LONGITUDINAL STUDY OF THE INCIDENCE OF PROXIMAL FEMUR FRACTURES IN SÃO JOÃO HOSPITAL: ONE YEAR FOLLOW-UP

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I dedicate this work to my Parents and

my nephew Gabriel

Resumo

As fraturas da extremidade proximal do fémur são um importante fator de morbilidade e mortalidade nos idosos. A Osteoporose e a tendência para as quedas nos idosos são indicadas como as principais causas deste tipo de fraturas. Os objetivos deste trabalho foram: determinar a incidência das fraturas da extremidade proximal do fémur, durante um ano, no principal hospital do norte de Portugal, caracterizar a coorte de pacientes seleccionados relativamente a dados demográficos, clínicos e comportamentais e avaliar a sobrevivência durante o internamento e após a alta hospitalar. Para cumprir os objetivos propostos, foram convidados a participar no estudo todos os pacientes internados com idade igual ou superior a 50 anos com o diagnóstico de fratura da extremidade proximal do fémur provocada por uma queda de baixo impacto. Durante o internamento hospitalar um questionário foi aplicado por entrevista pessoal com questões demográficas, comportamentais e clínicas. Um follow-up de seguimento foi efectuado aos 3, 6, 9, 12 meses após a fratura através de contacto telefónico, de forma a avaliar a sobrevivência dos pacientes. No estudo participaram 252 pacientes, 79% mulheres e 21% homens. Os homens eram quatro anos mais novos que as mulheres. Factores de risco que potenciam a queda e a fratura foram encontrados entre os pacientes como a presença de co morbilidades e a elevada quantidade de medicamentos. A principal causa das fraturas foi queda em casa, reforçando a necessidade do desenvolvimento de ações de prevenção tanto para controlar a osteoporose como para evitar quedas. A letalidade foi alta nos homens e nas idades mais avançadas. Os pacientes com ASA score III e IV e com mais tempo de espera para a cirurgia contribuíram para a elevada letalidade encontrada nestes pacientes.

Palavras- chaves: fraturas da extremidade proximal do fémur, quedas, letalidade, ASA score, osteoporose

Abstract

Proximal femur fractures (PFF) are associated with high morbidity and mortality among the elderly. Osteoporosis and simple falls are the main causes of these fractures. The main objectives of this study were: determine the one year incidence of fractures of the proximal femur in the main hospital in the north of Portugal, characterize, regarding demographic, clinical and behavioral data, a cohort of patients with such a condition, determine the survival rate after one year and investigate the determinants for fatality. To fulfill the objectives patients aged 50 years and above with proximal femur fractures diagnosis caused by low-energy impacts admitted for hospitalization was invited to participate in the study. During hospitalization a questionnaire was applied, through a personal interview with questions about demographic characteristics, both behavioral and clinical. A follow-up study, at 3, 6, 9 and 12 months after the fracture, was conducted with interviews made by telephone. Two hundred and fifty two patients agreed to participate in the study. Women had a higher risk of proximal femur fracture and were, on average, four years older than men at the time of fracture. Risk factors that enhance the fall and fractures were found among the patients as the presence of comorbidities and high number of medication. The majority of the fractures were caused by a fall, at home, reinforcing the need to develop preventive action, either to avoid osteoporosis or to avoid falls in the elderly. An increase in fatality among men and increasing age was found, together with increased delay in surgery and high ASA score classification.

Keywords: Proximal femur fracture, falls, fatality, ASA score, osteoporosis

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- My parents for all their love

List of Original Papers

Paper I: Campos SM, Alves S, Trigo Cabral A, Pina MF. Incidence of a proximal femur fracture: a longitudinal study in the São João Hospital

Paper II: Campos SM, Carvalho M, Trigo Cabral A, Pina MF. Survival in the Elderly, due to Proximal Femur Fracture: One-Year Follow-up Study

Table of Contents

Index of Figures and Tables

List of Abbreviations

ASA Score American Society of Anesthesiologist

LOS Length of hospitalization

PACS Picture Archiving and Communication Systems

PFF Proximal femur fracture

1. INTRODUCTION

In the emergency departments of hospitals, every day people attend with an acute fracture of the proximal femur (PFF). These fractures represent serious injuries affecting both young and old people [1]. In younger groups, these fractures are most commonly seen following accidents of higher impact, such as traffic accidents and falls from a height. After the age of 50, due to the prevalence of osteoporosis and the increased risk of falls at this age, the risk of sustaining a fracture of the proximal femur increases substantially and exponentially with age [1,2]. An osteoporotic bone is more fragile than the normal bone and a simple fall from standing height or less is enough to cause a fracture [3]. Due to the loss of bone mineral density during the years of the menopause, women represent a higher risk group for osteoporosis and consequently the incidence of proximal femur fractures among them is higher than in men [4].

There is a large variation in the incidence of proximal femur fractures around the world [5]. Highest incidences have been seen in North America and in Northern Europe (Scandinavia countries). Lowest incidences have been found in Europe in the Mediterranean area. Portugal together with Germany, Switzerland, Finland, Greece, the Netherland, Hungary, Italy, the United Kingdom, have been described as “high risk” countries defined as having a proximal femur fracture probability that lies between 50% and 75% of the risk that is observed in Sweden, which is a very high risk country [6]. Asia, Africa and Latin America represent, as far as is known, regions with lowest incidence rate, but the increasingly elderly population and the change in habits seen recently in these countries will help to increase their future risk [7,8]. The geographic variation of the incidence of proximal femur fractures not only occurs between different countries but significant differences can be found in regions within the same country and between races [9,10]. Portugal is an example of this internal variability. In a study using Portuguese hospital registers (2000-2002), Pina and co-workers studied the geographic distribution of age-standardized incidence rates of proximal femur fractures in all of the 18 districts of Portugal [11]. They found in the north of the country, for instance in the district of Porto, an urban/semi urban area, regions with incidences that ranged from 154.4 to 572.2 among women and from 77.4 to 231.5 among men, per 100,000 inhabitants. In contrast in the northeast in the

rural district of Bragança and in the south in district of Faro (the hottest district of Portugal) highest incidence was found for women ranging from 350.0 to 572.2.

Worldwide, over the last few years, the incidence of proximal femur fracture has increased considerably, mainly due to the aging of the population. As the elderly population grows, the number of people at risk of sustaining a fracture of the proximal femur also increases. According to the epidemiologic projections the worldwide annual number of proximal femur fractures will rise to 6.26 million by 2050, becoming a major public health problem [12].

Proximal femur fracture patients lose a lot of their quality of life because of the fracture [13]. Most of them lose their autonomy, becoming dependent on others for walking and to performing simple activities of daily life [14]. Institutionalization and social isolation increase among these patients. Their families lose the ability to take care of them and the houses that they lived before the fracture do not have the best conditions for a person with reduced mobility [15]. Difficulties in walking and the decline seen in bone mineral density during the year of fracture increase their risk of suffering a second fracture or another fall [16]. Clinical practice guidelines frequently recommend osteoporosis evaluation and treatment of adults with minimal trauma fractures in an effort to prevent subsequent fractures [17,18,19]. However many studies have shown that patients with proximal femur fractures rarely receive bone protective therapies or adherence to the treatment is low [20,21].

Another adverse outcome associated with these fractures is the higher risk of fatality that these patients are subjected to in the first months to a year following the fracture [22]. Fatality increased with age and is higher among men even if they are younger than women at the time of the fracture [23]. The risk declines with time but remains higher when compared with the general population without a fracture but of similar age and sex distribution [24,25]. The higher fatality observed following a proximal femur fracture is difficult to explain and to find the main causes. Many of the patients who sustained this fractures tend to have other medical problems (comorbidities) that might also put them at risk of dying. Several studies have shown that the presence of comorbidities influences the treatment, the recovery process and survival [26,27]. Other studies suggested that some fatalities observed after a proximal femur fracture may be associated with complications triggered by the fracture itself or related to post-operative complications [28,29,30]. An effort is being made to identify patients at higher risk of death, and to find among them risk factors

that might influence mortality and that can be modified, in order to improve survival rates [24,31]. Older age, male gender, place of residence before the fracture, degree of mobility and cognitive state at the time of the fracture, time of surgery, number of comorbidities and their severity are seen as good predictors of mortality [32,33,34]. An early identification of patients with less chance of survival would be beneficial for the patient, the doctors and for the health care systems [35]. The patients and families would benefit from realistic information regarding the outcome. The doctors would be able to make appropriate decisions concerning the type of orthopedic surgery to use and either to optimize comorbidities or to perform early surgery. The health care systems would benefit from a proper allocation of resources, reducing the cost, normally related to these kinds of fractures.

A multidisciplinary team is required in the treatment of patients with proximal femoral fracture. The management of these fractures demands from the health care systems and from society a huge economic effort, during the acute care and the rehabilitation phase [36]. Almost half of the costs are related to the time spent in hospital beds in recovering from the fracture involving surgery, medication, laboratory and radiology cost [37]. These account for nearly as many hospital days as acute myocardial infarction and for more than prostate and breast cancers combined [38]. Some of the rehabilitation costs involved nursing care, home care assistance, institutionalization, walking aid devices and transportation to physiotherapy centers. In Europe, based on the expected changes in the demography, the economic burden of osteoporotic fractures has been estimated at €76.7 billion a year 2050 [39].

There is a clear need to reduce the number of proximal femur fractures as they represent an important cause of morbidity and mortality among the elderly and consume a large amount of health care resources. Recognizing and understanding the factors that affect the risk of hip fracture could help in the early identification and treatment of higher risk individuals.

Improving care and prevention is an urgent clinical and public health priority.

1.1. Proximal Femur Fractures - Studies in Portugal

In Portugal, over the last few years some epidemiological data on proximal femur fractures have been published. Most studies used retrospective data from medical records in the Hospital [40,41,42,43] or from the National Hospital Discharge Register [44,11]. The Health Information and Financial Management Institute (Instituto de Gestão Informática e Financeira da Saúde– IGIF) of the Portuguese Health Ministry manage this register.

The first article published in Portugal reported the results of a four-year study, covering 1981 and 1986, where the incidence of proximal femur fractures was determined in a region with nearly 1,100,000 inhabitants of the district of Porto. The incidence reported concerned 128 women and 84 men, per 100,000 inhabitants [45].

In 1988 an epidemiological study carried out in a population of 88,692 inhabitants aged over 50 from the city of Porto in the catchment area of the São João Hospital reported an incidence of 297/ 100 000 among women and 136/ 100 000 among men [46]. In this year the fact that 5,600 fractures had occurred throughout Portugal was extrapolated.

At the beginning of the 21st century a study using the data from the National Hospital Discharge Register found in the period between 2000-2002, significant geographic differences in the incidence of these fractures in 18 districts of Portugal. Spatial clusters of high incidence rates were found with annual averages (per 100.000 inhabitants) varying from 154.4 to 572.2 and 77.3 to 231.5 for women and men respectively.

In 2003, recommendations for therapeutic intervention in the elderly with a fracture of the proximal femur were published by the Direcção Geral de Saúde of Portugal with the aim of standardizing the treatment of these fractures and to optimize the functional outcomes with reduced length of stay and cost [47].

A study published by the Direcção Geral da Saúde of Portugal in 2006 showed that fractures of the proximal femur had occurred 9523, almost double the numbers for 1988 [48]. The hospitalization cost of these fractures increased substantially from nearly €11 million in 1988 [49,50] to 52 million euros in 2006 [51]. The average cost per patient with a proximal femur fracture represents the second highest cost when compared with diseases like chronic obstructive pulmonary disease, myocardial

infarction, chronic alcohol hepatic diseases, neoplasm of the digested tube [52, 53, 54].

In 2007, the Portuguese Society of Rheumatology and the Portuguese Society of Metabolic Bone Diseases published a document with recommendations for the diagnosis, clinical evaluation, prevention, treatment and monitoring of osteoporosis. These guidelines aim to achieve, through validated clinical practices, the reduction of osteoporotic fractures in post-menopausal women and in men [55].

In 2009, a prospective study conducted in a defined geographical region, the district of Viana do Castelo, during one year was published [56,57]. The advantages of prospective studies consisted in a better control of the information received, improving the local knowledge of risk factors and avoiding missing and biased information and codification errors.

The present study is a prospective study developed in the catchment area of São João Hospital during one year. The information was collected directly from the patient and from realistic sources, avoiding biased information. With this study we aim to increase knowledge in Portugal on risk factors and fatality in patients with a proximal femur fracture.

1.2. Objectives of the Study

The objectives of the present study were:

- To determine the one year incidence of fractures of the proximal femur in the São João Hospital and to characterize, regarding demographic, clinical and behaviour data, a cohort of patients with such condition;

- To identify risk factors that explained the occurrence of the fall and fracture in order to trace the profile of patients with a proximal femur fracture;

- To determine fatality in hospital and at 3, 6,9,12 months after the fracture;

- To investigate the effect of demographic, social or clinical variables on one year fatality in an attempt to find the main predictors of fatality.

1.3. Structure of the thesis

This work was structured in six important chapters: introduction, state of art, material and methods, results, papers and discussion.

In the introduction of this work, in a succinct way the main aspects related to the proximal femur fracture was approached, such as incidence variability, mortality, morbidity and the costs associated. Then some studies developed in Portugal concerning the problem of proximal femur fracture were referred to. The final part involves the presentation of the objectives of the study and the structural description of the work.

The state of art began with a small approach to the anatomy of the proximal femur. This was followed by a characterization of the different types of fractures that may occur in the proximal femur and the different surgical treatment commonly used to restore the functionality of the hip. This chapter was completed with an approach to the main risk factors for proximal femur fractures, osteoporosis and falls.

In materials and methods the methodology in the selection of the patients and in the implementation of the questionnaire during the hospitalization and during the follow-up study is described. In this chapter some important variables used in the study were presented and the statistical methods applied in the characterization of the study were explained.

In the results chapter there is a link with the papers chapter as some of the results are described and presented in the form of papers.

In the last chapter the results were discussed and the main limitations of the work are described.

All work undertaken is aimed at all those who have an interest in acquiring knowledge on this subject.

2. THE STATE OF ART

2.1. The Anatomical Structures of the Proximal Femur

The femur is the longest and strongest bone in the human body and is responsible for bearing the largest percentage of body weight during normal weight-bearing activities. The femur, like other long bones, is divisible into a body (shaft) and two extremities [58]. The proximal extremity of the femur forms the hip joint with the acetabulum and the distal extremity forms the knee joint with the tibia.

The bone structures that form the proximal extremity of the femur are the femoral head, the femoral neck, the greater and the lesser trochanter [58]. These bone structures are showed in Figure 1.

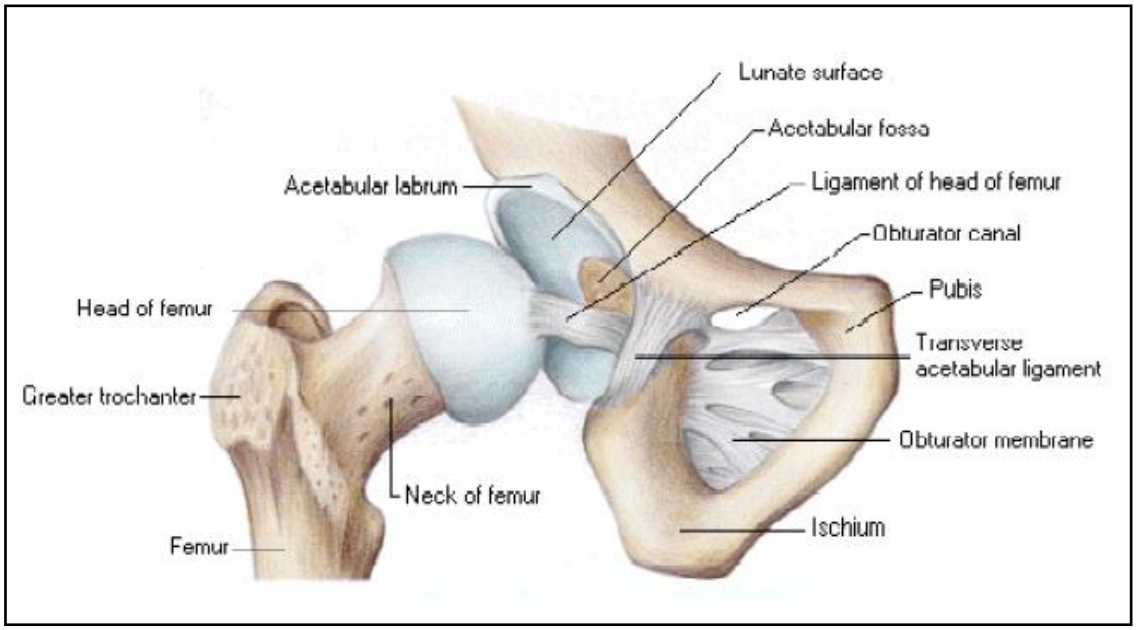


Figure 1 Bone and ligaments structures of the proximal extremity of the femur
Source:http://www.netterimages.com

The femoral head is similar to two thirds of a sphere, and fits into a cup-shaped depression in the hip bone, the acetabulum, to form the hip joint, a ball and socket joint [59].

The acetabulum is formed by the three bones of the pelvis, the Ilium superiorly, the pubis anteroinferiorly and the ischium posteroinferiorly. It is coated by a hyaline

cartilage and bounded by a prominent rim to which the glenoidal labrum attaches, deepening the surface that will receive the femoral head.

The head of the femur is smooth and coated by hyaline cartilage except in a small depression called the fovea of the femur to which the ligamentum teres femoris, also known as the ligament of the head of the femur is attached. This ligament is clearly seen in figure 2 as a coronal plane of the hip joint, together with other structures that are important to the functionality of the hip joint, such as the hyaline cartilage and the synovial membrane and fluid.

The hyaline cartilage covering acts as a shock absorber during compressive force, and provides smooth surfaces allowing easier motion without pain. A synovial fluid between the two surfaces acts as a lubricant to reduce friction.

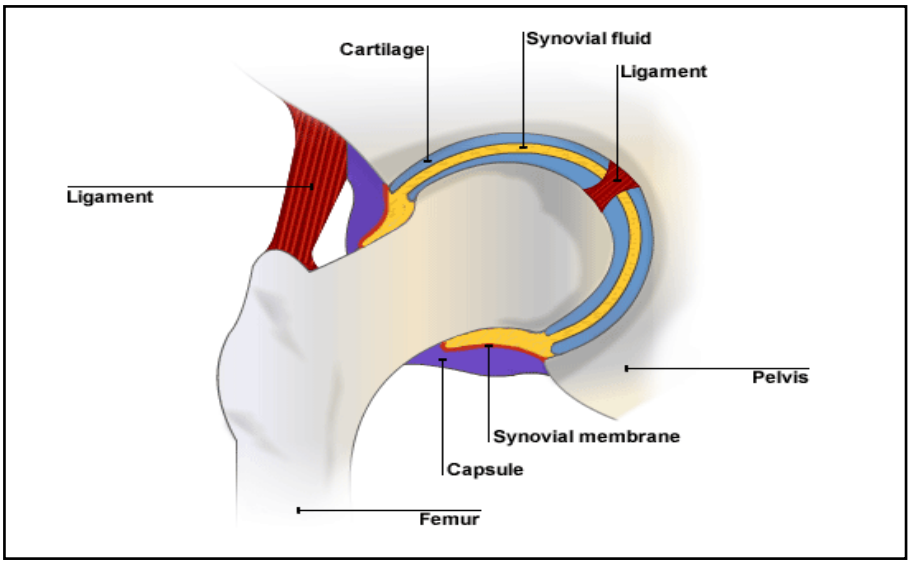


Figure 2 Coronal plane of the hip joint showing the hyaline cartilage covering the acetabulum and the femoral head and the synovial fluid between then.
Source:http://www.bbc.co.uk/scotland/learning/bitesize/standard/biology

The ligament of the head together with the hip joint capsule, a strong and dense fibrous structure, is responsible for maintaining the head of the femur within the acetabulum thus avoiding the occurrence of dislocation of the head, during the movement of the hip.

The hip capsule covers the entire femoral head surrounding the neck of the femur and is attached anteriorly to the intertrochanteric line and posteriorly 1.25 cm above the intertrochanteric crest (figure 3).

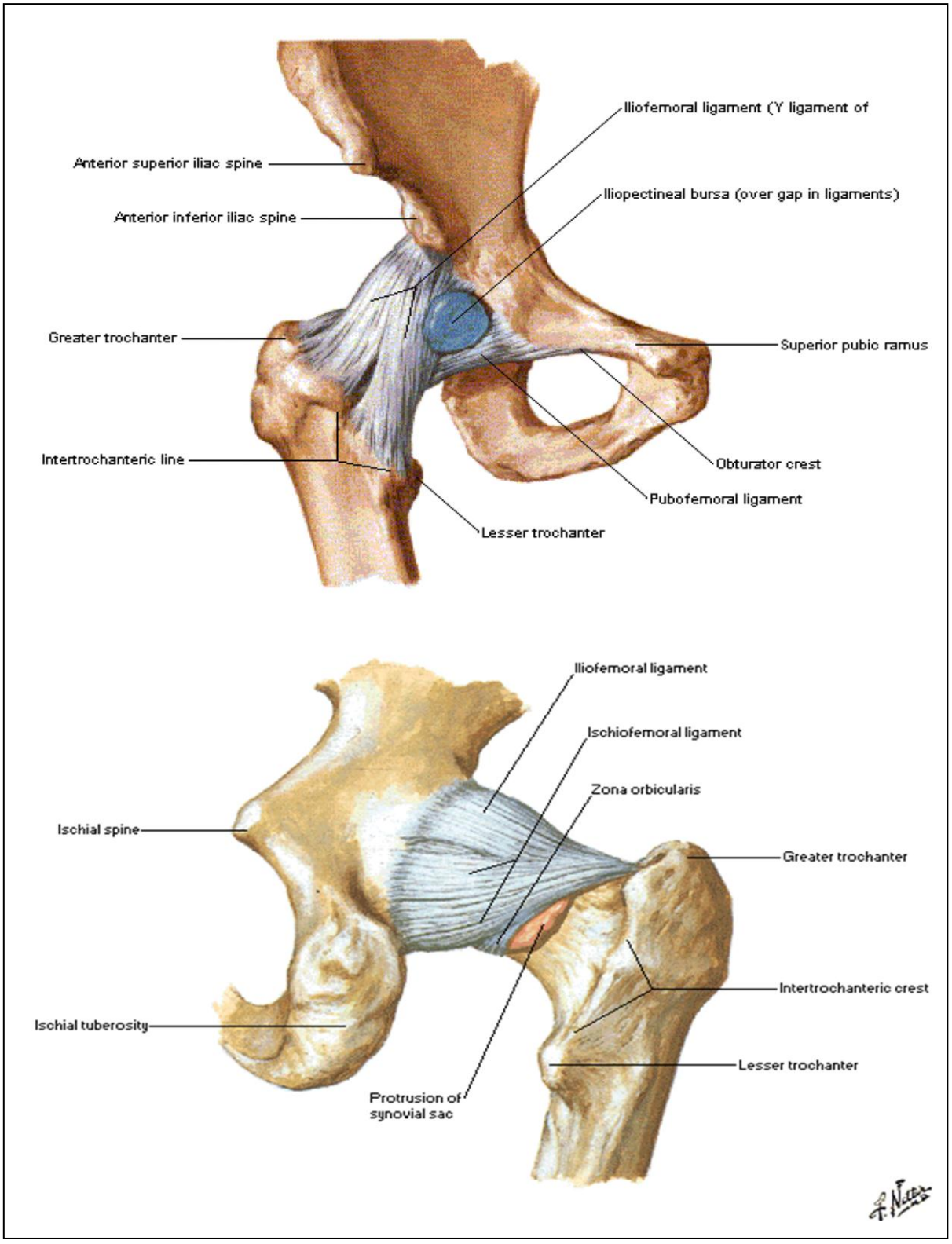


Figure 3 The right hip joint. Anterior and posterior view of the hip capsule
Source:http://www.netterimages.com

The capsule of the hip is divisible into thickened layers forming anteriorly the iliofemoral and pubofemoral ligaments and posteriorly the ischiofemoral ligament.

The femoral neck comprises the region between the base of the femoral head and the intertrochanteric line anteriorly and the intertrochanteric crest posteriorly. As shown in figure 4 the femoral neck, when viewed from the front, forms an angle with the femoral shaft, known as the angle of inclination, ranging from 125º to 140º, an average value on population of 135º [60]. Abnormally small angles of inclination are known as coxa varus and an abnormally large angle as coxa valgus. Viewed from above, the femoral head and neck form an angle of anteversion in relation to the axis of the femoral condyles, ranging from 10º to 15º, an average value on population of 9.73º [60]. Abnormal angles increase stress on the hip joint, affecting the normal gait and causing impingement, joint destruction and osteoarthritis. Differences existed between men and women and between those younger and older than 50 years of age.

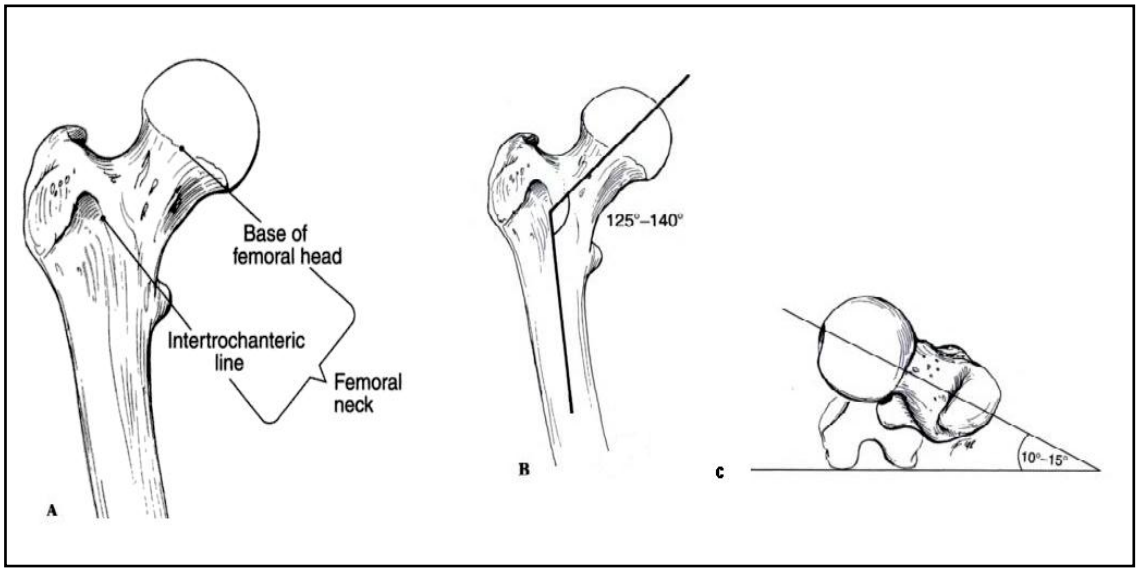


Figure 4 Proximal femur. (A) Anterior aspect of proximal extremity of the femur. (B) The femoral neck forms an angle with the femoral shaft ranging from 125º to 140º in the anteroposterior plane (C) and anteversion of the femoral neck in relation to the axis of the femoral condyles, 10º to 15º (C).
Source: http://www.netterimages.com

The intertrochanteric region between the greater and lesser trochanters represents a zone of transition from the femoral neck to the femoral shaft.

The greater trochanter can be felt on the side of the proximal thigh and normally when a fall to the side occurs this is the structure that absorbs the impact. The greater and the lesser trochanters are the site of insertion of important muscles. The subtrochanteric region extends from the lesser trochanter to an area 5 cm distal.

2.1.1. The Muscles of the Hip Joint

The ranges of motion of the hip joint include flexion, extension, abduction, adduction and rotation. The muscles of the hip joint are responsible for all these movements and particularly for the movements necessary for locomotion. They are also necessary in keeping the body stable while standing, walking and when performing weight-bearing activities.

The muscles that surround the hip are often divided into four groups: the gluteal group, the lateral rotator group, the adductor group and the iliopsoas group [58].

2.1.1.1. The gluteal group

The gluteal group includes the gluteus maximus, gluteus medius, and gluteus minimus. Of these muscles only the gluteus medius and the mimimus are attached to the greater trochanter of the femur. These muscles originate from the external surface of the Ilium and their actions are to abduct the thigh and rotate it medially (Figure 5).

The gluteus maximus is one of the largest muscles of the body and acts to extend the hip and assists in externally rotating the hip.

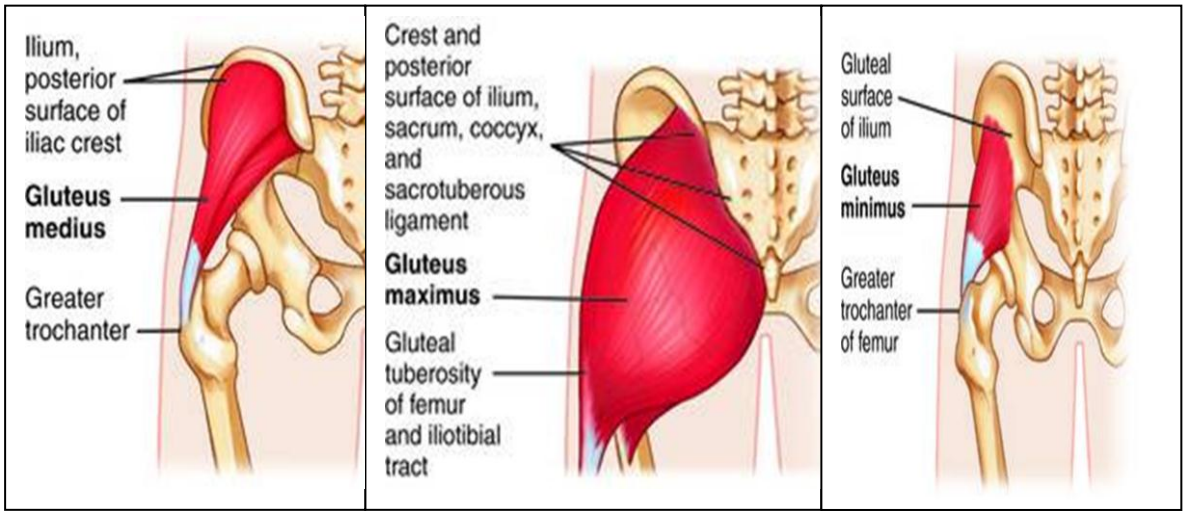


Figure 5 The Gluteus muscles.
Source: http://img.tfd.com/MosbyMD/thumb/gluteus-2.jpg

2.1.1.2. The lateral rotator group

The lateral rotator group includes the muscles shown in figure 6. They are the piriformis muscle, the obturator internus and externus, the inferior and superior gemellus and the quadratus femoris.

The Piriformis muscle originates from the capsule of the sacroiliac articulation and the margin of the greater sciatic foramen. It is inserted on the superior border of the greater trochanter of the femur. Its action is to rotate the femur laterally and to abduct the thigh when the leg is flexed.

The Internal Obturator muscle originates on the medial surface of the obturator membrane, the ischium and the rim of the pubis attached to the greater trochanter of the femur in the trochanteric fossa. The External Obturador muscle originates on the postero medial surface of the pubis and ischium and is inserted in the trochanteric fossa. Their functions along with the piriformis muscle are to laterally rotate the thigh and hold the head of the femur in place inside the acetabulum.

The Gemellus Inferior and Superior are two small muscles which arise from tuberosity and from the spine of the ischium respectively and they are inserted into the lower and upper surface of the tendon of the Obturator internus respectively.

The Quadratus Femoris muscle is a strong lateral rotator and adductor of the thigh. It originates on the lateral border of the ischial tuberosity of the ischium and is attached to the intertrochanteric crest.

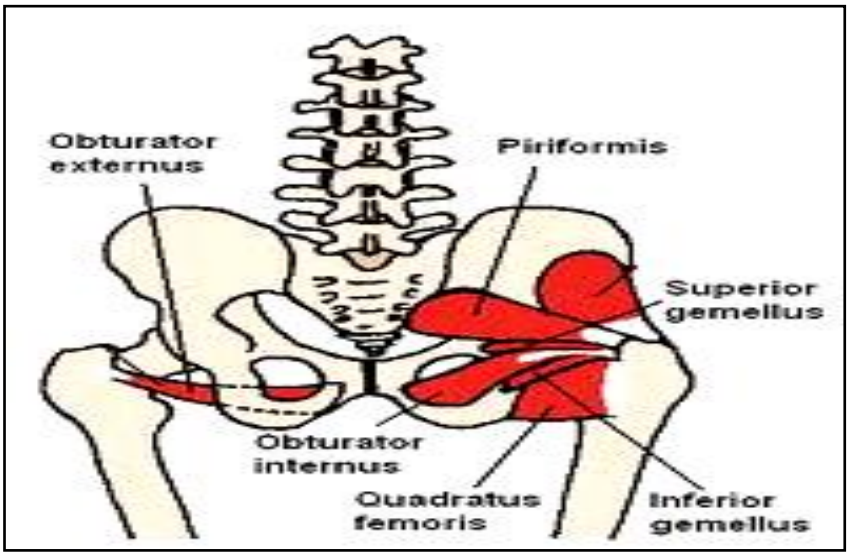


Figure 6 The lateral rotator group of the hip joint.
Source: http://upload.wikimedia.org/wikipedia/

2.1.1.3. The Adductor group

There are numerous adductors of the leg, including the pectineus, adductor brevis, adductor longus, adductor magnus and gracilis muscles, shown in figure 7.

The adductors originate on the pubis and ischium bones and are inserted on the medial, posterior surface of the femur. Their action is to adduct the thigh and flex the hip and knee.

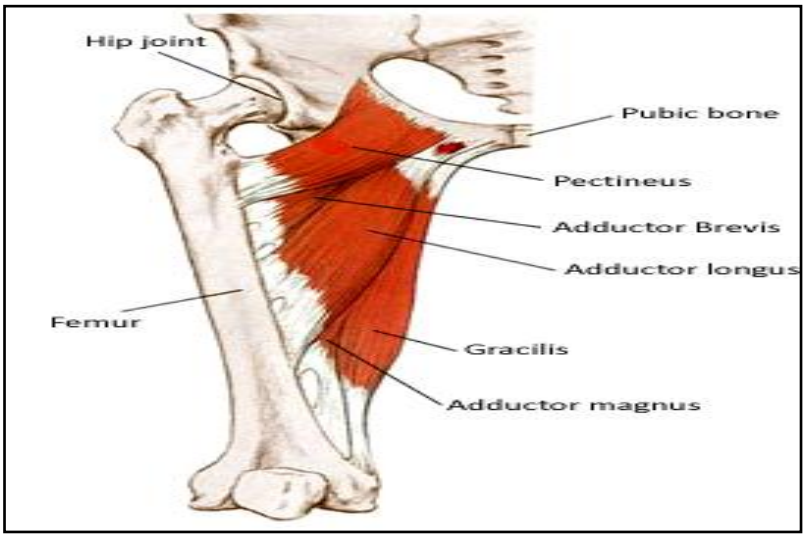


Figure 7 The adductor group of the hip joint.
Source: http://thansworld.com/exercise / images/section8/adductos.jpg

2.1.1.4. The Iliopsoas group

The Iliopsoas group includes the Psoas muscle and the Iliacus muscle, both acting to flex the thigh at the hip. The Psoas muscle runs from the transverse processes of the lumbar vertebrae to attach to the lesser trochanter, The Iliacus muscle originates from the iliac crest, iliac fossa and ala of the sacrum lateral and attaches below the lesser trochanter (Figure 8).

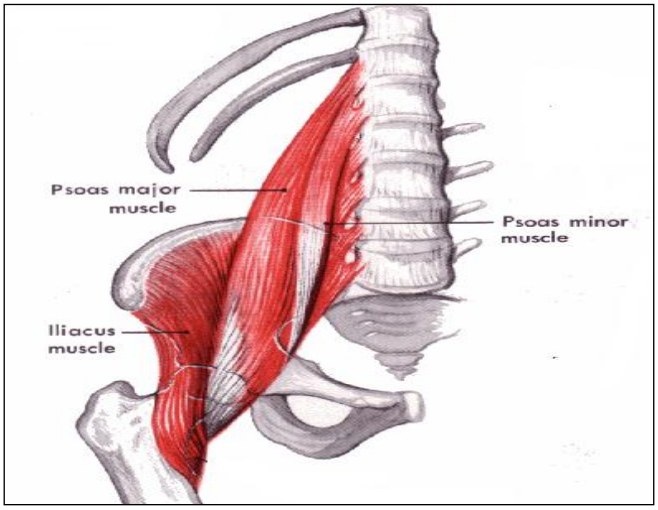


Figure 8 The Iliopsoas group
Source:http://destroychronicpain.files.wordpress.com

2.1.1.5. The tensor muscle of fascia latae

The basic functional movement of the tensor fascia latae is walking. This arises from the posterior part of the outer lip of the iliac crest and from the outer surface of the anterior superior iliac spine. It is inserted between the two layers of the iliotibial band of the fascia lata around the junction of the middle and upper thirds of the thigh. Its action is thigh flexion, abduction and medial rotation.

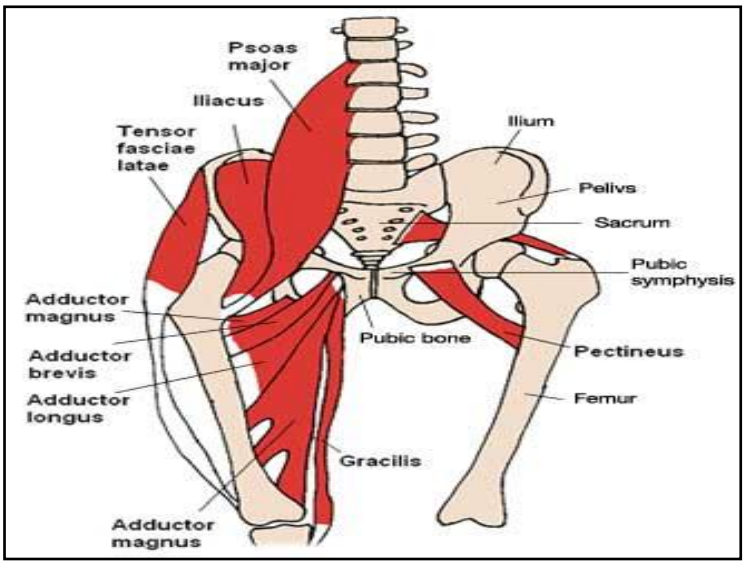


Figure 9 Tensor muscle of fascia latae and other muscles of the hip.
Source: http://upload.wikimedia.org/wikipedia/

2.1.2. The Blood Supply to the Proximal Femur

The blood supply to the femoral head and neck is complex, as can be seen in figure 10 and has important orthopaedic implications.

The medial and lateral femoral circumflex arteries provide 80% to 90% of the blood supply to the femoral head and neck [61]. These arteries are a branch of the profunda femoris artery, which in turn is a branch of the femoral artery.

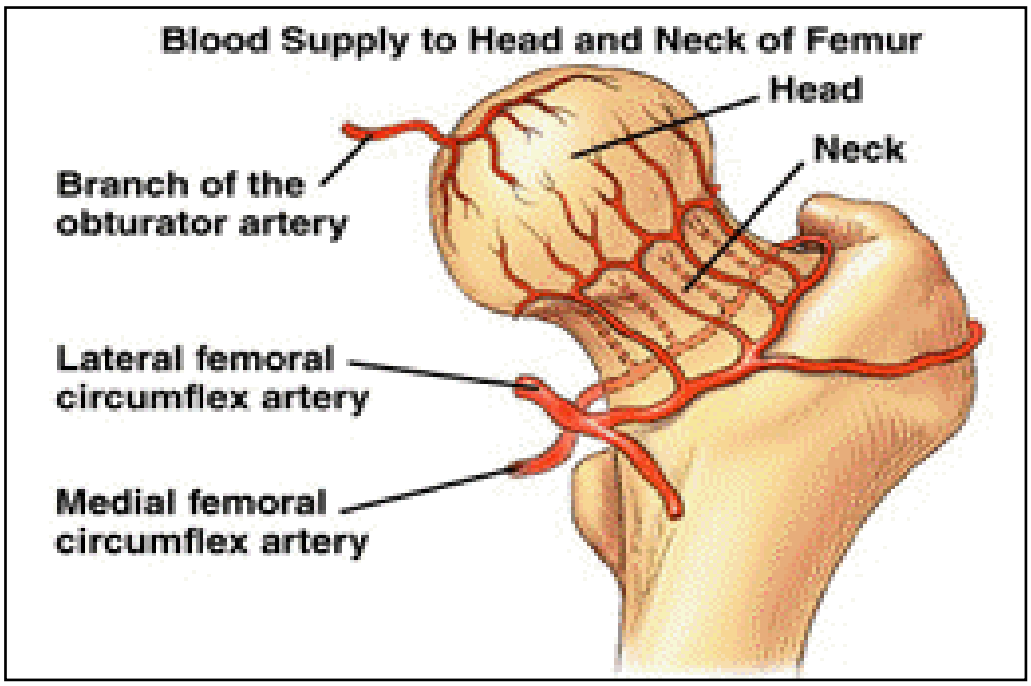


Figure 10 Posterior view of the proximal femur showing the blood supply of the femoral head and neck
Source:http://www.zimmer.co.uk/web/images/anatomy/hips/Traumatic ArthritisHip1.jpg

At the base of the femoral neck, outside the capsule, branches from the medial and lateral circumflex arteries anastomose to form an arterial ring. From this arterial ring, a group of arteries, known as reticular arteries, penetrates the joint capsule and runs deep to the synovial membrane, which covers the femoral neck. The superior retinacular arteries give rise, at the base of the femoral head, to the subsynovial intraarticular ring. From this ring small epiphyseal arteries penetrates and supply blood to the femoral head.

The ligamentum teres contains a small blood vessel, a branch of the obturator artery, which supplies only a small region of the femoral head near the site of attachment of this ligament.

When fractures occur in the femoral neck, the retinacular arteries and veins that supply the femoral head may tear or become incarcerated between the fragments. These may result in nonunion of the fracture and total collapse of the femoral head due to avascular necrosis[1]. The treatment in these cases must be the replacement of the hip joint surfaces with prosthetics.

2.1.3. The Bone Structure

Bone is a complex, highly organized, specialized tissue with many important functions [62]. Bones offer mechanical support allowing attachment on their surfaces of various muscle groups. Some bones provide protective functions to vital organs and others have haematopoietic functions. Besides all these functions, the bones are excellent reservoirs of calcium participating actively in calcium homeostasis of the body.

Macroscopically, there are two types of bone. These are cortical bone and cancellous bone. Eighty percent of the skeleton is cortical bone and the remaining 20% is trabecular bone. Cortical bone or compact bone or haversian bone is typically found in the shafts of long bone and in the vertebral endplates. Cancellous bone or trabecular bone is primarily found in the vertebral bodies and distal ends of long bones.

The femoral head is characterized by a relatively dense meshwork of trabecular bone that facilitates the absorption and the distribution of weight-bearing stresses to the dense cortical bone of the femoral neck.

The strong medial cortical bone of the diaphysis of the femur continues on the medial side of the neck formed the Adam's arch (Figure 11). The Adam's arch becomes thinner from the lesser trochanter to the head and ends in the compression trabeculae system.

[1] Avascular necrosis is a condition in which the poor blood supply to an area of bone leads to bone death.

Figure 11. The dense meshwork of trabecular bone, Adam´s arch. Hip radiograph showing a more dense area on the medial side of the femur extending up to the head of the femur
Source: adapted of Manninger J, Internal fixation of femoral neck fractures,2th edition

The femoral neck is composed of cortical bone surrounding trabeculae. Within the femoral neck there is a large and dense structure known as the Calcar Femorale that contributes to the strength of the femoral neck. The Calcar Femorale is a vertical plate composed of multilayer compact bones. This is located in the posteromedial conjunction of the femoral neck and shaft, under the lesser trochanter, and radicates laterally through the cancellous tissue toward the greater trochanter [63].

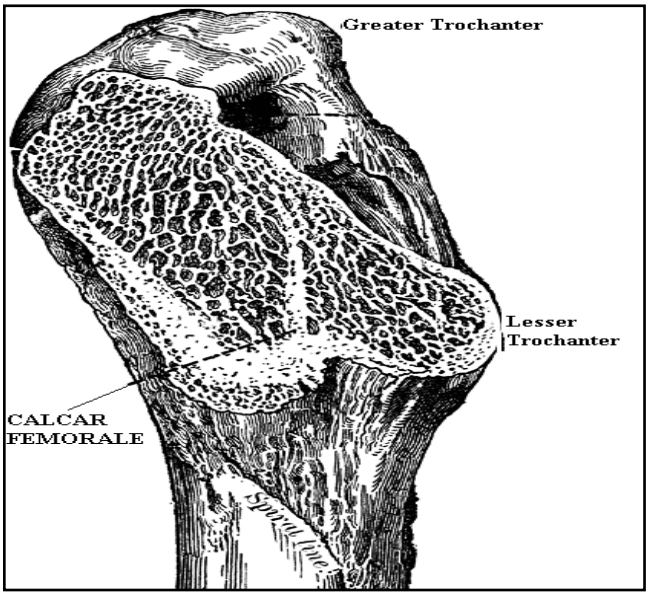


Figure 12. Calcar Femorale of the proximal femur.
Source: http://etc.usf.edu/clipart/53400/53485/53485_femur_lg.gif

The calcar femorale plays an important role in the proximal femoral loading system, and is capable of conducting load from the trabecular bone of the femoral head to the femoral shaft and is highly significant in the treatment of proximal femoral fracture [64]. If the calcar femorale is broken by a proximal femoral fracture, this usually implies that the fracture is very unstable and surgical reduction and fixation of the calcar femorale is critical in achieving a good recovery. An intact calcar femorale is helpful in maintaining the stability of the surgical material.

The forces applied to the articular surfaces of the hip joint are supported principally by the trabecular bone of the proximal femur. Figure 13 represents the three most important groups of the trabecular architecture of the proximal femur [65]. The first is the medial trabecular system or compression trabeculae that runs from the Adam`s arch to the weight bearing surface of the head. The second is the lateral trabecular system or tension group that runs from the femoral head to the femoral shaft, and is inferior to the greater trochanter. The third group extends from the greater trochanter to the lesser trochanter and they represent the secondary compressive forces.

Between the principal compressive group, the principal tensile group and the secondary compressive trabecular mesh, lies an area called the Ward's triangle. The Ward's triangle is very sensitive to age and osteoporosis and most fractures of the femur neck occur in this area.

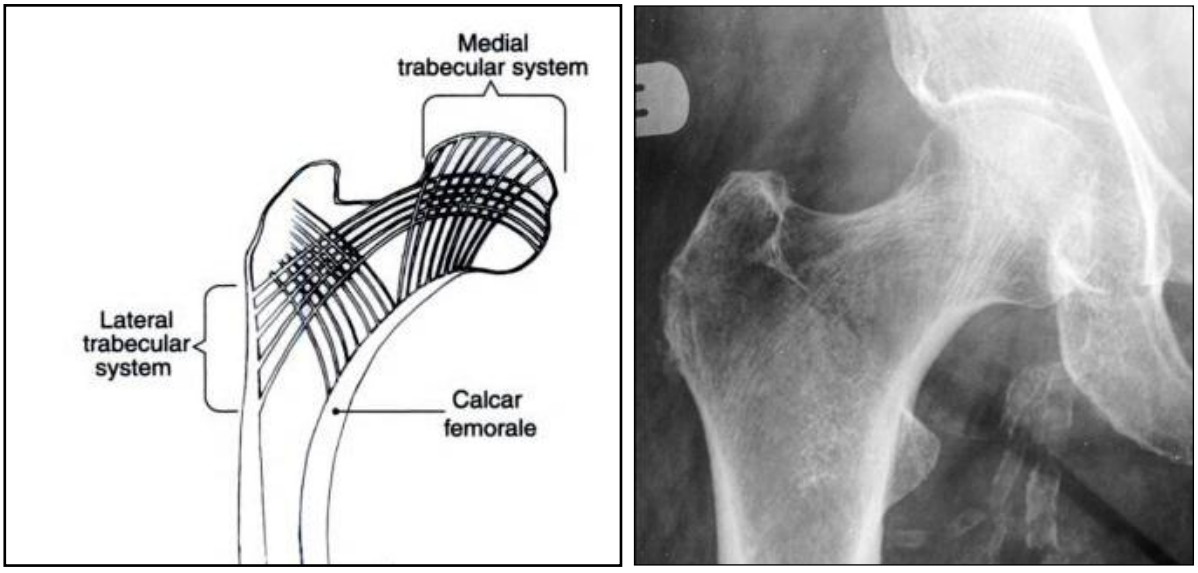


Figure 13. The architecture arrangement of the proximal femur. Hip radiograph showing the medial trabecular system and the lateral trabecular system
Source: Adapted from Singh et al. (1970)

2.2. Classification of Proximal Femur Fracture

The diagnosis of a proximal femur fracture, in most cases is done after a simple x-ray to the hip. An anterior-posterior and a lateral view of the hip are necessary for the doctor to correctly identify the type of fracture. Good classifications of fractures of the proximal femur are the key to planning the right surgical treatment minimizing the appearance of complications during the recovery phase.

Proximal femoral fractures can be classified according to their relationship to the capsular attachment of the hip and intracapsular and extracapsular fractures. In daily practice, these fractures are categorized according to their anatomical location as femoral neck fractures, trochanteric fractures and as subtrocanteric fractures (Figure 14). They may be further subdivided in displaced fractures or undisplaced fractures depending on the presence or absence of displacement and comminution [66] .

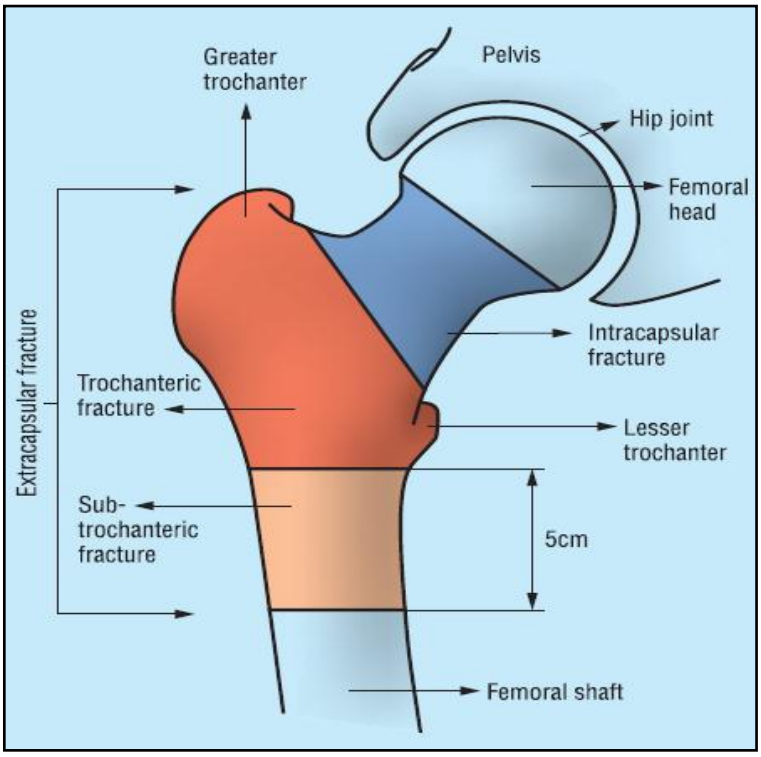


Figure 14. Fractures of the proximal femur classification. Fractures in the blue area are intracapsular and those in the red and orange areas are extracapsular. Source: Parker & Johansen 2006

2.2.1. Femoral Neck Fracture

Femoral neck fractures occur distal to the femoral head but proximal to the greater and lesser trochanters (Blue region on Fig 14). These fractures are intracapsular and the first immediate consequence is disruption of the blood supply to the femoral head so increasing the risk of avascular necrosis.

Several classification schemes have been proposed for femoral neck fractures. There are the Pauwels classification [67], the AO classification [68] and the Garden classification [69]. The most commonly used scheme is the Garden Classification, described in figure 15, where femoral neck fractures are classified into four types based on displacement on the anterior posterior radiographs.

Garden stage I : Incomplete or impacted valgus fracture.

Garden stage II : Complete fracture without displacement.

Garden stage III : Complete fracture with partial displacement.

Garden stage IV : Complete fracture with total displacement.

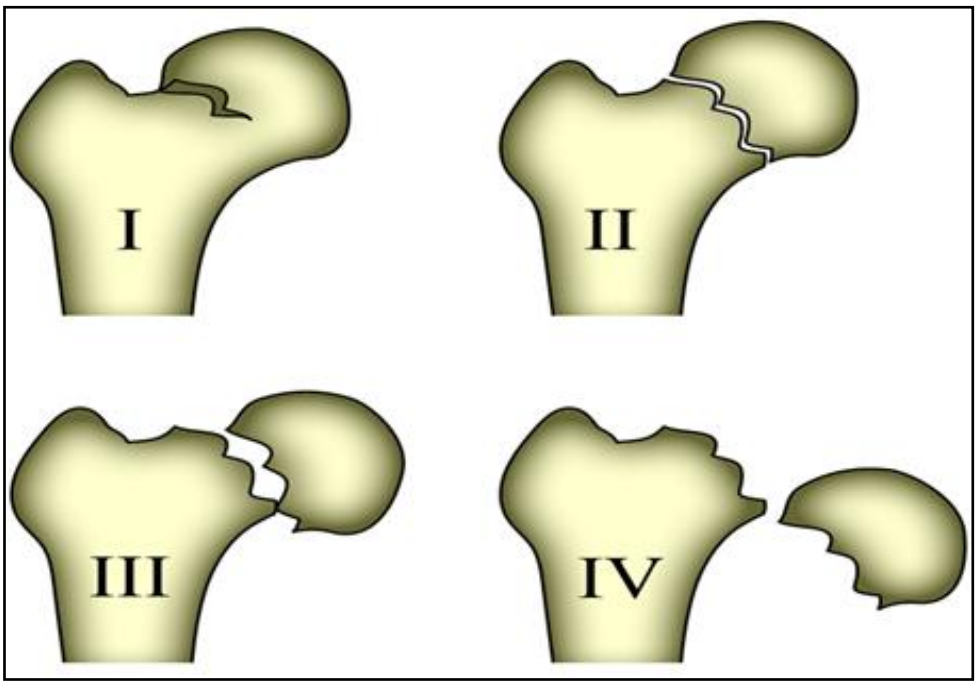


Figure 15. Garden`s classification of the femoral neck fractures.
Source: http://roentgenray reader .blogspot.com

Although the Garden`s classification of fractures is the most widely adopted system, there is much inter-observed variability[2]. Many surgeons find it difficult to distinguish all four Garden fracture types, finding it more easy to distinguish between undisplaced (Garden I and II) fractures from displaced fractures (Garden III and IV) [70]. These distinction is very important in these type of fractures because it will influence the treatment approached and the healing process. In undisplaced or minimally displaced femoral neck fractures, the blood supply to the head is easily restored and these fractures can be treated by closed reduction and internal fixation with two or three parallel cannulated screws, as showed in figure 16. The screws will compress the fracture and maintain the reduction while the fracture heals.

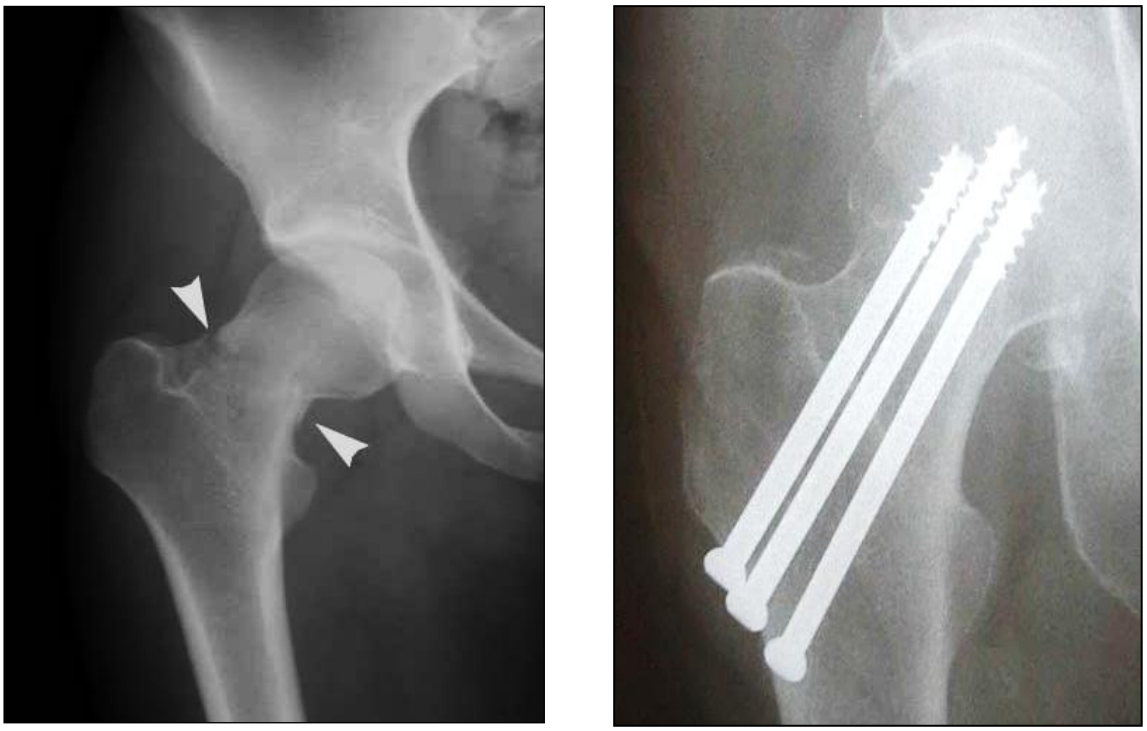


Figure 16 . Undisplaced femoral neck fracture treated with three parallel cannulated screws.

In displaced femoral neck fractures, the blood supply to the head of the femur is seriously affected by the displacement of the fracture and the risk of avascular necrosis of the head is very high.

[2] Is the amount of variation between the results obtained by two or more observers examining the same material

Preservation of the femoral head is appropriate for displaced fractures in younger patients (under 50 years old). For elderly patients, the most indicated approach is an arthroplasty[3].

The type of arthroplasty to perform will be determined by the age, comorbidities and the degree of mobility of the patient before the fracture (figure 17)

Hemiarthroplasty, where just the femoral head is replaced, is often performed in older patients with reduced mobility. Total hip arthroplasty, where both sides of the hip joint are replaced is done in patients who are more active.

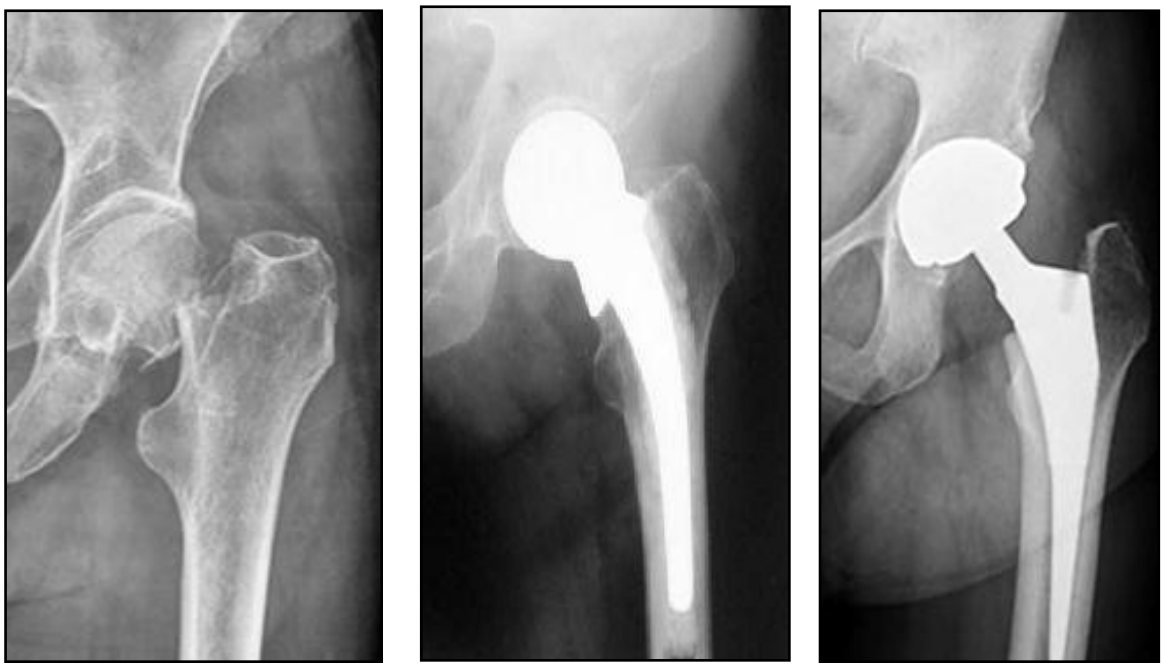


Figure 17. Displaced femoral neck fractures are treated normally with hemiarthroplasty or total hip arthroplasty.

2.2.2. Trochanteric Fracture

Trochanteric fractures occur in the transitional bone between the femoral neck and the femoral shaft region (red region on Figure 14). These fractures may involve the greater and the lesser trochanter and the stability depends on the integrity of the posteromedial cortex of the calcar femorale. Instability increases with comminution of the fracture and in the presence of a reverse oblique fracture pattern.

Various classification schemes of these fractures have been suggested based on location, angulation, fracture plane and degree of displacement. Probably the most

[3] Arthroplasty is surgical procedures were the articular surfaces of the bones are replaced by a prosthesis.

widely used scheme is the Jensen and Michaelsen`s modification of Evans classification [71] described in figure 18. Types 1 and 2 are regarded as stable fractures and types 3 to 5 as comminuted or unstable fractures.

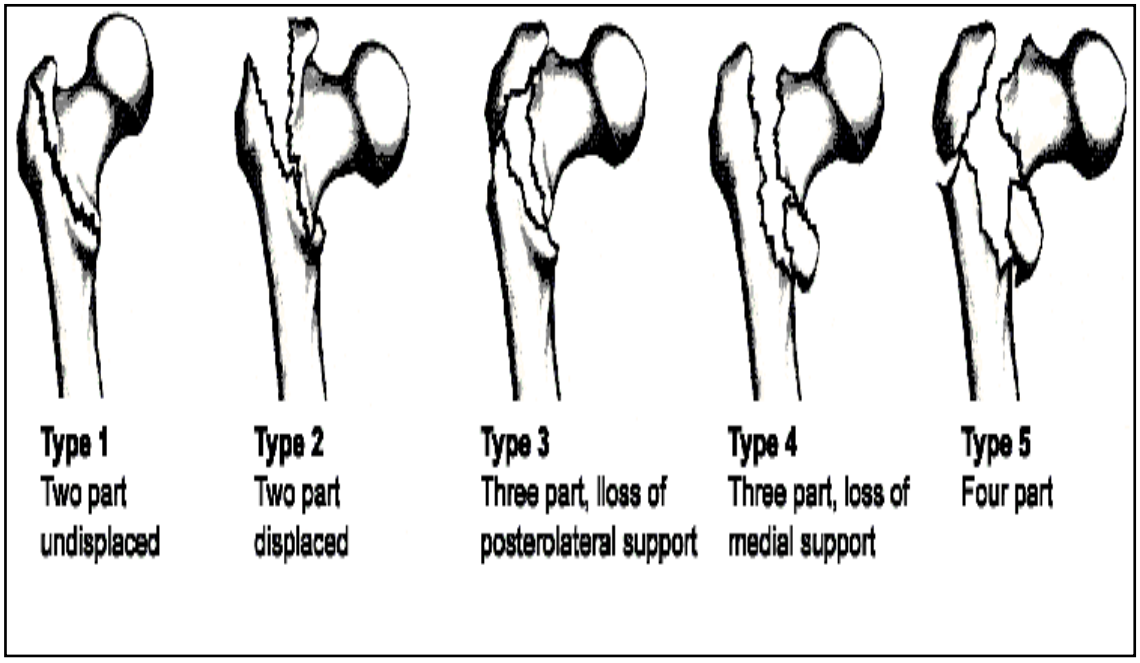


Figure 18. The Jensen and Michaelsen`s modification of Evans classification of trochanteric fracture.
Source:Jensen & Michaelsen 1975.

Surgery is the mainstay of treatment for both displaced and nondisplaced trochanteric fractures. The most common internal fixation device used today is the sliding screw-plate device, shown in figure 19. This implant consists of a large lag screw placed in the centre of the femoral neck and head and a side plate along the lateral femur. The screw-plate interface angle is variable and depends on the anatomy of the patient and the fracture. The advantage of this system compared with a static screw is that allows for impaction of the fragments, promoting osseous healing while decreasing implant stress. The disadvantage is common shortening and rotation at the fracture site.

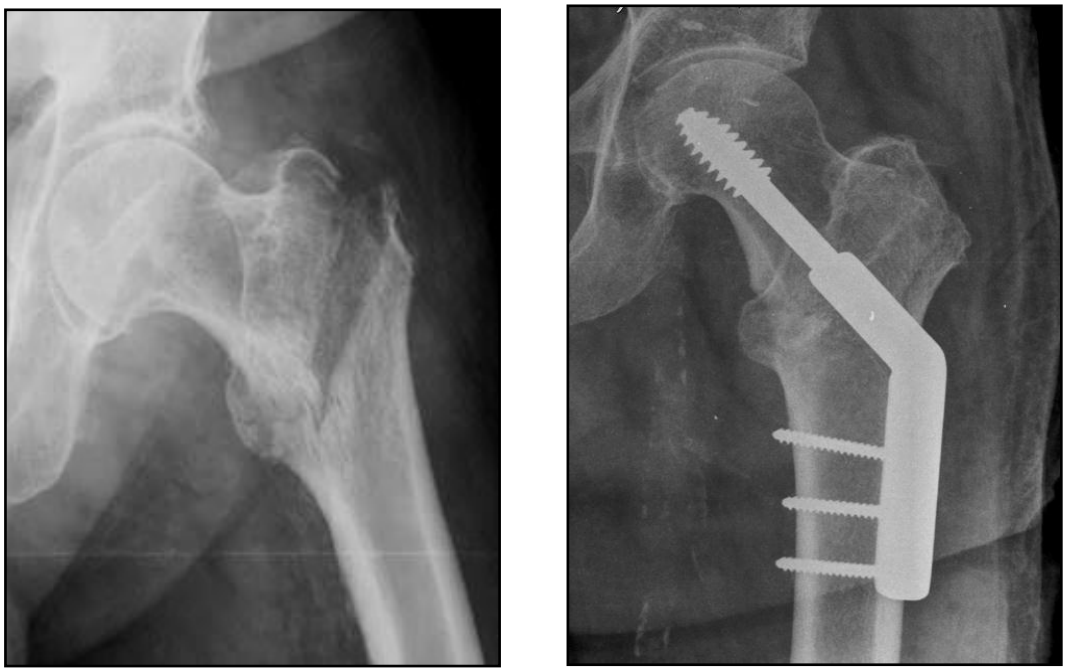


Figure 19. Pre and pos-operative x –rays of a trochanteric fracture showing the most common implant used to treat these fractures, the sliding screw-plate devise.

2.2.3. Subtrochanteric Fracture

Subtrochanteric fractures occur below the level of the trochanters in a region located 5 cm below the lesser trochanter of the femur. Normally the fracture line may extend distally into the femoral shaft or proximally into the intertrochanteric region. These fractures are less common than femoral neck and trochanteric fractures and in patients over 50 years old, being more common in younger patients after accidents of higher impact. These fractures can be subdivided into displaced, two-part and comminuted fractures and the Seinsheimer classification described in figure 20 is that which is mostly used [72].

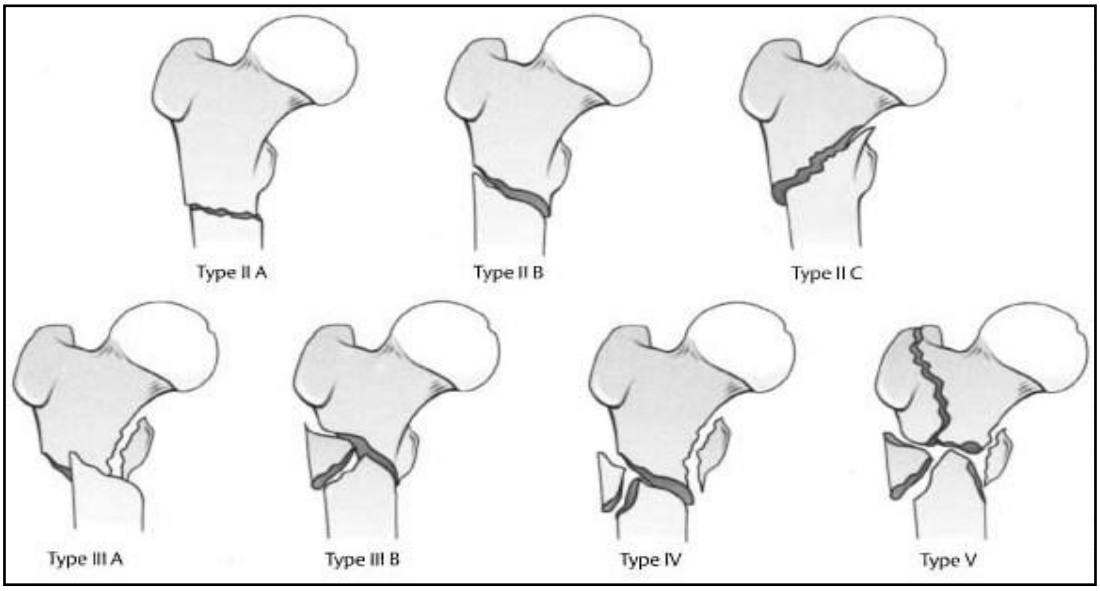


Figure 20 . Seinsheimer classification of the subtrochanteric fractures.
Source: http:// www. aceproindia.com

These fractures are very unstable and are repaired either by insertion of an intramedullary device like the one shown in figure 21 or by placement of a sliding screw with a long side plate.

Figure 21. Radiographs of a subtrochanteric fracture treated with an intrarmedullary device (Gamma Nail).

2.3. Risk Factors of Proximal Femur Fractures

Ageing is inevitable and is an irreversible process. As people become older, become less active and several physical, psychological and social changes occur. Multiple risk factors must interact when a proximal femur fracture occurs (figure 22). Most of the fractures occur after a simple fall, but a fall may also be caused by the fracture. These normally occur in severe cases of osteoporosis. Factors related to bone strength, like the peak bone mass, bone mineral density and bone architecture modified by the presence of osteoporosis seem to increases the risk of proximal femoral fracture. Also clinical characteristics of the patients related to the process of ageing, will influence the propensity for falls and the predisposition to a proximal femur fracture [73].

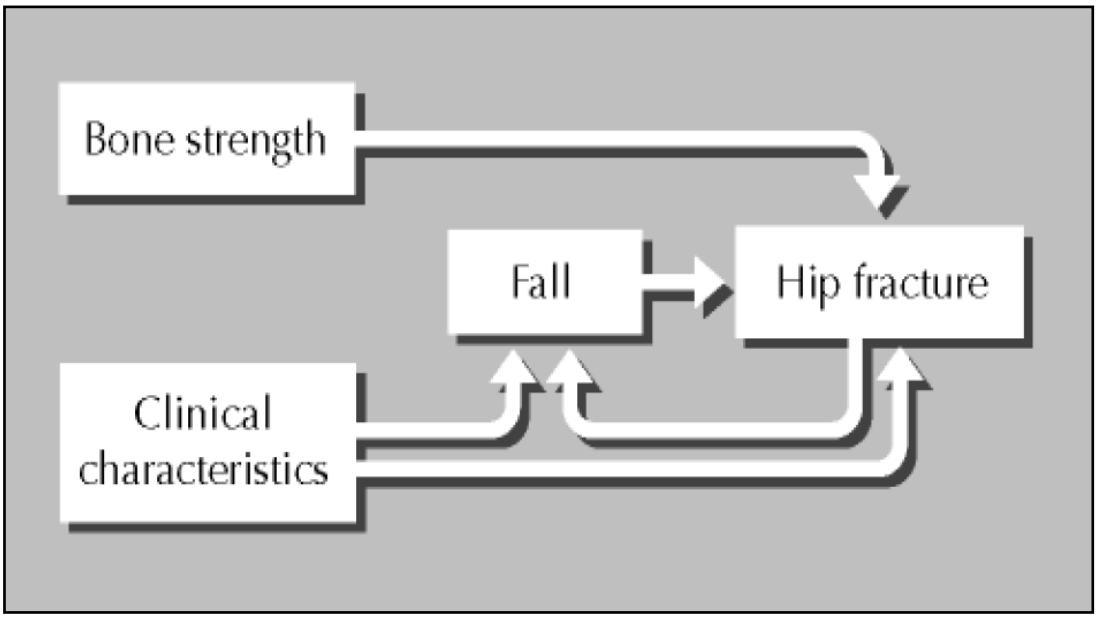


Figure 22. Contributors to risk of hip fracture.
Source: Wehren & Magaziner 2003

2.3.1. Osteoporosis

Osteoporosis is a silent disease that affects especially postmenopausal women and men in older age. It is characterized by low bone mass and microarchitectural deterioration with a resulting increase in bone fragility and hence susceptibility to fracture [74].

Any bone in the body, can be affected by this disease, but typically fractures related to osteoporosis are those of the proximal femur, vertebral body and distal forearm [4]. Of this three osteoporotic fractures, the fractures of the proximal femur are the most severe, affecting considerably the health and quality of life of the elderly [13].

Osteoporosis affects the bone structure of the proximal femur thinning the cortical bone and increases the loss of the trabecular bone mass and connectivity, reducing the strength of the bone (Figure 23).

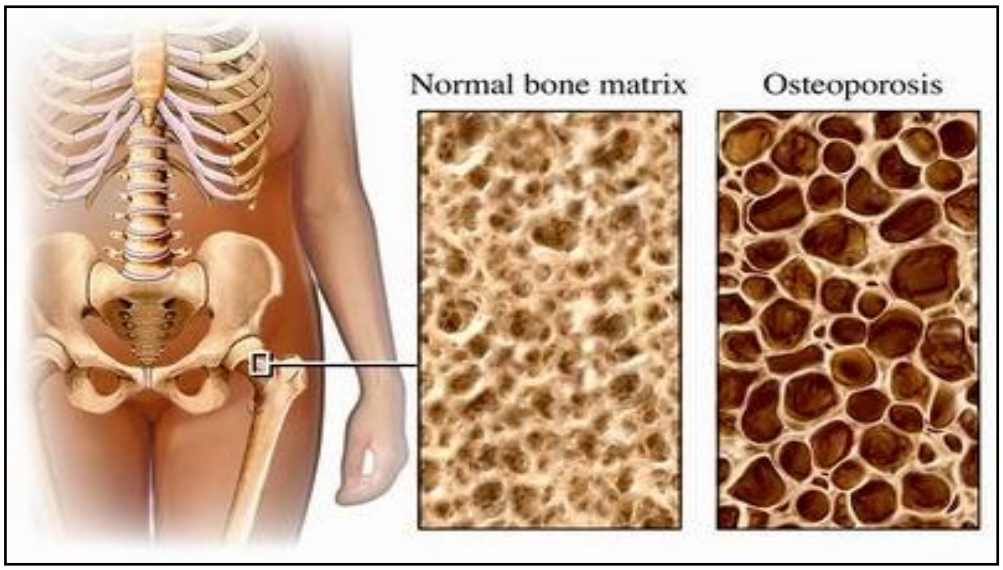


Figure 23. Normal femoral neck matrix compare to osteoporosis femoral neck matrix.
Source: http:// medicalbook.com/Bone_Diseases/Osteoporosis.htmy

In adulthood, peak bone mass is an important determinant of osteoporotic fracture risk and represents the maximum bone or skeletal mass that a person can reach at the end of the skeletal maturation. Up to 90% of peak bone mass is acquired during childhood and adolescence and is influenced by genetic and hormonal factors and by lifestyle behaviour, such as smoking, alcohol use, sedentary lifestyle and nutrition [75]. The amount of bone mass achieved up to 30 years of age will have a significant role in adulthood, minimizing the rate of bone loss that will occur during the succeeding years [76]. Therefore older women represent a higher risk group of suffering of osteoporosis in consequence of their inferior peak bone mass, and rapid bone loss after the menopause [77].

It is normal during ageing that the bones become more fragile but this process can be accelerated by some factors. The main risk factors for osteoporosis are described in table 1, according to the National Osteoporosis Foundation.

Table 1. Risk Factors for the Development of Osteoporosis.

- Female gender
- Advanced age
- Caucasian
- Prior bone fracture
- Family history
- Thin frame
- Ovariectomy
- Early onset of menopause
- Diet low in calcium
- Sedentary lifestyle
- Smoking and Alcohol abuse
- Some diseases and medication

2.3.2. A Simple Fall

In the elderly a proximal femur fracture can occur spontaneously in severe cases of osteoporosis but most of the cases occur after a simple fall [78]. A simple fall is defined as “an unexpected descent from an upright, sitting or horizontal position, being the descent height equal or less than 1 metre [79]. In the elderly 80% of injury-related admissions to hospital are due to fall. Injuries that could go from simples contusions, soft-tissue bruises to major injuries such as head injuries or bone fractures [80].

Only 1% to 2% of all falls result in a fracture of the proximal femur, suggesting that certain conditions, besides bone fragility, need to be satisfied when a fracture occurs [81]. First, elderly persons fall differently from the younger persons. Elderly people tend to fall laterally on their hip or their buttocks (Figure 24).

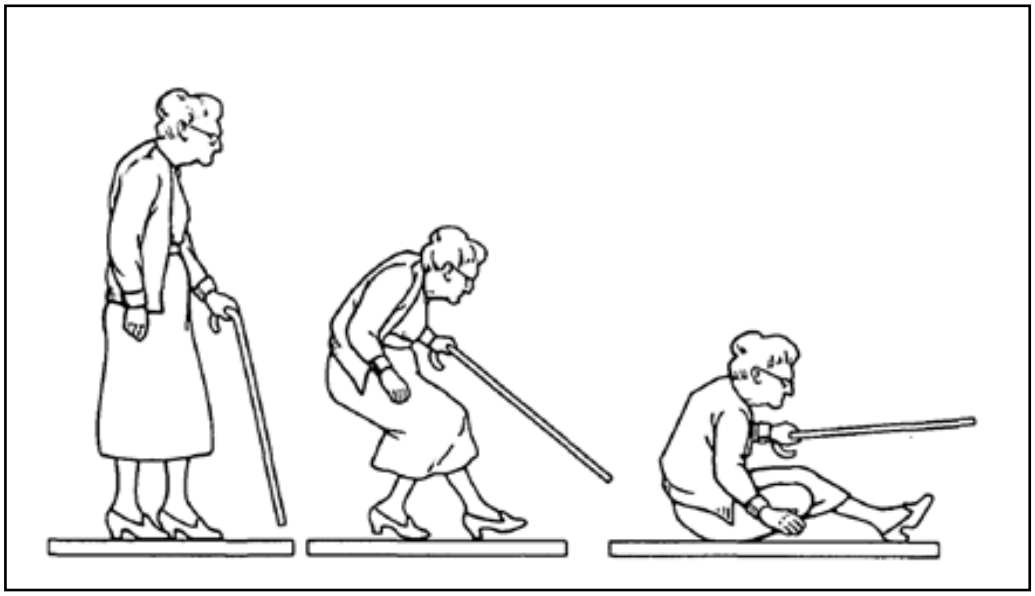


Figure 24. A fall occurring in an elderly person. The principal point of impact will be near the hip. Source: Cummings & Nevitt 1989

On the other hand, younger persons fall forward and use their hand to cushion the fall (Figure 25). Elderly people also tend to have less soft tissue around the hip that is necessary to protect the hip from the impact energy of the fall [82].

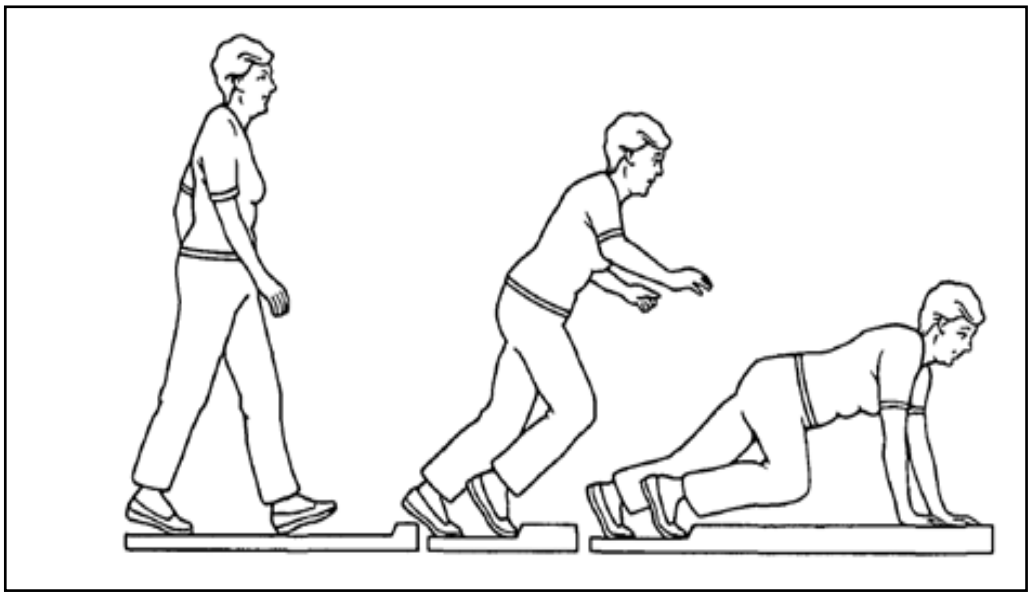


Figure 25. A fall occurring in a younger person. Protective responses using the hands to minimize the force of impact. Source: Cummings & Nevitt 1989

Falls are very common in the elderly, as often they have problems in balance, impaired vision, low perception, impaired mobility and gait, nutritional deficiencies and many diseases such as cardiovascular diseases, depression and diabetes. Plus they frequently are medicated with many medications such as psychotropic and sedatives that may influence the physical balance. Most falls occur at home reflecting the inactivity and the social isolation characteristic in this age group. [83].

Environmental hazards also contribute to increasing the risk of fall among the elderly such as carpets on the floor, poor lighting, slippery floors, uneven surfaces, slippery shoes, baggy clothes, domestic animals and inappropriate walking aids or assistive devices [84].

Many of these risk factors can be modified by alerting the elderly and their doctors to the risk of falling and by implementing simple measures like removing carpets from the floor, lighting up the houses and frequent medical visits to review the medication and health condition.

3. MATERIALS AND METHODS

Participants of the study are all patients of 50 years old and above, who were admitted into the orthopaedic service of São João Hospital, a main hospital in Portugal, for treatment of an acute proximal femur fracture during the period of 1st of May 2008 to 30st of April 2009.

The diagnosis, in most cases is easy to make, a simple x-ray to the hip is enough to confirm the fracture. During the period of the study, the archives of radiography images (PACS-Picture Archiving and Communication Systems) were consulted on a daily basis, searching for hip images of patients with a PFF. With the help of this system, the patients were identified showing their names and date of birth, and their admission to the hospital was confirmed by consulting the database of the hospital or the nurses' board in the orthopaedic service.

This study had three important acquisitions of data:

- Questionnaire during the hospitalisation of the patient.
- Data from the Medical records
- Second questionnaire applied during the follow-up study.

The inclusion criteria were:

- All patients aged 50 years and above with a proximal femur fracture caused by a fall of low-energy impact.

In contrast the exclusion criteria defined for the study, were patients that reported a:

- High energy trauma;
- Past or current history of cancer;
- Confirmation or suspicion of pathological fractures;
- Current or past treatment with corticosteroids

The study was approved by the Ethical Committee of the São João Hospital and the participants were informed as to the objectives of the study and signed a consent form.

3.1. The Questionnaire

A questionnaire was designed to gather information about the patient and about the event that caused the fracture. The questionnaire was applied by personal interview, during the hospitalization of the patient.

The questionnaire was structured so that the first questions were to characterize socio-demographic status of the patient such as data of birth, age, marital status, parish and district of birth and residence and others that can be seen in Annex 1. These initial questions also served in a rough way to identify the patients that were mentally and cognitively able to answer the questionnaire. In cases of cognitively compromised patients, the questionnaire was applied to their relatives.

Following the socio-demographic questions, were questions to explore the event that caused the fracture (day and location of the fracture). An open question was made to the patient asking them to described the details of the fall, giving us information on how the fall happened.

For the female patients, questions about their reproductive medical history were asked. The questionnaire also included questions about lifestyle such as physical activity, past and present smoking, alcohol habits, food habits and ingestion of milk.

Clinical history of the patients was evaluated using the questionnaire with questions about comorbidities, present medication, previous fractures, osteoporosis state and pharmacological treatment of osteoporosis.

The questionnaire was initially developed to perform a case-control study to compare the data reported by the MEDOS study. So some of the question were made to the patients but were not analysed in this study.

3.1.1. Characterization of some variables

In this part we will describe some of the variables that were used in the study. After seeing the answers given by the patients there was a need to adjust some of them to facilitate the statistical analysis.

Variable Fall

After reviewing the answers given by the patients this question was divided into two categories:

- Fall from standing height, meaning that the patient was in the standing position when the fall occurred

- Fall less than the standing position for instance from the bed or chair or when trying to sit or to rise from the sitting position

The falls from standing height were later divided into those that were caused by an environmental hazard:

- Fall after stumbling in the sidewalk, stairs or in an uneven surface,
- Fall after tripping over an obstacle,
- Fall after slipping on a slippery floor or by using slippery footwear.

Variable Medications

The medications reported by the patients at the time of the fractures were categorized according to the Anatomical Therapeutic Chemical (ATC) classification system [85].

Variable Comorbidities

The question used to evaluate the comorbidities in the questionnaire covers the following diseases: hypertension, diabetes mellitus, osteoarthritis, thyroid disease and stroke and was recorded as “yes”, “no” or “don’t know “.The first conclusion after the analysis of this question was that many patients were not aware of their state of health, and answered this question with a “don`t know”. To solve this problem and to ensure a good assessment of the patient’s co-morbidities, a request to the Codification Service of the São João Hospital was made in order to provide us the

discharge register records of all patients admitted to the hospital with a proximal femur fracture (codes ICD9-CM 820) during the study period. These discharge records included the main diagnosis that was the principal cause of patient admission and another 19 secondary diagnoses, all coded according to the International Classification of Diseases, version 9, Clinical Modification (ICD9-CM). The following co morbidities were chosen as the most important ones as being reported in other studies: Diabetes Mellitus (ICD-9:250); Anaemia (ICD-9: 280-289); Stroke and related conditions (ICD-9:430-438); Heart Disease (ICD-9: 410-414; 420-429); Renal Disease (ICD-9-580-589); Hypertension disease (ICD-9:401-405), Chronic obstructive pulmonary disease and other respiratory Diseases (ICD-9: 486; 490-496; 510-519), Osteoarthritis (ICD-9 -715) and Dementia and Alzheimer`s disease (ICD-9: 290-299; 331).

3.2. The Medical Records

Some data were obtained from the medical records of the patients in the hospital. Information related to type of fracture, day of surgery, surgical treatment and duration of hospitalization (LOS-Length of hospitalization). From the anaesthesiologist records the ASA score - American Society of Anaesthesiologists classification was obtained [86].

The variable type of fracture was used as a three category variable (Femoral neck fracture, Trochanteric fracture and Sub-trochanteric fracture). Because the proportion of subtrochanteric fractures was low, as they are less common, there was the need in some statistical tests to a group this variable and form a two category variable: intracapsular fracture (femoral neck fracture) and extracapsular fracture (trochanteric and subtrochanteric fracture).

The variable type of surgery was divided into: hemiarthroplasty, total hip joint replacement, dynamic hip screw, intramedullary hip screw and osteosynthesis with cannulated screws. Also in some statistical tests this variable was grouped according to the surgical methods used in Arthroplasty (Hemiarthroplasty and Total hip joint replacement) and Osteosynthesis (with dynamic hip screw, intramedullary and with cannulated screws).

The variable time to surgery was determined as the difference, in calendar days, between the date of surgery and the date of admission. So a patient waited one day for surgery, if they underwent surgery after midnight on the day of admission.

ASA Score is used by the anaesthesiologists to evaluate the severity of comorbidities that affect the patients before any surgery. This system is based on five classes:

- **Class I** indicates a normal, healthy patient;
- **Class II** indicates a patient with mild systemic disease,;
- **Class III** indicates a patient with severe systemic disease that is not incapacitating;
- **Class IV** indicates a patient with incapacitating systemic disease that is a constant threat to life and finally class V indicates a moribund patient;

3.3. The Follow-up study

The patients were followed for up to one year, and they were contacted by telephone every three months from the day of the fracture.

A questionnaire was created specifically for this follow-up study and can be seen in annex 2. It consists of 5 questions that evaluated survival, independence in walking and in daily tasks, the occurrence of new fractures and treatment for osteoporosis.

Whenever possible the questionnaire was applied to the patient himself. If the patients were cognitively compromised, unable to talk or reach the telephone the interview was made through their close relatives or the person who took care of them. The telephone contact was conducted during the morning between 11am to 13pm and in the afternoon between 16pm to 20pm. We waited 10 ringtones before ringing off. The patients were considered lost to the follow-up if contact was not made in the month of follow-up and in the three months following. For example if a patient was not contacted in the 3 months follow-up we tried to reached him at 6 months after the fracture. If not he was considered lost. If he was contacted we made a retrospective of the 3 months follow-up.

For the study of fatality, patients were only considered permanently lost if no information was found after consulting the hospital records, by looking at new hospital admissions, medical appointments, diagnostic examinations or death. In this study it will be only analysed the fatality found among the patients. The others questions will be developed in a future work.

3.4. The Data Base

A data base was developed for this study to facilitate data entry from the questionnaire and latter was useful for analysis of the data and cross information. In figure 26 and 27 the form used for the introduction of data from the initial questionnaire and from the follow-up can been seen.

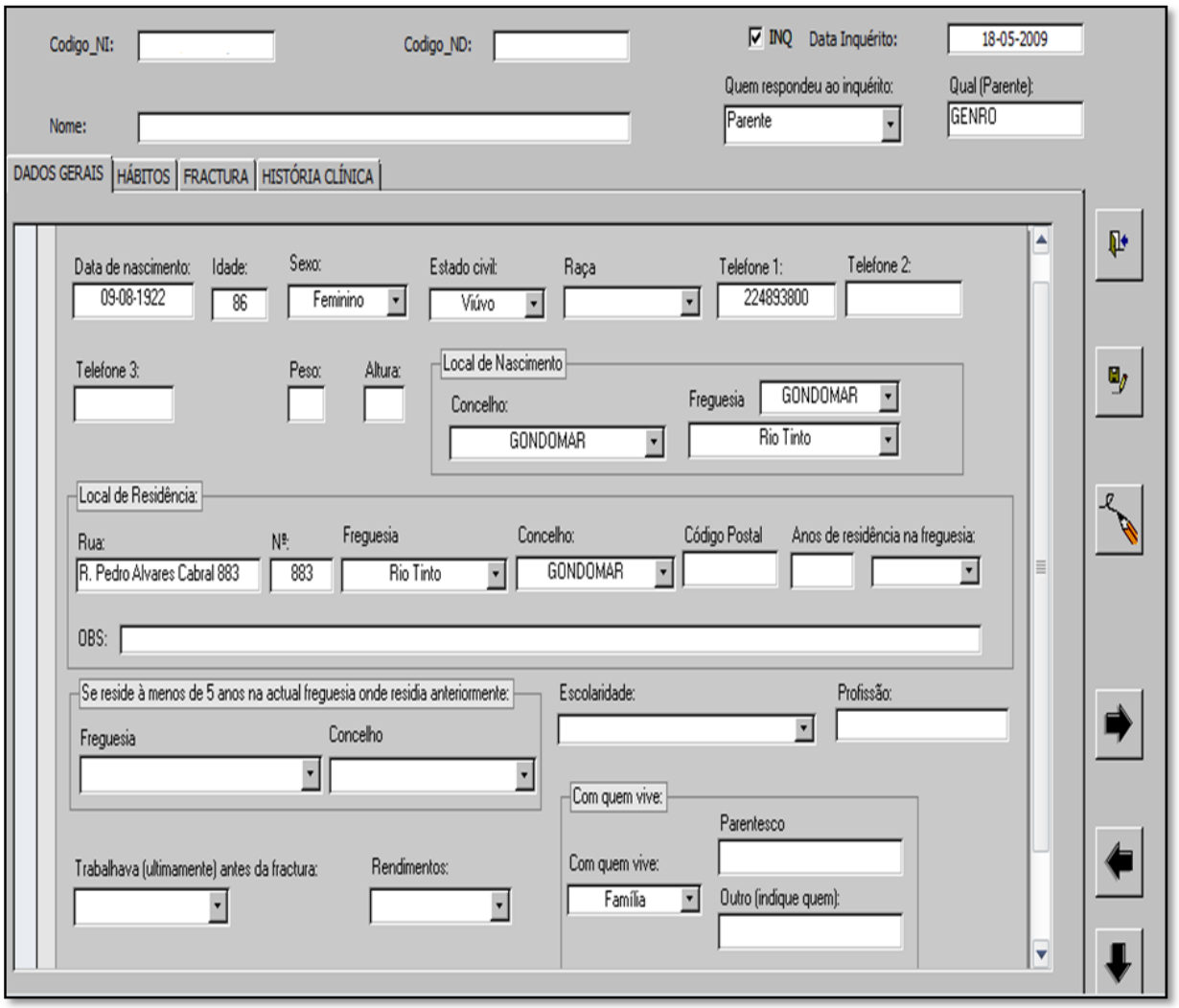


Figure 26 Form for the introduction of the data from the questionnaire

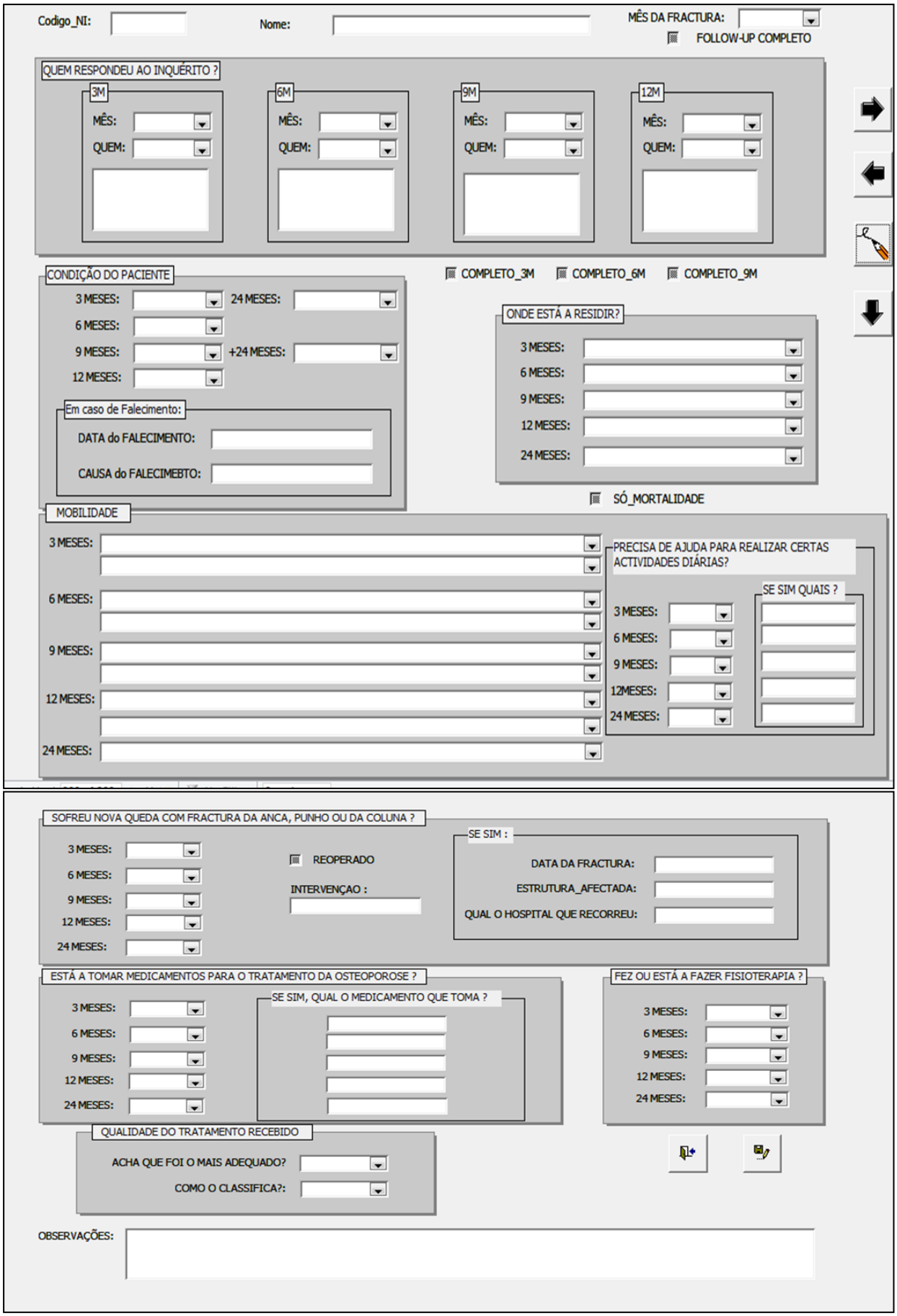


Figure 27 Form for the introduction of the data from the follow-up study

3.5. The Statistical Analysis

The statistical analysis of the data was made using the SPSS statistical program (version 17.0). Categorical variables were compared using Chi square test or Fisher`s exact test and continuous variables were tested using the *t*-student test. Values were considered statistically significant at or below p=0.05.

A Cox`s proportional hazards model was used to determine the association between mortality and the independent variables. The independent variables included were those found to be associated using the Kaplan-Meier method and the log-rank test. The number of days each patient survived after sustaining a proximal femoral fracture was determined using the date of death for patients who died and the date of hospital admission which for the majority of the cases was the date of the fracture. For the patients that were lost during the follow-up their most recent information was used, in some cases the discharge date and in others the last appointment at the hospital

4. RESULTS

São João Hospital is the second largest hospital in Portugal, situated in the north of the country in the city of Porto. The majority of the patients in the study come from the catchment area of the hospital, from the city of Porto (parish of Paranhos n= 47, Campanhã n=27 and Bonfim n=24), from the city of Gondomar (parish S.Cosme n=15, Rio tinto n=33) and from the city of Valongo (Ermesinde n=27), as seen in figure 28.

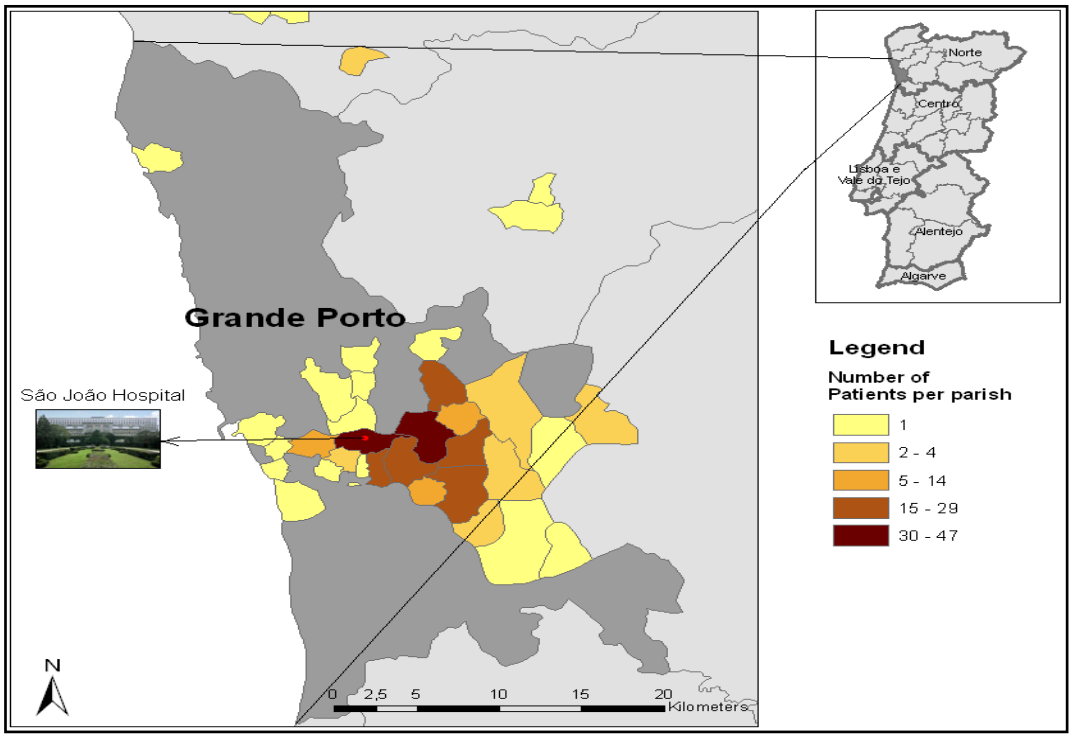


Figure 28 Map from the city of Porto with the catchment area of the Hospital São João showing the number of patients with a proximal femur fracture of the study distributes by parish.

In the study period, in the emergency department of São João Hospital, 381 patients with a proximal femur fracture were diagnosed. Forty one patients were transferred to another hospital for treatment. Of the 340 patients that were admitted to this hospital for treatment 4 patients refused to participate in the study, 3 died before the interview and ten patients did not have enough mental autonomy or a direct family to answer the questions. Also, five patients stayed less than 3 days in the hospital and therefore there was no time to hold the interview. Of these patients

one left the hospital against medical advice and four patients were immediately transferred to another unit of care after receiving surgical treatment. Three patients were not admitted into the orthopaedic service and so the questionnaire was not applied and three patients were not found by the interviewer.

After the interviews and in agreement with the exclusion criteria defined previously for this study we excluded 60 patients. Pathological fractures were confirmed in 6 patients and 37 patients reported a present or a past history of cancer. Twelve patients had suffered a high energy trauma and five patients were currently medicated with corticosteroids.

This left a sample of 252 patients for analysis. During the study 5 patients after discharge from the hospital and one patient in the hospital sustained a second fracture on the contralateral hip, leaving a sample of 258 fractures of the proximal femur to analysis.

Demographic and clinical characteristics of the patients, medication more often used by them and information about fracture type, causes and place of fall, ASA score and surgical treatment are presented in a form of a paper, which can be found in chapter 5 – Paper I.

Some of the questions in the questionnaire were not the aim of this study and so they were excluded.

Of the 252 patients, 13 patients (5%) had died during hospitalization and 239 were discharged from the hospital. After being discharged, 23 patients were never contacted again, due to changes in phone number or residence. For the fatality study, it was possible to determine the survival status of 14 patients that were initially lost, questioning the database of the hospital, checking new hospital admissions, medical appointments, diagnostic examinations or death. At the end of one year follow-up there were 14 patients lost: nine at discharge, one after 9 months and four others after one year. Therefore, the cohort after one year of follow-up was 238 patients. One year after the fracture 59 patients had died.

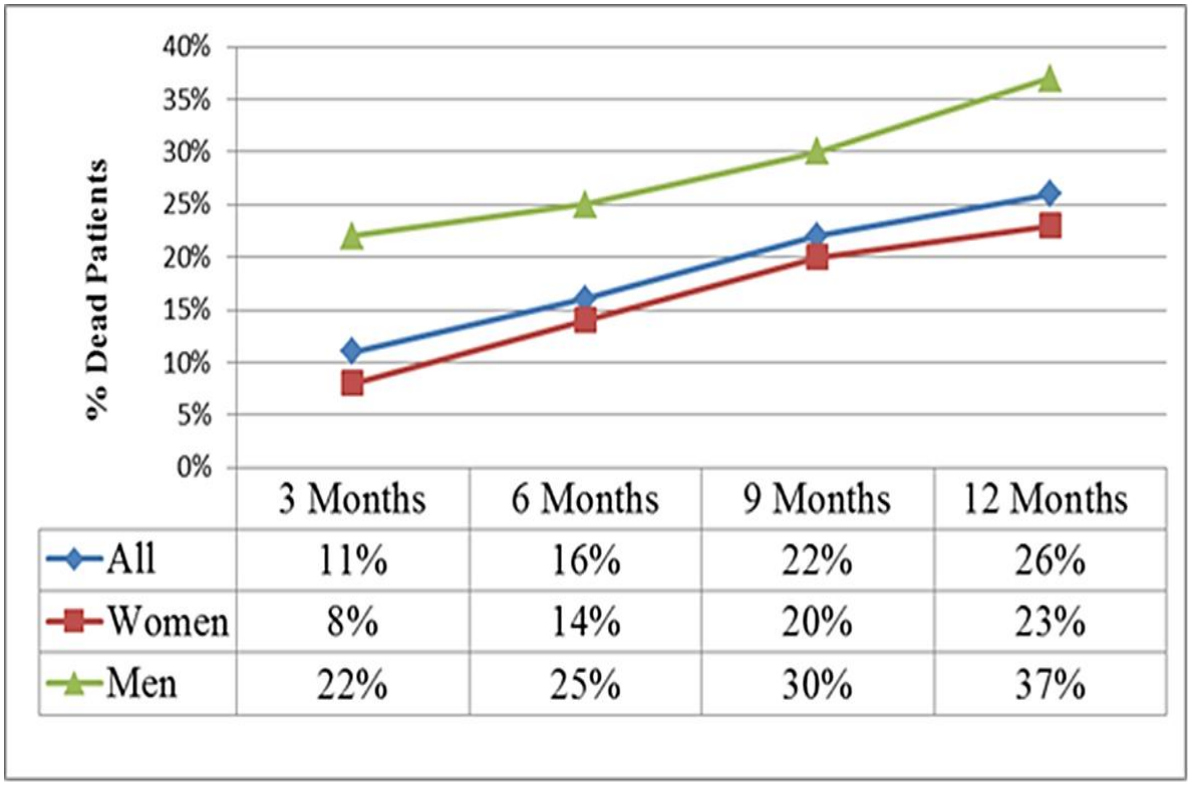
The characteristics of the patients, according to the survival status after 12-months are shown in Table 2.

Table 2 The Baseline characteristics of patients by vital status at one year follow-up

Patient characteristic		Dead		Survival		p-value
		No.	Mean(SD) or %	No.	Mean(SD) or %	
N		59	25%	179	75%	
Sex						
	Women	41	70%	147	82%	
	Men	18	30%	32	18%	0.04
Age	50-59	-	-	12	7%	
	60-69	5	8%	13	7%	
	70-79	14	24%	68	38%	
	80-89	28	47%	73	41%	
	90 +	12	20%	13	7%	
		82.5 (8.6)		78.2 (10.0)		0.004
Marital status						
	Widowed	32	54%	86	48%	
	Married	19	32%	62	35%	
	Single/ Divorced	8	14%	31	17%	0.67
Pre-fracture living situation						
	Living with someone	39	66%	121	68%	
	Living alone	12	20%	47	26%	0.15
	Institution	8	14%	11	6%	
Mobility						
	More than 4 hours a day	13	22%	65	36%	0.04
	Less than 4 hours a day	46	78%	114	64%	
Comorbidities						
	Hypertension					
	Yes	30	51%	95	53%	0.77
	No	29	49%	84	47%	
	Heart Disease					
	Yes	28	47%	45	25%	0.001
	No	31	53%	134	75%	
	Anaemia					
	Yes	21	36%	35	20%	0.012
	No	38	64%	144	80%	
	Diabetes mellitus					
	Yes	16	27%	36	20%	0.26
	No	43	73%	143	80%	
	Respiratory Diseases					
	Yes	16	27%	28	16%	0.053
	No	43	73%	151	84%	
	Previous Stroke					
	Yes	10	17%	21	12%	0.30
	No	49	83%	158	88%	
	Demencia					
	Yes	16	27%	29	16%	0.063
	No	43	73%	150	84%	
Fracture Type						
	Intracapsular	19	32%	78	44%	0.25
	Extracapsular	40	68%	101	56%	
Surgery Type						
	Osteosynthesis	38	69%	118	66%	0.32
	Arthroplasty	17	31%	60	34%	
ASA Score[a]						
	ASA I / II	18	31%	96	54%	0.003
	ASA III / IV	38	64%	80	45%	
Mean time to Surgery		4.89 (5.81)		2.96 (3.38)		0.002
Mean length to Hospital		18.0 (12.8)		13.8 (14.0)		0.042

Data not available for [a] 3 patients; Categorical variables p-value by chi-square or fisher`s exact test; Continuous variables p-value by Student`s *t* test

The fatality at 3, 6, 9 and 12 months was higher among men patients and can be seen in Figure 29.



	3 Months	6 Months	9 Months	12 Months
All	11%	16%	22%	26%
Women	8%	14%	20%	23%
Men	22%	25%	30%	37%

Figure 29 Fatality of the patients at 3, 6, 9 and 12 months of follow-up

The survival of the patient was analyzed by the Kaplan Meier method and predictors of fatality were determined using the Cox proportional hazards regression. The results are presented in the form of an article, which can be found in chapter 5 – Paper II

In this thesis the results for the other questions of follow-up will not be presented. This will be a future challenge to be developed, during the following year

5. Papers

5.1. Paper I

S.M. Campos • S. Alves • A. Trigo Cabral • M.F. de Pina

Incidence of a proximal femur fracture: a longitudinal study in São João Hospital

Incidence of a proximal femur fracture: a longitudinal study in São João Hospital

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Abstract

Introduction: Proximal femur fracture is among the most serious and common injuries experienced by the elderly. They occur as the result of a decrease in bone mass density in combination with an increased risk of falls in the elderly. Worldwide, these types of fractures are the cause of great disability, loss of independence and mortality in the elderly. The aim of this study was to determine the one year incidence of fractures of the proximal femur in the main hospital in the north of Portugal, and characterize, regarding demographic, clinical and behaviour data, a cohort of patients with such a condition.

Methods: All patients admitted in the orthopaedic service with an acute fracture of the proximal femur, caused by a fall of low energy impact, from 1st May 2008 to 30th April 2009 were invited to participate. During hospitalization, a questionnaire was applied by personal interview with questions as to demographic factors, life style, activities before fracture and clinical history. From the hospital records information as to type of fracture, type and date of surgery, comorbidities and ASA score were collected.

Results: 252 patients agreed to participate in the study. The majority of the patients were women (79%) with a mean age of 80.3±9.5 years. Male patients were younger, with a mean age of 76.3± 11.3 years (p= 0.02). Among women 57% were widowed while the majority of men were married (53%). Almost half (47%) of the men related a history of past smoking and 55% were frequent consumers of alcoholic drinks. The majority of the fractures occurred following a fall at home (78%).

Previous fractures were reported by 20% of the patients. The most common co-morbidity among women was hypertension (56%) versus 38% among men, p= 0.02. Respiratory disease was the most frequent disease among men (36%) and one of the less frequent among women (11%), p< 0.001. Eight per cent of the patients didn't report any co-morbidity. At the time of surgery, 52% of the patients were categorized as having an ASA score I or II, 47% with an ASA score III or IV and such information was not available for 1% of the patients. The mean time between admission and surgery was 3.4 ± 4.1 days, median 2 days. The mean hospitalization length was 14.5±12.3, median 10 days.

Conclusions: Women had a higher risk of proximal femur fracture and were, on average, four years older than men at the time of fracture. The majority of the fractures were caused by a fall at home, reinforcing the need to develop preventive actions, either to avoid osteoporosis or to avoid falls in the elderly.

Keywords: Proximal femur fractures, falls, osteoporosis

Introduction

Proximal femur fractures (PFF) are among the most serious consequences of osteoporosis and they are one of the most frequent injuries among elderly individuals. They are strongly related to low bone mineral density (BMD) and to an increased risk of falls in the elderly [1].The incidence of these fractures increases exponentially with age, especially after 45 years of age, in both sexes, but is much higher in women [2].

Osteoporosis is a silent disease that especially affects postmenopausal women and men in older age groups. It is characterised by low bone mass and microarchitectural deterioration with a resulting increase in bone fragility and hence susceptibility to fracture [3]. Every bone in the body can be affected by this condition, but proximal femur, vertebral body and distal forearm are the ones typically affected by osteoporosis [4]. Of these, the fractures of the proximal femur are the most severe, affecting considerably the health and quality of life of the elderly [5]. Previous studies have shown that after a PFF most elderly patients have difficulty in recovering, becoming dependent on others to walk and carry out the basic activities of daily life, such as dressing and bathing [6,7,8].

In some cases it becomes impossible for the family to provide the necessary care for the elderly, and institutionalization in nursing homes is the most viable solution for both [9]. Immobilization caused by the fracture and the health problems common in these ages contribute to increased mortality among patients compared to individuals of the same age but without PFF [10,11,12].

In the elderly a PFF can occur spontaneously in severe cases of osteoporosis but most of the time occurs after a low impact fall [13], as an unexpected descent from an upright, sitting or horizontal position, the descent height being equal to or less than 1 metre[14].Falls in the elderly account for over 80% of injury-related hospital admissions. Such injuries can be simple contusions, soft-tissue bruises or major injuries such as head injuries or bone fractures[15]. Another consequence of falling is the fear of falling, which contributes to social isolation and restrictions in some daily living activities that are important to maintain a good physical and mental condition in the elderly[16]. Despite the frequency of falls, only 1% to 2% of all falls result in a PFF [17]. Certain conditions related to the fall characteristics, such as fall mode,

direction and protective response are necessary for a fall to result in PFF [18,19]. Falling to the side with impact on the greater trochanter of the hip seems to increase the risk of a PFF, especially if protective response is weak or absent [12].

Management of a PFF requires hospitalization, orthopaedic surgery, and a rehabilitation period, demanding of the health care system and society an economic and social effort to support the inherent costs, not only related to the hospitalization but also to long term care, particularly during the first year following the fracture [20,21, 22].

Worldwide guidelines are being developed to identify people at high risk of suffering an osteoporotic fracture, and also to prevent falls and improve treatment associated with these fractures [23,24,25,26,27]. Studies that focus their attention on tracing the profile of patients with a PFF, looking for local and generalized risk factors, are extremely important for developing strategies that may improve the care and prevention of these serious health problems.

The aim of this study was to determine the one year incidence of PFF in the main hospital in the north of Portugal, and to identify characteristics, by gender, of a cohort of patients with a diagnosis of PFF.

Materials and Methods

Participants of the study are all patients aged 50 and above, that were admitted into the orthopaedic service of São João Hospital, a main hospital in Portugal, for treatment of an acute PFF, during the period of 1st of May 2008 to 30st of April 2009.

The São João Hospital is the second largest hospital in Portugal and it is located in the city of Porto, in the north of Portugal. Almost every day people with fractures of the proximal femur attend the emergency service of this hospital. The diagnosis, in most cases, is easy to make; a simple x-ray to the hip is enough to confirm the fracture. During the period of the study, the archives of radiography images (PACS-Picture Archiving and Communication Systems) were consulted on a daily basis, searching for hip images of patients with a PFF. With the help of this system, the patients were identified and their admission to the hospital was confirmed by consulting the database of the hospital or the nurses' board in the orthopaedic service using their names and date of birth.

During hospitalization a questionnaire was applied by one the authors, through personal interview, to all the patients who agreed to participate in the study. If the patients were cognitively compromised, the questionnaire was given to their closest family member.

The questionnaire consisted of several closed questions, and one open question as to characteristics of the patient and also about the event that caused the fracture.

Questions focused on socio-demographic data (age, gender, years at school, marital status, and pre-fracture living situation), lifestyle (past or present smoking habits, alcohol consumption), activity before the fracture, history of fractures, comorbidities, current medication, clinical history and current therapy for osteoporosis. The activity of the patients before the fracture was divided into three categories: activity of more than 4 hours a day, activity less than 4 hours a day and non-active patients (patients who were confined to bed).

The question about comorbidities, covers the following diseases: hypertension, diabetes mellitus, osteoarthritis, thyroid disease and stroke and was recorded as "yes", "no" or "don't know ".To ensure a good assessment of the patients' co-morbidities the discharge register records of all patients that were admitted to the hospital with a PFF during the study period were analysed to get information as to secondary diagnosis. These discharge registers included the main diagnosis that

was the principal cause of patient admission and another 19 secondary diagnoses, all coded according to the International Classification of Diseases, version 9, Clinical Modification (ICD9-CM). To study the event that caused the fracture, an open question was made to the patient asking them to describe the details of the fall, with information on location (at home or in the street) and how the fall occurred. This question was divided into two categories: a fall from standing height, meaning that the patient was in the standing position when the fall occurred; fall less than the standing position, for instance from the bed or chair or when trying to sit or rise from the sitting position. The falls from standing height were divided into those that were caused by an environmental hazard such as falls after stumbling on the road, stairs or in an uneven pavement, falls after tripping over an obstacle and falls after slipping on a slippery floor or by using slippery footwear.

The medication reported by the patients at the time of the fractures was categorized according to the Anatomical Therapeutic Chemical (ATC) classification system [28].

Additional data was obtained from the medical records of the hospital such as type of fracture, day of surgery, type of surgical treatment, and the surgical risk for each patient according to the American Society of Anaesthesiologists classification (ASA score)[29]. ASA Score is used by anaesthesiologists to evaluate the severity of comorbidities that affect the patients before surgery. This system is based on five classes: Class I indicates a patient without comorbidities, class II indicates a patient with mild systemic disease, class III indicates a patient with severe systemic disease that is not incapacitating, class IV indicates a patient with incapacitating systemic disease that is a constant threat to life and finally class V indicates a moribund patient. The patients were categorized into those with low operative risk (I and II) and high risk (III and IV).

The interval between the admission and the surgery was determined as the difference, in calendar days, between the date of surgery and the date of admission. A patient waits one day for surgery, if he underwent surgery after midnight of the day of admission.

The treatment for most of the patients was surgical and consisted of arthroplasty (total hip joint replacement or hemiarthroplasty) or osteosynthesis with cannulated screws, dynamic hip screw or intramedullary hip screw.

The exclusion criteria defined for our study were patients that reported a fall from greater than standing height, patients with a past or current history of cancer, patients with confirmed pathological fractures and patients in treatment with corticosteroids.

The statistical analysis was made using the Statistical Package for Social Sciences (SPSS version 17.0). Categorical variables were compared using Chi square test or Fisher`s exact test and continuous variables were tested using the *t*-student test. Values were considered as statistically significant at or below p=0.05.

The study was approved by the Ethical Committee of the São João Hospital and the participants were informed about the objectives of the study and signed a written consent form.

Results

During the study period, 381 patients were diagnosed with a PFF, but only 340 patients were admitted to the São João Hospital for treatment. From this group of patients 4 refused to participate, 3 died before the interview and 10 patients did not have enough mental autonomy or a direct family member to answer the questions. Also, 5 patients stayed less than 3 days in the hospital and therefore there was no time to hold the interview. Of these patients one left the hospital against medical advice and four patients were immediately transferred to another unit of care after receiving surgical treatment. Three patients were not admitted into the orthopaedic service and so the questionnaire was not applied and three patients were not found by the interviewer.

After the interviews and in agreement with the exclusion criteria defined previously, 60 patients were excluded. A second fracture on the contralateral hip was experienced by 5 patients after discharge from the hospital and one patient during the hospitalization. Therefore, there were 258 proximal femur fractures from 252 patients, included in the study.

The questionnaire was answered by patients in 62% of the cases and in 38% by a close family member. The median time from admission to interview was 4 days. The patients whose questionnaire was answered by a relative were older (82.9±7.7 years old) than the patients who answered themselves (77.2±10.3 years old, $p<0.001$). Demographic and clinical characteristics of the patients are presented in table 1. Most of the patients were women (79%), with a mean age of 80.3±9.5 years, statistically different from the mean age of men that was 76.3±11.3 years ($p= 0.02$). The age of more than half of the participants (53%) was above 80 years old. The female patients who lived alone before fracture were older (82.4±5.9 years old), than the ones who lived with someone (79.1±10.02 years old), this difference being statistically significant ($p=0.006$). Among men, there was no statistical difference between age of those living alone and those living with someone.

Table 1. Demographic and medical characteristic of patients (n=252) with proximal femoral fracture

Characteristics	All		Women		Men		p-value
	No.	Mean(SD) or %	No.	Mean(SD) or %	No.	Mean(SD) or %	
Age	252	79.4 (9.7)	199	80.3 (9.5)	53	76.3 (11.3)	0.02
Marital status							
Widowed	127	51%	114	57%	13	24%	
Married	84	33%	56	28%	28	53%	
Single /Divorced	41	16%	29	15%	12	23%	< 0.001
Living place							
Living with someone	169	67%	132	66%	37	70%	
Living alone	64	25%	51	26%	13	24%	
Institution	19	8%	16	8%	3	6%	0.81
Years of Schooling [a]							
No school Level	55	22%	51	26%	4	8%	
1 to 4 years	154	61%	120	60%	34	64%	
5 to 9 years	20	8%	13	7%	7	13%	
More than 10 years	15	6%	9	5%	6	11%	0.004
Activity before fracture							
More than 4 hours a day	85	34%	63	32%	22	42%	
Less than 4 hours a day	167	66%	136	68%	31	59%	0.18
Habits							
Alcohol [b]	45	18%	16	8%	29	55%	< 0.001
Smoking habits							
Current [c]	16	6%	5	3%	11	21%	< 0.001
Past [d]	28	11%	3	2%	25	47%	< 0.001
Comorbidities							
Yes	233	92%	185	93%	48	91%	
0 comorbidities	19	8%	14	7%	5	9%	0.56
1 to 2 comorbidities	74	32%	65	35%	9	19%	
3 to 4 comorbidities	80	34%	58	31%	22	46%	
More than 5	79	34%	62	34%	17	35%	0.06
Hypertension Disease	131	52%	111	56%	20	38%	0.02
Heart Diseases	80	32%	64	32%	16	30%	0.84
Anaemia	61	24%	50	25%	11	21%	0.56
Diabetes mellitus	57	23%	46	23%	11	21%	0.72
Respiratory diseases	44	17%	25	13%	19	36%	<0.001
Thyroid disease	12	6%	12	6%	0	0%	-
Cerebrovascular diseases	33	13%	26	13%	7	13%	0.91
Renal Diseases	18	7%	13	7%	5	9%	0.47
Dementia	48	19%	39	20%	9	10%	0.73
Hearing Impairment [e]	78	31%	63	32%	15	28%	0.89
Postural Instability [e]	40	16%	38	19%	2	4%	0.01
User eyeglasses [f]	118	47%	101	51%	17	32%	0.14

Data not available for: [a] 8 patients; [b]13 patients;[c]16 patients ;[d] 30 patients ; [e] 71 patients ; [f]59 patients .
Categorical variables p-value by chi-square or fisher`s exact test; Continuous variables p-value by Student`s *t* test

At the time of the fracture among the less active patients 1% of the patients were confined to bed. The less active patients had a mean age of 81.3±9.1 years, statistically different from the mean age of the most active ones (75.8±10.0 years, p<0.001). This was true among women but not among men. Among the patients that were less active, men were younger (76.2±12.9 years) than women (82.4±7,7 years, p= 0.014).

Comorbidities were presented in 92% of the patients. The presences of heart disease was common in both sexes: 32% of the women and 30% of the men. Hypertension disease was more common among the female patients (56%) than among men (38%, $p_{chi\text{-}square}$=0.02) and respiratory disease was more common in the men (36%) compared to women (13%, $p_{chi\text{-}square}$ <0.001). Among the female patients, 19% related to having balance problems previous to the fracture compared with 4% of the men ($p_{chi\text{-}square}$ =0.011).

The medications more often used by the patients are described in Table 2. On average patients reported the use of more than 3 drugs per day (3.6±2.14 drugs).

Table 2. Medication used by the patients, distributed by men and women

Characteristics	All		Women		Men		p-value
	No.	Mean(SD) or %	No.	Mean(SD) or %	No.	Mean(SD) or %	
Medication [a]							
Yes	192	76%	158	79%	34	64%	
No medication use	25	10%	15	19%	10	8%	0.009
1 to 3 medications	106	55%	83	53%	23	68%	
More than 3 medications	86	45%	75	47%	11	32%	0.063
Antihypertensive	104	54%	84	53%	20	59%	0.55
Anxiolytics / Sedatives	71	37%	63	40%	8	24%	0.07
Antithrombotic	58	30%	44	28%	14	41%	0.13
Lipid Modifying Agents	42	22%	38	24%	4	12%	0.12
Cardiac Therapy	34	18%	29	18%	5	15%	0.61
Antidepressants	29	15%	27	17%	2	6%	0.12
Insulins and Analogues	26	14%	22	14%	4	12%	0.98
Blood Glucose Lowering Drugs	20	10%	16	10%	4	12%	0.76

[a] Data not available for 35 patients. Categorical variables p-value by chi-square or fisher`s exact test

In table 3 the baseline information concerning the fracture type, the causes and place of fall, ASA score and surgical treatment are described.

Table 3.Characteristics of PFFs and causes of fall (n=258) by sex

Characteristics	All		Women		Men		p-value
	No.	Mean(SD) or %	No.	Mean(SD) or %	No.	Mean(SD) or %	
N	258	100%	204	79%	54	21%	
Type of fracture							
Trochanteric	142	55%	110	54%	32	59%	
Femoral neck	103	40%	83	41%	20	37%	
Subtrochanteric	13	5%	11	5%	2	4%	0.78
Place of Fall							
At home	202	78%	167	82%	35	65%	
In the street	56	22%	37	18%	19	35%	0.007
Causes of Fall[a]							
Fall from standing height	178	69%	141	69%	37	69%	
Fall less than standing height	58	22%	45	22%	13	24%	0.8
Fall from standing height:							
Without specific cause	74	42%	58	41%	16	43%	
Fall after stumbling on the road, stairs or in an uneven pavement	43	24%	32	23%	11	29%	
Fall after tripping over an obstacle	37	21%	32	23%	5	14%	
Fall after slipping in a slippery floor or by using slippery footwear	24	13%	19	13%	5	14%	0.61
Asa Score (n=254) [b]							
Asa I	6	2%	5	3%	1	2%	
Asa II	125	49%	101	50%	24	45%	
Asa III	108	43%	86	43%	22	42%	
Asa IV	12	5%	7	3%	5	9%	0.34
Type of surgery (n=254)							
Dynamic hip screw	140	55%	112	56%	28	53%	
Hemiarthroplasty	34	13%	26	13%	8	15%	
Total hip joint replacement	46	18%	38	19%	8	15%	
Intramedullary hip screw	19	8%	15	7%	4	8%	
Pinning with cannulated screws	15	6%	10	5%	5	9%	0.72
Hospital Length of stay (LOS)		14.5(12.3)		14.9 (12.3)		13.2 (12.2)	0.38
Time to surgery		3.4 (4.1)		3.5 (4.4)		3.2 (2.8)	0.57

Data not available for [a] 22 patients and [b] for 3 patients;
Categorical variables- chi-square or fisher`s exact test; Continuous variables- Student`s *t* test

The ratio of trochanteric to femoral neck fractures was 1.3 and 1.6 in women and men, respectively. Patients with a femoral neck fracture were younger (78.0±9.7 years) than those that suffered a trochanteric fracture (80.6±9.8 years), p=0.04. Women suffering a trochanteric fracture were older (82.1 ± 8.7 years) than men with the same type of fracture (75.4±11.6 years, p= 0.004) and also older than women with a femoral neck fracture, (p=0.002) (table 4). Among men the opposite was observed: men suffering a femoral neck fracture were older than men suffering a trochanteric fracture, the difference in mean age being 2.7 years, but without statistical significance (p=0.42). No differences in age between gender was seen among the patients that suffered a femoral neck fracture.

Table 4. Mean age at admission by gender and type of fracture

Gender and /or type of fracture	n	Mean age (SD)	Ratio
Gender			
Women	199	80.2 (9.1)	3.8
Men	53	76.0 (11.5)	
Type of fracture			
Femoral neck fracture, Women	83	78.0 (9.4)	4.15
Femoral neck fracture, Men	20	78.1(11.3)	
Trochanteric fracture, Women	110	82.1 (8.7)	3.44
Trochanteric fracture, Men	32	75.4 (11.6)	
Subtrochanteric fracture, Women	11	82.6 (5.9)	5.5
Subtrochanteric fracture, Men	2	66.0 (5.6)	

Most of the fractures occurred after a fall from standing height (69%). Of these falls 58% were caused by environmental hazards: 24% by slippery floors or slippery footwear, 21% caused by obstacles like carpets, blanket, furniture, toys, animals, baggy clothes and 13% by uneven pavement or stairs.

Patients whose fracture was caused by an environmental hazard were younger 77.8 ±10.2 years old, compared to patients that had a fall from less than standing

height 82.0±7.3 years old (p=0.003), and also compared to the other patients that had a fall from standing height but without specific cause, 79.4±10.1,(p=0.31).

In 98% of the patients the treatment was surgical. The mean time for surgery was, among women, 3.5 ± 4.4 days, median 2 days and among men 3.2 ± 2.8, median 2 days. The waiting time for surgery was similar both in trochanteric (2.9 ± 2.9 days, median 2 days) and in femoral neck fractures (3.73 ± 5.2 days, median 2 days) p=0.20. The mean time from admission to surgery for the subtrochanteric fractures was 5.67 days± 4.7 days the median being 5 days.

Patients using anticoagulant therapy before the fracture had a waiting time for surgery of 4.8 ± 4.6 days, median 3 days, statistically different from the other patients (3.0 ± 3.9 days, median 2 days), p=0.011.

The time from admission to surgery among patients with ASA score I or II was shorter (2.7 ± 2.8 days, median 2 days), than among patients with ASA score III or IV (4.23 ± 5.12 days, median 2 days, p=0.004).

Even with an ASA scores III and IV, 34% of the women underwent surgery on the day of admission or the following day compared to 7% of the men.

Of all the participants in the study, 19% reported being informed by their doctors that they had osteoporosis, 18% had undergone at least one DXA (dual energy X-ray absorptiometry) and 13% reported being in treatment for osteoporosis. History of previous fractures was found in 50 patients (20% of the participants, being 9% of the wrist, 8% of the hip and 3% of the spine). Almost all were women (n=48). Among the patients who had a previous fracture, 16% were receiving medicaments for osteoporosis, namely 14% anti-osteoporosis drugs and 2% vitamin A12.

The mean hospitalisation length of stay (LOS) was 14.9±12.3 (median 10 days) for women and 13.2±12.2 (median 9 days) for men. No statistical difference in hospital length of stay (LOS) was found by type of fracture or by surgical treatment. The LOS of patients who lived alone before the fracture were higher (18.5±15.6 days) than of patients who lived with someone before the fracture (13.2±12.2 days) (p=0.005).

During the hospital stay the fatality was 4% among the women and 9% among the men (p=0.15). Among patients who died during hospitalization, women (n=8) were younger than men (n=5), the mean difference being 4 years and men died sooner (9.7±2.9 days after admission) than women (28.2±18.5 days after admission), p=0.03.

Discussion

In this study patients aged 50 and above with a diagnosis of PFF caused by low-energy impacts admitted for hospitalization during a one year period were invited to participate in the study. Sociodemographic, and lifestyle variables plus clinical and treatment variables were acquired and registered on a database, that allowed to cross data in order to trace the profile of patients with a proximal femur fracture.

PFF is more frequent in the elderly, especially among women [30]. As the elderly population grows, the number of people at risk of sustaining a PFF increases. In Portugal, as in other countries in the world, the elderly population represents the fastest growing age-group. Since 2004 the ageing index of the Portuguese population continues to increase, reaching an index ageing of 118 elderly per 100 young in 2009 [31]. It has been estimated that the worldwide annual number of PFF will rise to 6.26 million by the year 2050 [32].

Women represented 79% of the participants.The ratio of women: men was of 3.8, higher than the ratio (3.0) found by Aroso Dias et al (1988) in a study done in the same region as our study [33]. A study done by Pina et al (2008) described a geographic variation in the ratio of women: men in Portugal, the minimum being 1.5 and the maximum 5.1 [34]. Compared to other studies done in Europe, a lower ratio was founded in Finland (2.28) [35], a similar ratio in Geneva, Switzerland (3.62) [36] and a higher ratio in a region in the north of Spain (4.7) [37].

The higher proportion of women can be explained by the higher incidence of osteoporosis in women due to menopause and because women have more problems of postural instability than men, and therefore they fall more often and in a more dangerous way [14].

Men were, on average, four years younger than women at the time of the fracture and the majority were married. In contrast women were mostly widows. This can be explained by the fact that in Portugal the average life expectancy for men (76 years old) is lower than for women (82 years old), therefore men die sooner, so explaining the high percentage of widowed women [38].

The mean age of women (80.3±9.5 years) and of men (76.3±11.3 years) at the time of the fracture was lower than the mean age of women (83.1±8.9 years) and men (78.3 ±9.5 years) found in a study done in Geneva, Switzerland [36] and also lower than the mean age reported in a study done in a region of Spain where women

were 84.0±8.0 years old and men were 78.0±12.0 years old on average [37]. Compared to Finland the mean age of women was similar but men were 4 years younger (72.1±17.6 years) [35].

Comorbidities are very common among patients with a PFF and some are not controlled at the time of the fracture, delaying the treatment and rehabilitation [39]. In this study only 8% of the patients were without comorbidities at the time of the facture. A higher percentage of male patients reported smoking habits compared to females, which can explain the higher proportion of respiratory disease among men. Compared to women, men have fewer than 1 to 2 comorbidities concomitant which could confirm the fact that many authors argue that men at the time of the fracture are more sick than women [40]. Hypertension was more frequent in women, this disease often being associated with orthostatic hypotension which puts women at higher risk of suffering a fall and therefore a PFF [41].

Medication is another important risk factor for PFF. In this study, 76% of the patients were taking medication and 45% were medicated with more than 3 different drugs. Antihypertensive drugs were the most commonly used drugs among patients followed by the Anxiolytics/Sedatives and hypnotic groups. The association of medication with PFF is explained by the side effects of some drugs and the cumulative effects of multiple drugs or the inadequate dosage and incorrect use of medication [42]. Somnolence, dizziness, fainting are common side effects of medication that put the elderly at risk of suffering a fall and consequently a PFF [43].

The participants of this study had higher rates of trochanteric fractures compared with femoral neck fractures (55% vs. 40%).Patients with a femoral neck fracture were younger than those that suffered a trochanteric fracture. Trochanteric fractures are more strongly associated with osteoporosis and older age than femoral neck fracture [44].

Ageing is inevitable and is an irreversible process. As people become older, and become less active several physical, psychological and social changes occur. Falls are very common in the elderly, but in a fall that results in a fracture of the proximal femur, certain conditions must be fulfilled. One of these is that the point of impact must be on or near the hip. Falling from standing or lower, sideways or straight without protective response has been reported as the most common type of fall leading to a PFF [45,46]. In this study the majority of the fractures (69%) occurred after a fall from standing height, 58% being caused by environmental hazards like

carpets, blankets, animals, furniture, toys, slippery floor or footwear and uneven pavements. Most of the falls occurred at home for both sexes but male patients felt more outdoors than women, which is normal since they are younger and more active than women at the time of the fracture. Patients whose fractures were caused by an environmental hazard were younger (77.8 ±10.2 years old) than the patients who had a fall from standing or lower, indicating that measures to prevent falls should be made at this age.

The risk of fractures is substantially greater in individuals with a history of previous fragility fracture [47]. In this study, 24% of the women and 4% of the men had a previous fracture. In a Portuguese study [48] 39% of prior fragility fractures in women and 23% in men, in a cohort of 188 patients older than 65 years old, were reported. In 2007 the Portuguese Society of Rheumatology and the Portuguese Society of Metabolic Bone Diseases published guidelines to help doctors in the diagnosis and treatment of osteoporosis [49]. However, our study revealed that only 13% of all patients and 16% of patients with a previous osteoporotic fracture were receiving pharmacological treatment for osteoporosis. These results are in accordance with what was reported by other studies, that patients even with a history of previous osteoporotic fractures do not receive adequate treatment for osteoporosis [50].

The standard of care for proximal femur fracture is surgery as soon as possible in order to restore the functionality of the hip so avoiding long term immobilization and serious complications. The goal is to give the patients the same walking ability that they had before the fracture [51]. Over the past years, new surgical techniques, new anaesthesia methods and new medication have been developed to reduce the delay in surgery, duration of surgery and length of stay (LOS) in hospital. In a previous study conducted in 1990 done in the same hospital of this study [33] the length of stay was for female patients of 34 days and for men of 42 days. In our study the LOS was significantly lower being for women 15 days and for men 13 days. Costa et al (2007) [48] reported a LOS of 10 days for women and 14 days for men.

The time for surgery is a controversy issue. International guidelines recommend that patients should be operated on as soon as possible, within 24 hours of admission [52,53]. In Portugal the recommendation is that the surgery must be performed in the first 24 to 48 hours from admission and can only be delayed if the patient needs to be stabilized due to some comorbidities [54]. The mean time for

surgery in this study was of 3.5 ± 4.2 days, median 2 days in accord with the Portuguese recommendations.

A limitation of this study was the lack of information on the true difficulties of the elderly in walking before the fracture since the variable used only reflects the number of hours that patients were active and does not take into consideration the possible limitation on walking and the use of devices.

This study is a prospective observational study where the data was collected directly from the patient and from realistic sources, avoiding biased information and codification errors seen in retrospective studies. Studies that focus their attention on tracing the profile of a patient with a PFF, looking for risk factors, are extremely important for developing strategies that may improve the care and prevention of these serious fractures.

Conclusion

Women had higher risk of proximal femur fracture and were, on average 4 years older than men at the time of the fracture. It was found among the patients higher prevalence of comorbidities and medication. Most of the falls were at home and more than 50% were caused by environmental hazards. Only 13% of the patients were in treatment for osteoporosis. This study reinforces the need to develop preventive actions, either to avoid osteoporosis or to avoid falls in the elderly

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5.2. Paper II

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Survival in the Elderly, following Proximal Femur Fracture: One-Year Follow-up Study

Survival in the Elderly, following Proximal Femur Fracture: One-Year Follow-up Study

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Abstract

Introduction: The worst prognosis after a low impact fracture of the proximal femur (PFF) in the elderly is death and the most feared is the loss of independence. The purpose of this study was to analyse the one-year survival of patients following a proximal femur fracture in an attempt to find the main predictors of fatality. If at the time of the fracture patients with highest risk of death could be immediately identified, measures could be directed to these patients in order to prevent death.

Methods: During hospitalization, a questionnaire was applied by personal interview to all patients that agreed to participate in the study. Questions as to demographic factors, life style, physical activities before fracture and clinical history were made. A follow-up study was conducted, by phone call interviews, 3, 6, 9, and 12 months after the fracture.

Results: 252 patients agreed to participate in the study. Most of the patients were women (79%) with a mean age of 80.3±9.5 years, statistically different from the mean age of men: 76.3± 11.3 years (p= 0.02). The fatality for men was 22%, 25%, 30%, 37% respectively at 3, 6, 9 and one-year follow-up. For women it was 8%, 14%, 20% and 23%. The predictors of fatality were: male gender (HR: 2.53 95%CI 1.40-4.57), age (HR: 1.06 95% CI 1.03-1.10), delay in surgery (HR 1.07 95%CI 1.03-1.12) and ASA score (1.92 95% 1.09-3.42).

Conclusions: In the present study, an increased fatality with increasing age, increased delay to surgery, male gender, and high ASA score classification was found.

Keywords: Hip fracture, proximal femur fracture, fatality, ASA score

Introduction

The worst prognosis after a low impact fracture of the proximal femur in the elderly is death and the most feared is the loss of independence [1,2]. Worldwide these fractures represent an important public health concern due to their negative impact on the quality of life of patients and families and due to the economic effort that is demanded of the health systems and society in the treatment, during the acute phase and in recovery [3,4]. The majority of patients with a PFF are women with a mean age of 80 years old, with underlying bone fragility and whose fracture was caused by a simple fall [5]. However, the mortality following these fractures is much higher among male patients, even though they are younger than women at the time of fracture [6,7]. Mortality risk remains higher within the first 3 to 6 months of the fracture. This declines with time thereafter but may persist for several years after the fracture and does not return to the mortality rates observed in the general population with similar age and sex distribution who did not experience a proximal femur fracture [8,9]. The mortality observed after a PFF is difficult to explain since the patients who sustained this type of fracture tend to have other health problems that also contribute to an increase in their risk of death [10]. In this sense, the causes of death after a PFF are associated with medical complications triggered by the fracture trauma and surgical treatment or related to the health and physical condition of the patients at the time of the fracture [11,12,13,14].

Previous studies have found that it is possible to predict mortality after a PFF if certain factors are present at the time of admission. The goal is to identify earlier those patients at greater risk and implement measures that might reduce the risk [15]. Factors such as patient's age and gender, residence prior to the fracture, mobility prior to the fracture, pre-existing medical conditions and their severity and date of surgery, have been associated with an increased risk of death following a PFF [16,17,18]. However, some of their effects remain controversial.

The aim of this study was to determine the survival rate at one year among a group of patients with a proximal femur fracture and to investigate the determinants for fatality.

Methods

In our study, we analysed all patients admitted into the orthopaedic service of the São João Hospital, for treatment of an acute fracture of the proximal femur, during the period of 1st of May 2008 to 30st of April 2009.

The São João Hospital is the second largest hospital in Portugal, situated in the north of the country in the city of Porto. Almost every day people with fractures of the proximal femur attend the emergency service of this hospital. The diagnosis, in most cases, is easy to make; a simple x-ray of the hip is enough to confirm the fracture. During the period of the study, the archives of radiography images (PACS-Picture Archiving and Communication Systems) were consulted on a daily basis, searching for hip images of patients with a PFF. With the help of this system, the patients were identified and their admission to the hospital was confirmed by consulting the database of the hospital or the nurses' board in the orthopaedic service using their names and date of birth

During hospitalization a questionnaire was applied by one of the authors, through a personal interview, to all the patients who agreed to participate in the study. If the patient was cognitively compromised, the questionnaire was given to their closest family member.

The aim of the questionnaire was to gather information about the patient and about the event that caused the fracture. Information about the patients focused on socio-demographic data (age, gender, marital status, pre-fracture living situation), pre-fracture activity, previous fractures, comorbidities, current medications. The activity of the patients before the fracture was divided into three categories: activity of more than 4 hours a day, activity less than 4 hours a day and non-active patients (patients who were confined to bed). In order to explore the event that caused the fracture, information around the accident where and how it happened were describe by the patient.

In order to ensure a good assessment of patients' co-morbidities, a request was made to the Codification Service of the São João Hospital, asking that they send us the discharge register records of all patients admitted to the hospital with a proximal femur fracture (codes ICD9-CM 820) during the study period. The discharge records included the main diagnosis that was the principal cause of patient admission, and another 19 secondary diagnoses, all coded according to the International Classification of Diseases, version 9, Clinical Modification (ICD9-CM). The following

co morbidities were found among the patients: Diabetes Mellitus (ICD-9:250); Anaemia (ICD-9: 280-289); Stroke and related conditions (ICD-9:430-438); Heart Disease (ICD-9: 410-414; 420-429); Renal Disease (ICD-9-580-589); Hypertension disease (ICD-9:401-405), Chronic obstructive pulmonary disease and other respiratory Diseases (ICD-9: 486; 490-496; 510-519), Osteoarthritis (ICD-9 -715) and Dementia and Alzheimer`s disease (ICD-9: 290-299; 331).

Additional data was obtained from the medical records of the Hospital such as type of fracture, day of surgery, type of surgical treatment and preoperative risk determined by American Society of Anesthesiologist (ASA score) [19]. This system is based on five classes. Class I indicates a normal, healthy patient, class II indicates a patient with mild systemic disease, class III indicates a patient with severe systemic disease that is not incapacitating, class IV indicates a patient with incapacitating systemic disease that is a constant threat to life and finally, class V indicates a moribund patient. The patients were categorized into those with low operative risk (I and II) and high risk (III and IV).

The interval between the admission and the surgery was determined as the difference, in calendar days, between the date of surgery and the date of admission. A patient waits one day for surgery, if he underwent surgery after midnight of the day of admission.

According to the description in the medical records, the fractures in the study were classified as femoral neck fracture, trochanteric and subtrochanteric fracture. Most of the patients were operated on and the surgery consisted of hemiarthroplasty, total hip joint replacement, osteosynthesis with two or three parallel cannulated screws, dynamic hip screw and intramedullary hip screw. The surgery chosen took into account the location of the fracture, the age of the patients, the health condition of the patients and degree of mobility before the fracture. For analysis purposes the types of fracture were divided into intracapsular (femoral neck fracture) and extracapsular (trochanteric and subtrochanteric fracture) and the type of surgery into osteosynthesis and arthroplasty.

The exclusion criteria defined for our study were patients that reported a fall from greater than standing height, patients with a past or current history of cancer, patients with confirmed pathological fractures and patients in treatment with corticosteroids.

After discharge from the hospital, a follow-up study at 3, 6, 9, and 12 months following the fracture, was conducted by phone call interviews. The same author that performed the interviews in the hospital made the interviews by phone. Every phone call checked the survival of patient, the place of residence, autonomy in walking and in performing two activities of daily life (dressing and taking a bath), the occurrence of new fractures, physical therapy and the use of medications to the treatment of osteoporosis.

All the information from the patients' questionnaires and from the follow-up was collected in a Database especially developed for this study using the Microsoft Office Access 2007 program. The database was useful in analysing the data and crossing information. Statistical analysis of the data was made using the SPSS statistical program (version 17.0). Categorical variables were compared using Chi square test or Fisher`s exact test and continuous variables were tested using the *t*-student test. Values were considered as statistically significant at or below $p$=0.05. A Cox`s proportional hazards model was used to determine the association between mortality and the independent variables. The independent variables included were those found to be associated using the Kaplan-Meier method and the log-rank test. For patients that were lost during the follow-up their most recent information was used, in some cases the discharge date and in others the last appointment at the hospital.

The study received approval from the local ethics committee of the São João Hospital.

Results

In the study period, in the emergency department of São João Hospital, 381 patients with a proximal femur fracture were diagnosed, but only 340 patients received treatment in the hospital. Of these patients, 4 refused to participate, 3 died before the interview and ten patients did not have enough mental autonomy or a direct family to answer the questions. In addition, five patients stayed less than 3 days in the hospital and therefore there was no time for the interview. Of these patients one left the hospital against medical advice and four patients were immediately transferred to another care unit after receiving surgical treatment. Three patients were not admitted into the orthopaedic service and so the questionnaire was not applied and three patients were lost. After the interviews and in agreement with the exclusion criteria defined previously for this study we excluded 60 patients (high energy fall, cancer, patients taking corticosteroids and pathologic fracture).

Our final cohort included 252 patients. During the study, five patients after discharge from the hospital and one patient in the hospital sustained a second fracture on the contralateral hip.

Descriptive analysis

Of the 252 patients included in the study, 79% were women, with a mean age of 80.3±9.5 years, statistically different (p= 0.02) from the mean age of men (76.3± 11.3 years). The ratio of female to male was 3.8. More than half of the patients (53%) were over 80 years old. The characteristics of the study population are described in table 1.

Only 8% of our patients had no comorbidities. The presence of heart disease was similar in both sexes: 32% for women and 30% for men ($p_{\text{chi-square}}$= 0.84). Hypertension disease was more frequent among the female patients (56%) than in the men (38%), $p_{\text{chi-square}}$ =0.02 and respiratory diseases were more common in the men (36%) compared to women (13%) $p_{\text{chi-square}} < 0.0001$.

The ratio of trochanteric to femoral neck fractures was 1.32 and 1.6 in women and men, respectively. Patients with a femoral neck fracture were younger (78.0±9.7 years) than those that suffered a trochanteric fracture (80.6±9.8 years), the difference in mean age being 2.6 years (p=0.04).

Table 1. Baseline characteristics of the patients (N=252)

Characteristics	N	%
Sex		
Women	199	79%
Men	53	21%
Age		
< 60	12	5%
60-69	19	8%
70-79	88	35%
80-89	105	42%
90 +	28	11%
Marital status		
Widowed	127	50%
Married	84	33%
Single/ Divorced	41	16%
Pre-fracture living situation		
Living with someone	169	67%
Living alone	64	25%
Institution	19	8%
Mobility		
More than 4 hours a day	85	34%
Less than 4 hours a day	167	66%
Previous Fracture		
Hip	21	8%
Wrist	22	9%
Spine	7	3%
Comorbidities		
No comorbidities	19	8%
Hypertension	131	52%
Heart Disease	80	32%
Anemia	61	24%
Diabetes mellitus	57	23%
Demencia	48	19%
Respiratory Diseases	44	17%
Cerebrovascular Disease	33	13%
Renal Diseases	18	7%
Thyroid disease	14	6%
0 to 1 comorbidities	57	23%
2 to 4 comorbidities	116	46%
More than 5	79	31%
Place of Fall (n=258)		
Home	202	78%
Street	56	22%
Fracture Type (n=258)		
Femoral neck	103	40%
Trochanteric	142	55%
Subtrochanteric	13	5%
Surgery Type(n=254)		
Osteosynthesis	174	68%
Arthroplasty	80	32%
Asa Score (n=254)[a]		
Asa I and Asa II	131	52%
Asa III and Asa IV	120	47%

[a] Data not available for 3 patients.

In 98.4 % of the patients, the treatment was surgical. Four patients were not in a condition for surgical treatment. The mean time for surgery was 3.42 ± 4.1 days, median 2 days, and there was no statistical difference by sex. Considering time to surgery, 36% of the patients were operated on the day of admission or the following day and 64% underwent surgery on the second day or in the following days after admission. The time from admission to surgery among patients with ASA score I or II was shorter (2.7 ± 2.8 days, median 2 days), than for a patient with ASA score III or IV (4.23 ± 5.12 days, median 2 days, p=0.004). This difference was significant among men and women, the difference in mean days being equal to 2.3 and 1.4, respectively.

Even with an ASA score III and IV, 34% of the women underwent surgery on the day of admission or the following day compared to 7% of the men.

The mean hospitalisation length was 14.9±12.3, median 10 days for women and for men 13.2±12.2, median 9 days, p=0.38. The patients that lived alone before the fracture were discharged from the hospital 18.5±15.6 days (median 14 days) after admission, while the patients who lived with someone were discharged earlier 13.2±12.2 days, median 10 days (p=0.005).

The in-hospital mortality in men was 9% compared with 4% in women. After discharge, 23 patients were lost and never contacted again, because of lack of information or changes in the phone number. Of these, it was possible to determine the survival status of 14 patients, by checking the database of the hospital, seeking new hospital admissions, medical appointments, diagnostic examinations or death, although for the 9 others this information was not recovered and they were considered lost after the discharge date. At the end of one year follow-up there were 14 patients lost: nine at the discharge, one after 9 months and four others after one year. Therefore, the cohort after one year of follow-up had 238 patients. One year after the fracture, 59 patients had died (41 women and 18 men) of whom 13 died during hospitalization (20%) and 46 (80%) died after discharge. The majority of the deaths occurred in the first 3 months (44%) following the fracture, the number being higher in men (61%) than in women (37%), $p_{\text{chi-square}}$=0.08. During the 3,6,9 and 12 months of follow-up, the fatality among men was higher than in women, being 22%,25%,30% and 37%, respectively for men and 8%, 14%, 20% and 23%, respectively for women.

The patients who died were older (82.4 ± 8.6 years old) than those who remained alive (78.2 ± 10.0 years old) and this difference was statistically significant for both sexes the difference in mean age (death vs alive) being for men 9.25 years (p=0.005) and for women 3.31 years (p=0.03).

The mean time for surgery, of the patients that died was 4.9 ± 5.8 days, median 3 days, statistically different (p=0.02) from the mean time for surgery among the survivors (2.9 ± 3.4 days, median 2 days). Analysing by sex, this was statistically significant only for male patients, the difference in mean time being 2.2 days (p=0.02) and for women 1.9 days (p=0.09).

The length of stay in hospital for the patients that died was 18.0 ± 12.8 days, median 13.5 days, statistically different (p=0.04) from the length stay in the hospital among the survivors (13.8 ± 14 days, median 9 days).

Survival analysis

The one year survival rate was 75%, 95% CI (70% to 81%). Among male patients, the survival rate was 64%, 95% CI (52% to 78%) and among female patients was 82%, 95% CI (73% to 84%). In figure 1 Kaplan-Meier curves of the variables of the study can be seen whose result of the log-rank test was statistically significant. After adjustment for age the variables referred in Figure 1 remain statistically significant with the exception of the variable degree of mobility that lose their significance (hazard ratio 1.56 95% CI 0.830 to 2.95, p=0.167).

Of the women patients, living at home alone before the fracture, after one year they have a better survival rate than women that were admitted from an institution (hazard ratio 0.30, 95% CI 0.10 to 0.85, p=0.024) even after adjustment for age, degree of mobility and number of co-morbidities.

Patients with 5 or more comorbidities had a hazard ratio for death of 2.8, 95% CI 1.2 to 6.4, p=0.02) compared to patients with 0 to 1 comorbidities even after adjustment for age, sex and degree of mobility before the fracture.

The Kaplan-Meier curve of ASA score showed that patients with ASA score I or II had better survival than patients with ASA score III or IV. This was statistically significant for women (hazard ratio 2.0, 95% CI 1.02 to 4.0, p=0.05) even after adjusting for age and time to surgery but not for the male patients (hazard ratio 1.4, 95% CI 0.5 to 4.1, p=0.50).

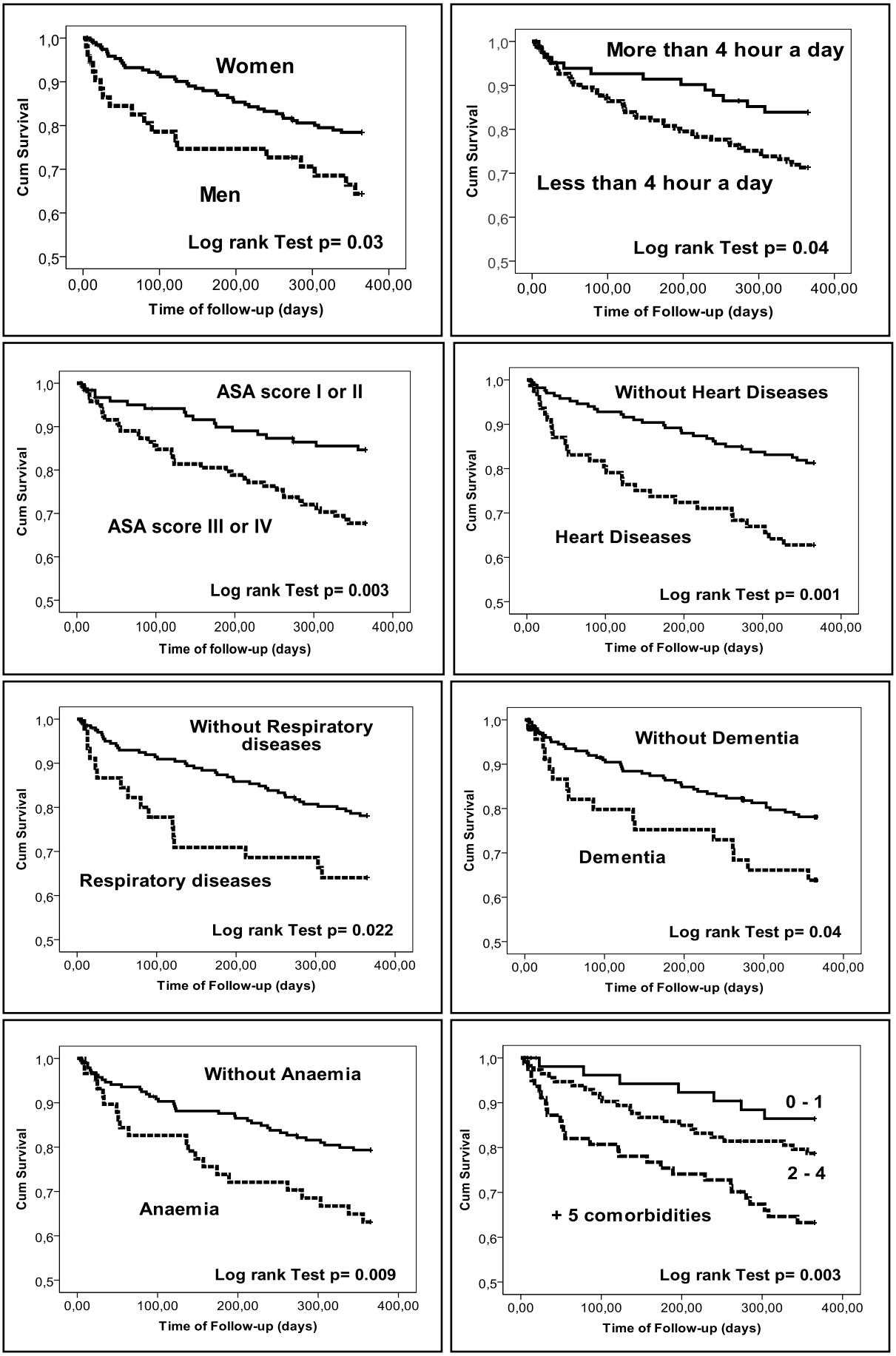

Figure 1. Kaplan Meier curves with significant log rank test of some variables of the study

There was an increased mortality in patients with extracapsular fractures compared with those with intracapsular fractures (hazard ratio 1.32 95%CI 0.76 to 2.30, p=0.321), but without statistical significance, even after adjusted from age.

In table 2 the results of the Cox`s proportional hazards are yielded. Using women as reference, the risk (95% CI) of death among men, after one year, was 87% (5%-219%) higher. After adjusting for confounders the risk increased. The risk of fatality increased 6% for each age-year and did not change after adjustment for confounders.

Table 2 Cox`s proportional hazards analysis. Predictors of decreased 1-year survival after a proximal femur fracture

Variable	Crude analysis HR (95%CI)	HR(95% CI) adjusted for age	Adjusted HR(95% CI)	Adjusted HR(95% CI)
Sex				
Women	1.00	1.00	1.00	1.00
Men	1.83 (1.05-3.19)	2.44 (1.38-4.31)	2.71 (1.50-4.91)	2.53 (1.40-4.57)
Age	1.05 (1.02-1.08)	1.06 (1.02-1.09)	1.06 (1.03-1.10)	1.06 (1.03-1.10)
Delay to surgery	1.08 (1.03-1.12)	---	1.09 (1.04-1.13)	1.07 (1.03-1.12)
Asa Score	2.31 (1.32-4.05)	---	---	1.92 (1.09-3.41)

Association of delay in surgery and fatality was positive in this study, increasing 7% for each day of delay.

ASA score was used to analyse the severity of health conditions of the patients prior to the fracture and the risk of fatality in our study was 1.92 fold higher in patients with worse ASA score compared to patients with ASA score I and II.

Substituting the ASA score by the individual diseases (heart diseases, respiratory diseases, dementia and anaemia) increased the hazard ratio of men to (HR 2.62 95% CI 1.39 to 4.94) but none of the variables was significantly related to the risk of death along with the other confounders. Similar finds were made using the number of comorbidities instead of the variable ASA score (HR 2.66 95% CI 1.47 to 4.83).

Discussion

The purpose of this study was to analyse the one-year survival of patients after a proximal femur fracture in an attempt to find the main predictors of fatality. If at the time of the fracture patients with highest risk of death could be immediately identified measures can be directed to these patients in order to prevent their fatality.

In the present study, an increase in fatality was found with increasing age, increased delay to surgery, male gender, and high ASA score classification.

Age was the major predictor of fatality with a significant 6% increase in fatality for each year increase in age (HR 1.06, 95%CI 1.03-1.05). In a study of 1109 patients 10 years after the fracture the effect of age on fatality was still significantly with a hazard ratio of 1.04 , 95% CI 1.03-1.05 [20].

In accord with others studies [21,22], higher fatality among the male patients was found, despite there being fewer men than women, with female-male ratio of 3.8 and 4 years younger at the time of the fracture. The overall one year fatality in our study was 26%, 37% for men and for women 23%. The fatality for men was a little higher than those found in some studies done in European countries that normally range from 31% to 34% [23,24,25]. However it was similar to a study done in Denmark (35.8%) but men were 3 years older than the age of our men [26]. In the Portuguese population, in a prospective study with similar methodology to ours, an overall fatality at one year of 26.8%, 48% of the men, and 22% of the women is reported. The population in the study was more than 65 years old and men were fewer (18%) while they were 3 years older than the men in our study [27]

After adjustment from potential confounders, male patients had a risk of fatality of 2.53 95% CI (1.40-4.57) fold compared to women. Alegre-López et al (2007) [28] found a similar risk of fatality 2.44 95% CI (1.01-5.93) in a prospective population-bases inception cohort of 218 patients.

The reasons for the sex differences in fatality are difficult to explain, although it seems that men are sicker and more frail than women at the time of fracture, having more respiratory diseases making them more vulnerable to postoperative complications [29]. In this study no significant differences among sex and ASA score was found, except in ASA score IV whose percentage of men was a little higher than in women. A predominance of respiratory diseases in men was confirmed, putting them at higher risk of developing pulmonary embolism, an important complication associated with this type of fracture. Another aspect that could show that male

patients were more sick than women at the time of the fracture was that in only 7% of the men with ASA score III and IV, was the risk of performing a control risk surgery taken on the day of admission or in the following day compared to 34% of cases in women patients.

In this study, we found a positive association between delay in surgery and fatality. For each day of delay in surgery there was an increased risk of 7% in fatality. The optimal time for the surgery of proximal femur fractures in the elderly is not clear. Most the authors indicate that early operation (<24, < 48 or <72 hours) is associated with better prognosis and improved health quality [30,31,32]. Zuckerman et al. reported that a delay of three calendar days or more from the time of admission to the time of surgery almost doubled the risk of mortality within the first year after the fracture [33].

One of the most important reasons for performing surgery on patients as soon as possible in addition to reduced pain and discomfort is to prevent complications like pulmonary embolism, deep vein thrombosis, heart failure, urinary infections and pressure scores [34]. These complications increased the risk of death and increased the time of hospitalization, delaying the beginning of rehabilitation [35].

International guidelines recommend that patients should be operated on as soon as possible, within 24 hours of admission [36,37]. In Portugal the recommendation is that the surgery must be performed in the first 24 to 48 hours from admission and can only be delayed if the patient needs to be stabilized due to some comorbidities [38].

Surgery is often postponed for both medical and non-medical reasons. The most common delay for medical reasons is to stabilize patient's medical condition and to optimize their hemodynamic status, improving their fitness for surgery. Most patients with a PFF are dehydrated, anaemic and malnourished on admission [39]. A reason for this is not only due to the blood loss caused by the fracture but also because in some cases these patients spend a long time on the floor without access to food and water until someone finds them, as they may be or live alone or the fracture occurs during the night.

Another medical reason for delay is related to anticoagulation treatment, which is very common in the elderly for preventing thrombosis and atrial fibrillation. Anticoagulation should be temporarily discontinued in preparation for surgery in order

to prevent excessive bleeding at the time of surgery, but this puts patients at higher risk of a thromboembolic event [40].

The non-medical reason is normally due to the unavailability of an operating theatre which is very common in the emergency department when several medical specialties compete to have their surgery [41].

Most of the patients that suffer a PFF have comorbidities; as seen in this study, this is 92% of the patients. The presence of comorbidities may predispose the occurrence of the fall, which is the cause of the fracture and after the fracture will influence the treatment, the survival and the process of recuperation [13].

Those with comorbidities at the time of the fracture suffer the greatest impact on fatality during the first year after the fracture, but the healthier patients seem to suffer a decline in health triggered by the fracture that may persist for several years [12].

ASA score is a widely used and internationally accepted measure of preoperative fitness and is a good predictor of fatality after a hip fracture. It takes into consideration the severity of the different diseases that may affect survival, whereas the number of comorbidities merely reflects the patient's general health status without providing an indication of the potential life risk involved [42].

In the present study patients with ASA score III or IV had an increased risk of 92% compared to patients classified with ASA score I or II. Gdalevich et al [43] found in their study a risk of fatality associated with ASA score III or IV of 1.96 fold, but their 651 patients were over 60 years old.

Patients with trochanteric fractures seem to have a higher risk of death compared to patients with femoral neck [44]. In this study this was not confirmed.

In this study, an association between fatality and the degree of mobility of patients before the fracture was not confirmed. This may be a limitation in this study, as the variable used reflects the number of hours that patients were active and does not take into consideration the possible limitation on walking and the use of devices. Poor mobility before the fracture has been shown to correlate with higher fatality [45,46, 47].

Another predictor of fatality reported by some studies is the reduced mental status of patients at the time of the fracture [47,48,49]. In this study the mental state of our patients was not tested in a direct way. However we believed that most of the patients were oriented in time and space as they answered the first questions of

questionnaire correctly, being age, parish and district of birth and residence and phone number.

Another limitation of the study was the lack of information on post-operative complications that may have occurred during hospitalization and after discharge. However as reported by other studies [33], the rate of complication is generally low, and a good study of the impact of complications on fatality must involve a greater number of participants.

Conclusion

In conclusion in the present study, an increase in fatality with increasing age was found, together with increased delay in surgery, male gender, and high ASA score classification. No association was found between fatality and type of fracture, type of surgery, degree of mobility before fracture and length of stay in the hospital. Identification of factors that may influence fatality will help in optimizing the recovery from this type of fracture

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6. DISCUSSION

The incidence of proximal femur fracture is predicted to double during the first decade of this century in both industrialized and developing countries mainly due to the ageing of the population [12]. In Portugal it was estimated that in 2020 there will be 10 684 individuals experiencing a proximal femur fracture and 11 522 in 2050 [89]. Proximal femur fracture is considered one of the most serious public health problems due to the negative effect in the quality of life of patients and due to the economic costs related to hospitalization and to social support [13, 36].

However, the adverse effects of proximal femur fracture can be prevented through interventions that prevent falls and osteoporosis. For proper implementation of preventive measures, a good knowledge of risk factors is important.

The main objective of this study was to determine the one year incidence of PFF in the main hospital in the north of Portugal, and to characterize a cohort of patients with such a condition, regarding demographic, clinical and behavioral data. The second objective was to determine the survival rate at one year and investigate the determinants for fatality.

In this study and as confirmed by others [4,79] proximal femur fractures is more frequent in elderly women. The ratio of women: men was 3.8, a little higher compared both to national [42,45] and to international studies [88,89].

Men were, on average, four years younger than women at the time of the fracture and the majority were married. Higher percentages of male patients reported smoking habits and they had more respiratory diseases than women. In contrast women were mostly widows and reported more postural problems as they were more hypertensive. Risk factors for falls and for proximal femur fracture were present among the patients. Many comorbidities were founded plus too much medication. On average patients reported the use of more than 3 drugs per day.

The majority of the fractures occurred at home and 58% of the falls from standing height were caused by environmental hazards. These falls could have been avoided by simple changes in the houses of the patients. Most of the falls occurred at home for both sexes but male patients fell more outdoors than women, which is normal since they are younger and more active than women at the time of the fracture.

Patients with a femoral neck fracture were younger than those that suffered a trochanteric fracture. Trochanteric fractures are more strongly associated with osteoporosis and older age than femoral neck fracture [90]. The standard of care for proximal femur fracture is surgery and the goal is to give the patients the same walking ability that they had before the fracture [91]. In 98% of the patients of this study the treatment was surgical. Among the patients that were not operated on only one was alive at the end of the study.

The fatality between patients with a proximal femur fracture is higher, especially for male patients. In this study the fatality reached 37% among the men at one year, and was higher compared to fatality reported by some European studies (31% to 34%) [92,93]. Age was the major predictor of fatality with a significant 6% increase in fatality for each year increase in age (HR 1.06, 95%CI 1.03-1.05). In this study, a positive association was found between delay to surgery and fatality. For each day of delay to surgery there was an increased risk of 7% on the fatality rate. Most authors indicate that early operation (24, < 48 or <72 hours) is associated with better prognosis and improved health quality [94,95]

The other predictors of fatality were male gender (HR 2.53 95%CI 1.40-4.57), and ASA score (HR 1.92, 95%CI 1.09-3.41).

6.1. Limitation of the study

The questionnaire applied to patients was rather long, but the initial objective was to gather the most information possible for future use in a study with a case control group. So in the end some of the questions were analyzed but were not relevant for the study.

The Mini-mental test was not used. This test could have been important to evaluate the cognitive impairment of the patients at the time of the fracture and to a better analysis of the impact of this condition on the fatality of the patients.

The question that evaluated the mobility of the patients before fracture reflects the number of hours that patients were active and does not take into consideration the limitation on walking and the use of canes, crutches or walkers.

Another limitation of the study was the lack of information on post-operative complications that may have occurred during hospitalization and after discharge. This

may influence the fatality of the patients, but a greater number of participants is necessary to study their impact.

6.2. Future Work

The work developed for this thesis is the beginning of a long journey.
Future work in the following year will be:

- To study the impact of a proximal femur fracture on the quality of life of the patients, evaluating the changes in the place of residence and in walking ability.

- To try to submit the papers to a scientific journal

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ANNEX I

Questionnaire

INQUÉRITO AOS PACIENTES COM FRACTURA DA EXTREMIDADE PROXIMAL DO FÉMUR, INTERNADOS NO SERVIÇO DE ORTOPEDIA E TRAUMATOLOGIA DO HOSPITAL DE SÃO JOÃO

Data do Inquérito: ...../...../.....

ETIQUETA HOSPITALAR DO DOENTE

Dados Gerais:

1) **N.º Processo Hospitalar:**

2) **Data de Nascimento: ...../...../..... Idade: anos**

3) **Sexo:** ☐ Feminino ☐ Masculino

4) **Estado Civil:** ☐ Solteiro(a) ☐ Casado(a) ☐ Viúvo(a) ☐ Separado(a)

5) **Raça:** ☐ Branca ☐ Negra ☐ Asiática

6) **Telefones para Contacto:**

1----------

2----------

3----------

7) **Peso: (kg)**

8) **Altura: (Cm)**

9) **Local de Nascimento:**

Freguesia:_____

Concelho:_____

10) **Local de Residência:**

Freguesia:_____

Concelho:_____ Código Postal: _ _ _ _ / _ _ _

11) **Há quanto tempo reside nesta freguesia? anos**

12) **Se reside há menos de 5 anos na actual freguesia, onde residia anteriormente?**

Freguesia: _____

Concelho: _____

13) Escolaridade:

☐1º ciclo do ensino básico (1º ao 4º ano)

☐2º ciclo do ensino básico (5º ao 6º ano)

☐3º ciclo do ensino básico (7º ao 9º ano)

☐Ensino Secundário (10º ao 12º ano)

☐Ensino médio

☐Ensino superior

☐Nenhum nível de escolaridade

14) Profissão: _____

15) Trabalhava antes da fractura?:

☐ Sim ☐ Não ☐ Aposentado ☐ Invalidez

16) Rendimento mensal do agregado familiar:

☐ abaixo de 350 € ☐ entre 350 e 1.000 € ☐ entre 1.000 e 1.500 €

☐ entre 1.500 e 3.000 € ☐ acima de 3.000 €

17) Com quem vive?

☐ Sozinho

☐ Família

☐ Lar

Tipo De Fractura: ☐ anca direita ☐ anca esquerda

18) Data da Fractura: ...../...../.....

19) Hora da Fractura: ..... horas

20) Como ocorreu a fractura?

☐ Baixa energia ☐ Média energia ☐Alta energia Como:_____

21) Onde ocorreu a fractura?

☐ Em Casa ☐ Na Rua ☐ No Trabalho ☐ Outros:_____

História Ginecológica (só para o sexo feminino)

22) Idade da Menarca (1ª. Menstruação) : _____anos

☐ Não sabe Informar

23) Idade da Menopausa: _____anos

☐ Não sabe Informar

24) Fez Histerectomia (operada ao útero)?

☐ Sim ☐ Não ☐ Não sabe Informar

25) Idade da Histerectomia: _____anos

☐ Não sabe Informar

26) Foi-lhe removido algum ovário?

☐ Não ☐ Sim, 1 ovário ☐ Sim, 2 ovários ☐ Não sabe Informar

27) Com que idade lhe foi removido(s) o(s) ovário(s) _____anos

☐ Não sabe Informar

28) N.º de Gravidezes:

29) Idade da 1ªGestação:

30) N.º de Abortamentos :

31) Quantos filhos amamentou por mais de 6 meses?

32) Tomou complemento de cálcio durante a gravidez e a lactação?

☐ Sim ☐ Não

33) Fez ou faz Terapia Hormonal de Substituição para a menopausa (THS)?

☐ Sim ☐ Não

34) Com que idade iniciou a THS? _____anos

35) Com que idade terminou a THS? _____anos

Hábitos

36) Fazia alguma actividade física em casa (caminhar, subir escadas, lavar roupa, aspirar, jardinagem, engomar, tratar de crianças, etc):

☐ Mais de 4 horas por dia ?

☐ Menos de 4 horas por dia ?

☐ Nenhuma actividade

37) Praticava alguma actividade física fora de casa, como caminhadas ou outros exercícios físicos?

	Infância	Adolescência	Adulto	Actualmente
Nunca				
Ocasionalmente				
- 6h por semana				
+ 6h por semana				

38) Fumava?

☐ Sim ☐ Não

39) Quantos cigarros fumava por dia?

40) Com que idade começou a fumar?

41) Com que idade parou de fumar?

42) Quantos cigarros fumava por dia?

43) Consome bebidas alcoólicas?

☐ Sim ☐ Não

44) Com que frequência consome bebidas alcoólicas?

☐ 2 a 3 vezes por dia ☐ 1 ou menos vezes por dia

☐ 2 a 3 vezes por semana ☐ Ocasionalmente ☐ Nunca

45) Em relação aos seus hábitos alimentares, quantas doses diárias ingere dos seguintes alimentos:

Alimento	Consumo Diário
Café (chávenas)	
Queijo (fatias)	
Leite(copos)	
Iogurte	
Hortaliças	
Legumes	
Fruta (peças)	

46) Qual a frequência com que tomou leite ao longo da sua vida:

	3 ou mais copos por dia	1 a 2 copos por dia	Todas as semanas mas não todos os dias	Raramente ou nunca
Até aos 25 anos				
Entre os 25 e os 50 anos				
Depois dos 50 anos				

Dados Clínicos

47) Algum médico já lhe disse que tem osteoporose?

☐ Sim ☐ Não ☐ Não sabe Informar

48) Se sim, que idade tinha ? _____anos

☐Não sabe Informar

49) Já fez alguma densitometria óssea (medição da quantidade de osso)?

☐Sim ☐ Não ☐ Não sabe Informar

50) Quantas densitometrias já fez?

51) Com que idade fez a primeira densitometria? _____anos

☐Não sabe Informar

52) Com que idade fez a última densitometria? _____anos

☐ Não sabe Informar

53) Já sofreu outras fracturas?

☐ Sim ☐Não ☐ Não sabe Informar

54) Complete o quadro abaixo para fracturas anteriores

	Total	Idade da 1ª Fractura	Idade da Última Fractura
Anca			
Vértebra (coluna)			
Punho			

55) Ficou com alguma limitação motora após a(s) fractura(s)?

☐ Sim ☐ Não ☐ Não sabe Informar

56) Durante quanto tempo ficou com limitação motora?

57) Tem algum parente em 1º grau (pai, mãe, irmãos) que tenha sofrido fractura da anca (colo do fémur), punho ou vértebra (coluna)?

☐ Sim ☐ Não ☐ Não sabe Informar

58) Se sim, complete o quadro abaixo

	Anca	Vértebra	Punho
Pai			
Mãe			
Irmão			
Irmã			

59) Alguma vez algum médico lhe disse que sofre de algumas destas doenças?:

Artrose: ☐ Sim ☐ Não ☐ Não sabe Informar

Hipertensão Arterial: ☐Sim ☐Não ☐ Não sabe Informar

Fribromialgia: ☐ Sim ☐ Não ☐ Não sabe Informar

Diabetes: ☐ Sim ☐ Não ☐ Não sabe Informar

Doença da Tiróide: ☐ Sim ☐ Não ☐ Não sabe Informar

Doença da Paratiróide: ☐ Sim ☐ Não ☐ Não sabe Informar

Outras:_____

60) Usa Óculos?

☐ Sim ☐ Não ☐ Não sabe Informar

61) Têm problemas auditivos?

☐ Sim ☐ Não ☐ Não sabe Informar

62) Ultimamente tem sentido tonturas, problemas de equilíbrio?

☐ Sim ☐ Não ☐ Não sabe Informar

63) Está a tomar algum medicamento?

☐ Sim ☐ Não ☐ Não sabe Informar

64) Quais os medicamentos que está a tomar? Há quanto tempo?

Medicamento: _____**Tempo:**_____

Medicamento: _____**Tempo:**_____

Medicamento: _____**Tempo:**_____

Medicamento: _____**Tempo:**_____

Medicamento: _____**Tempo:**_____

65) Já tomou algum destes medicamentos por mais de seis meses consecutivos?

Cálcio:	☐ Sim	☐ Não	☐ Não sabe Informar
Vitamina D:	☐ Sim	☐ Não	☐ Não sabe Informar
Fosamax; Adronat; ou Actonel:	☐ Sim	☐ Não	☐Não sabe Informar
Evista ou Optruma:	☐ Sim	☐ Não	☐ Não sabe Informar
Estrogénios (THS/ Menopausa):	☐ Sim	☐ Não	☐ Não sabe Informar
Corticóide (> 4 mg/d):	☐ Sim	☐ Não	☐ Não sabe Informar

Ambiente

66) Tem o Hábito de tomar banhos de sol?

☐ Sim ☐ Não

67) Na sua opinião, o lugar onde mora:

☐ Tem muito sol

☐ Tem pouco sol

☐ Quase não tem dias de sol

ANNEX II

Follow-up questionnaire

INQUÉRITO FOLLOW- UP

ID Paciente: _____ **Mês da Fractura:**

_____

Nome do Paciente :

_____

Telefone: _____

_____

_____

	3M	6M	9M	12M
Mês				
Quem respondeu ao Inquérito	☐ Próprio ☐ Familiar:_____ ☐ Outro:_____	☐ Próprio ☐ Familiar:_____ ☐ Outro:_____	☐ Próprio ☐ Familiar:_____ ☐ Outro:_____	☐ Próprio ☐ Familiar:_____ ☐ Outro:_____

1. Condição do Paciente:

Follow-up	Vivo	Falecido
3M		
6M		
9M		
12M		

Em caso de Falecimento:
Data do Falecimento _____
Causa do Falecimento
_____

2. Autonomia

Onde está a residir?

RESIDÊNCIA	3M	6M	9M	12M
Casa Própria sozinho	☐	☐	☐	☐
Casa Própria com familiares	☐	☐	☐	☐
Casa de Familiares	☐	☐	☐	☐
Instituição	☐	☐	☐	☐

Necessita de ajuda para se deslocar?

MOBILIDADE	3M	6M	9M	12M
Mobilidade sem apoio	☐	☐	☐	☐
Mobilidade com apoio, uso de muletas ou andador	☐	☐	☐	☐
Mobilidade em cadeira de rodas	☐	☐	☐	☐
Acamado	☐	☐	☐	☐

Precisa de apoio para realizar as actividades diárias como higiene pessoal, vestir, preparação de refeições?

	3M	6M	9M	12M
Sim				
Não				

3. Ocorrência de Novas Fracturas

Sofreu nova queda com fractura da anca, do punho ou da coluna?

	3M	6M	9M	12M
Sim				
Não				

Se sim: Data da Fractura : _____

Estrutura afectada: _____

Qual o Hospital que recorreu? _____

4. Tratamento da Osteoporose

Está a tomar medicamentos para o tratamento da osteoporose?

	3M	6M	9M	12M
Sim				
Não				

Está a fazer Fisioterapia?

	3M	6M	9M	12M
Sim				
Não				

5. Qualidade do Tratamento

Relativamente ao tratamento recebido acha que foi o mais adequado? ☐ Sim ☐ Não

Como o classifica? ☐ Mau ☐ Razoável ☐ Bom ☐ Muito Bom