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Hip Fracture, Causes, Classification, and Management: A Literature Review

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ABSTRACT

The most prevalent reason for admission to an acute orthopedic unit is a proximal femoral or hip fracture. Hip fractures are prevalent fragility fractures among older people, affecting the quality of life, health outcomes, and medical expenses. Hip fractures directly influence public health and are one of the leading causes of disability due to their high mortality and morbidity rates. Therefore, proper management of the hip fracture is significant to hinder the potential difficulties and increase the life quality of such patients. This study aimed to cover the etiology and the management of hip fractures and provide a good review of the published literature. The PubMed database was utilized for article selection, and the following keys were used in the Mesh ((“hip fracture” [Mesh]) AND (“management”[Mesh]) OR (“causes” [Mesh])). Identifying possible risk factors for falls and hip fractures, such as age-related physiological changes and low physical activity levels, is crucial. Increasing awareness and avoiding such characteristics may aid in minimizing the long-term and devastating effects of hip fracture injuries. However, surgical treatment is usually recommended unless the patient has significant comorbidities at an unbearable risk. The fracture displacement determines the fixing method for femoral neck fractures. While arthroplasty is commonly used to treat displaced femoral neck fractures, undisplaced or mildly displaced femoral neck fractures can be repaired by a sliding hip screw or a series of cancellous lag screws. The deformation integrity and the lateral cortex preservation are important factors in implantation selection in intertrochanteric femur fractures.

Keywords: *Hip fracture, Evaluation, Management, Surgery*

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INTRODUCTION

The most prevalent reason for admission to an acute orthopedic unit is a proximal femoral or hip fracture. More than 86,000 such fractures occur yearly in the United Kingdom. In 1990, there were 1.3 million people in the world; by 2050, that number may rise to 7-21 million, depending on pattern changes (Gullberg *et al*., 1997). In developed countries, treating a hip fracture necessitates a multidisciplinary approach. The patient would first present to an ambulance and then to an accident and emergency unit before passing through radiology, anesthesia, orthopedic surgery, medicine, and rehabilitation departments. When the patient leaves the hospital, medical and social care in the community may be required (Keene *et al*., 1993; Gullberg *et al*., 1997).

After one month, the mortality rate linked with a hip fracture is around 5-10%. The mortality rate rises to around 30% a year following the fracture, compared to an annual death rate of around 10% in this age range. Only about a third of fatalities are related to hip fracture, although patients and families frequently believe that the fracture was a major factor in the last illness. More than a tenth of those who survive will not be able to return to their old residence. The majority of the remaining people will have some level of pain or impairment (Keene *et al*., 1993; Roche *et al*., 2005). Therefore, the proper management of hip fractures is significant to hinder the potential difficulties and increase the life quality of such patients. These articles aim to cover the etiology and the management of hip fractures and provide a good review of the published literature.

MATERIALS AND METHODS

The PubMed database was used to select articles, and the following keys were utilized in the Mesh ((“hip fracture” [Mesh]) AND (“management”[Mesh]) OR (“causes” [Mesh])).
Regarding the inclusion criteria, the articles were chosen according to hip fracture, causes, and management.
Exclusion criteria included all other articles that lacked the mentioned topics as their primary endpoint.

RESULTS AND DISCUSSION

Hip fractures are most commonly caused by falls. However, it is widely assumed that this disease is linked to osteoporosis. The pharmaceutical industry developed the term “osteoporotic fracture” to describe any fracture experienced by an older individual. Although all older individuals have osteoporosis, they can also be affected by stroke, ocular or inner-ear balance issues, or heart disease, all of which can lead to a fall (To *et al*., 2014; Guerado *et al*., 2016). Since osteoporosis by itself never causes a fall, yet falls are the leading cause of hip fractures, a discrepancy must exist in the assumption of causation between hip fracture and osteoporosis in the pathophysiology of this illness. Osteoporosis makes it easier to break a bone with less energy than a not osteoporotic bone. Although all older individuals have osteoporosis, only some will fall, and lower than half of them will get injured due to the fall (Guerado *et al*., 2016).

Furthermore, more than half of those aged 65 and up who fall will fall again within a year. It has been suggested that the alleged bone metabolism disease that reduces “bone strength” must be addressed to hinder hip fractures. Nonetheless, the data does not support this. The traditional therapy for osteoporosis is vitamin D supplementation, either with or without calcium. However, low plasma 25-hydroxy vitamin D condensation is correlated with the risk of hypertension and high arterial blood pressure (Vimaleswaran *et al*., 2014). Hence, a permanent treatment with vitamin D, either alone or in combination with calcium, for the treatment and prevention of osteoporosis appears to be inappropriate.

Moreover, this treatment has been linked to increased renal disease and gastrointestinal symptoms. In spite of the risks, over 50% of all people over the age of 50 continue to consume these supplements. In reality, the impact of vitamin D on senior fatality is bizarre: While vitamin D3 appears to reduce fatality, alfacalcidol, vitamin D2, and calcitriol appear without any positive benefits and may even cause hypercalcemia. Furthermore, combining vitamin D3 with calcium treatment increases the risk of nephrolithiasis. However, just because of its positive effects on muscle atrophy, senior individuals’ current usage of vitamin D as a method for preventing hip fractures may be encouraged. This would support the theory that hip fractures are caused by falls rather than osteoporosis.

Mineralization deficiency has also been suggested to cause “bone weakening,” putting older people at risk of hip fractures known as “osteoporotic.” Recent research suggests that the issue with mineralization in the elderly is not a normal calcium reduction in the bone but rather uneven distribution of mineralization. The mineral density of tissue is greater in the periosteum and declines from there to the endosteum; it decreases from the distal to the proximal section of the femur neck and thus changes radially (Guerado *et al*., 2016). Furthermore, changes in bone elasticity are caused by tissue differences in the femoral neck’s axial direction. If the main cause of hip fractures is osteoporosis, many fractures might be avoided by treating osteoporosis. Nevertheless, other factors such as auditory or ophthalmic problems, brain illness, or decreased movement are all possible causes. As a result, taking steps to avoid falls induced by these situations will lower the risk of hip fracture (Avenell *et al*., 2014; Bjelakovic *et al*., 2014).

Inactive older people are more than twice as likely as active adults to have a pelvic fracture, based on the past 30 years (Lyritis, 1996). Physical inactivity is becoming the utmost significant explanatory parameter for the rising prevalence of hip fractures recorded in emerging and developed nations due to its significantly harmful effect on muscle mass, overall health status, muscle physiology, vitamin D exposure, and bone health (Hayes *et al*., 1996; Slemenda, 1997; Marks, 2010).

While body height, a non-modifiable characteristic, may predispose to a hip fracture, there is a constant link between having a low body mass and an enhanced risk of fracture beyond 50, which may be addressed. This link is more significant in those with poor bone mineral density and who have lost more than 10% of their body weight than their maximum weight. Furthermore, older women with lower body masses are more likely to fracture their hips because they have lower bone mineral density and less soft tissue coverage than women of an average mass (Langlois *et al*., 2001; Lau *et al*., 2001; De Laet *et al*., 2005).

Many aging-related chronic diseases, such as Parkinson’s disease and arthritis, significantly enhance the chance of falling and, as a result, the probability of sustaining a hip fracture. Peripheral neuropathies, postural hypertension, and arrhythmias, as well as the presence of Alzheimer’s disease and other neurological disorders like stroke, may all enhance the danger of falls and hip fractures. Diabetes, hyperthyroidism, and medical disorders linked to osteoporosis and different types of impairment linked to the falling risk, the walking aids usage, and extended immobility may all enhance the danger of hip fracture. The presence of concurrent clinical diseases, particularly lung disease or cancer, may influence rehospitalization after a hip fracture, as well as the outcomes of an acute hip fracture (Schwartz *et al*., 2001).

Besides these characteristics, depression or any cognitive impairments can raise the chance of falling and breaking a hip. Furthermore, a cognitive impairment history can limit the rehabilitation efficiency following the hip fracture operation and increase the chance of falling after a hip fracture (Huang *et al*., 1996).

Except for antibiotics, those who took drugs were found to be less at risk for pelvic fractures. Nevertheless, cimetidine, hypnotic drugs, opioid analgesics, and antihypertensives are linked to an enhanced risk of hip fractures. Moreover, using sedatives, tranquilizers, and any of the three antidepressants has been linked to an enhanced chance of falling and a hip fracture. Alcohol and long-acting sedatives normally reduce reaction time and increase hip fracture risk. Moreover, alcohol addiction can lead to bone balance, poor gait, reduced balance, and enhanced risk-taking behaviors. In addition, Tricyclic antidepressants can raise the risk of hip fracture attributable to their negative hemodynamic adverse effects and drowsiness and confusion. use of corticosteroids and levothyroxine in males has been linked to a higher hip fracture risk. This might result from the negative impact of corticosteroids on bone mineral density. Smoking cigarettes or pipes and tea consumption all raise the hip fracture risk.

In conclusion, age, various age-related physiological changes, poor dietary habits, different types of medicine, and low physical activity may all influence two important predictors of hip fracture, namely femoral bone strength and the tendency to fall. Furthermore, older individuals' susceptibility for hip fracture injuries is believed to be influenced by diminishing muscular, cognitive, ocular, and neurological reflex reactions. Understanding these characteristics may aid in minimizing the long-term and devastating effects of hip fracture injuries (Rees *et al*., 1977; Rashiq & Logan, 1986; Hemenway *et al*., 1988).

Fracture types

Hip fractures are classified into several types using categorization systems. A fracture classification should be highly reliable and reproducible, widely acknowledged, and have prognostic value in clinical situations. Hip fractures are proximal femoral fractures that occur distal to the lesser trochanter within up to 5 cm. They are evaluated and classified based on fracture anatomy on plain radiographs. If necessary, plain radiographs can be complemented by augmented by CT or MRI (Cannon *et al*., 2009). There are two primary groups with similar patient distribution based on the hip capsule. They are trochanteric and sub-trochanteric fractures, femoral neck fractures, and intra-capsular and extra-capsular basicervical fractures (Khairy *et al*., 2019).

Intra-capsular fracture types

In a fragility fracture scenario, intra-capsular hip fractures are true via the femoral neck, as femoral head fractures are not common in older adults. Femoral neck fractures are at risk of non-union with or without structural collapse due to poor fixation or avascular necrosis of the femoral head. In adults, the femoral head is primarily supplied by the distal recurrent arteries that enter the femur on the shaft side of the fracture. Ischemia can result in avascular necrosis from direct injury to the arterial supply crossing the fracture line or a brief arterial impingement resulting from artery stretching or intra-capsular hematoma. Preoperative scintigraphy, electrode measurement, and arthroscopic visualization of ischemia have all been tried, but none of these have proven to be predictive regarding prognosis. Because ischemia may be transient, acute repositioning within hours has been recommended, which may be augmented by hematoma emptying (Heetveld *et al*., 2009; Loizou & Parker, 2009; Ahmed *et al*., 2021).

Historically, numerous techniques have classified femoral neck fractures based on fracture displacement visible on anterior–posterior radiographs. Garden's Classification has been the most often used **(Table 1)**. Fractures are classified into four phases (Garden, 1961). Garden's categorization has only good interobserver reliability when all four stages are used, but moderate to considerable interobserver reliability when Undisplaced (Garden I–II) and displaced (Garden III-IV) fractures are the main used types of fractures. Prognosis is believed to be affected by a vertical fracture line in the anterior-posterior imaging or posterior wall multi-fragmentation, femoral head diameter, and posterior tilt angulation shown on the lateral imaging (Palm *et al*., 2012). Nevertheless, the distinction between undisplaced and displaced fractures remains the utmost reliable failure predictor and the most common fracture classification, accounting for about one-third and two-thirds of all femoral neck fractures, respectively (Zlowodzki *et al*., 2005).

Table 1. Garden's Classification for Femoral Neck Fracture

Stage	Description
I	Incomplete femoral neck fracture
II	Complete femoral neck fracture
III	Partial displacement femoral neck fracture
IV	Full displacement femoral neck fracture

Extra-capsular fracture types

Due to inadequate fixation, extra-capsular fractures are in danger of non-union and mechanical collapse. Because the fracture line is located laterally to the femoral head's nutritional veins, avascular necrosis is uncommon; nonetheless, muscle interconnections usually deform the fragments, and bleeding into neighboring muscles may be serious and life-threatening. The position of the fracture line and the number of pieces are used to classify fractures. Basicervical fractures are a small percentage of intra- and extra-capsular fractures that are physically located on the capsular attachment line.

Although they are classified as intra-capsular by the AO/OTA **(Table 2)**, they behave biomechanically similar to extra-capsular fractures, except for the danger of medial segment rotation due to the muscle attachments lack. Trochanteric fractures affect the trochanter region between the capsule and the lesser trochanter. The ambiguous, misleading, and useless prefixes per-, inter-, and trans- are often used as unneeded prefixes. The AO/OTA Classification is presently the most widely used. It categorizes the trochanteric region into nine severity levels (Mallick & Parker, 2004; Marsh *et al*., 2007).

Table 2. AO/OTA Classification for Hip Fractures

Fracture type		Fracture subtype	
31-A1	Femur, proximal, pertrochanteric simple (only 2 fragments)	31-A1.1	Through the greater trochanter: (1) non-impacted (2) impacted
		31-A1.2	Below lesser Trochanter
		31-A1.3	Along intertrochanteric Line
31-A2	Femur, proximal, trochanteric fracture, pertrochanteric multifragmentary (always have posteromedial fragment with lesser trochanter and adjacent medial cortex)	31-A2.1	With 1 intermediate Fragment
		31-A2.2	With several intermediate Fragments
		31-A2.3	Extending more than

			1 cm below lessor Trochanter
31-A3	Femur, proximal, trochanteric area, intertrochanteric fracture	31-A3.1	Simple oblique
		31-A3.2	Simple transverse
		31-A3.3	Multifragmentary: (1) extending to greater trochanter (2) extending to neck

Simple two-part fractures are covered by fracture type 31-A1, whereas 31-A2 requires a detached lesser trochanter with an unbroken or detached greater trochanter. The subgroups 31-A3.1 and 31-A3.2 represent reverse and transversal fracture lines through the lateral femoral wall—defined as the lateral cortex distal to the greater trochanter—while the most comminuted 31-A3.3 fracture requires both a detached lesser trochanter and a fractured lateral femoral wall.

Other than rare trochanteric fractures in which the greater trochanter is detached, but the smaller trochanter is preserved, the AO/OTA classification includes most fractures classified by earlier classification systems. When all nine kinds are used, the dependability is low, but the reliability skyrockets when only the three primary groups are used (A1-2-3). Subtrochanteric fractures occur distally from the trochanters and account for about 5% of all hip fractures (Pervez *et al*., 2002; Marsh *et al*., 2007; Loizou *et al*., 2010).

Management

Early mobility is the major objective of hip fracture therapy since it reduces the chance of postoperative difficulties and increases the long-run fatality rate (Maheshwari *et al*., 2018; Lu & Uppal, 2019). In turn, unless the patient has substantial comorbidities that pose an intolerable risk, surgical therapy is usually recommended.

Surgical treatment of femoral neck fractures

The fracture displacement determines the fixing method for femoral neck fractures. While displaced femoral neck fractures are often treated with arthroplasty, undisplaced or minimally displaced femoral neck fractures (Garden type I or II fractures) may be handled with several cancellous lag screws or a sliding hip screw. Screws are generally inserted in an inverted triangle arrangement with screws positioned posterosuperiorly, anterosuperiorly, and along the inferior femoral neck in the cancellous lag screw method. The cancellous screws must abut the cortical walls to increase fracture stabilization (Zdero *et al*., 2010; Anbar *et al*., 2021). Compared to alternative screw fixation patterns, biomechanical studies show that the inverted triangle arrangement with screws contacting the cortical surfaces offers the best mechanical stability (Lu & Uppal, 2019; Selvan *et al*., 2004). The sliding hip screw is an alternate fixation technique for femoral neck fractures. This fixed-angle device comprises a lag screw that runs parallel to the femoral neck's axis and is then placed into a barrel coupled to a lateral plate. This lag screw is free to move around inside the barrel, allowing minimal movements and compression over the fracture location (Lu & Uppal, 2019).

Furthermore, the lag screw must be positioned near the calcar area (next to the cortex) to optimize stability rather than the central part of the femoral neck. A biomechanical investigation found that screw fixation nearby the calcar cortical had better fracture consistency and stiffness than screw fixation in the center. Importantly, subgroup analysis revealed that patients who received the sliding hip screw fixation had significantly lower reoperation rates than those who did not. Patients who had basicervical or displaced fracture patterns and were current smokers had significantly lower reoperation rates than those who did not. As a result, even though these two surgical strategies produce similar results, the biomechanical advantages of the sliding hip screw fixation translate into better clinical results in situations where bone quality is poor due to smoking, fractures near the intertrochanteric region, or fracture displacement (Lu & Uppal, 2019; Orekhov *et al*., 2021).

Furthermore, Cancellous screw fixation may assist in the preservation of femoral head and neck blood flow. Aside from unusual scenarios, the surgeon's personal preference for surgical fixation is usually the deciding factor. Displaced femoral neck fractures are connected to a higher rate of avascular necrosis of the femoral head. As a result, arthroplasty is frequently utilized in the elderly to repair these fractures (Parker *et al*., 2002; Nauth *et al*., 2017; Guyen, 2019; Lu & Uppal, 2019).

Total Hip Arthroplasty (THA) involves replacing the acetabulum and the femoral head, whereas Hemiarthroplasty involves replacing only the femoral head. Compared to THA, Hemiarthroplasty is a technically easier operation with cheaper expenses, less surgical time, less blood loss, and a decreased dislocation risk (Noor *et al*., 2020). On the other hand, THA is linked to superior functional results, particularly in physically younger and more active individuals. In addition, acetabular erosion may need conversion to a THA, particularly inactive individuals. THA was linked with a considerably decreased reoperation risk and superior functional results in the literature; meanwhile, Hemiarthroplasty was related to a considerably lower risk of dislocation. Hemiarthroplasty was also linked to a higher likelihood of revision in a recent large retrospective analysis. Although THA is a more expensive operation, the study revealed that THA was linked with lower total expenditures than Hemiarthroplasty after a year of follow-up. THA's superior functional results and decreased revision rate may be enough to cover the procedure's initial expenses. Overall, patient variables, including the presence of arthritis, activity level previous to injury, the existence of additional comorbidities, and age, should all be considered when deciding between THA and Hemiarthroplasty.

Cemented versus cementless Hemiarthroplasty can also be used to treat displaced femoral neck fractures. Fat embolism, which can result in cardiac problems, is a potential danger of employing a cemented stem. On the other hand, cementless stems have a greater risk of periprosthetic fracture.

In addition, cementless Hemiarthroplasty was linked with a substantially higher risk of intraoperative fracture and considerably worse functional result ratings at one year.

Cementless stems were also shown to be linked with a substantially higher risk of overall and implant-related problems. The use of cemented stems for displaced femoral neck fractures is recommended due to the higher frequency of periprosthetic fractures and lower functional result ratings with cementless Hemiarthroplasty.

Surgical treatment intertrochanteric femur fractures

The integrity of the lateral cortex and the stability of the fracture pattern plays a big role in implant selection. A well-reduced or intact posteromedial cortical calcar is present in a stable intertrochanteric fracture. The proximal femur can transfer stress and resist medial compressive pressures because the medial buttress is intact (Lewis *et al*., 2019). However, when employing extramedullary fixation methods, unstable intertrochanteric fracture patterns cannot sustain adequate proximal femur reduction. Common patterns are fractures with internal calcaneus damaged by fracture or a large posterior medial segment, fractures extending to the subtrochanteric region, inverted oblique fractures, or transtrochanteric fractures involving fractures in the lateral cortical wall. Intramedullary implants provide more biomechanical stability than sliding hip screws, which is especially essential in the case of unstable intertrochanteric fractures. In these cases, lack of contact between the posteromedial osseous pieces leads to the higher medial compressive stresses being transferred to the implant. The intramedullary device has a shorter lever arm and is closer to the force vector line of action via the middle of the femoral head. As a result, the nail feels less moment for the same force and may withstand higher loads before failing. In the setting of stable and unstable intertrochanteric fracture models, a biomechanical investigation revealed that using the cephalomedullary device caused similar load to failure and considerably less fracture displacement than using the sliding hip.

Intramedullary fixation has been linked to better radiographic results such as limb shortening or femoral neck shortening and reduced rates of partial union compared to sliding hip screw fixation in unstable intertrochanteric fractures. The existence of transtrochanteric patterns and a lateral wall fracture in reverse obliquity might compromise the stability of an intertrochanteric fracture, necessitating intramedullary treatment. In researches investigating sliding hip screws and intramedullary constructions, lateral cortical wall fracture prevalence was a strong independent predictor of implantation and therapeutic failure when using sliding hip screws. Because the lateral cortical wall functions as a lateral buttress, placing a sliding hip screw in the presence of a lateral wall fracture might result in loss of reduction due to medialization of the femoral shaft and lateralization of the proximal femoral component. Furthermore, the fracture plane for reverse obliquity fractures is almost parallel to the path of the sliding lag screw, resulting in a loss of reduction and substantial femoral neck collapse if this implant is used.

Compared to the 95 blade plate, sliding hip screws were linked with greater failure levels in transtrochanteric fractures or reverse obliquity, based on retrospective investigations. When compared to the 95 blade plate, intramedullary fixation was linked with a reduced risk of failure. On the other hand, in the treatment of reverse obliquity and transtrochanteric fractures and any intertrochanteric fracture with lateral wall fracture, intramedullary nails surpass sliding hip screws. This is because the intramedullary device acts as a substitute lateral wall, preventing medialization of the femoral shaft and lateralization of the proximal femoral component.

The most common mechanism of failure of the sliding hip screw fixation is varus collapse of the femoral neck, which results in lag screw cutoff. As a result, the helical blade with a side plate was proposed as an alternate design to increase anchoring into the osteoporotic femoral neck and head, reducing the chance of implant failure. Compared to a conventional lag screw, biomechanical research revealed that utilizing a helical blade provided considerably better resistance to withdrawal and rotational stability (Sanders *et al*., 2017; Gao *et al*., 2018).

The helical blade was linked with a considerably reduced risk of fixation failure in a clinical investigation comparing the sliding hip screw with a helical blade with a lag screw in the context of stable and unstable intertrochanteric fractures. Implant transmission into the femoral head was significantly decreased in the helical blade. In both approaches, the rates of reoperation and cutoff were comparable. Consequently, the side plate with helical blade is a surgical technique with biomechanical and clinical benefits over the typical lag screw approach. Although early research showed that using either the helical blade or the lag screw had similar clinical results, more current studies suggest that utilizing the lag screw has a therapeutic benefit (Ciufo *et al*., 2017; Stern *et al*., 2017; Chapman *et al*., 2018; Lu & Uppal, 2019).

CONCLUSION

Identifying possible risk factors for falls and hip fractures, such as age-related physiological changes and low physical activity levels, is crucial. Increasing awareness and avoiding such characteristics may aid in minimizing the long-term and devastating effects of hip fracture injuries.

Nevertheless, surgical therapy is usually recommended unless the patient has substantial comorbidities that pose an intolerable risk. The fracture displacement determines the fixing method for femoral neck fractures. While arthroplasty is commonly used to treat displaced femoral neck fractures, undisplaced or mildly displaced femoral neck fractures can be repaired with a sliding hip screw or a series of cancellous lag screws. The integrity of the deformation and the preservation of the lateral cortex are important factors in implantation selection in intertrochanteric femur fractures.

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