of mortality by 1.7 times as compared to surgical management.[2] The preventable risk factors of mortality after hip fractures are malignancy, residential status (nursing home/home), time to surgery (>2days/<2days), pulmonary disease (COPD and Pneumonia), diabetes, and cardiovascular disease (MI, arrythmia, valve disease, CHF and hypertension).[39]

Conflict of Interest

None

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