Prognostics of recovery in hip fracture patients

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Chapter 1

General introduction

Epidemiology

Proximal femoral fractures are amongst the most prevalent fractures in older patients. The lifetime risk for women in Western countries is about 12%, and 5% for men.[1] In the Netherlands, the combined incidence of approximately 20.000 proximal femoral fractures annually accounts for about 500 million euro's in acute treatment costs, which corresponds with 0.5% of the total national healthcare budget.[2-4]

The high risk for this type of fracture results from a variety of age-related health factors. The average patient is aged 80 years or older and has significant comorbidities.[2] Up to 40% of patients already experienced onsets of disability shortly before the fracture.[5] The typical trauma mechanism is a fall from a standing height on the ipsilateral hip.[6] The risk of falling increases with age, and simple falls are the leading cause of traumatic injury and death in patients 65 years of age and older.[7, 8] The age-related factors contributing to a fall include musculoskeletal disorders (impaired strength due to sarcopenia, joint pain associated with arthritis or degenerative arthropathies), cardiovascular disorders (temporary loss of consciousness due to cardiac arrythmias, orthostatic hypotension, myocardial infarction), neurological disorders (impaired functionality due to stroke, Parkinsonism or diabetic neuropathy), impaired vision, medication induced vertigo, hypoglycaemia and infections.[8] In most cases, a specific cause is hard to determine, as it is often a combination of multiple factors.

Etiopathogenesis

Although the femur is the largest and strongest long bone, the bone quality can be so poor in older people, that a low-energy trauma results in a fracture.[9] The poor bone quality is characterized by a low bone mass density: the definition of osteoporosis.[10-12] In older women, osteoporosis is most frequently attributed to a postmenopausal hormonal disbalance which leads to a systemic increase in the reabsorption and insufficient mineralization of bone.[10] Consequently, these fractures are more than twice as prevalent in women compared to men.[13] Diminished physical activity, chronic disease, poor calcium and vitamin D intake and medication can also lead to severe osteoporosis at an old age in both sexes.[14]

Fractures caused by these age-related factors are collectively referred to as 'fragility fractures'.[15, 16] Besides the proximal femur, which accounts for approximately 18% of these fractures, other common fractures are of the distal radius, vertebrae, proximal humerus and pelvis.[13] The social and economic impact of most other fragility fractures, however, is by far not as significant as that of the proximal femoral fractures.[17] Fragility fractures other than the proximal femur are often treated conservatively, and cause less morbidity and functional impairment.

Treatment

Proximal femoral fractures are often extremely painful as they cover a large area of bone and periosteum.[18, 19] In addition, muscle tension of the upper extremity causes rotation and compression at the fracture site. Bearing weight on the fractured extremity is extremely painful, unstable and risks an increase in the displacement in virtually all types of fractures except the stable fractures.[20, 21] Closed anatomic reduction and fixation with a splint to effectively stabilize the fracture and enable mobility is practically impossible.[22]

In general, the primary aim of proximal femoral fracture surgery is to allow for immediate mobilization and early rehabilitation. In contrast to many other long bone fractures treated surgically with internal fixation, successful fixation of a proximal femoral fracture allows for relatively immediate and unrestricted activity. Alternatively, replacement of the fracture by prosthesis implantation removes the fracture site altogether and allows for immediate mobilization also.

The surgical options (osteosynthesis or prosthesis) are determined by the anatomical fracture characteristics, the patient's condition and the patient's prefracture mobility. The two main groups of proximal femoral fractures, femoral neck fractures and pertrochanteric fractures, each pose their own therapeutic challenges.[23] Femoral neck fractures are located in the collum femoris, between the femoral head and the trochanter complex.[24] Displacement in this type of fracture can lead to a disruption of the blood-supply to the femoral head, which is provided by femoral circumflex arteries running around the femoral neck.[24] This can lead to an avascular osteonecrosis of the femoral head or non-union of the fracture. For this reason displaced fractures are frequently treated with arthroplasty, especially in older patients with limited mobility.[25-27] The operation requires an approach to the hip joint that provides an adequate exposure to remove the femoral head and insert a prosthesis in the femoral canal. The approach can be performed in a number of ways, but all require substantial traumatic manipulation of the surrounding tissues, which may affect outcomes in different ways. Trochanteric fractures intersect either the major trochanter or the lesser trochanter of the femur, and are often comminuted.[28] These fractures pose little risk for avascular necrosis and the main goal of the surgical procedure is to achieve an adequate fracture stability.[29] Fixation with intramedullary nails tend to provide the most stability with the best outcomes.[30-32]

Practice to regain mobility starts as early as possible after surgery.[33, 34] During admission patients are instructed by a physiotherapist and train mobility, including transfers in and out of bed, use of walking aids, walking short indoor distances and climbing stairs.

Patients who previously lived in a nursing home can frequently return to the same institution and receive locally organized rehabilitation and upscaling of professional care if necessary. In the Netherlands, these nursing home patients are not eligible for rehabilitation conform the geriatric rehabilitation DBC, but for another, more limited care package (ZZP9B). The majority of patients, however, lived independently at home without personal care before occurrence of the fracture.[35] Generally, the more fit patients are mobilized sufficiently during the hospital admission

to be able to make independent transfers, walk indoors and go to the bathroom. This is considered self-reliant enough to return safely to their independent living situation, if necessary with the aid of caregivers or professional home-care.[36] Further rehabilitation through physiotherapy can be provided by home visits of the physiotherapist or in an ambulatory setting.[37] This applies to approximately 40-50% of the prefracture community dwelling patients.[38, 39] For those patients who have not recovered sufficiently during admission, or for those patients whose premorbid home-situation proves problematic due to logistic or organizational reasons, temporary admission to a specialized rehabilitation home for geriatric rehabilitation is warranted. This option has gained favour in the past decades.[40]

Currently, limited consensus and no validated rehabilitation protocols designed specifically for patients with a proximal femoral fracture exists in the Netherlands and elsewhere.[41] Although many studies on more elaborate rehabilitation programs have indicated improved outcomes, few are validated and no single evidence-based program is advised.[42, 43]

Outcomes

Proximal femoral fractures can have a detrimental impact on patients, including mortality, disability, loss of independence, depression and fear of falling.[44, 45] Despite the high standards of in-hospital care and the availability of rehabilitation options in developed countries, the survival remains poor.[46] In-hospital mortality rates are about 3% and rises to about 20% at one-year after treatment.[47-50] Large studies on survival revealed a significant excess mortality in this population, indicating an elevated mortality risk inherent to the fracture and treatment itself.[49, 50] This implies a big potential for improvements. But despite many efforts, little progress has been made in contrasts with other conditions such as heart disease, stroke, and cancer, for which significant improvement in survival has been achieved over the past decades.[46, 51]

Much of the morbidity in patients with a proximal femoral fracture is caused by perioperative complications. Complication rates of up to 75% have been described in literature, of which the majority are non-surgical, such as delirium, pneumoniae, urinary tract infections, pressure-sores and heart failure.[52] Many of the risk factors associated with these complications are age related. Improvements in the perioperative management, more specifically in geriatric management, may help to deter the onset of these complications.[52]

In addition, significant adversity is caused by deterioration of the patient's functionality. Older adults are expected to experience a gradual loss of function over time, but acute injury has a sudden effect from which at least half of all proximal femoral fracture patients do not fully recover.[44, 53, 54] One-third of all prefracture community dwelling patients are permanently institutionalized due to subsequent loss of independence.[38] This loss of self-reliance goes hand in hand with a loss in privacy and health-care costs associated with homecare requirements or admissions to nursing homes.

Although surgical complications after proximal femoral fractures are relatively rare compared to non-surgical complications, the consequences are often severe. Osteosynthesis can result in fracture-healing complications that generally require revision surgery.[55] This should be taken into consideration when the use of osteosyntheses rather than hip arthroplasty for femoral neck fractures in older patients is considered.[56-58] Arthroplasty, however, poses its own risks including dislocation of the prosthesis, periprosthetic fracture and deep wound infection.[55] The forementioned surgical complications often lead to readmissions, reoperations and prolonged patient immobilization. This could cause delays in the patients' rehabilitation, but the effects of surgical complications on functional outcome are poorly studied.[59, 60] Despite many improvements in the surgical techniques over the past decades, very little effect has been observed for the patient outcomes.[46]

Due to the unimproved outcomes and prevalence of complex medical and social needs, the treatment goal has shifted away from merely fracture treatment to a more holistic approach aimed at optimal recovery.[61] In recent decades, this has led to the development of ortho-geriatric care units, where older patients are treated by a multidisciplinary team including a geriatrician. This is aimed at mapping and addressing frailty characteristics in order to optimise recovery strategies. The holistic approach can include assessments of cognition, nutritional status, comorbidities and depression, which have all been associated with outcomes.[62] Malnutrition has a high prevalence in this patient population and adequate treatment with diets and supplements has shown positive effects on complication rates, mortality and quality of life.[63-66] Formal falls assessments are another method of secondary prevention and have been shown to reduce morbidity through the management of the aforementioned risk factors.[67] The fear of falling, which has a prevalence of over 50% in these patients, can impair mobility through avoidance.[68] Different interventions developed to mitigate the fear of falling, however, have shown inconsistent outcomes.[69-71]

Overall, the collaborative care models with geriatricians for patients with a proximal femoral fracture have shown improvements in outcomes, including mortality rates and mobility.[72-75] Currently, orthogeriatric management is provided for 78% of the operated patients aged 70 years and older in the Netherlands, but only 23% is treated in a special comprehensive orthogeriatric ward.[2]

Prognostics

Prognostication is a fundamental clinical activity and an important concern for patients and physicians.[76-78] Both need prognostic information to determine treatment strategies and anticipate advance care planning.[76] Exploring ways to improve patient care requires sufficient knowledge on the relevant factors. Modifiable factors, such as nutritional state, anaemia and management of comorbidities may be targets for interventions while unmodifiable factors such as functional and cognitive impairments may be valuable for the prognostic accuracy and advanced care planning.[79] The prognostic accuracy of functional recovery is vital for a variety of decisions during the treatment process. It could be used to determine whether patients are more eligible for femoral

head reduction surgery or total hip arthroplasty, whether they would benefit from more, less, or different types of physiotherapy and training, or whether care in the patients living situation should be temporarily or permanently upscaled.

Numerous prognostic factors of functional recovery have been studied.[79] From these, prediction models have been constructed and studied in relation to adverse outcomes (predominantly mortality).[80, 81] The prefracture status of patients, including function and comorbidities such as those mentioned before, seems most relevant for the functional recovery. The enormous heterogeneity in the health status of older patients, however, makes for poor prognostic accuracies of the current studied models.[79] This may in part be explained by the limited understanding of the complex underlying mechanisms and mediators.[79]

Aim and outline of this thesis

The primary aim of this thesis is to provide a better understanding of the factors relevant for survival and the functional prognosis of patients with a proximal femoral fracture. The thesis is divided into two parts.

Part I focusses on the surgical approaches for arthroplasty in patients with a proximal femoral fracture. *Chapter 2* provides an overview of the available literature on the main surgical approaches. A meta-analysis was performed to compare surgical outcomes, complication rates, survival and the functional outcomes of each approach. *Chapter 3* describes the current application of the anterior and lateral approach in clinical practice and its surgical outcomes in a prospective observational cohort study.

Part II focusses on the methods to assess prognostic factors and their independent relevance for functional outcomes. Factors including the nutritional status, general health status, cognition and serum metabolites are studied to create a better understating of a patient's physical capacity for rehabilitation. Methods to assess the nutritional state of an older proximal femoral fracture patient during admission are discussed in *Chapter 4*. An overview of the available literature on independent prognostic factors of long-term functional outcome is provided in *Chapter 5*. *Chapter 6* to *8* elaborate on a new way to define functional outcome using a composite outcome. In *Chapter 6*, this outcome is used to study prognostic factors for resilient patients using a multi-state model. *Chapter 7* describes a design article for a prospective study focused on the effects of muscle strength and sarcopenia. The relevance of serum metabolites, which have been used to define a mortality risk score, is explored in *Chapter 8*.

The main findings of this thesis and their implications are discussed in a broader context in the General Discussion (*Chapter 9*). Future perspectives on the treatment of patients with a proximal femoral fracture and the field of prognostic research in particular are also discussed in this chapter.

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