Hip Fractures

Hisham Gad

MSC

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Hip Fractures

Author:

Hisham Gad MSc
Centre Hospitalier de Bayeux Service de Chirurgie Ortho-
pédique et Traumatologique
13, rue de Nesmond 14400 Bayeux France
hichamgad@yahoo.fr

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Abbreviations

HF: Hip Fractures
FNF: Femoral Neck Fracture
AVN: Avascular Necrosis
DVT: Deep Venous Thrombosis
LMWH: Low Molecular Weight Heparin
VKA: Vitamin K Antagonists
IPCD: Intermittent Pneumatic Compression Device
PU: Pressure Ulcers
SSI: Surgical Site Infection
CRP: C Reactive Protein
ESR: Erythrocyte Sedimentation Rate
SFFN: Stress Fracture of the Femoral Neck

Introduction

Hip fractures (HF) are very common fractures and their frequency is increasing with time. They represent a social and economic problem worldwide. Approximately 330 000 hip fractures occur yearly in the United States [1]. This number is expected to range from 458,000 to 1,037,000 by 2050 [2].

Hip fractures are divided into 3 types: femoral neck, intertrochanteric and subtrochanteric fractures. Fractures of the femoral head, of the acetabulum and pelvic fractures are not included in this review (Figure 1).
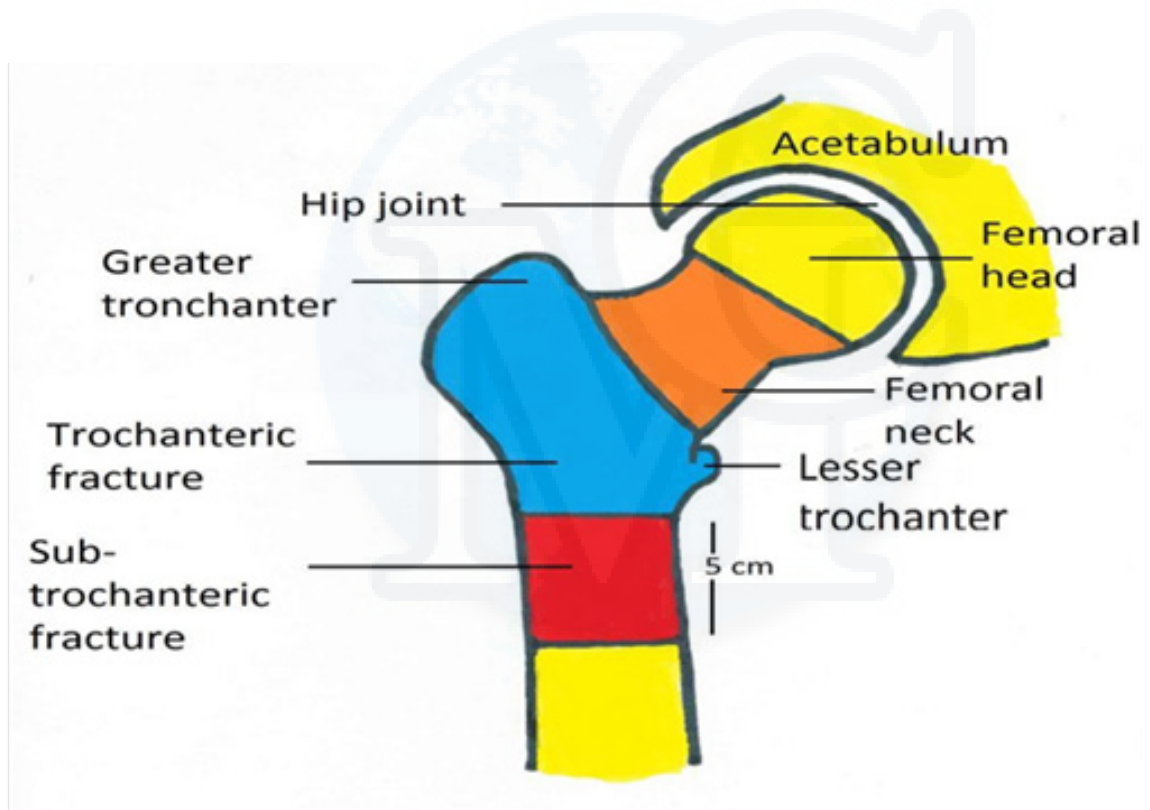
Figure 1: Hip Joint

Risk factors

HF mostly affect elderly patients with osteoporosis following a simple fall, but it can also affect young patients with solid bone following high energy injuries such as road accidents. Risk factors of HF include.

Age

Normally, bone density decreases with age. At the level of the femoral neck, there is a normal decrease in bone density of about 53% in women and 35% in men [3,4]. Almost half of all hip fractures occur in patients aged 80 or over [5]. Another reason for higher frequency of HF in the elderly is that they are more liable to fall.

Sex and race

About 75% of HF occurs in women. This is due to osteoporosis following menopause [6]. HF is more common in white women.

Falls

Difficulty walking, balance and eye problems, mental illness such as Alzheimer disease and other health problems related to aging increase the risk of falling [7]. In North America, about 20% of women between 60-64 years and 33% of women between 80-84 years fall at least once per year. About 1% of these falls lead to a HF. If there is a direct impact on the hip area, the risk of a HF rises to 13% [3].
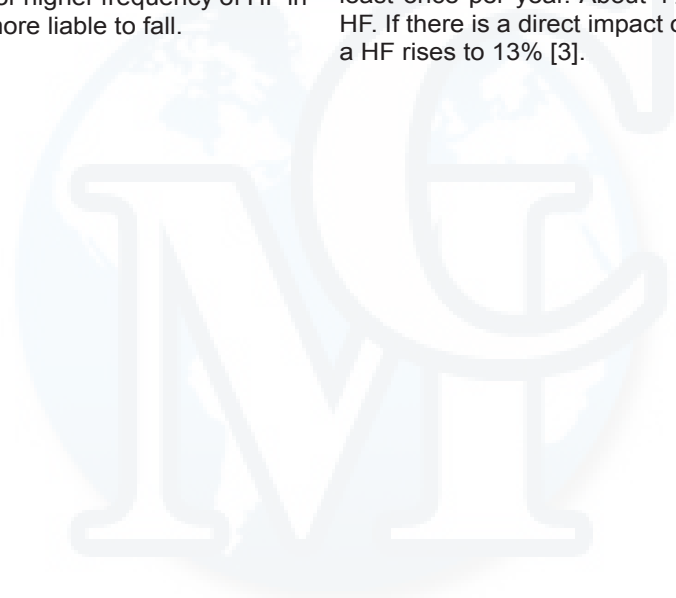
Diagnosis

A patient with a HF presents with pain in the groin and inability to walk. There is shortening of the affected limb with external rotation (Figure 2). A bruise in the hip region may or may not be present. Sometimes, in impacted un displaced fractures, patients are able to walk and there is no lower limb deformity.

Plain x-ray of the pelvis and the affected hip are usually sufficient to confirm the diagnosis,. If there is doubt, MRI is an excellent imaging tool to diagnose hidden hip fractures with 100 % specificity and sensitivity. It is superior to bone scan and CT scan. The only disadvantage of MRI is cost and availability [8]. It is to be noted that if a bone scan is used to diagnose a hidden hip fracture, it may be normal up to 72 hours after a fracture [9,10].

According to the level of the fracture, we can divide HF into 3 types (Figure 1):

I. Femoral neck fracture (FNF) which may be displaced (Figure 3) or undisplaced (Figure 4).

II. Intertrochanteric fracture which cross in the area between the lesser trochanter and the greater trochanter (Figure 5).

III. Subtrochanteric fracture: Below the lesser trochanter until an area 2 ½ inches below.

This distinction is essential as the treatment of each of these three types may differ.

Figure 2: A left femoral neck fracture with shortening and outward rotation of the left lower limb.
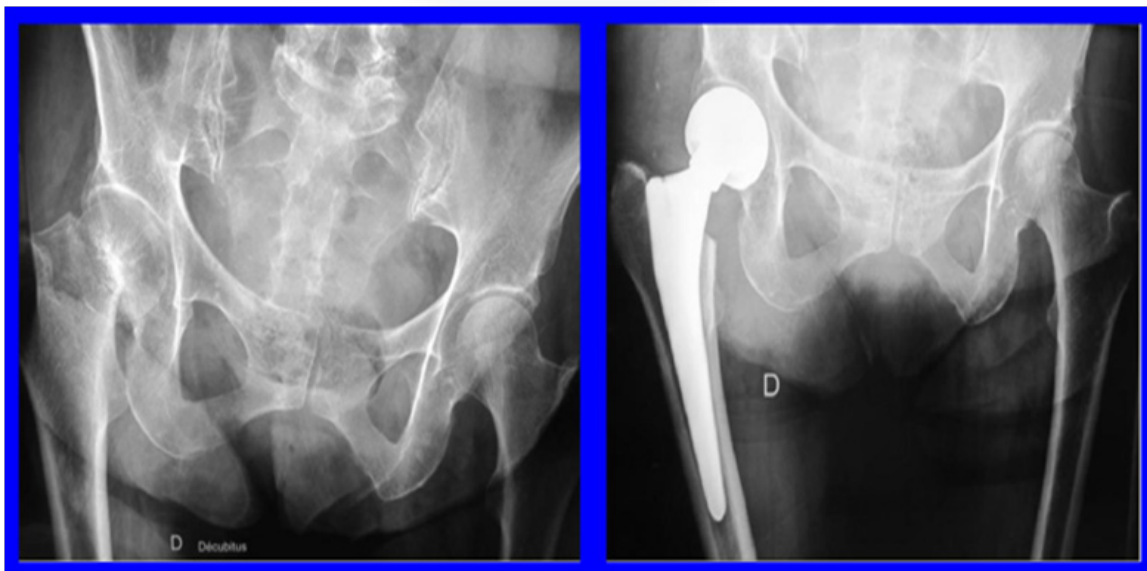
Figure 3: A displaced right FNF (Garden 4) in an 80-year-old patient treated with a femoral prosthesis.
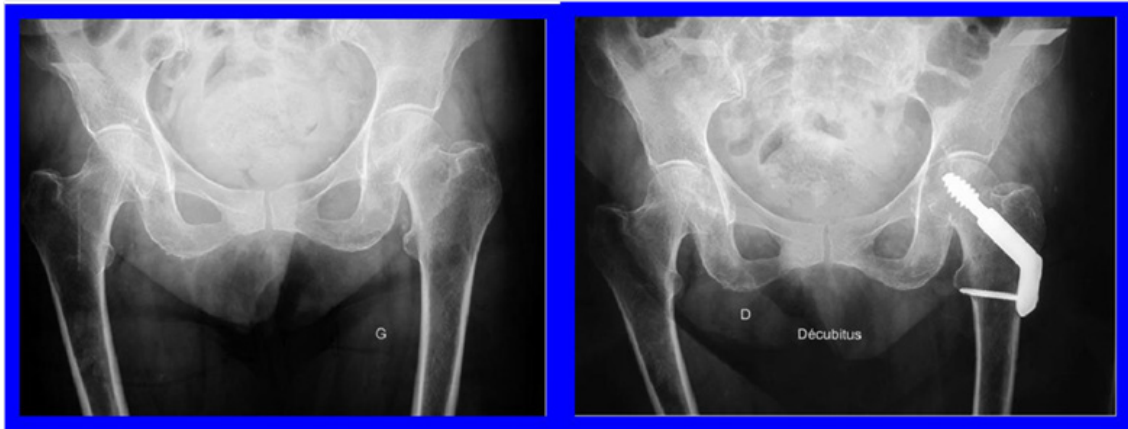
Figure 4: A left undisplaced FNF treated with screw and plate.
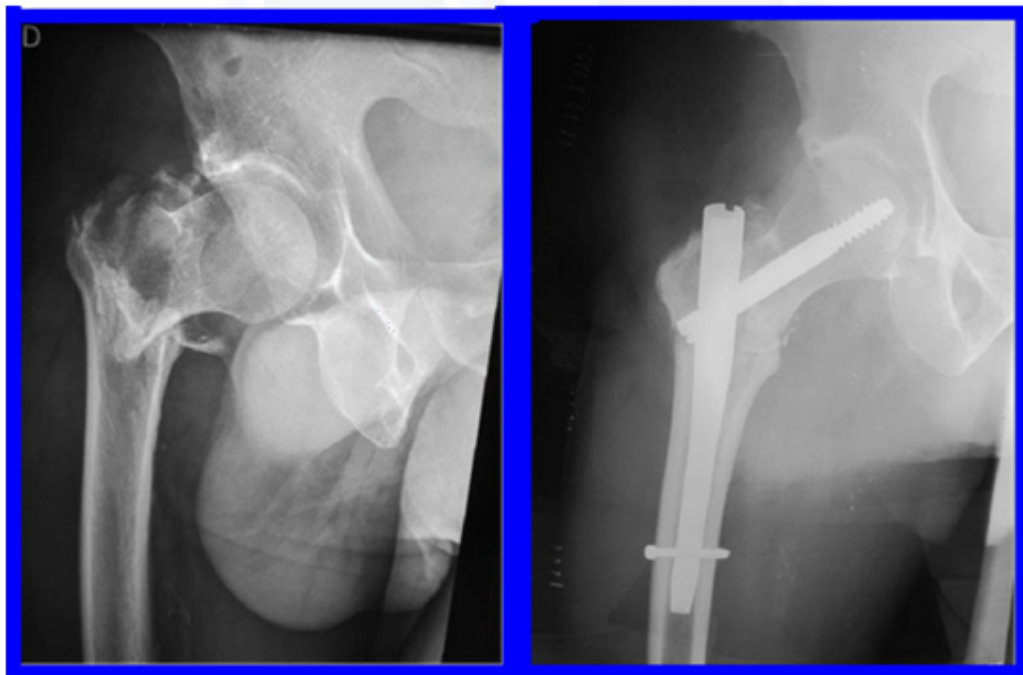
Figure 5: A right intertrochanteric fracture treated with a gamma nail.

Treatment

Treatment of HF is surgical, as surgery is the only way to help these patients regain their autonomy and to avoid complications related to bed confinement. Even in bedridden patients, surgery will relief their pain and allows nursing in good conditions. Exceptionally, in severely ill and fragile patients, surgery may not be done. According to the type of HF, two methods of surgical treatment are available:

Hip prosthesis with or without cement

It is indicated in displaced FNF (Figure 3 & 6). Only the femoral side of the hip joint is replaced,. In most FNF, a femoral prosthesis is used. However, in patients suffering from osteoarthritis before the FN, a total hip replacement may be indicated. A total hip replacement may be also indicated in elderly patients who are active and independent [11] or whose life expectancy is more than 10 years [12] (Figure 6).
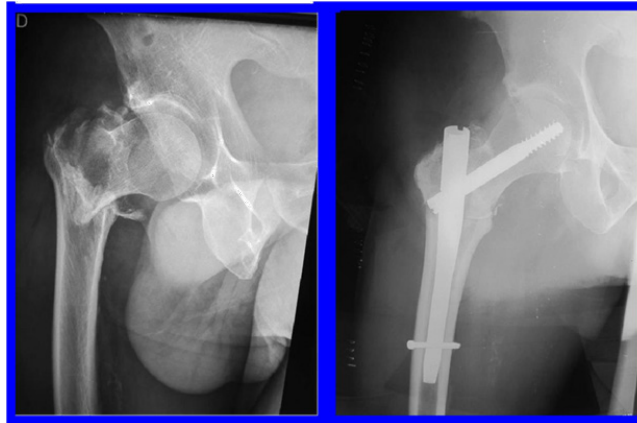
Figure 6: A displaced right FNF (Garden 4) in a 68-year-old active female patient treated with a total hip arthroplasty.

This is because friction of a femoral prosthesis against the patient's acetabular cartilage will eventually lead to acetabular erosion. Acetabular erosion occurs much more rapidly in active patients. This is why some surgeons prefer doing a total hip prosthesis in these patients.

Osteosynthesis using a Screw and a femoral nail or plate (Figure 4,5,7)

Osteosynthesis is indicated in the following cases:

I. Intertrochanteric and subtrochanteric fractures.

II. Undisplaced FNF which represents about 15 % of FNF.

III. Young patients with undisplaced and displaced FNF.

Arthroplasty following a FNF is indicated in displaced FNF because in these fractures the risk of avascular necrosis (AVN) of the femoral head is high, so the femoral head has to be replaced. On the other hand, in intertrochanteric and subtrochanteric fractures, blood vessels nourishing the femoral head and neck are preserved, so the head and neck could be fixed. There are some exceptions where we perform osteo synthesis in FNF instead of arthroplasty. Osteosynthesis is indicated in undisplaced FNF and FNF in younger patients.

In undisplaced FNF (Garden 1), osteosynthesis is possible, as the risk of non union and AVN is much less [13-15]. In younger patients with a displaced FNF, and in spite the risk of non-union and/or AVN, arthroplasty should be avoided. This is because in young active patients, wearing of hip prosthesis is much faster than in older patients. On the other hand, osteosynthesis in young patients will preserve the femoral neck and if AVN develops, hip replacement could be done. These patients will have gained some time. Moreover, patients with AVN after FNF may not require further treatment. [14] (Figure 7).
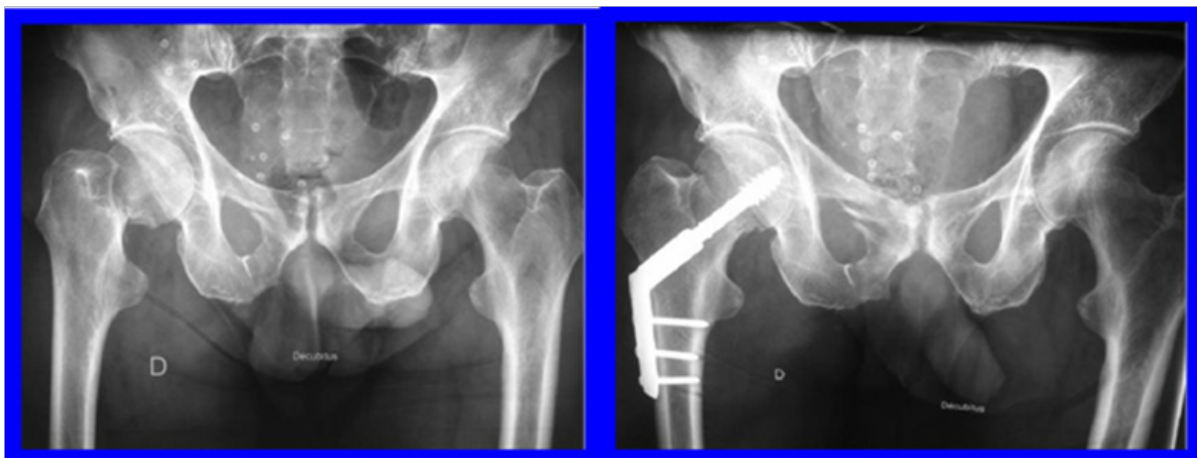
Figure 7: Osteosynthesis of a right displaced (Garden 4) FNF in a young male patient.

Timing of Surgery

According to different studies, it is better to operate elderly patients with HF within 24 hours. Early surgery offers a better functional outcome and a lower rate of complications and death rate after surgery [16-19].

However, some studies found no effect of waiting time between injury and surgery on death rate [20,21] Moreover, operating elderly patients, who often suffer from associated illness, in an emergency setting is not always possible, as these patients often need preparation before surgery. In these patients, a delay of surgery does not result in a significant difference in death rate [22]. In a recent study, comparing two groups of patients, the first operated within 48 hours and the second operated after an average of 1 week from the fracture, no difference in death rate and functional recovery were found at 3 months and 1 year. However, the rate of complications (Pressure ulcers, UTI, DVT and length of hospital stay) was higher in the group with surgical delay [23].

In younger patients with displaced FNF, most studies recommend fracture fixation in the first 6 hours following the fracture, as this will give better results in terms of healing and AVN [24,25].

Here again, other studies showed comparable good results in patients operated beyond 24 hours of the fracture [13,26].

In fact, there are other factors that contribute to the development of non-union and AVN of the femoral head such as the importance of the initial fracture displacement as well as the quality of fracture reduction and fixation [13,14].
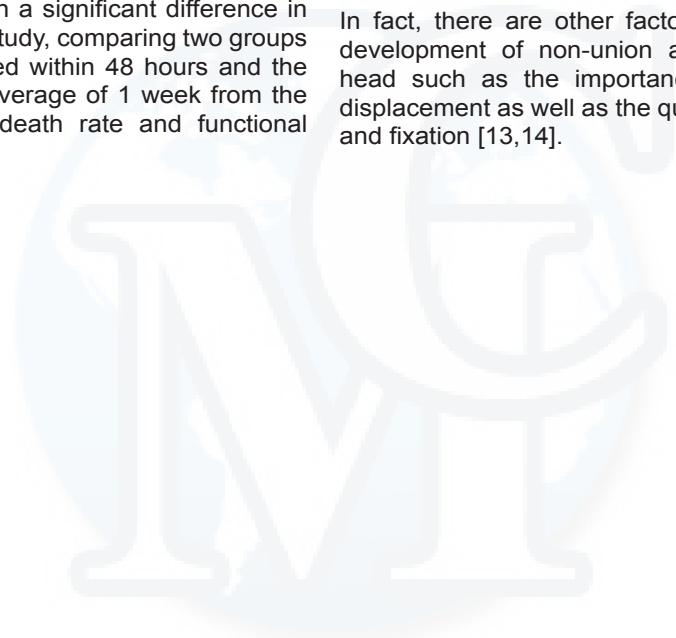
Postoperative Care and Complications

Our aim at this point is to control the pain following surgery, to start ambulation and to prevent and treat complications.

Pain control

Medications for pain started on admission are continued intravenously and then orally. Regional anesthesia using nerve blocks and catheters improves rehabilitation and decreases pain medications after surgery.

Blood loss

A significant number of patients will be transfused following surgery. Blood loss is caused by the fracture itself as well as by surgery. Sub trochanteric fractures tend to bleed more than other types of HF. Blood loss is calculated on the basis of hemoglobin concentration difference before and after the operation. Anemia is defined as blood hemoglobin concentration lower than 12 mg/dl in women and 13 mg/dl in men. Studies have shown that hemoglobin levels lower than 8 mg/dl are associated with poor physical performance, poor functional recovery and increased death rate. In mild anemia, iron supplementation without transfusion may be enough [27].

Risk factors to develop anemia after a HF are advanced age, poor functional level before fracture, heart or lung disease, low hemoglobin level on admission, duration and degree of bleeding during surgery [28]. Other factors increasing the risk of blood loss include patients taking anticoagulants or aspirin before surgery, kidney disorder after surgery, stomach or intestinal bleeding. Blood loss may be less important if regional anesthesia is used [29,30].

Hemoglobin concentration may be overestimated in patients dehydrated before fracture, whereas fluid retention after surgery may underestimate hemoglobin concentration, exaggerating total blood loss [31]. Anemia has been associated with increased death in patients refusing transfusion [32] whereas transfusion has been associated with an increased risk of infection [31,33].

Stockings and anticoagulants

Deep venous thrombosis (DVT) prophylaxis is mandatory. Its risk increases with age. The risk is multiplied by 10 to 20 times after the age of 65 years [34-36]. Other risk factors are obesity, varicose veins, heart disease, stroke and cancer [37]. Signs of DVT are pain and swelling of the affected limb. Sometimes the only signs are fever or tachycardia. In about half of the patients with DVT, there are no signs. Signs of pulmonary embolism are chest pain, coughing and/or shortness of breath. Without treatment, the incidence of (DVT) following a HF is about 48 % and of lung embolism is 8 % [38]. With treatment, the incidence of DVT falls to about 10 % [38,39].

Prevention is through wearing stockings and giving anticoagulants. Recommended anticoagulants include low molecular weight heparin (LMWH), fondaparinux, low dose unfractionated heparin, vitamin K antagonists (VKA), aspirin or an intermittent pneumatic compression device (IPCD) [40]. Patients under low LMWH should have platelets count checked weekly. Several studies recommend continuation of anticoagulants for at least 3 weeks and up to 5 weeks [40-42].

Rarely, in patients in whom anticoagulants are contraindicated, mechanical compression devices may be used to enhance venous circulation. These devices have the potential advantage of reducing the incidence of VTE without the risk for increased bleeding [40]. According to different studies, these devices may significantly reduce the incidence of DVT [43]. Compliance remains a problem with the use of IPCDs. Moreover, properly functioning IPCDs were encountered in less than 50% in a study [44].

Newer portable devices are now available, and a recent study reported increased compliance (77.7% compared to 58.9%) [40,45]. However, anticoagulants remain the mainstay preventive measure against DVT and PE. Performing a Doppler ultrasound to search for silent DVT before discharge is not recommended, as this may lead to unnecessary anticoagulation for several months, resulting in a higher risk of bleeding complications [40].

Delirium

Delirium presents as a change in the patient's mental status with concentration and memory problems as well as changes in the sleep cycle during the first days following surgery. Stress related to surgery and anesthesia and change of the patient's surrounding environment increase the risk of delirium [46].

It is a common problem following hip fractures, estimated between 28% and 61 % [47]. Patients at risk to develop delirium are elderly patients, patients who already have mental or psychological problems before surgery and those operated under general anesthesia. Other factors include opiate medications, inadequate pain control, poor nutritional status and infection [10].

Delirium negatively affects functional results, increases the length of hospital stay and increases death rate after a hip fracture [47]. Certain measures may reduce the risk of development of delirium, such as adequate pain control, decreasing opiates, removing intravenous lines and catheters as soon as possible to decrease the risk of infection. Allowing patients to have an easy access to their eye glasses and their hearing aids, avoiding sleep interruptions, improving the ward environment, active nutrition, regular communication with the patient and the daily presence of family members could be of great help [10]. Delirium is a reversible condition with most patients recovering within 4 weeks. Only a small percentage extends beyond this period.

Depression

Incidence of depression rises with age. A study showed that it increased from 5.6 % at the age of 70 years to 13 % at the age of 85 years [48]. Following a HF, its incidence is about 14 % in patients with no history of depression [49]. Pain and anxiety after a HF increase the risk of depression [50]. Other risk factors of developing depression after a HF are poor mental health, decreased mobility before fracture and history of depression [50].

The first signs of depression appear within 2 weeks from surgery. It presents itself as lack of interest and motivation [51]. Lack of interest known as apathy following a HF is estimated at 37 % in a study [51]. It may cause less participation in physiotherapy programs leading to poorer functional recovery [51].About 1/3 of these patients may recover after 2 weeks [51].

Physiotherapy

Physiotherapy is started as soon as possible to avoid complications related to bed confinement (Pressure sores, DVT, UTI and pneumonia). The intensity of rehabilitation depends on the patient's physical and mental function before the fracture. Patients will sit the day following surgery and will start supervised walking using one or two canes or a walker. If one cane is used it is be held with the hand opposite the fracture side [10].

Weight bearing

Weight bearing on the operated limb is usually allowed immediately after hip replacement. Following fixation of a FNF or an intertrochanteric fracture, weight bearing is usually allowed. However, in case of complex FNF fracture, very fragile bone or in case of doubt as for the quality of fixation weight bearing may not be allowed until 45 days after surgery. The same applies to sub trochanteric fractures.

Prevention of pressure ulcers (PU)

Pressure ulcers occur when there is prolonged compression of skin or underlying tissue between a bony prominence (such as the sacrum or heels) and an external surface (such as a mattress or chair seat), leading to impaired blood flow and depriving tissues of oxygen and nutrients [52,53] (Figure 8).

The main risk factor to develop a PU is immobility. That is why it is a common complication in patients with HF. Incidence of between 8.8 % and 55% has been reported. Other risk factors include poor nutritional status, dehydration, urinary incontinence, age of or above 71 years, poor mental status, bedridden patients, moist skin, diabetes, lung disease, low immunity, cortisone, lower limb vessel disease, long wait before surgery and intensive care unit stay [52-56].

Figure 8: Stage IV pressure ulcer following a hip fracture with exposed bone.

According to severity, PU is classified into four stages:

i. Stage I: Intact skin with non-blanching redness.

ii. Stage II: Shallow, open ulcer with red-pink wound bed.

iii. Stage III: Full thickness tissue loss with visible subcutaneous fat.

iv. Stage IV: Full thickness tissue loss with exposed muscle and bone (Figure 8).

Prevention of PU is through treating risk factors, caregiver education, patient frequent repositioning, keeping the head of the bed at the lowest safe elevation to prevent shear, using pressure-reducing surfaces or devices, assessing nutrition and providing supplementation, if needed. Despite preventive measures, some PU is unavoidable [53].

Treatment of PU depends on the stage: A protective dressing is used in stage I, a moist dressing in stage II and a moist to absorbent dressing in stages III and IV. If dressings are not effective in stages III and IV or if there is infection, topical or systemic antibiotics and surgical removal of infected and dead tissue may be needed [53,57].

Urinary retention

Urinary retention is common after a hip fracture. Up to 82% of patients may have urine retention before surgery [58,59]. It is more common and longer to resolve in elderly patients [60]. Causes include immobility, confusion, pain medications, anesthesia and opiates. These conditions may cause decreased awareness of bladder fullness, bladder over distension or an inability to void [61].

A urinary catheter placement will solve this problem, but it should be removed within 24-48 hours from surgery, as it may increase the risk of urinary retention after removal [10], as well as infection. A study showed that leaving a urinary catheter more than 48 hours doubled the incidence of urinary infection and increased death rate at 30 days from surgery. A catheter may also be needed in case of urinary incontinence or if fluid monitoring is needed [62].

Urinary infection

Urinary infection (UI) occurs in 12 to 53 % of HF patients. It is more common in women and its risk increases if a urinary catheter is placed [63]. It is also very common in diabetic patients following HF [64].

Urine infection must be treated with antibiotics as soon as it is diagnosed to avoid infection of the wound.

Constipation

Constipation is also a common problem especially in elderly patients. It is worsened by immobility and opiates use. Treatment is through diet modification, stool softeners and/or laxatives. At the same time, medications that contribute to constipation are stopped or decreased.

Lung infection

Immobility after surgery is a risk factor. Getting the patient out of bed with early physiotherapy and mobility reduces the risk of lung infection.

Infection of the wound

Surgical site infection (SSI) is a serious, life threatening complication in elderly patients. Infection is more common in diabetics, patients with inflammatory joint disease as Rheumatoid arthritis, malignancy, elderly, obese, patients with mental problems and those with poor medical condition [65]. Delay before surgery, duration of surgery more than 3 hours and previous surgery involving the same joint also have a negative effect [66]. Infection is more common with arthroplasty than with osteosynthesis [67].

The source of SSI may come from the patient's skin (Staphylococcus coagulase negative, Corynebacterium diphtheria, Propionibacterium acne), the patient's or medical staff nose (Staphylococcus aureus), a close or distant organ of the patient acting as a septic focus, such as Gram negative bacilli in urinary and digestive systems, and Streptococcus hemolyticus in the mouth and throat. Strict precautions are normally taken to decrease the risk of SSI including patient's preparation, protocols in the ward and in the operating room and administration of prophylactic antibiotics. Death rate rises if SSI develops. It may reach 50 % at 1 year following surgery [67].

Infection may be superficial or deep. Distinction between them is not always easy. Infection may be early, within 1 month following surgery, or late. The most common bacteria found in SSI are staphylococcus aureus, staphylococcus epidermidis and pseudomonas aeruginosa [67,68]. Diagnosis is based on the presence of inflammation of the wound with or without oozing of pus and/or fever. Low grade fever after surgery as well as redness of the scar with a transparent or bloody oozing during the first days following surgery may be a normal finding. Sometimes, the clinical picture is less revealing and the only symptom present is persisting hip pain months after surgery.

Blood tests may show persistent rise of C reactive protein (CRP), hyperleucocytosis and increased erythrocyte sedimentation rate (ESR). The levels of these normally rise after surgery but should normalize within 3 weeks. They are not specific for SSI and may rise with infection or inflammation elsewhere in the body but with a suggestive clinical picture they may help in diagnosis of SSI. It is to be noted that normal levels of WBCs, CRP and ESR do not eliminate a SSI [69].

Serial measurements are useful for monitoring effectiveness of treatment. Gradual decrease of elevated WBCs, CRP and ESR until normalization reflects effective treatment of SSI. In case of doubt, diagnosis is confirmed by aspiration of synovial fluid. This aspiration is guided using ultrasound or CT scan. Germs may be found on direct examination or after culture. Culture should continue for at least 2 weeks. The presence of more than 1700 WBCs/mm3 and more than 65 % neutrophils (a type of WBCs) is highly suggestive of infection. Absence of bacteria does not eliminate infection.

X-rays of the hip may be normal in early infection. In chronic infection signs of infection such as bone destruction or loosening of the prosthesis may be seen. Bone scan (Scintigraphy) may be done to help in diagnosis. Bone scan with technetium may be abnormal in non infected prosthesis up to 12 months following surgery, so they are not reliable. On the other hand, bone scan with radio labelled WBCs has an accuracy of about 90 % [70].

Once diagnosis is confirmed, treatment should be undertaken as early as possible. Early treatment is essential for eradication of infection. Methods of treatment may vary from one patient to another, but also from one center to the other. However, there are common broad outlines for treatment. First, lavage and irrigation of the hip in the operating room with removal of infected tissue and taking biopsies for germ analysis are mandatory. If diagnosis of infection is early, i.e. within the first month after surgery, the prosthesis may not be removed. On the other hand, in late infections and infections evolving over a long period of time, the prosthesis must be removed, as infection is most probably present between the prosthesis and bone and simple irrigation would not be sufficient to eradicate it [69].

If the prosthesis is removed, a new prosthesis may

be implanted immediately after lavage or after a certain period of time to assure complete eradication of infection. This period may vary from 1 to 6 months. The new prosthesis is implanted after treatment with 2 or 3 antibiotics for 3 months in average and after normalization of WBCs, CRP and ESR levels in blood. Antibiotics used must be effective against the causative germs, have a good bone penetration and well tolerated by the patient. Some studies show comparable results of implanting the new prosthesis immediately or after 1 to 6 months with a success rate of about 80 to 90 % [69], whereas other studies showed disappointing results with immediate implantation of a new prosthesis with a success rate rarely exceeding 50 % [71].

If infection develops after osteosynthesis, irrigation with implant removal and antibiotic treatment are considered if the fracture has already healed. If the fracture has not healed yet, and infection is not severe, irrigation and antibiotic treatment may be done and then implants are removed after fracture healing. On the other hand, if infection is severe or if healing is not expected to occur, removal of implants may be done during the first operation. In this case, a prosthesis may be implanted later after elimination of infection.

Sometimes, in fragile patients, lavage and removal of the prosthesis or implants without reimplantation of a new prosthesis are done. This is called Girdle stone operation. Its inconvenience is considerable shortening of the lower limb and instability on walking.

In patients who are too fragile to be operated, suppressive antibiotics for a long period may be the only possible treatment available [72].

Fracture displacement

Fracture displacement may occur after osteosynthesis. Risk factors are complex fractures, bad positioning of fixation materials [73], osteoporosis and premature weight bearing.

In case of non union there will be either a fracture displacement or rupture of hardware, as there is a race between healing and rupture of hardware. Revision consists of removal of material and implanting a hip prosthesis. If a hip screw penetrates the hip joint and pierces the acetabulum, a total hip prosthesis is indicated as the acetabular cartilage will be compromised (Figure 9). Implanting a hip prosthesis following failed fixation is reliable with acceptable results, but the rate of complications may be high [74,75]. The nail and screw were removed and as the acetabular cartilage was destructed by the screw, a total hip prosthesis was placed

Prosthesis dislocation

I. Incidence of dislocation with femoral prosthesis varies from 0.5 % to 3 % [76].

II. The risk is higher with total hip prosthesis where it may reach up to 10 % [77-79].

III. Using total hip prosthesis with double mobility significantly reduces this complication.

IV. Risk factors include posterior surgical approach [80-83], inaccurate positioning of prosthetic components, patients suffering from neurological disease and patients with mental illness.

Nerve injury

This is a rare complication. Nerve injury causes sensitivity and/or motor problems. Sensitivity problems may be felt as tingling, numbness or burning. Nerves vulnerable to injury in hip fractures are the pudendal nerve, the femoral nerve, the sciatic nerve and the lateral cutaneous nerve of the thigh. The nerve is rather stretched or compressed than torn. This may occur either before surgery while applying traction on the lower limb to reduce the fracture, during surgery or after surgery due to a compressive hematoma. In the later case urgent surgery to evacuate the hematoma is indicated [84].

Rarely, a protruding part of a hip prosthesis or a fragment of cement may come in contact with a nerve, causing irritation [85]. Pudendal nerve injury is probably underestimated. Studies report an incidence of 2 to 15 % [86]. It usually occurs following traction on the orthopaedic table to reduce the fracture. It leads to sensitivity disorders in the area of the perineum and/or incontinence and sexual disorders [87].

In 90 % of cases injury is due to a simple contusion and sensitivity disorders usually resolves within 4 weeks (sometimes more). On the other hand, evolution of severe nerve injury with incontinence and sexual problems is unpredictable [86,88,89]. It seems that the risk is more important in women. It is less frequent in obese patients as fat protects the nerve [86,90]. Risk is related to the force and duration of traction [86]. Femoral nerve injury presents as weakness of quadriceps muscle whose principal function is knee extension. Studies report an incidence of 0.1 to 2.4 % [91].

Sciatic nerve injury leads to weakness of ankle and toes elevators leading to foot drop associated with sensitivity problems at the back of the foot. Its incidence varies from zero to 2.8 % [84,92].

Lower limb over lengthening after hip prosthesis implantation is a risk factor. Recovery from sciatic nerve injury may be partial or complete. Full recovery is estimated at 36 to 60 %. Partial nerve injury has a better chance for full recovery. Average time to recovery is about 10 to 24 months (1 year for partial lesions and 1 and ½ years for complete lesions). Obesity may have a negative effect on recovery [93,94].

Lateral cutaneous nerve of the thigh injury may occur following anterior surgical approach. It causes tingling, numbness or burning sensation on the front or on the outer part of the thigh. It usually does not lead to functional limitations [95,96]. Incidence varies from less than 1 % to 14.8 % [95].

Femoral fracture

Fracture of the femur may occur during surgery while introducing prosthesis or a nail into the femoral canal, or it may occur after surgery. The distal part of a prosthesis or a nail acts as a stress riser. Femoral fracture may also occur after hardware removal due to stress shielding. This is a serious problem with a high complication rate, as it occurs in already fragile patients [95,97]. It is more common in un cemented prosthesis [98-102], where it reached more than 15 % in a study [103].

In another study on 8354 patients with hip fractures treated with either a cemented or uncemented prosthesis, the incidence of femoral fracture was 2.3 % in the uncemented prosthesis group and 0.5 % in the cemented prosthesis group. Seventy two percent were women and the mean age was 86 years [104].

Some studies also reported less pain following cemented prosthesis [105,106]. Advocates of un cemented prosthesis, avoid using cement as it may increase the risk of cardiovascular complications during and after surgery [99,107-109]. However, modern cementing techniques have significantly reduced this risk [110-112]. Most cases of femoral fractures are treated surgically [113] (Figure 10).

Femoral fracture following nail implantation decreased with new nail designs. A study comparing femoral fracture rate in 89 studies on 13568 patients who received a nail following a hip fracture, showed that the incidence of fracture has declined from 2.6 % in older designs to 1.7 % in more recent ones [114]. The prosthesis was replaced by a long stem after doing a femorotomy. A total hip arthroplasty was performed, as painful osteoarthritis of the acetabulum has developed.
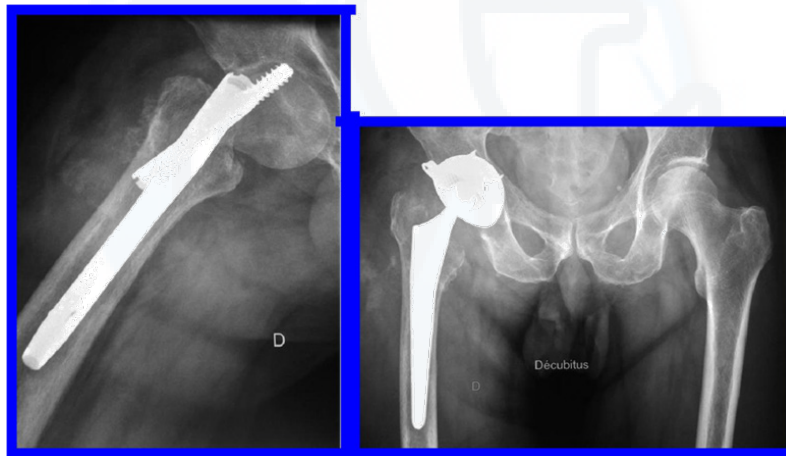

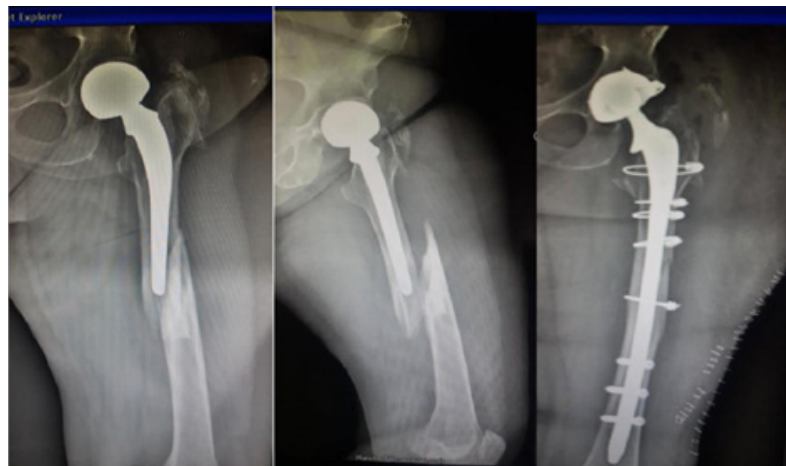**Figure 9:** Perforation of the hip joint by the femoral neck screw.

Figure 10: A 68y old female presenting with a femoral diaphysis fracture 12 years following a FNF treated with a unipolar arthroplasty.

Functional Results

A hip fracture is a turning point of life in elderly patients. 1 year after HF, only 20 to 60 % of living patients have the same activity level as before [115]. Only 40 % of patients who walked without aide will do the same at 1 year, 25 % will need a walker and 10 % will not be able to walk [116]. After a HF, patients have a worse function (walking) and a longer time needed to rise from a chair than women of the same age [117]. Table 1 shows the results of a study on 103 patients comparing their activities before HF and 1 year after the fracture [118].

After a HF, a vicious circle of fear of falling together with hip pain and muscle weakness leads to immobility. Immobility in turn leads to muscle weakness and problems with balance increasing the risk of falls and fractures [119]. Maximal recovery occurs during the first months following surgery. A study showed that recovery beyond 4 months after a HF is little [120].

Table 1: Shows the results of a study on 103 patients comparing their activities before HF and 1 year after the fracture.

Ability To	Walk	Climb Stairs	Take Care of Themselves*	Walk Outdoors
Before Fracture	93.20%	74.80%	90%	73.80%
1 Year After Fracture	70.90%	49.10%	75%	58.20%

*Feeding, dressing and toileting themselves.

Mortality Rate

Death rate during the first year following a HF varies from 22 to 33 % [121]. It may reach up to 67 % in patients over 80 years [122]. Risk factors for a bad outcome are age over 80 years, men, poor general health [122-124], poor function before surgery, complications after surgery [124], especially deep wound infection and pressure sores, a 2nd surgery due to displaced screws [123], poor mental status [4,18], heart disease, lung disease, and a long time between a HF and surgery.

A long time between a HF and surgery is defined as more than 2 days in some studies [125-127] and more than 4 days in one study [128]. In another study, a long time between a HF and surgery seems to increase the risk of complications such as blood clots, pressure sores and urinary and lung infection, without increasing the risk of death [129]. At the same time, a delay in the time of surgery may reflect a fragile health condition which needs to be prepared before surgery and may partly explain the higher death rate in these patients. Whites seem to have better function and fewer death rates than nonwhites [130].

Special Types of Hip Fractures

Stress fracture of the femoral neck (SFFN)

Bone is a dynamic tissue, which remodels in response to muscle force applied to it. Its strength increases when muscle activity increases and decreases when muscle activity decreases [131-133]. Normally, bone is continuously undergoing destruction and reparation. There is a normal balance between these two processes. Any disturbance of this balance may lead to a stress fracture.

In fact, a stress fracture occurs when bone is exposed to a repetitive force, which is beyond the capacity of bone to adapt leading to fracture. It is due to a force that would not normally cause a fracture, but with repetition, becomes capable of causing a fracture. The force applied to bone is from muscle contraction and/or weight bearing on the ground [134,135].

Depending on the quality of bone, there are two types of stress fractures. If a stress fracture occurs following excessive muscle force applied to normal bone, we call it a fatigue fracture. On the other hand, if a stress fracture occurs following normal repetitive muscle force on fragile bone, we call it an insufficiency fracture [136-138]. Insufficiency fractures are most commonly seen in elderly patients, patients with inflammatory joint disease or patients taking cortisone and diabetics [136-139]. Fatigue fractures are most commonly observed in military recruits and in long distance runners [140,141]. Increased training intensity, incorrect training techniques, hard training surfaces and inappropriate footwear may play a role in the development of a stress fracture [142].

Women may be more exposed. SFFN may occur in young women suffering from the female athlete triad. Whites are at higher risk to develop a SFFN than African Americans and Hispanics, probably due to lower bone density [143,144]. First, SFFN presents as pain in the groin that appears during training and disappears at rest, and then pain appears at rest [132]. Sometimes, pain is irradiated to the thigh or the knee. The majority of SFFN are undisplaced and X-rays are usually normal. Bone scan and MRI are very helpful in diagnosis of stress fractures [132].

Displaced fractures or initially undisplaced fractures displaced secondarily may lead to AVN [131]. According to the level of the fracture line, SFFN are divided into 2 types: The compression type and the tension type [145,146]. The compression type initially appears at the lower part of the femoral neck and is considered stable. The tension type appears at the upper part of the femoral neck and is unstable [145,146].

Prevention of SFNN is through modification of training programs, improving training surfaces and footwear modification (Shock-absorbent materials). These measures may help to reduce the risk of SFFN but do not totally prevent them [147]. Treatment of SFFN: Most SFFN are undisplaced and do not require surgical treatment [131].

Undisplaced compression fractures are treated conservatively with no weight bearing until disappearance of pain and normalization of X-rays, physiotherapy for muscle strengthening and adequate nutrition. Treatment of the undisplaced tension type of SFFN is controversial. Some surgeons treat it conservatively while others treat it surgically to avoid secondary displacement, which carries the risk of AVN. Displaced SFFN is treated surgically. As these fractures usually occur in younger individuals, osteosynthesis rather than prosthesis are the method of choice.

Isolated fracture of the greater trochanter

Isolated fracture of the greater trochanter is rare. It usually occurs following a fall on the side of the hip [4,148]. Diagnosis is usually made using plain X-rays. In case of doubt or if a pertrochanteric fracture is suspected, we order an MRI, a CT scan or a bone scan. MRI is more accurate than CT scan [149] and bone scan [148]. However, Modern CT scan seems to be as accurate as MRI [150].

Treatment of isolated greater trochanteric fractures depends on displacement. In un displaced or little displaced fractures, treatment is conservative with bed rest and weight bearing is allowed as tolerated [4]. Some surgeons do not allow weight bearing before 6 weeks. In case of displaced fracture, treatment may be conservative or surgical. Surgical treatment consists of osteosynthesis of the greater trochanter. Weight bearing is not allowed for 6 weeks.

Isolated fracture of the lesser trochanter

Isolated fracture of the lesser trochanter is rare. It occurs in adolescents after a significant injury. In this case healing occurs without surgery [151]. It presents with pain in the groin with limping. In older patients, it often occurs with no history of injury and is usually due to metastasis [151,152]. In this case, preventive fixation with osteosynthesis is considered to prevent a sub trochanteric fracture [151,152].

Pathological fractures

Pathological fractures occur when bone becomes abnormally fragile. This fragility may be due to the presence of a tumor in the femoral neck, or due to a change in bone structure due to a genetic, metabolic or neurological disease. A pathological fracture may occur after a mild injury, which normally would not cause a fracture in normal bone, or may occur without injury. In this case, fracture occurs before the patient falls and the patient may hear or feel a crack before falling. Pathological fractures may be prevented using

osteosynthesis if diagnosis is made before fracture occurs. Before a pathological fracture, patients present with pain at the hip joint that may irradiate to the knee.

Bone tumours

Bone tumours may be benign or malignant. Benign tumours Common benign bone tumours include fibrous dysplasia, aneurismal bone cysts and simple (unicameral) juvenile bone cysts. They are more common in children. Treatment of benign tumours of the femoral neck depends on the type of the tumour, the presence or absence of pain and the risk of fracture. In case of absence of pain with X-rays showing no risk of fracture, observation is indicated. Otherwise, surgery is indicated to prevent a FNF or to treat a spontaneous FNF occurring through a benign tumor. Surgery consists of removing the tumour and fixation of the fracture. Bone usually heals normally. Sometimes bone grafting may be needed. Recurrence of a benign tumour may occur. Some tumours have a higher tendency of recurrence. For example, an aneurismal bone cyst may recur after treatment in 10 to 44 % of cases [153-155].

Malignant tumours

Malignant tumours may be primary or secondary. Primary malignant tumours: The occurrence of a pathological fracture through a primary malignant tumour may worsen the outcome as the fracture may cause spread of malignant cells to the surrounding soft tissue and distant organs [156,157]. It may also increase the risk of recurrence [156-158].

We order CT scan and MRI to evaluate the tumour. Other exams as bone scan, tumour markers may be needed. A biopsy of the tumour should be done before the definitive treatment to confirm the diagnosis and to plan the treatment according to the type of the tumour. If the tumor is sensitive to chemotherapy, it could be started and continued for 3 months before surgical treatment [156]. Radiotherapy may also be used for radiosensitive tumours.

Treatment of a primary malignant tumour with FNF consists of excision and reconstruction of the hip joint using a special prosthesis, bone grafts and cement. The aim is to achieve complete recovery and to avoid recurrence of the tumour.

Metastatic tumours

The most common malignant tumours that metastasize to the femoral neck are and not limited to breast, lung, thyroid, kidney and prostate cancer. A FNF may be the first presenting sign. In general, bone metastasis affect men 3 times more than women. The average age of patients is 61 to 65 years [156,159-162].

Life expectancy is about 40 % after the 1 year and 20 % at 3 years [159]. If bone metastasis is only limited to the femoral neck, especially if the primary tumor originates from the thyroid or the breast [163-165], removal of the tumor may be considered to try to achieve recovery.

On the other hand, if exams show that the tumor has spread to multiple organs, complete recovery is most likely not possible. Our aim here is to fix the FNF in order to relief the pain and to improve the patient's quality of life. Pain control and psychological support are very essential in these patients. Radiotherapy could be very helpful against the tumor but also to relief the pain [156,166,167]. About 70 % of patients are relieved with radiotherapy [156].

Complications of radiotherapy are fatigue, skin irritation, delay of bone healing and radio-induced sarcoma [156]. Treatment of metastatic femoral neck fracture is a femoral prosthesis if the acetabulum is not involved. In case the acetabulum is involved, a total hip prosthesis is indicated. In pertrochanteric and sub trochanteric fractures, osteosynthesis or prosthesis may be considered. Prosthesis is preferred if there is a unique lesion that is too big to be stabilized with osteosynthesis material, when the tumor is not sensitive to radiotherapy and when the life expectancy of the patient is relatively high [168].

Genetic disorders

Examples include osteogenesis imperfecta, osteopetrosis and pycnodysostosis.

Metabolic disorders

Osteoporosis, osteomalacia, primary and secondary hyperparathyroidism [169] and Paget's disease cause bone fragility and may lead to fracture [156].

Other causes of pathological fractures

Juvenile osteoporosis, Gorham's disease and radiation may cause pathological fractures. Pathological fractures following radiation are difficult to heal with up to 40 % rate of non-union, and infection rate after surgery is high [170,171]. Radiation may also lead to sarcoma, which in turn may lead to a pathological fracture [156].

Atypical femoral fractures

Atypical femoral fracture is a recent entity, which has been linked to bisphosphonate medications. Bisphosphonates are the most common medications used for treatment of osteoporosis [172]. Mechanism of these fractures is through bisphosphonate inhibition of bone remodelling by suppressing osteoclast-mediated bone resorption. This leads to micro damage accumulation [173,174] and impaired stress fracture-healing, a reduction in matrix heterogeneity and an increase in advanced glycation end-products [175,176]. Bilateral involvement of AFF affects 28 % to 44.2 % of patients [172,177-179].

According to the American Society for Bone and Mineral Research, diagnosis of atypical femoral fractures (AFF) is based on major and minor features [177]. To diagnose an AFF, all major features must be present. For more accuracy, some authors recommend the presence of both features [172,180]. Other factors include Asian descent, probably due to femoral bowing [179,181].

Major features

I. Located anywhere along the femur from just distal to the lesser trochanter to just proximal to the supracondylar flare.

II. Associated with no trauma or minimal trauma, as in a fall from a standing height or less.

III. Transverse or short oblique configuration.

IV. Noncomminuted.

V. Complete fractures extend through both cortices and may be associated with a medial spike; incomplete fractures involve only the lateral cortex.

Minor features

I. Localized periosteal reaction of the lateral cortex.

II. Generalized increase in cortical thickness of the diaphysis.

III. Prodromal symptoms such as dull or aching pain in the groin or thigh.

IV. Bilateral fractures and symptoms.

V. Delayed healing.

VI. Comorbid conditions (e.g. vitamin D deficiency, RA, hypophosphatasia).

VII. Pharmaceutical agents (e.g. Bisphosphonates, Glucocorticoids, Proton Pump Inhibitors).

It is to be noted that AFF represent only 17 % to 29 % of subtrochanteric or diaphyseal fractures [173]. Moreover, AFF may occur in patients not taking bisphosphonates [182]. Hence, diagnosis must be made precautiously.

Bisphosphonates accumulates in bone and continues to be released for months or years after treatment is continued. That's why it is recommended to stop bisphosphonates after 5 to 10 years of treatment. This is known as a 'drug holiday' [172]. The duration of treatment and of the drug holiday depend upon the type of bisphosphonate and the risk of fracture [172,183].

Treatment consists of stopping bisphosphonate [184], giving an anabolic agent that promotes fracture healing, such as teriparatide [185], calcium and vitamin D supplementation, intramedullary fixation of the fracture and identifying any underlying metabolic bone disease (measuring calcium, phosphate, 25 hydroy vitamin D, etc.) [172]. Finally assessment of the contralateral femur is mandatory especially if there is history of thigh or groin pain [172].

Conclusion

Hip fractures are very common and their incidence is rapidly increasing due to increasing number of aging population. It represents a social and economic problem worldwide. Elderly women are at highest risk due to osteoporosis. Treatment is almost always surgical to allow early mobilization, the only guaranty for better function and avoiding complications. Complication rate is relatively high especially in elderly patients leading to high death rate. Death rate is about 25 % at the end of the first year. A multidisciplinary approach involving emergency doctors, hospitalists, family physicians, orthopaedic surgeons, anesthetists, geriatricians, physiotherapists, nutritionists, nurses, paramedical staff and last but not least support from family members is mandatory.

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