THE INTRACAPSULAR FEMORAL NECK FRACTURE IN RELATION TO MENTAL STATE

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ISBN: 90-77017-18-6

Cover: Marjan Menke

Print: Optima Grafische Communicatie te Rotterdam

THE INTRACAPSULAR FEMORAL NECK FRACTURE

IN RELATION TO MENTAL STATE

DE INTRACAPSULAIRE FRACTUUR VAN HET COLLUM FEMORIS

IN RELATIE TOT DE MENTALE STATUS

PROEFSCHRIFT

TER VERKRIJGING VAN DE GRAAD VAN DOCTOR AAN DE ERASMUS UNIVERSITEIT

ROTTERDAM OP GEZAG VAN DE RECTOR MAGNIFICUS

PROF.DR.IR. J.H. VAN BEMMEL

EN VOLGENS BESLUIT VAN HET COLLEGE VOOR PROMOTIES.

DE OPENBARE VERDEDIGING ZAL PLAATSVINDEN OP

WOENSDAG 10 OKTOBER 2001 OM 11.45 UUR

DOOR

LOURINA MARIA CATHERINA VAN DORTMONT

GEBOREN TE RIDDERKERK

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De publicatie van dit proefschrift werd ondersteund door de firma's Ortomed, Nutricia Nederland BV, Sulzer Vascutek, Sulzer Orthopedie Nederland BV, Stryker Howmedica, Mathys Medical Nederland BV, Bard Benelux, B Braun Medical, Rx Medical en tevens door de afdeling Traumatologie AZR, de maatschap Vlaardingse chirurgen, de maatschap heelkunde SFG en de medische staf en de raad van bestuur van het Vlietlandziekenhuis, waarvoor mijn oprechte dank.

The Queen had only one way of settling all difficulties, great or small.

"Off with his head!"

Alice in Wonderland

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Introduction and outline of this thesis.

One of the major achievements of the last century is the increase of the average life expectancy. In 1900, fifty per cent of the population could expect to live to the age of 55. Nowadays, however, fifty per cent of the population lives to the age of 80. In the industrialized countries less than ten percent of the population was 65 years of age or over in 1965. It is expected that in 2025, this percentage will be twenty percent! The other side of the coin is the growing morbidity of the aging population. Much of the current debate is concerned with the way in which the increase in impairments and disabilities resulting from the aging of the population should be dealt with. [5]

Geriatric surgery has become of major importance and hip fractures make up a large proportion of cases. The amount of people who are 30 to 40 years old today of whom it is predicted that they will sustain a hip fracture in the 2030s rests on a solid epidemiological base and the incidence of hip fractures will continue to increase.

Management of hip fractures does not solely require an operation; socio-economic factors are as important as surgery. Placement in a (psycho-)geriatric institution is often necessary for the nursing and rehabilitation of the patients. There is a chronic shortage of beds in these institutions. The turnover of patients is low and the waiting lists are long; this leads to excessively long hospital stays and permanent occupation of hospital beds by elderly hip fracture patients. In the Netherlands, hospitalization time was 39 days in 1979 [4] and has not decreased significantly since then [1]. In the Netherlands, we call this the problem of the 'wrong bed' [3, 6, 8].

Another effect of increased life expectancy is that the number of elderly people, suffering from impaired mental health will also continue to rise. In the Netherlands, the prevalence of senile dementia between the ages of 60 to 85 doubles with every five years of age. As a consequence, a large percentage of hip fracture patients suffer from senile dementia.

In every study on hip fractures there is an excess mortality for patients with hip fractures in comparison with the general population. Survival after hip fracture is associated with many factors, such as age, pre-operative medical conditions and pre-operative level of functioning. Most populations studied are very heterogeneous with respect to pre-operative physical and mental health, living situation, type of fracture and treatment.

In 1822, Sir Astley Cooper [2] was the first to classify proximal femoral fractures in intracapsular and extracapsular fractures. Intracapsular fractures are notorious for their high failure rates, due to avascular necrosis of the femoral head and non-union. In 1934, Kellog Speed called the intracapsular femoral neck fracture "the unsolved fracture" [7].

Today, there is still a lot of controversy in literature about the treatment of intracapsular hip fractures. According to the literature, reduction and internal fixation of the fracture has a lower mortality, but a higher reintervention rate because of early secondary dislocation, non-union and avascular femoral head necrosis at longer term. Subsequent surgery after failure of internal fixation is avoided by hemiarthroplasty. A higher early mortality and complication rate is a major disadvantage of primary prosthetic replacement, as well as late failure in the active elderly. Only a few prospective studies have been carried out comparing internal fixation and prosthetic replacement and, so far, there have been no randomized trials comparing both techniques of treatment in relation to mental state.

The major objective of the present study was to demonstrate the effect of mental state on survival and functional outcome after surgical treatment for a displaced intracapsular femoral neck fracture. Rehabilitation of elderly patients after a hip fracture is often very disappointing and restoration of function does not seem a realistic goal for patients with a limited life-expectancy or severe cognitive problems. Surgery for an intracapsular femoral neck fracture is then palliative. The second objective of our work therefore was to develop a well-substantiated treatment strategy.

In the first part of this thesis a general review is presented about specific aspects of femoral neck fractures and senile dementia (chapter 1-3). The second part contains the results of our own studies.
We started with a retrospective study to assess mortality and functional outcome of hemiarthroplasty in cases of intracapsular femoral neck fractures in 543 consecutive cases. Of these, we compared 215 patients who suffered from senile dementia with 328 patients without senile dementia with respect to mortality and functional outcome (chapter 4).
The complications of hemiarthroplasty for displaced intracapsular femoral neck fractures in the study population were also evaluated (chapter 5).
These retrospective studies gave rise to the question if hemiarthroplasty should be the preferred treatment for patients with an intracapsular femoral neck fracture, suffering from senile dementia. We performed a prospective randomized study to compare hemiarthroplasty to internal fixation with regard to mortality, complications and functional outcome for patients with senile dementia (chapter 6).
During this period, patients without senile dementia were treated by hemiarthroplasty. The outcome of treatment in this group of patients was compared with the outcome of hemiarthroplasty in demented patients (chapter 7).

Additionally, we retrospectively analyzed the causes of failure of osteosynthesis related to pre- and peroperative parameters (chapter 8).

We summarized our results and made future recommendations for the treatment of the displaced intracapsular femoral neck fracture (chapter 9, 10).

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PART I. FEMORAL NECK FRACTURES AND SENILE DEMENTIA

Review of the literature

CHAPTER 1. FEMORAL NECK FRACTURES

1.1. Epidemiological aspects.

The increase of the mean life expectancy in industrialized countries has caused a significant increase in the percentage of elderly people in the total population as a whole. Calculations of the Netherlands Interdisciplinary Demographic Institute show that the number of people of 90 years of age and over will be approximately 175,000 in 2050. With increasing age, the morbidity of the population will increase as well. Hip fractures are very common and are an important cause of morbidity and mortality in the elderly.

The incidence of femoral neck fractures is higher than what can be explained by demographic aging alone [19, 23, 58, 72, 75, 80, 102, 111, 114, 136, 140, 143, 228, 238].

In 1970, the number of femoral neck fractures in the United States was 197,000. Ten years later, there were 267,000 femoral neck fractures [117]. It is estimated that in the year 2040 approximately 512,000 femoral neck fractures will occur in the United States [130]. A femoral neck fracture incidence study in New England during the period of 1984-1986 showed an incidence rate for white females of 2.2 (per 1,000 person-years) for ages 65-69, rising to 31.8 for ages 90-94. For white males the incidence rate was 0.9 for ages 65-69, increasing to 20.8 for ages 90-94 [76]. In the United Kingdom, a regional survey of the South-west Thames Region in 1974 showed a femoral neck fracture incidence rate (per 1000) for females of 1.6 for ages 65-69 and 32.8 for ages 90-94 and 0.7 and 14.0 respectively for males [84]. Between 1978-1981 and 1993-1995 the age-sex-standardized hip fracture rates rose from 1.9 to 2.3 (per 1000 per year) for men and from 5.7 to 7.7 for women in the former Wessex region. In 1995 femoral neck fracture in England (UK) resulted in over 55,000 admissions and was reported as a certified cause of death in over 1600 people [145, 152]. The total incidence of femoral neck fractures in Lund in southern Sweden increased during the period of 1966-1986 from 3.3 to 5.1 per 1,000 inhabitants over 50 years of age. For persons over 80, the incidence almost doubled from 13.2 to 25.5 [111]. Comparable figures were reported for Göteborg [238] and the north of Sweden [136]. Femoral neck fracture incidence in Norway [72, 75] and Finland also continues to increase. There will be about 7800 femoral neck fractures in Finland in 2000 and approximately 13900 in the year 2020 [143, 157].

In the Netherlands, the age-adjusted frequency of hospital admissions for a femoral neck fracture (per 100,000 inhabitants) during the period 1967-1979 increased from 26,6 to 46,0 for men and from 67.7 to 93.0 for women [102]. During the period 1972-1987, the age-adjusted incidence of femoral neck fractures (per 100,000 per year) increased linearly from 479 to 669 in women aged 65 and over during the period 1972-1987. In men of the same age group the age-adjusted incidence of femoral neck fractures increased linearly from 198 to 308. In 1996, 16,613 femoral neck fractures in patients over 50 years of age were registered. The number of femoral neck fractures was estimated at 22,726 for the year 2010 [19].

The incidence of femoral neck fractures increases with age [19, 34, 72, 75, 76, 80, 84, 97, 136, 238]. Females have a higher risk of femoral neck fracture than males[58, 76, 80, 84, 107] and the increase in the incidence of femoral neck fractures is more pronounced in female patients than in male ones [34, 76, 80, 84, 97]. Male femoral neck fracture patients are in general younger than female patients [58, 76, 107, 238].

There are also racial and geographical differences in femoral neck fracture incidence. The incidence among blacks is lower in all age and sex groups [76] and there is a tendency to a higher incidence of femoral neck fractures in urban than in rural populations[72, 75, 111, 136].

Several studies have shown that institutionalized geriatric patients run a greater risk of sustaining a femoral neck fracture than the elderly population in general. A study from New Zealand found the average annual incidence rate (per 100,000) of hip fracture to be 348 for those living in private homes and 3975 for institutionalized elderly patients [34]. Impaired cognitive status was associated with a higher incidence of femoral neck fractures [93, 181]. In a Swedish study, a significant increase in the incidence of femoral neck fractures was observed when the population of a mental hospital was compared with the general population of Lund. The relative risk of femoral neck fractures was about seven times larger for females and about twelve times for males at the mental hospital [93].

The aging of the population and the accompanying physical and mental morbidity has an enormous impact on health care management and costs. In Denmark, hip fracture patients constantly occupied about 18% of all orthopedic hospital beds in 1976 [114]. In the United States 14% of the gross domestic product is spent on health care. For the year 2000 the costs for femoral neck fracture patients represent nearly 1% of the nation's total health care costs [97, 98]. A large Australian study predicted an 83% increase in bed occupancy due to femoral neck fractures between 1986 and 2011 [58].

In the Netherlands, the number of admissions of patients over 65 increased by 43% between 1980 and 1989. The admission rate for patients over 85 was three times higher than for patients between 50 and 54 years of age [123]. For the year 2010, the annual need of hospital

beds, based on a 30-day hospital stay, has been estimated at 1866. Should the duration of hospital admissions due to hip fractures be reduced to 20 days, then the annual need of hospital beds in 2010 would be 1244 [19].

The demand for high-quality medical and nursing care and the economic restrictions could raise numerous medical, ethical and economical problems in the nearby future. A further allotment of resources for hospital or rehabilitation institutions cannot be expected and we will be forced to treat an increasing number of femoral neck fractures using the same number of hospital beds.

1.2. Biological and biomechanical aspects.

The factors responsible for the progressive increase in the incidence of femoral neck fractures with advancing age are not yet completely understood.

Due to the increased urbanization and the increase in standard of living in industrialized societies, there is a general decrease in the level of physical activity, which may lead to osteoporosis and increase the risk of sustaining an osteoporotic fracture [6].

Although osteoporosis is an important risk factor for femoral neck fractures, a clear relationship has not yet been established. The bone mass starts to decline around middle age and the reduction in bone mass leads to an increased risk of osteoporotic fractures. Dietary factors such as an increase in the consumption of phosphates (animal proteins, eggs, alcohol) and even calcium-intake have been associated with osteoporosis [75, 102]. Although hypocalcaemia and a raised alkaline phosphatase level are common biochemical abnormalities in elderly patients with femoral neck fractures, these were not associated with histologically proven osteomalacia [234, 235].

In several studies it has been shown that the increasing age-specific incidence of femoral neck fractures in female patients is mainly an increasing incidence of trochanteric fractures [93]. It seems that femoral neck fractures are not a homogeneous group and there are indications that osteoporosis is a more important etiologic factor in trochanteric than in cervical fractures [72, 75, 111]. Most femoral neck fractures result from accidental falls on to the greater trochanter. In the presence of a relative paucity of soft-tissue coverage in the frail elderly, this may predispose to an increased proportion of trochanteric fractures. In relatively younger patients, a faster gait, greater strength, and more soft tissue protection may result in more selective loading of the femoral neck during a fall. The ratio of cervical to trochanteric fractures is decreasing with increasing age [72, 97, 111, 136]. This may also be an indication that trochanteric fractures happen more on account of bone fragility owing to age than the cervical ones [138].

A greater risk of falling in the elderly may be even more important in the etiology of femoral neck fractures [234, 235]. Concomitant illnesses or disturbances - for instance Parkinson's disease, orthostatic hypotension, arrhythmia's, TIA's, vertebrobasilar insufficiency and the use of sedatives - are risk factors for an increased risk of falling. It is estimated that 1-3% of falling incidents lead to femoral neck fracture.

The upper end of the femur consists of the head, the neck and the greater and lesser trochanter. In 1838, the internal trabecular system of the femoral head was first described by Ward [229]. The orientation runs along lines of stress, with thicker lines coming from the calcar and rising superiorly into the weight-bearing dome of the femoral head. Forces acting in this arcade are largely compressive. Lesser trabecular patterns arise from the lateral portion of the shaft curving upward, ending in the upper portion of the neck and lower portion of the head. Both systems enclose a triangular zone (Ward's triangle) which contains only a few wide-mesh osseous bands. Most fracture lines run through this section of the femoral neck.
Singh used the trabecular pattern seen on x-rays of the upper end of the femur as an index for the diagnosis and grading of osteoporosis.
Femoral neck fractures are notorious for their fracture-related complications. Anterior, the hip capsule is attached to the intertrochanteric line; posterior, the lateral half of the femoral neck is outside the capsule. The intracapsular segment of the femoral neck has essentially no cambium layer in its fibrous covering to participate in peripheral callus formation during the healing process. Unless the fracture fragments are carefully impacted, synovial fluid can lyse blood clot formation and thereby destroy another mode of secondary healing by preventing the formation of cells and scaffolding that would allow for vascular invasion of the femoral head. The femoral head is rendered largely avascular by a displaced fracture. The arterial supply to the proximal end of the femur has been studied extensively. The medial and lateral femoral circumflex arteries form an extracapsular arterial ring from which ascending cervical branches arise. These ascending cervical branches pass upward under the synovial reflections of the capsule toward the articular cartilage that demarcates the femoral head from its neck. These arteries are known as retinacular vessels and play a major role in the vascularization of the femoral head. The proximity of the retinacular vessels to bone puts them at risk for injury in femoral neck fractures. Additionally, there are intraosseous cervical vessels that cross the marrow spaces from below and the artery of the round ligament. When a femoral neck fracture occurs, the intraosseous cervical vessels are disrupted; femoral head nutrition is then dependent on remaining retinacular vessels and

the artery in the round ligament. The femoral head has been recognized for some time to be avascular in most cases after displaced femoral neck fractures. Revascularization can arise from areas of the femoral head that remain viable and from vascular ingrowth across the fracture site. The term aseptic necrosis describes the infarct that occurs soon after a femoral neck fracture. In contrast, late segmental collapse in the femoral head occurs late in the course of the vascular insult. This complication may occur some time after union when an ischaemic femoral head is incompletely revascularised and the load-bearing segment eventually gives way [9]. In the survey of Barnes segmental collapse was seen to occur at any time after six months, but most often during the second year [10].

Attempts to determine the viability of the femoral head at the time of the surgery have not been very successful. The correlation between vascular findings and the clinical end result has never been very accurate and is therefore of little practical value in the management of femoral neck fractures. Union of the fracture can occur in spite of an avascular fragment, although the incidence of non-union is of course increased for intracapsular femoral neck fractures.

1.3. Fracture classification.

Femoral neck fractures are historically divided into intracapsular and extracapsular fractures. The extracapsular fractures are of the inter- or pertrochanteric type. The intracapsular fractures are further divided into subcapital, mid-cervical and basal types. True mid-cervical and basal fractures are infrequently seen and there is no real functional difference with regard to fracture healing. In 1915, Fred Albee stated that classifying femoral neck fractures further than "fracture of the neck" is meaningless with regard to treatment or prognosis of these fractures [3]. The subdivision of intracapsular fractures was gradually discarded in favor of the Pauwels classification (1935).

1.3.1. Pauwels classification. The Pauwels classification is based upon the obliquity of the fracture line as shown in the anteroposterior radiograph. The shearing angle is the angle of the fracture line with the horizontal. The Pauwels angle is equivalent to 90° minus the shearing angle. The Pauwels angle is divided into three grades: I - angle of less than 30°; II - angle of 30-70° and III - angle of or larger than 70°.

Pauwels suggested that the more vertical the shearing angle, the higher the incidence of non-union. Practical objections to the Pauwels classification are that determination of the projected fracture line angle on the pre-operative radiograph can only be accurate if the femoral neck is parallel to the film. This is rarely possible because of pain and the fact that the leg is usually externally rotated. Femoral neck fractures exhibit scarcely ever a straight fracture line, more often the fracture has a spiral surface.

There is no significant difference in the incidence of non-union related to the Pauwels fracture type for displaced fractures [24, 36, 168-170]. Therefore, measurement of the Pauwels angle has limited value. For undisplaced fractures, the results of different studies are heterogeneous. A vertical angle may indicate a fracture that is more likely to displace. When these fractures are treated operatively, then the Pauwels angle has no clinical relevance [174].

1.3.2. Garden's classification. Garden proposed a classification system of intracapsular femoral neck fractures based on the degree of displacement of the fracture on the pre-reduction radiograph. The Garden I fracture is an incomplete or impacted fracture. In this fracture, the trabeculae of the inferior neck are still intact. A Garden II fracture is a complete fracture without displacement. The weight-bearing trabeculae are interrupted by a fracture line across the entire neck of the femur. A Garden III fracture is a complete fracture with partial displacement. The two fragments retain their posterior retinacular attachment and crushing of the posterior cortex has not yet taken place. Lateral rotation of the distal fragment therefore tilts the capital fragment into varus and medial rotation. A Garden IV fracture is a complete fracture with total displacement of the fracture fragments. Contact between the two fragments has been lost, allowing the proximal fragment to resume its natural position in the acetabulum. This stage has the worst prognosis, because of the complete rupturing of the posterior retinaculum and damage to the vascularization. The drawback of this classification is that there is a large inter-observer variation and that there is little difference between Garden stage I compared with II and between Garden stage III and IV with regard to fracture treatment and outcome [78, 184, 185].

1.4. Treatment.

1.4.1. Non-operative treatment. Before Marius Smith-Petersen introduced his operative technique using a three-flanged nail in 1931[204, 206], the treatment of femoral neck fractures was predominantly conservative, varying between total neglect of the fracture and immobilization by traction or a plaster spica. At the end of the nineteenth century Royal Whitman believed that extension, abduction and internal rotation could accomplish reduction of the fracture. He advocated maintenance of the reduction in a plaster spica cast from the rib cage to the toes for eight to twelve weeks. Whitman claimed improvement in healing of femoral neck fractures with the use of his technique but never formally reported his results [233].

Over a hundred years ago, Sir Astley Cooper suggested that non-union of femoral neck fractures could be related to the loss of blood supply to the proximal fragment. In his work on "Dislocations and Fractures of the Joints" he said: "I believe the reason that fractures of the neck of the thigh bone do not unite is that the ligamentous sheath and periosteum of the neck

of the bone are torn through, that the bones are consequently drawn asunder by the muscles, and that there is a want of nourishment of the head of the bone..." [52]

His contemporary Gross believed that union was possible if contact of the fragments could be achieved and immobilization maintained for a sufficient period of time [92]. Robert Smith (1845) also reported that osseous union of intracapsular fractures was more likely to occur when the fragments were impacted [203]. In 1911, Cotton put this idea into practice: after reduction of the fracture he tried to obtain fragment impaction with the blow of a hammer on the greater trochanter [53].

In 1818, Abraham Colles wrote in the Dublin Hospital Reports that "fracture of the neck of the femur has long been considered as one of the opprobria of surgery; and every one will admit that the stock of facts, from whence rules of practice in the treatment of the injury have been drawn, is very scanty". He was the first surgeon who distinguished between complete and incomplete fractures of the femoral neck [51]. The word "impacted" to denote the incomplete fracture was introduced by Bigelow (1873) [15]. Impacted fractures constitute about twenty per cent of femoral neck fractures and are classified as Garden I fractures. Because of the inherent stability at the fracture site, the patient may have minimal pain even on weight bearing. The best treatment of the impacted fracture has not been established. Some authors advised that impacted fractures should be treated operatively to prevent displacement and non-union [73, 81]. Raaymakers reported that only 15% of impacted femoral neck fractures develop secondary displacement and that delayed operation after secondary displacement caused no increase in the rate of mortality, non-union, or avascular necrosis. He stated that non-operative treatment of patients with impacted femoral neck fractures therefore is the preferred treatment. Impacted fractures of the femoral neck are distinctly different from undisplaced fractures. Undisplaced fractures have no bone impaction and have no inherent stability, these correspond to Garden II fractures. These fractures are likely to become displaced when treated conservatively. Non-operative treatment of displaced femoral neck fractures (Garden stage III and IV) is rarely indicated. However, non-operative treatment may be justified in case of severe associated medical conditions or mental deterioration (particularly in a non-ambulatory patient) [184, 185].

1.4.2. Osteosynthesis. Along with the development of reduction methods, the interest in the internal fixation of femoral neck fractures grew. In 1858, Von Langenbeck tried to treat a female patient with a very painful pseudarthrosis due to an old hip fracture with internal fixation. After reduction by extension, a specially designed threaded 'stiletto' was introduced from a little incision at the site of the major trochanter into the direction of the femoral neck

until he thought the femoral head was reached. The procedure failed after three weeks because of infection [135].

After the introduction of roentgenographic techniques, important improvement was made in the reduction and healing of femoral neck fractures. Internal fixation with the three-flanged nail under roentgenographic control was introduced by Marius Smith-Petersen in 1931 [204]. The original technique using open reduction was perfected by Watson-Jones, who introduced the lateral approach with exposure of the fracture [230]. Leadbetter presented his classical closed reduction in 1932. After positioning the patient on a fracture-table, the injured leg is flexed at the hip at 90°, with the knee also flexed at a right angle. Direct manual traction is made vertically in the axis of the flexed thigh, together with slight adduction of the femoral shaft. In this position internal rotation of approximately 45° should be carried out. After this maneuver, the leg is slowly circumducted into abduction, with maintenance of internal rotation. The leg is brought down, resting on the outstretched palm of the surgeon's hand. If the reduction is incomplete, external rotation recurs [139]. The combination of this technique with the use of a guide-wire technique with a cannulated nail described by Sven Johansson (1932) was a further improvement [119].

In displaced fractures of the femoral neck (Garden III and IV fractures), the goal is adequate reduction and stable internal fixation of the fracture. The handling of the patient before surgery, the reduction maneuver, the traction on the operation table, and the method of osteosynthesis are all potential sources of hazard for the vascular supply of the femoral head.

Several authors have recommended preoperative aspiration of the fracture hematoma, because they believe that the increased intra-articular pressure due to the hematoma will compromise the already tenuous circulation [55, 63, 209, 210, 215]. Drake and Meyers reported that preoperative aspiration of the hip joint after femoral neck fracture is unlikely to influence the vascularity of the femoral head because the volume of hemarthros is small and the pressure they measured in the capsule is well below that of the diastolic blood pressure [67]. Pre-operative skin or skeletal traction seems of no value in obtaining fracture reduction or pain control for patients with femoral neck fractures [74, 166]. Moreover, extension and internal rotation of the hip gives rise to very high intra-articular pressure [95, 225, 236].

The importance of adequate fracture reduction is indisputable; it is the first and most important step in the management of displaced femoral neck fractures. Closed reduction on the fracture table is obtained under radiographic control. The importance of reduction to the anatomical position or to slight overcorrection in valgus position has been the subject of many debates. On the anteroposterior radiograph the weight-bearing medial trabeculae of the head should form

an angle of approximately 170 to 180° with the medial cortex of the femoral shaft (Garden's angle). Barnes observed a higher incidence of non-union in fractures where the post-reduction Garden's angle was less than 160°, while more femoral head necrosis was seen when the angle exceeded 180° [10]. Within the range of 170-179° there is always a moderate valgus reduction. On the lateral radiograph, ventral and dorsal trabeculae converge upon an axis, which runs in a straight line along the center of the neck. A slight degree of either anteversion or retroversion is tolerated. A lateral angle exceeding 20° is mostly seen with communition of the posterior cortex of the neck, which is the main cause of instability. Posterior communition is an important factor in non-union. The Western Infirmary Glasgow (W.I.G.) angle measures the amount of upward or downward shift of the proximal fragment. After optimal reduction the WIG angle should range from 140 to 149°. Variations in the W.I.G. angle had no consistent impact on the incidence of late segmental collapse [10].

Many innovative design changes for internal fixation of femoral neck fractures have been described in the literature since 1931. Moore described multiple threaded pins shortly after the introduction of the three-flanged nail [160]. He stated that his method resulted in better fixation of the intracapsular fracture fragments with less damage to the blood supply. Moore and many other authors [5, 127, 128, 160] recommended a parallel placement of the pins. All different kind of pins have been advocated as the simplest and safest method of internal fixation of femoral neck fractures [1, 127, 128]. Deyerle recommended the use of an increased number of pins in combination with a metal template fixated on the lateral cortex of the femoral shaft [64]. In the nineteen-eighties Strömqvist introduced hook pin fixation for femoral neck fractures [217]. The hook is supposed to retain the pin within the femoral head. This concept of anchorage had already been used in the development of the Ross-Brown nail as described by Barnes in 1967 [9].

Bone grafts have been suggested as a desirable method to promote healing of intracapsular fractures. In 1915, Fred Albee gave a full description of his technique of treating intracapsular femoral neck fractures with an autogenous tibial bone graft. He believed that with his technique adequate internal fixation was accomplished without the disadvantages of a metallic foreign body [3]. Judet introduced the muscle-pedicle graft utilizing the quadratus femoris muscle and internal fixation to improve the revascularisation process in the head fragment in an attempt to reduce the incidence of osteonecrosis [122]. Meyers (1973) advocated the use of a modified Judet muscle-pedicle-transplant technique as he found that there was a significant improvement in the rate of union and a marked reduction in the incidence of segmental collapse in the treatment of displaced femoral neck fractures [156].

The original technique of femoral neck fixation with the triflanged nail of Smith-Petersen is now outdated. Many authors demonstrated improved fixation of femoral neck fractures using implants with a side plate attached to the femoral shaft. In 1937, Thornton suggested that a side bar attached to a hip nail would be useful to treat intertrochanteric fractures [222]. Neufeld and Jewett (1941) developed a single nail plate, which was used in a large series of patients, who were treated successfully with such a device [118, 218]. Another famous nail-plate system was described by McLaughlin in 1947. In 1955, Willis Pugh described a self-adjusting nail-plate system, originally designed for fractures of the femoral neck, to incorporate stable shaft fixation with prevention of femoral head penetration [183].

The Smith-Petersen nail and the fixed nail plate were important steps in the history of the treatment of this fracture, but these have been superseded by a variety of techniques that incorporate the sliding nail principle. Pugh developed a 135° sliding nail in the 1950s.

Brodetti's biomechanical study showed that a bolt screw was a more satisfactory device than a nail in the fixation of experimental fractures of the femoral neck [27]. Lorenzo (1941) described his technique of internal fixation with a molybdenum lag screw [141]. Barnes believed that crossed screws provided better fixation than parallel screws [9]. Crossed screws give control of axial rotation of the head and of lateral rotation of the distal fragment. The main criticism of this technique is the limited stability against varus displacement in osteoporotic bone. This may be prevented by the method of triangle pinning [207]. Parker found the incidence of non-union and avascular necrosis to be less in fractures treated with parallel screws [176].

Charnley (1956) devised a spring-loaded compression screw and claimed a clinical success rate of over 80 per cent[44]. Hargadon reported 100 patients treated with the Charnley compression screw and found that 65 per cent of intracapsular fractures united [94]. There were frequent problems with loss of compression and the need for a second operation. Schumpelick and Jantzen introduced an implant consisting of a screw fitted to a sliding barrel in 1955 [192]. Later, this concept was modified by adding a special screw in the sliding mechanism to obtain compression at the fracture site. A disadvantage of this implant is the possibility of rotation of the femoral head during screw insertion, which may increase the incidence of aseptic necrosis. A modification of the sliding hip screw was introduced by Calandruccio, who added two threaded pins above the screw to improve fixation and control rotation of the femoral head [198].

The development of the A.O. dynamic hip screw was based on the previously mentioned principles.

The ideal position of the fixation device has been the subject of much controversy. Central placement of the fixation device [21, 48, 153], as well as within the caudal segment of the femoral head on the anteroposterior view [73, 104, 183] have been advocated. On the lateral view, the optimal placement is central or slightly posterior to allow impaction and to prevent the nail

from cutting out of the head. The distance of the fixation device from the joint surface is also critical. The best results are achieved when the tip of the fixation device lay within half a centimeter of the articular surface. Neither the position, nor the degree of penetration of the femoral head by the fixation device had an appreciable effect on the incidence of late segmental collapse [10].

Barnes (1976) did not find a significant difference in the union rate or the incidence of late segmental collapse when various methods of internal fixation were compared, except for a 20 per cent higher non-union rate after Smith-Petersen nailing [10]. Christie et al. (1988) presented the results of a prospective randomized trial comparing compression screw fixation versus double divergent pin fixation and found a higher incidence of non-union and infection in the sliding screw-plate group [45]. Madsen (1987) performed a randomized study comparing a sliding screw plate and multiple screws and found a better clinical result for the screws. SSP fixation led to higher incidence of non-union and late segmental collapse than ASIF screw fixation [146]. Olerud (1991) reported to have better results with Uppsala screws than with the Hansson hookpins [171].
It is not possible to give a detailed account of all the types of internal fixation available. Some devices led to changes in technique that simplified surgical treatment and improved the results as well. Nevertheless, high failure rates due to avascular necrosis of the femoral head or non-union of the fracture still remained a serious problem. Even though the various designers claimed better results with the use of their individual devices, statistical analysis of comparative results did not demonstrate a significant improvement in the overall success rate. The frustration in achieving further improvement in the rates of nonunion and osteonecrosis following internal fixation of displaced femoral neck fractures was summarized by Kellog Speed. In 1934 he said before the Clinical Congress of the American College of Surgeons in Boston that "One cannot say in the early weeks after fracture, even in an average adult or adolescent to say nothing of a senile person, whether the head in a given case will die and yet unite to the neck, or live and unite and later break down. (...) It is this great uncertainty of the fate of the head and its subsequent mechanical changes which hold this fracture in the unsolved class" [211].

1.4.3. Hip arthroplasty. Endoprosthetic replacement of the femoral head, reported for the first time by Moore in 1952, seemed to be a useful alternative avoiding non-union, avascular necrosis and late segmental collapse [161, 162].
Early surgical efforts to correct deformity and increase motion in severely diseased or infected hips involved complete resection of the proximal femur. In 1822, Anthony White was the first in Europe to resect the head of the femur for tuberculosis. Major surgery of the hip began in

1826, when John Rea Barton performed a femoral osteotomy on a sailor with an ankylosed hip due to an old fracture [214]. New methods were sought, however, as surgeons attempted to maintain stability while providing relief of pain and correction of deformity. These goals required the reconstruction of the hip joint itself.

In 1917 Brackett described a reconstruction operation for non-union of the femoral neck, which consisted of hollowing out the femoral head and placing the upper end of the femur in this hollowed-out head after the greater trochanter had been transplanted with its attached abductor muscles lower down on the shaft.

The next step to restore the motion of an ankylosed joint was the so-called interpositional arthroplasty. Arthrodesed joints were divided and articulating surfaces were refashioned to approximate their original contours. An interpositional substance was inserted to prevent subsequent refusion. Probably the first of these was a wooden block placed between the resected ends of an ankylosed temporomandibular joint by Carnochau in 1840 [195].

Lexer (1919) opened the hip joint capsule and resected the proximal fracture fragment. The distal neck was covered with transplanted fatty tissue and positioned to replace the femoral head. At the beginning of the past century surgeons experimented with all kinds of inorganic and organic implant materials, like gold foil or the chromicized submucosa of pig's bladder (Baer, 1918) [195]. Murphy from Chicago experimented with muscle flaps and flaps of fascia with and without fat. His original memoirs on the subject were published in 1913 [164].

In 1923 Smith-Petersen discovered by chance that a piece of glass removed from a patient's back, was "lined by a glistening synovial sac, containing a few drops of clear yellow fluid." The concept of the "mold" was then born: "... A mold of some inert material, interposed between the newly shaped surfaces of the head of the femur and the acetabulum, would guide nature's repair..."[205]. From 1923 to 1938, Smith-Petersen experimented with various materials like Viscaloid, Pyrex glass and Bakelite. Then Venable, Stuck and Beach demonstrated the nonreactive qualities in the tissues of the metal Vitallium [226]. It showed to have sufficient strength to meet the demands of prostheses and could be shaped as desired. It was soon found suitable for nails, cups, and all types of prostheses. The first Vitallium mold arthroplasty was performed in June 1938. Otto Aufranc, who was an assistant to Smith-Petersen, reported the results of 1,000 Vitallium mold arthroplasties in April 1957. He claimed he had achieved more than eighty percent of excellent to good results [7].

In 1919 Delbet used a rubber prosthesis and in 1927 Hey Groves used an ivory prosthesis to replace the femoral head. But when the Judet brothers reported 300 cases in 1950 in which a short-stem acrylic hip prosthesis had been used, a tremendous worldwide interest in the treatment of hip fractures was born. After removal of the head and distal portion of the neck,

the stem of the prosthesis was inserted through a hole in the remaining neck to the outer cortex below the greater trochanter. Thirty or more different types of hip prostheses were developed in a very short time, some with a short and others with a long stem, and inserted into the medullary cavity of the upper femoral shaft. In 1940, Austin Moore and Harold Bohlman inserted the first Vitallium prosthesis to replace the upper part of the femur in a patient with a large malignant giant cell tumor [161]. The operation was quite successful; the patient regained a partly normal hip function and lived for about two years before he died of a heart attack. It was the first time such a procedure had been carried out and it was a significant development in hip surgery. In 1948, Earl McBride inserted his so-called "door-knob" prosthesis, which had a long tapered, threaded stem [151]. Thomson believed that "...if the Smith-Petersen nail is appropriate for internal fixation of fractures of the neck of the femur, it should be ideal for fixation of a prosthesis..." Because of the similarity of the prosthesis to an electric-light bulb, he called this the "light-bulb" prosthesis [220]. The long-stem prosthesis soon proved to be the most successful kind and became the one of choice. In 1950, Moore developed an intramedullary straight prosthesis with a solid stem. Later, this prosthesis was modified to obtain the right angle of the femoral neck to the shaft of the prosthesis. The prosthesis was called 'self-locking' because the stem was fenestrated, to allow cancellous bone to grow in and lock the prosthesis in place.

In the same period, Frederick Thompson implanted the first slightly curved non-fenestrated prosthesis [219]. After visiting Thompson, McKee popularized total hip replacement. The total hip prosthesis of McKee and Farrar consisted of a metal acetabulum cup and a Thompson prosthesis [154]. Serious problems in early arthroplasties were the progressive loosening and erosion of surrounding bone, lack of sufficient knowledge about the materials, sepsis and lack of durable fixation methods. Then Sir John Charnley made history with acrylic cement to anchor the femoral head prosthesis to the shaft of the femur (1960)[43].

As time passed, refinements were made to the prostheses. The most common types in use today are the Austin Moore and Thompson prostheses. The incidence of acetabular erosion and protrusion of the prosthesis into the acetabulum led to the theory of reducing motion between the outer metal shell and the residual acetabular cartilage by a bipolar device. In 1974, Bateman and Giliberty reported on the development of a bipolar femoral-head prosthesis [11, 88]. The femoral head and stem were similar to those of total hip prostheses. A polyethylene-bearing insert articulated with the head, and the insert was covered with a metal bearing surface that articulated with the acetabulum. An additional advantage of these implants is that they are easily converted to a total hip arthroplasty. The most commonly used are the Bateman and Giliberty prosthesis. It was hoped that the bipolar femoral head would diminish

acetabular wear. However, studies comparing protrusion and cartilage wear of the unipolar and bipolar devices have been contradictory [18, 62, 68, 82, 85, 134, 37, 157, 224]. As the public's cost consciousness increases, the continued use of more expensive devices will require clear evidence of their claimed superiority.

Placement of the prosthesis can be done by way of the anterolateral or posterior approach. The anterolateral approach was described by Smith-Petersen and the posterior approach by Moore. The posterior approach has been related to an increased incidence of dislocation of the prosthesis and sciatic nerve palsy. The posterior incision carries a higher risk of infection because it is situated in a contaminated area. Because of the problems noted with the posterior approach, the anterolateral approach has been recommended by several authors [42, 60, 197].
Early complications of hemiarthroplasty are per-operative fractures of the proximal femur, penetration by the prosthesis of the femoral shaft, luxation of the prosthesis and wound infections. Late complications are loosening of the prosthesis, intrusion of the prosthesis into the pelvis and acetabular erosion.
Accurate sizing of the femoral head prosthesis to the acetabulum is critical in achieving a good long-term result. If the femoral head is too large, equatorial contact occurs, resulting in a tight joint with decreased motion and pain. If the head is too small, polar contact occurs with increased stress over a reduced area. This leads to erosion, prosthetic migration and pain. Neck length also is critical in that, if the neck is left excessively long, reduction can be difficult and pressure on the acetabular cartilage is increased [190].

1.5. Mortality after femoral neck fractures.

In the Dutch population, mortality due to femoral neck fractures is ranked in the sixth place among causes of death. Early mortality rates after femoral neck fracture range from 2 to 13%. After six months, the mortality rates are between 8.8 and 33.3%, and after one year between 12.7 and 50.0% (table 1.5.1). Reported mortality figures have a wide range, owing to the fact that most populations studied are very heterogeneous with respect to pre-fracture physical and mental health status, living situation (community dwelling versus institutionalized patients), type of fracture and treatment. In every study on femoral neck fractures there is an excess mortality in the study group compared to the general population.

Table 1.5.1. Mortality of hip fractures

Author	Year	Population	Fracture Type	no. of patients	mean age	Mortality 1 mo.	6 mo.	12 mo.
Aharonoff	1997	home dwelling	unselected	612		3.9	8.8	12.7
Beals	1972	unselected	intracapsular	248	77.4	9.0		50.0
			extracapsular	359	79.0	15.0		50.0
Berglund	1994	unselected	unselected	1115	78.0	3.6		
Boereboom	1992	unselected	unselected	493		9.1		
		male		103	82.3			33.0
		female		390	73.9			23.6
Broos	1989	unselected	unselected	614	81.0	11.0		
Clayer	1989	unselected	unselected	405	77.5	8.4		24.0
Crane	1983	unselected	intracapsular	65	84.2	8.3	30.8	39.3
			extracapsular	90	84.6	8.0	33.3	34.9
Dahl	1980	unselected	unselected	675	73.9	13.9		
Davis	1987	unselected	unselected	538	79.5	6.3	16.0	20.4
Elmerson	1988	unselected	unselected	288	75.0	6.0	16.0	
Fisher	1991	unselected	unselected	22039		6.3		23.7
Gordon	1971	unselected	unselected	202	78.0			36.2
Goudke	1985	unselected	unselected	89	77.0	2.7	13.8	20.8
Holmberg	1986	institution	unselected	624				46.0
		home dwelling		2378				16.0
Hoogendoorn	1982	unselected	unselected	64443		12.4		
	1987	unselected	unselected	29685		8.7		
Ions	1987	unselected	unselected	158	76.8		17.0	
Jensen	1979	unselected	unselected	1592	77.0	8.6	21.5	27.0
	1984	unselected	unselected	518	78.0	6.0		
Jette	1987	unselected	unselected	70	78.0		22.0	
Kenzora	1984	unselected	intracapsular	187	72.0			13.4
			extracapsular	219	75.0			15.0
Magaziner	1989	home dwelling	unselected	814	80.1	4.3	12.6	17.4
Mckenzie	1980	unselected	unselected	100	75.6	13.0		
Miller	1978	unselected	unselected	360	73	8.3		27.0
Pitto	1994	unselected	extracapsular	143	81	6.0	23.0	
Poor	1995	male	unselected	131	79.2			42.0
Riska	1970	unselected	unselected	358	76.5	12.0		
Schroder	1993	unselected	unselected	3895	77.0	9.5	21.0	27.0
Stavrou	1997	unselected	unselected	202	76.0	2.0	11.0	18.0
Wood	1992	unselected	intracapsular	531	77.5		23.0	
Zuckerman	1995	home dwelling	unselected	367		4.0	9.0	14.0
					min	2.0	8.8	12.7
					max	15.0	33.3	50.0

Most of the excess mortality after femoral neck fracture occurs in the first year when compared with the general population matched for age and sex. The overall mortality rate after femoral neck fracture is much higher over the first months but thereafter approaches and after one year parallels the age- and sex-matched general population. This is a consistently observed phenomenon confirmed by many authors [33, 46, 59, 61, 76, 90, 109, 115, 116, 126, 147, 158, 167, 179, 193, 196, 232].
The apparent increase in mortality depends on the interplay of many factors like age, sex, pre-fracture health status and social dependency. According to many investigators, the increase reflects poor underlying health status in addition to the acute effects of the fracture. Magaziner compared the survival rate of community-dwelling white female hip fracture patients aged 70 years and over with that of white women aged 70 years and over without a femoral neck fracture. He also found an excess mortality attributable to femoral neck fracture in white women aged 70 years and over, but noticed that the timing of the effect was dependent on the health and functional status of patients at the time of the fracture. There was an immediate increase in mortality following a femoral neck fracture in medically ill and functionally impaired patients, whereas among those with no comorbidities and few impairments, there was a gradual increase in mortality that continued for 5 years post-fracture. The early impact of the fracture was greater for those with pre-existing comorbidities and functional impairments than for those with no prior comorbidities and minimal functional deficits [147]. Poór found that overall survival was similar for 131 male patients with femoral neck fractures without pre-existing comorbidity and an equal number of age-matched control men from the general community [180].
The nature and number of associated diseases was found to be a strong predictor of survival [20, 59, 71, 76, 126, 147, 158, 163, 165, 172, 179, 193, 212].

The number of associated comorbidities is only a reflection of the patient's general health status, whereas the ASA-classification of operative risk takes into account the severity of any systemic diseases that may affect survival. White concluded that this rating scale is a reliable predictor of mortality [232]. Aharonoff found that patients who had an ASA operative risk rating of 3 or 4 were more likely to die in the first year after fracture [2].
Most investigators have found that advancing age is associated with increased mortality after femoral neck fracture [2, 20, 46, 59, 61, 69, 71, 76, 84, 90, 91, 108, 109, 115, 116, 120, 147, 158, 180, 189, 193, 212, 223, 237, 239].
Kenzora showed a significant relationship between increased age and mortality in femoral neck fracture patients with intertrochanteric fractures, but was unable to show a similar relation in patients with subcapital fractures [126]. White concluded that the rate of mortality after femoral neck fracture had an inverse relationship with age, possibly explained by the fact that people who reach the eight or ninth decade represent a rather healthy group with a considerable life

expectancy [232]. For the same reason, Pitto advocated that the physiological age should establish the base line from which to evaluate the patiënt [179].

The relationship between the patient's sex and mortality risk after femoral neck fracture remains more controversial. Males are reported to have an increased mortality in many studies [10, 20, 30, 33, 46, 54, 59, 69, 76, 84, 90, 91, 103, 107, 109, 144, 147, 158, 163, 165, 223, 232, 239]. Gender was not predictive of increased mortality rate in other studies [2, 61, 71, 115, 116, 126, 193]. Poór studied survival in male hip fracture patients only and found that survival among men with femoral neck fractures was dramatically worse than among a group of age-matched control males from the general community [180].

Impaired cognitive status is significantly associated with increased mortality [20, 30, 41, 46, 71, 83, 116, 126, 147, 158, 163, 167, 194, 237]. Most of these studies, however, evaluated a very heterogeneous patient population. Ions [108] and Pitto [179] stated that the mental state was the most sensitive indicator for prognosis. Parker [173] found that the mental test score provided a significant assessment of the outcome after a femoral neck fracture, but that the mobility score had a superior predictive value. Surprisingly, Myers found a decreased risk of dying for patients with a mental disorder [165]. Sexson [193] also showed an increased mortality rate for patients with cerebral dysfunction, but when the mortality rate was related to the age of the patients with cerebral dysfunction, this was not significant.

Pre-fracture social dependency is a predictor of increased one-year mortality in ambulatory, community dwelling, and cognitively intact elderly population, according to Aharonoff [2]. Jensen [115] also emphasized that the influence of the patient's social dependence was a strong predictor of increased mortality after femoral neck fracture. However, this study included institutionalized patients as well as community dwellers. Ceder [37] reported a 15% mortality rate at one year for the femoral neck fracture patients who came from their own homes versus 45% for institutionalized patients. Pitto [179] reported a risk of death for those admitted from their homes of 20% compared with 51% for those admitted from nursing homes. Mossey [163] found no difference among survivors and those who died after femoral neck fracture in their level of pre-fracture functioning.

The age-adjusted mortality after femoral neck fracture is independent of the type of fracture (cervical or trochanteric) [2, 20, 30, 33, 59, 61, 69, 71, 90, 115, 116, 165, 193, 232]. Only Zuckerman [239] found that intertrochanteric fractures were a significant predictor of mortality.

In general, the opinion is held that operations for the treatment of fractures of the femoral neck in elderly patients should be performed within 24 hours of admission. The central finding in the study of Zuckerman [239] was that an operative delay of 3 days or more almost doubled the risk of mortality within the first year after the fracture. This remained even true when the age and

gender of the patient and the number of pre-existing medical conditions were controlled. In Stavrou's study [212], patients, whose operation was delayed for more than 3 days, had a higher incidence of mortality than those patients whom were operated on within 3 days. Several investigators have challenged the notion that the timing of operation is predictive of increased mortality [2, 10, 20, 91, 165]. Davis [61] reported a slightly lower three-month mortality rate for patients who had had the operation more than forty-eight hours after admission. Kenzora [126] found that patients who underwent surgery within one day of admission had a much greater one-year mortality rate than those who underwent surgery between days two and five and that this relationship was even stronger in relatively healthy patients. In contrast, Sexson and Lehner [193] reported an increased one-year mortality rate for relatively healthy patients for whom the operation had been delayed for more than twenty-four hours after admission. White et al. [232] also found an increased one-year mortality rate when the operative delay had exceeded twenty-four hours, but concluded that the relationship between increased mortality and delay of definitive surgical management in patients with a poor physical condition should be attributed to the inherent high risk for such patients, not to the delay in surgical treatment.
Although surgery for femoral neck fractures is predominantly done under spinal anesthesia, the mortality rate is independent of the anaesthetic technique applied [61, 155, 223].
The presence of one or more in-hospital post-operative complications is predictive of increased one-year mortality [2, 20, 61, 71, 115, 116, 126, 147, 163, 193]. Pulmonary complications were associated with increased in-hospital mortality [165]. Miller [158] did not find a difference in the number of postoperative complications in survivors and non-survivors one year after femoral neck fracture.

1.6. Rehabilitation after femoral neck fractures.

Rehabilitation of elderly patients after femoral neck fractures is not easily achieved. Age, pre-existent pathology, pre-fracture level of functioning and social circumstances are major influencing factors on outcome after femoral neck fracture [22, 28, 37, 38, 50, 56, 57, 130]. Gender, type of fracture or operative method is of less importance [14, 28, 38, 46, 50, 56, 124, 200]. Early mobilisation and full weight bearing after hip surgery has decreased the mean hospitalisation time, but rehabilitation after surgery is still open to improvement. The increased number of femoral neck fractures makes great demands both on surgical treatment and rehabilitation resources. Elderly patients who lived independently before the fracture often cannot return to their own homes directly on discharge from the hospital. Often a temporary placement in an institution is necessary to rehabilitate the patient. There is a chronic shortage of beds in these kinds of institutions, because the turnover of patients is low and the waiting list long. As a consequence,

femoral neck fracture patients stay for an excessively long time in hospital, occupying expensive beds (the so called 'wrong-bed-problem'). The average length of stay for hip fracture patients in acute hospitals is three times the average hospital stay [16]. Although patterns of discharge and average length of hospitalisation after acute hip fracture vary in different countries, the hospitalisation time was about 30 days in 1970 and has not decreased very much since then [20, 84, 106, 114].

The home-going rate in femoral neck fracture patients coming from their own homes, sometimes after several months in an institution, approaches eighty percent, depending mostly on how the community after-care support systems are organized [30, 38, 56, 110]. In Ceder's study [37] four out of five surviving patients coming from their own homes returned home within one year. The general medical condition, living with someone, the ability to visit someone, to shop and the ability to walk before the fracture and within two weeks post-surgery were the factors that proved of the greatest importance for returning home within three months after surgery [37-41, 50]. Reported recovery of ambulatory ability after femoral neck fracture varies from 41 to 97% [130]. The results depend to a high degree on definition of ambulation. Most studies define ambulation in the broadest sense of the word (functional versus non-functional ambulators). No distinctions are made as to the use of walking aids or the loss of ability to ambulate in the community. Few studies have evaluated the predictors of postfracture ambulation controlling for prefracture ambulation. In the study of Magaziner [148], the majority of femoral neck fracture patients did not regain their pre-fracture levels of performance. The physical therapist's rating of physical function prior to discharge from the hospital was highly correlated to the outcome at six months in the study of Fox [77]. Borgquist [22] analyzed functional outcome and social status ten years after femoral neck fracture and concluded that most of the femoral neck fracture patients, coming from their own homes, returned home very early and remained there; only patients above 80 years of age at the moment of fracture gradually needed institutional care. The main reason for the need for long-term care after a femoral neck fracture is concomitant diseases. Thus, most patients coming from their own homes at the time of the fracture return home after treatment. Therefore, in the long-term perspective, the hip fracture patient is no extra burden to the health care system and the femoral neck fracture in itself is not an obstacle for a continued long active life. Several studies have shown that hip function, ADL-activities and household functions for patients coming from their own homes were usually attained within four months after treatment [22, 38, 110, 200, 221]. By twelve months after the fracture, most of the changes had leveled off [99, 124, 148].

Whether or not the patients will be returning home is of major importance for the resource consumption. Being at home with or without home help is the least resource-consuming state of residence. Both patient and society gain from early rehabilitation at home at low cost in co-operation with primary care personnel and social workers without a long hospital stay and unnecessary institutional after-care.

Management by a multidisciplinary approach to improve the results of rehabilitation in elderly femoral neck fracture patients has been the subject of several studies [70, 86, 87, 100, 125, 182, 201]. Various rehabilitation settings include the orthopedic ward (with or without consultation from geriatrics), combined orthopedic-geriatric ward, generalized geriatric rehabilitation ward (run by geriatricians, internists, physiatrist, or family physicians), the patient's home (with early discharge and use of specialized community services), and specialized nursing facilities. Jensen [113] stated that early discharge of the patient to home with specialized after-care is preferable to discharge to a special rehabilitation clinic [175]. Ceder[39,40] introduced the 'rapid rehabilitation program' in which patients follow an active, individualized rehabilitation program at home in close co-operation with primary care services. The aim of this program was to reduce secondary institutionalized rehabilitation and consumption of resources. With such a program, quicker and more effective rehabilitation has been documented [182, 221]. Jette [117] also implemented a specialized rehabilitation program in a randomized trial, but could not find significant differences between experimental and control groups in survival and short-term and long-term functional status.

Patients admitted from a geriatric institution and patients with significant cognitive disorders have a very poor prognosis with respect to post-fracture ambulation [8, 46, 50, 130, 148, 150, 158, 167, 194, 200]. Patients with cognitive problems are often excluded from rehabilitation programs although they may require more specialized rehabilitation approaches designed to overcome the barriers imposed by these cognitive deficits [148]. Repeated studies have indicated that participation in a geriatric rehabilitation program improves functional ability. Specifically, hospitalized elderly patients who participate in a rehabilitation program achieve functional gains, return home, and remain home for significant periods of time after discharge. A rehabilitation program can result in improvement in functional ability for elderly femoral neck fracture patients both with and without cognitive impairments and may decrease the demand on health care resources [83, 96, 188].

1.7. Internal fixation versus hemi-arthroplasty.

One of the most important complications of all prosthetic surgery is the postoperative infection. Bronchopulmonary, urinary tract and wound infections are most frequently seen. Superficial wound infections lengthen the duration of hospital stay and sometimes give rise to deep infections. The introduction of laminar flow and body exhaust systems, prophylactic antibiotics and antibiotics placed in bone cement have led to a reduction of postoperative sepsis and have been of utmost importance in orthopedic surgery.

As early as 1953, James Dickson [65] protested strongly against the defeatist attitude in regard of the treatment of femoral neck fractures. He especially showed his disapproval of the use of prostheses: "Hence, I reiterate that I must protest the attitude of defeatism inherent in the present vogue for prostheses." Although he thought that the solution was just a matter of time - "I am certain that some such integrated program of action by all the members of our group would solve the 'unsolved' fracture" - there is still much controversy today about the best treatment for the femoral neck fracture.

In Scandinavia (except Finland), almost all displaced intracapsular femoral neck fractures are treated by closed reduction and internal fixation, whereas in other European countries and the United States, many trauma surgeons prefer primary hemi-arthroplasty for patients over 70. The reasons for this difference in the treatment of such a common condition are not easy to identify. Historically, Sven Johansson (1934), was the Swedish pioneer of hip nailing, while in the United States, Austin Moore (1957) provided a successful arthroplasty for the "unsolved" fracture.

The most common complications leading to reoperation after internal fixation are secondary dislocation, non-union and femoral head necrosis (table 1.7.1).

Subsequent surgery after failure of internal fixation is avoided by primary prosthetic replacement. Surgical complications such as per-operative fractures of the proximal femur, luxation of the prosthesis and wound infections are the most important disadvantages of primary prosthetic replacement. The rate of reoperation is considerably lower after primary hemiarthroplasty. Late complications are protrusion of the prosthesis into the pelvis and acetabular erosion, ectopic ossification and loosening of the prosthesis (table 1.7.2).

Everybody agrees that in the younger patient the femoral head should be preserved, if possible. Therefore, older patients may be good candidates for primary prosthetic replacement. On the other hand, up to half of the patients (especially inactive elderly patients) with avascular necrosis and femoral collapse after internal fixation are asymptomatic and require no treatment. The occurrence of acetabular erosion is no major topic, because older patients are less likely to wear out the prosthesis.

Table 1.7.1. Early and late complications of internal fixation.

Author	Year	no. of patients	Followup	Early complications		Late complications		
			(mo)	Inf	Sec disl	FHN	NU	Redo
Alho	1999	225	39.0	1.3	14.0	15.8	18.8	27.3
Barnes	1976	1503	36.0			22.3	25.3	
Christie	1988	127	33.0	4.7		15.7	27.6	29.9
Cobb	1986	65	47.0			18.5	4.7	18.5
Frandsen	1981	249	24.0			14.5	31.0	
Kofoed	1980	165	29.0	0.0		11.0	14.0	12.5
Madsen	1987	103	24.0	5.8		15.7	26.0	11.7
Nilsson	1988	510	60.0	3.3		11.0	23.0	33.0
	1989	191	24.0	2.1	3.1	6.3	22.5	20.0
Olerud	1991	115	12.0		7.0	0.0	13.0	
Parker	1991	242	24.0			21.0	25.0	
Stromqvist	1984	152	24.0	0.0		12.5	14.5	17.0
	1987	300	24.0	0.0		5.3	13.0	13.0
			min	0.0	3.1	0.0	4.7	11.7
			max	5.8	14.0	22.3	31.0	33.0

There is no consensus between authors concerning the treatment strategy for displaced intracapsular femoral neck fractures. Some authors prefer reduction and internal fixation as primary treatment [66, 101, 168, 169, 187, 216, 217], others advocate prosthetic replacement of the femoral head and neck [26, 29, 60, 112, 157, 197, 208]. Some authors state that internal fixation can be carried out with a lower mortality rate [14, 18, 25, 120, 131, 187, 197]. However, the groups studied are often heterogeneous as to age, type of fracture and associated ailments. Although closed reduction and internal fixation is a much smaller operation than prosthetic replacement, the mortality rate is not lower in comparable patient groups [144]. There are only a few prospective, randomized trials [26, 197, 199, 208, 227](table 1.7.3). Soreide[208] compared osteosynthesis with von Bahr screws versus Christiansen endoprosthesis. Internal fixation was a less time-consuming operation with less blood loss and less clinical morbidity compared to primary prosthetic replacement. No difference in wound infection, early or late mortality was found. Although a tendency to a higher reintervention rate in the osteosynthesis group was noticed, no significant differences could be demonstrated. Significantly more failures were seen after internal fixation; but when results of reintervention werre included, the final outcome at one year follow-up was comparable in both groups. Sikorksi[197] reported a randomized trial comparing internal fixation with Garden screws versus Thompson hemiarthroplasty through a posterior or anterolateral

approach. There was no significant difference in the mortality of the internal fixation and posterior arthroplasty groups. Both groups showed a significantly higher mortality than patients operated on through the anterior approach. The technical results of operation were worse in the internally fixed group, with only 40 per cent being satisfactory.

Mobilization was best achieved after the posterior approach. It was concluded that Thompson hemi-arthroplasty, using an anterolateral approach, was the safest operation in this group of patients. Bray[26] found that although the surgical risks were relatively high compared with internal fixation, two-year observations showed better functional results in the cemented hemiarthroplasty group. Skinner[199] compared internal fixation with a sliding compression screw plate with an uncemented Moore hemiarthroplasty with a cemented Howse II total hip replacement, both these latter through a posterolateral approach. One year after operation there was little difference between the three groups in mortality or general complications. The revision rate within the first year was highest for internal fixation. Total hip replacement resulted in the least pain and most mobility at one year, while hemiarthroplasty was worst in these respects. Van Vugt [227] compared dynamic hip screw fixation with a bipolar hemiarthroplasty in independent, healthy elderly patients. No differences were found in the mortality rates, complications or the need for secundary intervention. Comparable results were obtained with both methods up to 24 months. At the 36 month follow-up, a a significantly worse outcome could be demonstrated in the hemiarthroplasty group. The conclusion of this study was that internal fixation was justified as primary treatment for elderly patients in good physical and mental health. Until now, no randomized trials have been performed, comparing internal fixation and prosthetic replacement for elderly patients with a poor mental health .

Table 1.7.2. Early and late complications of hemiarthroplasty.

Author	Year	no. of patients	Followup (mo)	Early complications Inf	Perop	Lux	Late complications Loos	Redo	
D'Arcy	1976	354	36.0	4.7	3.2	2.0	6.1		1.4
Beckenbaugh	1977	109		4.7					20.0
Binns	1985	100		5.0	0.0	1.0	3.0		
Bochner	1988	120	38.0			2.5	1.7		
Broos	1999	778	12.0	1.7		1.8			4.0
Browett	1981	324	38.0	4.9	8.5	0.6			3.8
Carnesale	1975	100		6.0		1.0	2.0		
Chan	1975	243	1.5	13.2	2.5	8.2			5.8
Clayer	1997	154	120.0	2.6	1.9	1.3	5.8		5.2
Devas	1983	161				5.1			
Diercks	1985	166	52.0	0.0	7.8	1.2			1.2
Drinker	1979	221	38.0			9.5			1.4
Franklin	1984	101	24.0	1.0		0.0			
Gallinaro	1990	88	36.7	5.7	2.3				
Hunter	1980	100	48.0	8.0		11.0			6.0
Jensen	1975	169	58.8	4.7	10.0	0.6	1.2		
Johnston	1982	150	21.0	2.0	0.7	0.7			3.3
Kofoed	1983	106	24.0	9.5	4.7	1.9	9.0		16.0
Kuokkanen	1988	162	58.0	2.4		1.9	2.5		5.7
Kwasny	1993	621	30.0	2.4	2.9	0.5	0.8		4.3
Kwok	1982	599				5.3			
LaBelle	1990	128	89.0	2.0		0.8	2.3		7.8
Lausten	1987	181	51.0				2.8		1.7
Lunt	1971	98	18.0	17.2		10.2			
Montgomery	1978	250	60.0	2.4	0.8	1.4			2.0
Paton	1989	171	48.0			5.8			
Rae	1989	98	33.0	7.1		6.1			3.1
Smith	1975	451		4.0	4.2	2.2			
Wetherell	1990	561	60.0	2.9	1.4	2.9	7.0		3.6
			Min	0.0	0.0	0.0	0.8		1.2
			Max	17.2	10.0	11.0	9.0		20.0

Table 1.7.3. Complications of internal fixation and hemiarthroplasty (non-randomised and randomised trials).

Author	Year	No of patients	followup (mo)	Early complications inf	Sec displ	Late complications FHN	NU	redo	No of patients	followup (mo)	Early complications inf	perop	lux	Late complications loos	Redo
Non-randomised															
Bracey	1977	102	18.0		4.0	7.0	17.0	22.0	102	18.0			18.0		9.0
Holmberg	1987	2251	72.0	2.0	12.0	12.0	11.0	25.0	95	72.0			11.0		5.0
Johnson	1975	153	24.0	0.0	8.0	14.0			68	24.0	7.4		3.0		
Raine	1974	42	6.0	2.4	14.0	29.0			52	6.0	11.6		7.7		
Stewart	1984	50	24.0	8.0	16.0		12.0	24.0	50	24.0	1.0		8.0		2.0
Randomised															
Bray	1988	19	19.2	0.0				15.8	15	19.7	0.0				0.0
Sikorski	1981	76	24.0	4.0		18.0	2.0	38.0	114	24.0	21.0		4.0	23.0	19.0
Skinner	1989	92	12.0					25.0	92	12.0			11.0		13.0
Soreide	1979	51	14.7	3.9	22.0	4.0	0.0	17.6	53	14.5	5.7		6.0		7.5
Van Vugt	1993	21	36.0	0.0	33.3	9.5	19.0	27.1	22	36.0	9.1	0.0	0.0	9.0	22.7
			min	0.0	4.0	4.0	0.0	15.8			0.0	0.0	0.0	9.0	0.0
			max	8.0	33.3	29.0	19.0	38.0			21.0	0.0	18.0	23.0	22.7

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CHAPTER 2. DEMENTIA

2.1. Epidemiological aspects.

In the next decades the number of elderly people suffering from dementia will continue to increase. In the Netherlands, the prevalence of dementia in the general population over 55 is about 6.5%, ranging from 0.4% in those aged 55-59 to 43.2% in those aged 95 and over. Between the ages of 60 to 85 the prevalence doubles with every five years' increase in age [30]. As the average life expectancy has almost doubled in most industrialized countries during the past century, the incidence of dementia will also continue to increase. At present, in the Netherlands, an estimated 100,000 to 120,000 elderly people are suffering from severe dementia, based on prevalence values of 5% in those aged 65 and over, and of 20% in those aged 80 and over.

It is also known that dementia causes increased mortality [1, 21, 39]. In a Dutch study, the overall 2-year survival rate after admission to a nursing home was 43% [21]. Alzheimer's disease is the leading cause of dementia and it has been reported to be the fourth leading cause of death in adult Americans. These facts implicate a tremendous emotional and economic burden for our society in the 21st century.

2.2. What is dementia?

Dementia is a descriptive term derived from the Latin word 'dementatus', which means 'out of one's mind'. The definition of dementia is complicated [17]. To reach agreement on definition and diagnostic criteria, a consensus development conference was organized in 1988 by the National Organization for Quality Assurance in Hospitals in the Netherlands [36]. A revised consensus was published in 1997 [6, 7]. According to this consensus, dementia is defined as an acquired clinical syndrome, characterized by multiple disturbances of cognitive functions without alteration of consciousness, and by a significant disturbance of the patient's usual daily and social activities. A declining memory which is evident in learning, retention and recall of new information is considered obligate for the diagnosis of dementia. In addition at least one of the following symptoms is required: aphasia (disturbance of speech), apraxia (impaired practical ability), agnosia (impaired ability to interpret sensory impressions) and disturbance in executing

functioning such as the individual's ability to initiate, plan and control his behavior. Symptoms have direct relations to the site of the brain lesions, for example personality change and impaired power of initiative (frontal syndrome), practical inability and reduced ability to interpret sensory impressions (parietal syndrome), and mental slowness and motorial disturbances (subcortical syndrome). The clinical picture of dementia also contains secondary psychiatric features such as anxiety, depression, suspiciousness, delusions and obstinacy.

There are several international classification systems of dementia [39, 40]. A major step in the classification occurred with the publication of the American Psychiatric Association's third version of the diagnostic and statistical manual of mental disorders DSM-III and its revised edition, DSM-III-R in 1987 (table 2.2.1.) [10]. The fourth version of the manual was published in 1994 (DSM-IV) [11]. In DSM-IV, the diagnostic criteria are subdivided into criteria for dementia of the Alzheimer's type and criteria for vascular dementia.

At present, the DSM-IV diagnostic criteria are the most accepted for diagnosis of the dementia syndrome (table 2.2.2., 2.2.3.). Also frequently used in the literature and research are the NINCDS-ADRDA criteria for the clinical diagnosis of Alzheimer's disease [25] and the NINDS-AIREN criteria for vascular dementia [33].

Table 2.2.1. DSM-III-R criteria for the diagnosis of dementia. (American Psychiatric Association 1987 [10])

A.	**Demonstrable evidence of impairment in short- and long-term memory.**
B.	**At least one of the four following symptom groups:** **(1) impairment in abstract thinking** **(2) impaired judgement or sense of proportion** **(3) other disturbances of higher cortical functions** **(4) personality change**
C.	**The disturbance in A and B significantly interferes with social functioning**
D.	**The symptoms do not occur exclusively during the course of a delirium**
E.	**Either (1) or (2):** **(1) presence of one or more organic factors etiologically related to the disturbance** **(2) the disturbance cannot be accounted for by any non-organic mental disorder**

Table 2.2.2. DSM-IV criteria for the diagnosis of dementia of the Alzheimer's type. (American Psychiatric Association 1994 [11])

A. Multiple cognitive deficits manifested by both (1) and (2)
   (1) impaired short- or long-term memory
   (2) one or more of the following cognitive disturbances:
      a. aphasia (impaired language ability)
      b. apraxia (impaired ability to carry out motor activities)
      c. agnosia (impaired ability to recognize objects)
      d. impaired ability of executive functioning (abstract thinking, judgement, organizing)

B. Deficits in A are sufficient to interfere with occupational or social functioning representing a significant decline from a previously higher level of functioning.

C. Disease course is characterized by gradual onset and continuing cognitive decline.

D. Cognitive deficits are not caused by any of the following:
   (1) another progressive central nervous system disorder
   (for example, Parkinson's or Huntington's disease, normal pressure hydrocephalus, brain tumour)
   (2) systemic conditions, known for causing dementia (for example, hypothyreoidism, niacin deficiency, neurolues)
   (3) a substance-induced condition

E. The deficits do not occur exclusively during the course of a delirium.

F. Disturbance can not be accounted for by another disorder (for example, major depressive disorder, schizophrenia).

Table 2.2.3. DSM-IV criteria for the diagnosis of vascular dementia (American Psychiatric Association 1994 [11])

A. Multiple cognitive deficits manifested by both 1 and 2
   (1) impaired short- or long-term memory
   (2) one or more of the following cognitive disturbances:
   a. aphasia (impaired language ability)
   b. apraxia (impaired ability to carry out motor activities)
   c. agnosia (impaired ability to recognize objects)
   d. impaired ability of executive functioning (abstract thinking, judgement, organizing)

B. Deficits in A are sufficient to interfere with occupational or social functioning representing a significant decline from a previously higher level of functioning.

C. Cerebrovascular disease, defined by the presence of focal signs (such as hemiparesis, Babinski sign, gait disturbances, pseudobulbar palsy) and etiological evidence of multiple large vessel infarcts and white matter lesions by brain imaging.

D. The deficits do not occur exclusively during the course of a delirium.

2.3. Dementia disorders.

Dementia represents a complex heterogeneity of disorders, but every form of dementia is caused by global or multifocal brain damage. Alzheimer's disease represents the most common form of dementia in the Western world. Other forms of dementia include vascular dementia, Lewy body dementia and frontal lobe dementia. Clear distinction between the different forms is often not possible in the clinical situation.

Alzheimer's disease. Alzheimer's disease [3] (AD) is characterized by memory disturbances with a diminished ability of learning, retention and recall of new information. Although relatively rare genetic forms of AD exist, the majority of patients have no obvious family history.

The neuropathological substrate is characterized by neuronal cell loss, resulting in cortical atrophy, and the presence of senile plaques and neurofibrillary tangles. One of the major neurochemical characteristics of AD is a disturbance in amyloid metabolism. Amyloid is normally a soluble brain protein. In Alzheimer's disease, the soluble form changes into a non-soluble form, which precipitates in the senile plaques. Beta-amyloid is derived from a family of much larger precursors, collectively referred to as the amyloid precursor protein (APP). Thus, a disturbance in the amyloid precursor protein metabolism followed by increased production and deposition of beta-amyloid may be important in the pathogenesis of AD [23, 39].

The tau protein is a human brain phosphoprotein, and associated to the cytoskeleton. The tau protein is normally located in the axons. The normal function of the tau protein is to stabilize the microtubuli. In AD the tau protein is the principal component of the neurofibrillary tangles. The tau protein is abnormally hyperphosphorylated, which probably leads to the development of defect microtubuli and thereby to impaired axonal function [39].

Although our knowledge of both beta-amyloid and tau protein has increased enormously over recent years, the relationship between beta-amyloid deposition and senile plaque development on the one hand and development of neurofibrillary tangles on the other remains elusive.

Recent data have implicated ApoE in the pathogenesis of AD. Apolipoprotein E (ApoE) plays an important role in lipid metabolism. It is a constituent of several plasma proteins and is essential for the redistribution of lipids by mediating the uptake of lipoproteins following interactions with specific receptors. Antibodies to ApoE label senile plaques. ApoE is also found in neurofibrillary tangles and it is has also been suggested that it is involved in the regulation of the mobilization and transport of lipids during repair of neuronal membranes, in remyelinisation, and in sprouting after injury. It has been suggested that the central event in AD pathogenesis is a degeneration and loss of synapses, with senile plaques and neurofibrillary tangles occurring as secondary non-specific indices of brain damage.

Vascular dementia. Dementia caused by vascular defined brain damage is the most important cause of dementia after Alzheimer's disease. The vascular lesions may produce various alterations of the brain parenchyma. Atherosclerosis of the carotid and vertebral arteries causes thrombo-embolic occlusion of the larger intracranial arteries and is associated with large ischaemic infarcts in cortex and subcortical tissue. More often, there is microangiopathy leading to occlusion of intracerebral arteriolae. This 'small vessel disease' can cause lacunary infarcts, mainly in subcortical grey matter, white matter, and the brainstem. Also, there can be damage due to intracerebral or subarachnoidal bleeding.

Atherosclerosis, thrombo-embolic disorders, aging, chronic hypertension, hyperlipidemias and diabetes are important associated factors in vascular dementia [39]. The disorder often occurs in acute episodes, followed by some improvement.

Lewy Body Dementia. Lewy Body Dementia (LBD) represents a distinct dementia disorder with specific clinical features. Characteristic symptoms include cognitive impairment, extrapyramidal symptoms and hallucinations and a particular sensitivity to neuroleptic medication. The pathological substrate is the Lewy body, an intracytoplasmatic neuronal inclusions, sometimes found in the brain stem, diencephalon, basal ganglia, and cerebral cortex. [4, 20, 22, 24, 31]

Frontal lobe degeneration of non-Alzheimer type. Frontal lobe degeneration of the non-Alzheimer type (FLD) is classified in a group also including Pick's disease, progressive aphasia, dementia in motor neuron disease, and amyotrophic lateral sclerosis with dementia [39]. FLD is clinically marked by frontal lobe symptoms and frontotemporal reduction of blood flow. The clinical features show personality change, memory disturbances, behavioral disturbances, affective symptoms, expressive speech disorder and loss of initiative. These behavioral manifestations often precede the memory disturbances. From a histopathological point of view it is characterized by gliosis, microvacuolation and neuronal atrophy. The structural changes of AD including amyloid are entirely lacking [5].

2.4. Diagnosis and clinical evaluation

Because the diagnosis of dementia is based on clinical rather than on etiological grounds, case definition has been a problem in epidemiological research. The principal characteristic of dementia, impairment of memory, is shared with several other states.

First there is clouding of consciousness caused by medical disorders or medication with a reduced ability to keep one's attention fixed on external and internal stimuli and with fragmented thinking. Such delirious states can usually be distinguished from dementia by a history of acute mental impairment of short duration in a patient with a previously normal

mental state; in addition, the patient is often seriously ill. Delirium and dementia can occur simultaneously, and there is empirical evidence that the majority of delirious states in the elderly emerge in patients with subclicinical or manifest dementia disorders. The incidence of acute confusional state after femoral neck fracture among elderly persons has been reported to be between 50% and 61% [18, 19].

Secondly, there is the problem of distinguishing dementia from depression in old age. There is a great overlap of symptoms in both disorders; they often appear simultaneously and a depressive disorder with cognitive disturbances is associated with a higher chance of developing dementia at a later stage. Also, dementia disorders are frequently associated with depressive symptoms.

It has to be emphasized that the symptoms of dementia do not form part of the physiological process of aging. Normal aging is associated with some slowing in the information processing process, but can to a large extent be compensated and dealt with without social consequences.

The role of drugs in the aged cannot be overemphasized in the etiology of delirium and dementia. Psychofarmaceutics like benzodiazepines, but also anti-Parkinson, anti-epileptic and antihypertensive medication and cardiac glycocosides can cause delirious states and memory disturbances.

The diagnosis of dementia implies that several mental functions are affected simultaneously as distinguished from permanent impairment of single mental functions, for example, memory disturbance or aphasia, which can occur in focal brain damage.

If there is a suspicion of dementia, neuropsychological testing can be very useful in reliably differentiating between dementia and normal aging. Neuropsychological investigational methodology can vary from an extensive investigation performed by a neuropsychologist, to a simplified investigation on a primary care level, performed by a non-specialist [2, 39]. Today there is no international consensus as to what a basic test battery should imply. Several instruments are available for the clinical diagnosis and validation of dementia, such as the Comprehensive and Referral Evaluation (CARE), the Geriatric Mental State Examination (GMS) and its algorithm AGECAT, and the CAMDEX. Screening tests are available to assess deterioration of cognitive functions. By using standardized and validated psychometric tests, a quantitative description can be given of behavioral and cognitive level of functioning.

Bedside screening instruments. Many tests are bedside screening instruments and consist of simple questions and instructions for the patient to test orientation, memory and speech. Clinical rating scales and brief mental status tests are used to give a quick and rough evaluation of dementia in the mild to severe range of cognitive decline. The mental status tests

assess the degree of dementia based on cognitive functioning, whereas the rating scales evaluate dementia based on both cognitive and non-cognitive aspects of behavior. These instruments should be included as part of a comprehensive dementia examination, because they give a universally acknowledged index of the severity of dementia. Mental status tests are less demanding for the patient than neuropsychological tests. Furthermore, mental status tests and rating scales can also be administered by a variety of staff groups after a relatively short training.

The validity of these cognitive screening tests has been studied extensively. One of the problems is that different cut off points are used in different studies. The test items are influenced by cultural differences. Sensitivity and specificity are remarkably high with regard to distinction between dementia and normal aging or somatic pathology, in comparison with more sophisticated tests [8]. The main drawback is related to the relatively high proportion of false negative errors of diagnosis for patients with early dementia. A reliable and sensitive test for diagnosing early dementia has not yet been invented.

Screening tests frequently used in the Netherlands are the Mini-Mental State Examination (MMSE) and the Cognitive Screening Test (CST). The MMSE [13] consists of 10 questions for orientation as to time, person and place and three object names administered orally for immediate and delayed recall testing. Furthermore, a serial subtraction of sevens (so called serial sevens) as a measure of attention and concentration, five items of language fluency and understanding and one figure-copying exercise for constructional praxis. Correct responses are given differential weights to define a total score that ranges from 0 to 30. It has adequate reliability and it appears to discriminate well between clinically demented and non-demented individuals.

The Cognitive Screening Test (CST) was developed by Deelman [9] and was derived from the Short Portable Mental Status Questionnaire (SPMSQ), consisting of 10 questions assessing orientation, recent and remote memory, plus serial subtraction of threes to evaluate attention and concentration. The CST-14 is not an exact translation of the SPMSQ, but has specific adjustments for the Dutch situation. It is a brief questionnaire with fourteen items covering the most important symptoms of dementia: disordered orientation in time and place, short-term and long-term memory and intellectual functioning. Per item 0, ½ or 1 point is given, with a maximum of 14 points (cut-offscore 10 points). From several reports it appears that a significant distinction can be made between elderly patients with and without cognitive impairment. An important advantage of the test is that it is easy and very little time-consuming and that specific experience is not required from the interviewer. It can be carried out by laymen and by experienced users.

The MMSE is influenced by demographic characteristics such as education, age and race and functional status [12, 14].The CST-14 is less influenced by education level than the MMSE [8]. Internal consistency of the CST is higher than of the MMSE, because the latter consists of heterogeneous items. The CST tests orientation and memory, where the MMSE also measures practical skills and concentration.

It is important to recognize that no screening instrument can provide a diagnosis of dementia. All that can reasonably be expected is that it detects probable cognitive impairment. These tests show that *something* is wrong, not *what* is wrong.

Diagnostic tools. Diagnostic tools are used to exclude diseases with a known cause, rather than to diagnose the common dementia disorders.

Standardized laboratory tests should always be performed, not only to search for internal causes of reversible dementia or delirium, but also to treat diseases, which have a negative influence on the functioning of the patient, for example diabetes.

Electroencephalography (EEG) is a relatively simple and inexpensive diagnostic tool with a high sensitivity for diffuse organic encephalopathy. Electroencephalography should be performed when epilepsy is suspected. In case of dilemma between a depression with cognitive disturbance and dementia with depressive symptoms, EEG can be useful [34, 39].

Modern brain imaging techniques such as X-ray computed tomography (CT) and magnetic resonance imaging (MRI) are widely used in the clinical evaluation of patients with dementia disorders. It is useful to identify the changes manifested in vascular dementia (infarcts, abnormalities of the white matter) and to exclude secondary conditions of dementia, such as normal pressure hydrocephalus, tumors or subdural hematoma [38, 39]. The single photon emission computed tomography (SPECT) is a tomographical imaging method for assessment of regional cerebral blood flow [35, 38]. Positron emission tomography (PET) is a technique, which provides measurement of functional parameters such as cerebral blood flow, glucose metabolism as well as neurotransmitter activity and receptors [28, 38].

2.5 Pharmacological treatment strategies.

The last few years, there has been considerable progress in understanding the pathogenesis of dementia diseases, but the etiology needs to be clarified further before we can develop pharmacological therapeutic strategies.

During recent years a variety of therapeutic approaches has been tested on patients with AD. The effects of treatment have in many cases been negative or minor. The main strategy for drug development in AD treatment today is altering neurotransmitter functioning, anti-

inflammatory drugs and therapies that block abnormal phosphorylation of the tau protein. Research developing drugs affecting amyloid processing is currently undertaken.

The only pharmaceutical substances that so far have reached clinical practice are the acetylcholinesterase inhibitors, such as tacrine [27, 39], donezepil [32], metrifonate [26] and rivastigmine [37]. The clinical applicability, however, remains very controversial [15, 16].

There is no established drug therapy for treatment of cognitive impairment in vascular dementia but treatment with antihypertensive and anti-arrhythmia drugs and anticoagulants can be of benefit in the prevention of further brain damage in vascular dementia [29].

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CHAPTER 3. DISCUSSION

Due to the aging of our population and the accompanying physical and mental morbidity, our society has to face nearly unsolvable problems, considering health care management and costs. The growing number of femoral neck fractures has an enormous impact on the need for hospital beds and the need for health care workers, who are willing to take care of the elderly patients.

Technical improvements in the management of intracapsular femoral neck fractures made the femoral neck fracture by itself of less importance for recovery than sociomedical factors.

Specific milestones included the principle of reduction by dynamic traction, the importance of anatomical reduction and its maintenance in plaster, the development of stable internal fixation devices, and finally, the development of implant arthroplasty.

Currently, almost all femoral neck fractures are treated operatively, but there is still an ongoing discussion concerning the best treatment strategy for displaced intracapsular femoral neck fractures in elderly patients. Some prefer closed reduction and internal fixation, others prefer hemiarthroplasty. Whatever the method of treatment, the mortality rate after surgical treatment of a femoral neck fracture is still considerable compared to the general population. Early postoperative mobilization of the patients has decreased the mean hospitalization time, but successful rehabilitation after surgery is a major problem.

Patients, admitted from a geriatric institution and patients with significant cognitive disorders seem to have a very poor prognosis with respect to mortality and rehabilitation after a femoral neck fracture. Differences in patient selection, case-finding intensity and the diagnostic criteria employed make literature comparisons of the prevalence of cognitive disorders in hip fracture patients difficult. One of the problems is that other conditions like depression and acute confusional states are very common in the elderly. These conditions are often poorly documented in the medical records and difficult to discriminate from dementia.

Surgical, rehabilitative and economic aspects of hip fracture are well documented, but there are sparse data concerning the effect of mental status on treatment of femoral neck fractures.

Our study was started to analyze the effect of mental state on survival and functional outcome after surgical treatment for a displaced femoral neck fracture.

PART II. OUTCOME OF TREATMENT OF INTRACAPSULAR FEMORAL NECK FRACTURES IN RELATION TO MENTAL STATE

Introduction.

The Saint Franciscus Hospital in Rotterdam is a large district hospital with many institutions for elderly people, including psychogeriatric patients, in the direct environment of it. Most of the patients, treated for intracapsular femoral neck fractures in this hospital are referred from these nursing homes. The standard treatment for elderly patients with a displaced intracapsular femoral neck fracture in this district hospital has been cemented Thompson hemiarthroplasty since 1975.

In 1990, we started a retrospective study to assess survival and functional outcome of hemiarthroplasty in relation to mental state. The medical records of 543 consecutive patients, treated during the ten-year period 1979-1989, were reviewed. We compared the 215 patients with senile dementia with the 328 patients without senile dementia with respect to mortality and functional outcome (chapter 4) and evaluated the complications of hemiarthroplasty for displaced intracapsular femoral neck fractures in this study population (chapter 5).

This retrospective study gave rise to the question if hemiarthroplasty should be the treatment of choice for *all* patients with an intracapsular femoral neck fracture, regardless their mental state.

In 1991, we started a prospective study to compare hemiarthroplasty to internal fixation with regard to mortality, complications and functional outcome for patients with senile dementia.

The diagnosis 'senile dementia' already had been made before the time of admission by a professional Geriatric Assessment team, according to the DSM-III-R-criteria [9].

During the five-year period 1991-1995, 60 consecutive patients over 70 years of age with displaced intracapsular femoral neck fractures and who were known with the diagnosis 'senile dementia' were randomly allocated to internal fixation or hemi-arthroplasty (chapter 6).

Patients without senile dementia were treated by hemi-arthroplasty. The outcome of treatment in this group of patients was compared with the outcome of hemiarthroplasty in demented patients (chapter 7). After discharge from the hospital, all patients were reviewed by visiting them in their own environment at four months, one year and two years postoperatively. Patients were followed for a minimum of two years or until death.

Finally, the complications of internal fixation technique in relation to adequacy of the surgical technique were analyzed (chapter 8).

CHAPTER 4. EFFECT OF MENTAL STATE ON MORTALITY AFTER HEMIARTHROPLASTY FOR FRACTURE OF THE FEMORAL NECK

a retrospective study of 543 patients

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Published in: European Journal of Surgery 1994; 160: 203-208.

Effect of Mental State on Mortality after Hemiarthroplasty for Fracture of the Femoral Neck

A Retrospective Study of 543 Patients

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ABSTRACT

Objective: To assess mortality and functional results of Thompson's hemiarthroplasty for fractured neck of femur in patients with and without senile dementia.
Design: Retrospective study.
Setting: District hospital.
Subject: 543 Unselected patients who had intracapsular fractures of the femoral neck treated by hemiarthroplasty between 1979 and 1988.
Main outcome measures: Mortality and functional results during a median follow up period of 14.9 months (range 0.0–111) for patients with senile dementia and 27.4 months (range 0.1–131) for patients who were not demented.
Results: 156 of 215 demented patients (73%) died during the follow up period compared with 169 of 328 of those who were not demented (52%). Of the 109 patients with dementia who were mobile before operation only 59 were mobile after operation (54%), compared with 199 of the 215 patients (93%) who were not demented ($p < 0.001$). Senile dementia seemed to be the only coexisting condition that had a significant effect on mortality.
Conclusion: Hemiarthroplasty is probably too major an operation with which to treat fractures of the femoral neck in demented patients.

RÉSUMÉ

But: Evaluer la mortalité et les résultats fonctionnels de la mise en place d'une prothèse céphalique de Thompson pour fracture du col fémoral chez des patients avec et sans démence sénile.
Type d'étude: Rétrospective.
Provenance: Hôpital d'arrondissement.
Patients: 543 patients tout venant ayant une fracture intracapsulaire du col du fémur traités par mise en place d'une prothèse céphalique entre 1979 et 1988.
Principaux critères de jugement: La mortalité et les résultats fonctionnels sur une période médiane de suivi de 14.9 mois (extrêmes 0.0–111) chez les patients atteints de démence sénile et de 27.4 mois (extrêmes 0.1–131) chez les patients indemnes.
Résultats: 156 des 215 patients déments séniles (73%) sont décédés au cours de la période de suivi contre 169 des 328 qui étaient indemnes de l'affection (52%). Parmi les 109 patients déments séniles qui marchaient avant l'intervention seuls 59 pouvaient le faire après (54%) comparé à 119 des 215 patients (93%) indemnes de l'affection ($p < 0.001$). La démence sénile semblait être le seul facteur associé ayant une influence significative sur la mortalité.
Conclusion: La mise en place d'une prothèse fémorale est probablement une intervention trop lourde pour traiter une fracture du col du fémur chez les patients déments.

INTRODUCTION

In elderly people, particularly women, a fracture of the hip is becoming increasingly common. In the past, a hip fracture meant a certain death for a vulnerable elderly person, usually as a result of cardiac, pulmonary or renal complications, aggravated by prolonged immobilisation.

With the introduction and development of operative techniques such as internal fixation or prosthetic replacement of the femoral head and neck, patients can now be mobilised more quickly and their survival time prolonged. Nowadays more than 80% of hip fractures are treated by operation.

The optimal treatment for subcapital fracture of the femoral neck is controversial (1, 4, 10). Some authors prefer internal fixation with preservation of the femoral head as primary treatment (7, 8, 13, 14, 16, 20, 21), some others report better result after prosthetic replacement of the femoral head and neck (2, 5, 17, 18, 19).

In spite of modern treatment, acceptable rehabilitation of a patient with a subcapital fracture of the femoral neck is difficult. A hip fracture means a reduction in activities of daily living for elderly patients. They often lose their independence and have to live in a nursing home for the rest of their lives.

There are many homes for elderly people, including psychogeriatric patients, in the immediate environment of the Saint Franciscus hospital in Rotterdam.

Many of the patients, who are treated at this hospital for intracapsular femoral neck fractures are referred from these nursing homes. During the last 15 years, the standard treatment in the Saint Franciscus Hospital for elderly patients with subcapital fracture of the femoral neck has been hemiarthroplasty, whatever their mental state or ability to walk before the operation.

In this paper we describe the results of a retrospective study in which we have evaluated the outcome in terms of survival and functional results in a group of patients treated by Thompson hemiarthroplasty. We divided the patients according to their mental state so that we could draw some conclusions about the indications for Thompson hemiarthroplasty. Because of the large number of elderly patients and the large proportion of them who were demented, we have been able to draw separate conclusions for patients who were demented and those who were not.

PATIENTS AND METHODS

We reviewed the medical records of 543 patients who had intracapsular fractures of the femoral neck treated by hemiarthroplasty. All patients who were admitted to the Saint Franciscus Hospital, Rotterdam, during the period 1979–1988, were included and followed up until 31 December 1989.

We recorded age, sex, coexistent conditions, mental state, length of survival and ability to walk before and after the operation. We completed our mortality figures with information from the Civil Registry. To make the information as complete as possible, we visited or wrote to the nursing homes from which patients were admitted. We were therefore able to get a better picture of their daily activities, particularly their walking.

Patients were considered demented if they were referred from a psychogeriatric hospital, or if they were on the waiting list for admission to such a hospital for psychogeriatric symptoms.

The Thompson prosthesis was inserted through an anterolateral incision without trochanter osteotomy, which allowed immediate weightbearing after the operation. The prosthesis was fixed with polymethylmetacrylate bone cement.

Antimicrobial prophylaxis consisted of Cefazolin intravenously before operation and two further doses during the first 24 hours afterwards.

Prophylaxis against thromboembolism consisted of heparin 5000 IU subcutaneously before operation and continued until the patient was mobilised. Patients in whom mobilisation was delayed were given acenocoumarol.

Statistical methods

We performed a multivariate survival analysis (12). The outcome was mortality; the follow up of patients who did not die before 31 December 1989 was censored at that date. The explanatory variables in the analysis were: longitudinal ageing, time passed since operation, coexisting conditions and sex. Functional results were compared with the Chi-square test.

RESULTS

The comparability of the groups is shown in Table I and the coexisting conditions in Table II.

Mortality

The median follow up was 21.3 months (range 0.1–131); 325 patients had died by 31 December 1989. Forty patients (7.4%) died in hospital, and after six months 129 patients (24%) had died. One year after operation 174 patients (32%) were dead. After two years 240 patients (45%) were dead.

Separate survival curves for patients with and without dementia are shown in Fig. 1. The median follow up time for the 215 demented patients was 14.9 months (range 0.1–111), and the corresponding figures for the 328 who were not demented were 27.4 months (range 0.1–131). By the end of the follow up

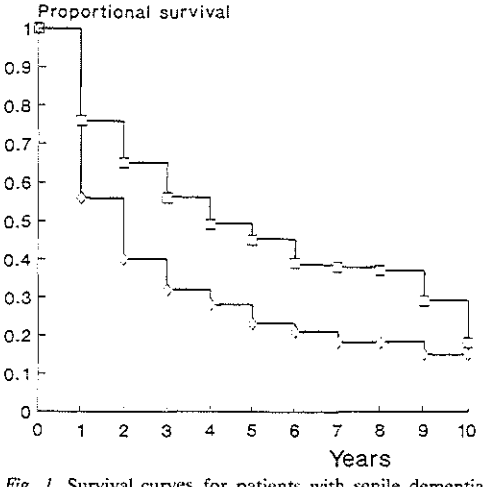

Fig. 1. Survival curves for patients with senile dementia (indicated by the *diamond*) and those who were not demented (indicated by the *square*).

Table I. *Comparibility of the groups*

Figures are number (%) of patients except where otherwise stated.

	Patients with senile dementia (n = 215)	Patients with no signs of senile dementia (n = 328)	Total (n = 543)
Sex:			
Male	45 (21)	70 (21)	115 (21)
Female	170 (79)	258 (79)	428 (79)
Male: female ratio	1:3.8	1:3.7	1:3.7
Age (years):			
Mean	82	81	82
Range	65–96	55–100	55–100
Median (range) time between admission and operation (days)	1 (0–16)	1 (0–48)	1 (0–48)
Median (range) duration of hospital stay (days)	9 (3–158)	21 (7–156)	18 (3–158)
Side of fracture:			
Right	102 (47)	156 (48)	258 (48)
Left	113 (53)	172 (52)	285 (52)
Surgeon operating:			
Staff surgeon	87 (40)	109 (33)	196 (36)
Resident	128 (60)	219 (67)	347 (64)

period 156 demented patients and 169 patients who were not demented had died. Hospital mortality for demented patients was 8% (n = 18) and for those without dementia it was 7% (n = 22). The mortality at six months was 34% (n = 72) and 17% (n = 57), respectively, and at one year the mortality was 44% (n = 94) and 24% (n = 80). At two years 128 demented patients had died (60%) compared with 112 patients (35%) who were not demented. The difference between the survival curves was significant ($X^2 = 34.75$, df = 1, $p < 0.001$).

As the effect of senile dementia on mortality may have been confounded by other covariables, we did a multivariate survival analysis (12) in which several explanatory variables were included simultaneously in the analysis. Two relevant variables related to time: ageing of the patient and time passed since operation.

As a consequence of ageing the mortality increased

Table II. *Coexisting conditions in 543 patients with fractured neck of femur*

Figures are number (%) of patients except where otherwise stated.

Coexisting condition	Patients with senile dementia (n = 215)	Patients with no signs of senile dementia (n = 328)	Total (n = 543)
Neurological	52 (24.2)	52 (15.9)	104 (19.2)
Cardiovascular	36 (16.7)	53 (16.2)	89 (16.4)
Metabolic	19 (8.8)	29 (8.8)	48 (8.8)
Pulmonary	11 (5.1)	30 (9.1)	41 (7.6)
Rheumatoid	7 (3.3)	25 (7.6)	32 (5.9)
Malignancy, treated	8 (3.7)	21 (6.4)	29 (5.3)
Malignancy with metastases	4 (1.9)	13 (4.0)	17 (3.1)
Pathological fractures	1 (0.5)	8 (2.4)	9 (1.7)
Other	1 (0.5)	6 (1.8)	7 (1.3)
No. of coexisting conditions:			
One	68 (31.6)	94 (28.7)	162 (29.8)
Two	26 (12.1)	47 (14.3)	73 (13.4)
Three	5 (2.3)	15 (4.6)	20 (3.7)
Four	1 (0.5)	1 (0.3)	2 (0.4)

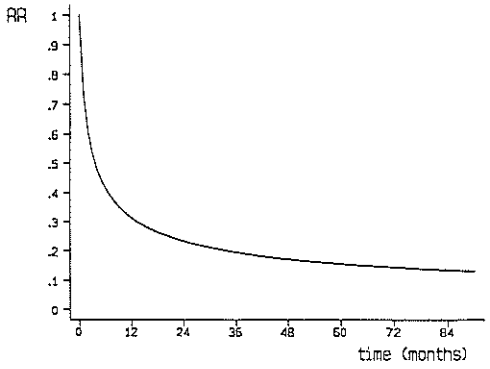

Fig. 2. The mortality rate ratio (*RR*) estimated as a function of time passed since operation.

by 6.5% per annum (95% confidence interval 4.7 to 8.2%, $p < 0.001$). The mortality sharply decreased in the first year after operation. The rate ratio decreased from 1 to 0.3 ($p < 0.001$), see Fig. 2. Sex and other coexistent conditions were also included as covariates. Sex, senile dementia, metabolic disorders and malignancies had a significant effect on mortality (Table III). The other coexisting conditions (cardiovascular, neurological, pulmonal, rheumatoid disorders and pathological fractures) were not significant. The mortality for patients with senile dementia was 100% higher than for those who did not have dementia (95% confidence interval 60% to 140%; $p < 0.001$).

Functional results

Ability to walk before and after operation was classified in four categories: walking, without help; walking, with support (stick or frame); walking only with the help of another person and not walking (confined to chair or bed).

The ability to walk was followed up for as long as possible, and four months after the operation it was supposed to be optimal.

Table III. *Mortality rate ratios*

RR = rate ratio, *95% CI* = 95% confidence interval.

Condition	RR	95% CI	*p*
Sex:			
male	2.4	1.8–3.1	<0.001
Dementia	2	1.6–2.4	<0.001
Metabolic	1.5	1–2.2	0.03
Malignancy:			
treated	1.9	1.2–2.9	0.006
metastased	3.3	1.9–5.5	<0.001

We divided the group with respect to mental state to compare the change within patients four months after operation compared with beforehand (Tables IV and V). Of the 215 demented patients, 156 were alive at four months, and complete information about preoperative as well as postoperative ability to walk was available for 121. Before operation, 109 of the 121 patients (90%) were able to walk with or without aids, but four months after operation, only 59 of the 109 (54%) were able to walk.

Of the 328 patients without dementia, 279 survived for four months after operation and of these pre- and postoperative information about walking ability was available for 220 patients. Before operation, 215 (98%) could walk with or without aids, and after four months, 199 of the 215 (93%) were able to walk.

Of the 109 demented patients, who were mobile before operation, 50 (46%) were not mobile four months after operation. Of the 215 patients without dementia who were mobile before operation, 16 (7%) were not mobile four months after operation. This difference is significant ($X^2 = 63.51$, $df = 1$, $p < 0.001$).

In conclusion, 50 of the 121 demented patients (41%) and 16 of the 220 who were not demented (7%) and who were alive four months postoperatively, were immobile four months after operation. This difference is significant ($X^2 = 55.82$, $df = 1$, $p < 0.001$).

DISCUSSION

One of the main goals of the treatment of elderly patients with fractures of the femoral neck is to mobilise them as soon as possible and return them to independence (5); this is an important factor in the choice of operative treatment. Although the optimal treatment for intracapsular fracture of the femoral neck is still controversial, hemiarthroplasty is an accepted method.

There are few published reports about the influence of the mental state of the patient on the results of treatment. Ceder et al (3) concluded that the general medical condition and age of the patient are important prognostic factors on outcome. Ions and Stevens (9), who studied the prediction of survival in patients with femoral neck fractures, came to the conclusion that mental competence had the greatest effect on mortality. Mortality in our total population is comparable with reported figures (5, 7, 11). However, when differentiating between patients with and without dementia, operative mortality shows that demented patients have a far greater risk of dying than those who are not demented, which is confirmed by the multivariate survival analysis.

Table IV. *Effect of hemiarthroplasty on the ability to walk of 215 patients with senile dementia*
59 patients died within four months postoperatively.

	Ability to walk four months postoperatively						
	Without help	With support	With the help of another person	Not walking	Total (%)	Missing values	Total (%)
Ability to walk before operation:							
Without help	17	31	23	14	85 (70.2)	7	92 (59.0)
With support	0	11	8	5	24 (19.8)	3	27 (17.3)
With the help of another person	0	0	3	5	8 (6.6)	0	8 (5.1)
Not walking	0	0	0	4	4 (3.3)	0	4 (2.6)
Total (%)	17 (14.0)	42 (34.7)	34 (28.1)	28 (23.1)	121 (100)		
Missing values	0	4	3	2		16	25 (16.0)
Total (%)	17 (10.9)	46 (29.5)	37 (23.7)	30 (19.2)		26 (16.7)	156 (100)

Mobility is not only reduced as a result of the hip fracture, but also as a result of the deteriorating general condition (6). From this study we can learn that demented patients have less chance of acceptable mobilisation after operation compared with those who are not demented. This was confirmed by the significant differences in ability to walk before and after operation for the two groups.

Hemiarthroplasty is convenient for the nursing staff in the geriatric hospitals and homes which have a chronic shortage of manpower. If a patient is not expected to mobilise satisfactorily after operation, however, and is condemned to bed and chair, then the question arises of whether such a major operation is justified.

Another important aim of treatment after an intracapsular fracture of the femoral neck is relief of pain, which can be achieved by simpler ways of stabilising the fracture. If the patients are not mobile before operation, therefore, or if the chances of mobilisation are small after such a fracture, a less radical operation may be advisable to stabilise the fracture, thus resulting in freeing the patient of pain. We therefore started a prospective trial in April 1991 in which demented patients are randomised to treatment with either hemiarthroplasty or cannulated screws.

Rehabilitation is difficult in patients whose mobility was moderate before operation and particularly in those who have senile dementia.

Hemiarthroplasty is a major operation with considerable risks: operative and intrahospital mortality is high, which is confirmed by our mortality. A fractured hip treated by hemiarthroplasty significantly decreased the life expectancy of our mentally compromised patients.

CONCLUSIONS

The results of Thompson hemiarthroplasty in terms of survival and ability to walk, are satisfactory in

Table V. *Effect of hemiarthroplasty on the ability to walk of 328 patients who did not have senile dementia*
Forty-nine patients died within four months postoperatively.

	Ability to walk four months postoperatively						
	Without help	With support	With the help of another person	Not walking	Total(%)	Missing values	Total (%)
Ability to walk before operation							
Without help	53	105	3	2	163 (74.1)	3	166 (59.5)
With support	0	41	6	5	52 (23.6)	7	59 (21.1)
With the help of another person	0	0	1	0	1 (0.5)	1	2 (0.7)
Not walking	0	0	0	4	4 (1.8)	0	4 (1.4)
Total (%)	53 (24.1)	146 (66.4)	10 (4.5)	11 (5.0)	220 (100)		
Missing values	0	12	2	5		29	48 (17.2)
Total (%)	53 (19.0)	158 (56.6)	12 (4.7)	16 (5.7)		40 (14.3)	279 (100)

patients who are not demented. A major operation such as a Thompson hemiarthroplasty, however, does not seem to be justified in demented patients, because their risk of death is high and the results of subsequent mobilisation are disappointing. These patients would therefore be better off with a less hazardous operation to stabilise the fracture and ease the pain. Nowadays, many techniques have been developed for stabilisation of fractures of the femoral neck, so there is no reason to treat elderly patients with hemiarthroplasty as a standard procedure. Long term complications of internal fixation such as non-union and avascular necrosis of the femoral head do not seem to be relevant in this group of patients because of their limited life expectancy and rehabilitation. To choose the most suitable operation for the individual patient, careful evaluation of mental state, mobility, and surroundings before operation could be more valuable than just treating the fracture without any other considerations.

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Submitted April 24, 1992; accepted September 22, 1993

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CHAPTER 5. COMPLICATIONS OF HEMIARTHROPLASTY.

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Published in: International Surgery 1996; 81: 200-204.

The objective of this study was to evaluate the complications of hemiarthroplasty for displaced intracapsular femoral neck fractures. The case histories of 543 consecutive patients with displaced intracapsular femoral neck fractures treated by hemiarthroplasty between 1979 and 1988 were studied. Early mortality was 7.0%. Peroperative complications were seen 23 times (4.2%). Wound complications were seen in 94 patients (17.3%). Ten patients (1.8%) developed a deep infection. Reoperations had to be performed in 19 patients (3.5%). Hemiarthroplasty is major surgery and should not be performed on patients with a limited life expectancy and poor mobility. The main goal of treatment for these patients is to provide the patient with an efficient form of analgesia which can be achieved by simpler techniques of stabilisation of the fracture.

KEY WORDS: Hemiarthroplasty - Femoral neck fractures.

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In 1934, Kellogg Speed [1] called the intracapsular femoral neck fracture "the unsolved fracture". Today, the best treatment for this fracture is still controversial. Some authors advocate reduction and internal fixation of the fracture,[2-4] others are in favour of primary prosthetic replacement of the femoral head and neck.[5-10]

Reduction and internal fixation of the fracture has a lower mortality, but a higher reintervention rate because of femoral head necrosis and non-union of the fracture.[5 7 11]

Subsequent surgery after failure of internal fixation is avoided by hemiarthroplasty. Immediate weight-bearing mobilisation after hemiarthroplasty is another major advantage. Higher mortality and surgical complications like peroperative fractures of the proximal femur, luxation of the prosthesis and wound infections are the most important disadvantages of primary prosthetic replacement.[2 7 12-14] Late complications are loosening of the prosthesis, intrusion of the prosthesis into the pelvis and acetabular erosion.[12 15-17] At our department of surgery the Thompson prosthesis has been used since 1975 to treat all patients over 70 years of age with a displaced intracapsular femoral neck fracture. The objective of this study was to evaluate the complications of hemiarthroplasty with the Thompson prosthesis.

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Materials and Methods

During the period 1979-1988, 543 consecutive patients, admitted to our hospital with a displaced intracapsular fracture of the femoral neck, Garden type III or IV, were treated by primary hemiarthroplasty. We recorded age, sex, coexistent conditions, intrahospital mortality and per- and postoperative complications by reviewing their medical records. The population consisted of 428

TABLE I.—*Coexisting conditions in 543 patients with a displaced subcapital femoral neck fracture. Figures are number (%) of patients.*

Coexisting condition	Total n=543	(%)
Senile dementia	215	(39.6)
Neurological	104	(19.2)
Cardiovascular	89	(16.4)
Metabolic	48	(8.8)
Pulmonary	41	(7.6)
Rheumatoid	32	(5.9)
Malignancy, treated	29	(5.3)
Malignancy with metastases	17	(3.1)
Pathological fractures	9	(1.7)
Other	7	(1.3)
No. of coexisting conditions:		
One	162	(29.8)
Two	73	(13.4)
Three	20	(3.7)
Four	2	(0.4)

TABLE II.—*Early mortality rates (%) of hemiarthroplasty.*

Author, year	Number of patients	Mean age (years)	Mortality within 30 days	Mortality within 6 months
Berglund, 1993 [18]	169	80	9	20#
Binns, 1985 [19]	100		28*	
Bochner, 1988 [11]	120	77	4	5
Bracey, 1977 [13]	163	77		30
Browett, 1981 [15]	324	79	11.1	27.5
Chan, 1975 [20]	243	77.2	14.4*	
D'Arcy, 1976 [12]	361	81.3	12.9	23
Devas, 1983 [21]	161	78	8.7	19.3
Diercks, 1985 [22]	166	77.3	5	20
Franklin, 1984 [23]	101	80	8	19
Gallinaro, 1990 [24]	88	75	3.4	
Holmberg, 1987 [25]	95		7	
Hunter, 1980 [26]	100	79		20
Johnson, 1975 [5]	68	80.5	6	
Johnston, 1982 [8]	150	79.8	4	
Kofoed, 1983 [27]	106	82.5	11	21
Kuokkanen, 1988 [14]	159	78.4	8	
Kwasny, 1993 [28]	621	84.7	9.7*	
Lausten, 1987 [16]	183	77.1	10	
Lunt, 1971 [29]	98		22.5	30
Rae, 1989 [30]	98	80	14.4	24.5
Raine, 1974 [2]	52	77		33
Sikorski, 1981 [7]	114	80	13	28
Soreide, 1979 [6]	53	78.3	5.7	9.4
van Vugt, 1993 [4]	22	76.0	0.0	8.8
van Dortmont 1994 [31]	543	81.7	7.0	24.0

*) Mortality within 6 weeks; #) Mortality within 4 months.

TABLE III.—*Peroperative complications (%).*

Author, year	Number of patients	Fracture of greater trochanter	Fracture of prox. femur	Fissure of femur	Girdlestone procedure	Penetration of femoral shaft
Binns, 1985 [19]	100	0	0	0	0	0
Browett, 1981 [15]	324		4.5			4.0
Chan, 1975 [20]	107 (ant)	0.8				1.6
	136 (pos)	0				0
D'Arcy, 1976 [12]	361	0.6	0.6			2.0
Diercks, 1985 [22]	166			7.8	1.2	
Gallinaro, 1990 [24]	88		2.3			
Johnston, 1982 [8]	150					0.6
Kofoed, 1983 [27]	106		4.7			
Kuokkanen, 1988 [14]	162	0	0.6	0	0	0
Kwasny, 1993 [28]	621	1.0	0.8		0.3	1.1
van Dortmont, 1995	543	0.4	1.3	1.5	0.6	0.2

women (78.8%) and 115 men (21.2%), (male/female ratio 1:3.7), with a mean age of 81.7 years (median 82.4, range 55-100 years).

Coexisting conditions of the 543 patients are outlined in Table I. Hemiarthroplasty was performed by means of an anterior incision without trochanter osteotomy. The Thompson prosthesis was fixed with polymethylmetacrylate bone cement. The operation was performed by experienced surgeons (36%) or by residents (64%).

Prophylactic antibiotic treatment consisted of Cefalozin immediately before operation and two doses during the first 24 hours postoperatively. Prophylaxis against thromboembolism consisted of daily injections of heparin 5000 IU subcutaneously just before operation and thereafter until the patient was mobilised. In case of a delayed mobilisation treatment with oral anticoagulants was started.

Patients were encouraged to weight-bearing mobilisation from the first day after surgery.

Results

The mean time between admission to the hospital and operation was 1.8 days (median 1 day). The mean length of hospital stay was 23 days (median 18). The mean follow-up time after operation was 30.0 months (median 21.3, range 0.1-131.2). Mortality within 30 days was 7.0%.

Peroperative Complications

Peroperative complications were seen twenty-three times (4.2%). Two times fracture of the greater trochanter, seven times fracture of the proximal femur and eight times a fissure of the femur occurred. Three times a Girdlestone procedure had to be performed as a result of multiple fractures. Once a prosthesis penetrated the cortex. Two patients died during the operation as a result of cardiac arrest.

Postoperative Complications

The postoperative course was undisturbed in 255 patients (47%). Ninety-four (17.3%) patients developed wound problems. Superficial infections with a positive culture (5.3%) and deep infections (1.8%) were considered serious surgical complications. Fifty-five of the 94 patients (10.1%) had minor wound problems such as haematoma (0.9%), skin necrosis (0.4%), wound dehiscence (0.7%) or a superficial wound infection with a negative culture (8.1%). Of other postoperative complications urinary tract infection was seen most frequently (18.0%). Clinically manifest thromboembolic complications were seen ten times (1.9%). Decubital ulcers were seen in 65 patients (13.3%).

The mean length of hospital stay was 19 days (median 16 days) for patients without complications and 26 days (median 19 days) for patients with complications. This difference is significant ($p< 0.0005$).

Reoperations

A reoperation was necessary for 19 patients (3.5%). The prosthesis had to be removed in 5 patients because of a deep infection. Two of these patients died within four weeks. Luxation of the prosthesis was seen 4 times. After reposition two patients developed a deep infection and the prosthesis had to be removed. One patient died after 4 weeks. In one patient a fracture of the acetabulum occurred during reposition and a Girdlestone procedure was performed. This patient died after 2 weeks. Two demented patients had a fracture of the femur and luxation of the prosthesis after failing in the postoperative period. A Girdlestone procedure was performed in these patients. They both died after 2 weeks. Revision by total hip prosthesis was performed 3 times because of loosening of the prosthesis. One patient had a redression of severe peri-articular ossification. One patient developed a serious wound abscess. After incision and drainage the wound healed without further problems. Two patients with serious decubital ulcers underwent a necrotectomy. One patient developed an infection because of a sponge gauze, which was left behind during surgery.

TABLE IV.—*General postoperative complications (%).*

Author, year	Number of patients	dvt	pulm. emboli	card/ resp.	cva	uro	decub
Bochner, 1988 [11]	120	1.7	0.8	2.5	2.5	12	
D'Arcy, 1976 [12]	361	4	1.4	10			
Diereksl,1985 [22]	166			5.4	1.2		
Gallinaro, 1990 [24]	88		1.1	3.4			
Hunter, 1980 [26]	100	10		19	3		4
Johnson, 1975 [5]	68	4.4	5.9	17.6	0	22	4.4
Johnston, 1982 [5]	150	2	4	10	0.7		1.3
Kofoed, 1983 [27]	106	5.7	3.8	18.9	3.8	11	
Kuokkanen, 1988 [14]	159		1.3	3.8			
Lunt, 1971 [29]	98		5.1				
Rae, 1989 [30]	98	4.1	2.0	24.5	5.1		
Sikorski, 1981 [7]							
Ant. appr.	57			23		12	
Post.appr.	57			44		21	
Smith, 1975 [32]	451		3.1	8.6	0.9	36	
Soreide, 1979 [6]	53	3.8		5.7			
Steen Jensen, 1975 [33]	169	9.5	6.5	17.2	1.8		6.5
van Vugt, 1994 [4]	22	0	0	36	9.1	18	0
van Dortmont, 1995	543	1.7	0.2	9.2	2.2	18	12

TABLE V.—*Wound complications (%).*

Author, year	Number of patients	Superficial/deep infection
Binns, 1985 [19]	100	3.0/2.0
Browett, 1981 [15]	324	4.9
Chan, 1975 [20]	107 (ant)	6.5/2.8
	136 (pos)	18.5/1.5
D'Arcy, 1976 [12]	361	4.7
Diercks, 1985 [22]	166	0
Franklin, 1984 [23]	101	1.0/0
Gallinaro, 1990 [24]	88	5.7/0
	100	-/8
Johnson, 1975 [5]	68	7.4/0
Johnston, 1982 [3]	150	0/2
Kofoed, 1983 [27]	106	5.7/3.8
Kuokkanen, 1988 [14]	162	1.2/1.2
Kwasny, 1993 [28]	621	2.4
Lunt, 1971 [29]	98	13.2/4
Rae, 1989 [30]	98	5.1/2.0
Raine, 1974 [2]	52	5.8/5.8
Sikorski, 1981 [7]	57 (ant)	14
	57 (post)	7
Smith, 1975 [32]	451	2.2/1.8
Steen, Jensen, 1975 [33]	169	4.7
Stewart, 1983 [9]	50	-/11
van Vugt, 1994 [4]	22	9.1/0
van Dortmont, 1995	543	13.4/1.8

After removal of the gauze the wound healed and the prosthesis could remain *in situ*.

Discussion

Hemiarthroplasty is an accepted method to treat the displaced intracapsular femoral neck fracture. Compared to internal fixation methods, however, hemiarthroplasty is described as having a greater incidence of per- and postoperative complications and a higher mortality rate.[2 13 14 18] Reported early mortality rates are given in Table II.

Mortality within 30 days ranges from 0.0 to 28%.

TABLE VI.—*Dislocation rate after hemiarthroplasty (%).*

Author, year	Prosthesis approach	Dislocation rate	Mortality after dislocation
Binns, 1985 [19]	Cemented Thompson Lateral/troch.ost.	1	
Bochner, 1988 [11]	Bipolar	2.5	
Bracey, 1977 [13]	Cemented Thompson Posterior	18	50
Browett, 1981 [15]	Uncemented Thompson	0.6	
Chan, 1975 [20]	Thompson	8.2	60
	Anterior	0.9	
	Posterior	14	
D'Arcy, 1976 [12]	Cemented Thompson Anterolateral	2	43
Devas, 1983 [21]	Bipolar (Hastings) Anterolateral	5.1	
Diercks, 1985 [22]	Uncemented Moore	1.2	
Franklin, 1984 [23]	Bi-articular	0	
Holmberg, 1987 [25]		11	
Hunter, 1980 [26]	Thompson/Moore	11	55
	Cemented	11	
	Uncemented	11	
Johnson, 1975 [5]	Moore	3	
Kofoed, 1983 [3]	Moore	1.9	
	Posterior		
Kwasny, 1993 [28]	Muller	0.5	
Kwok, 1982 [34]	Thompson/Moore	5.3	
Lunt, 1971 [29]		10.2	80
Paton, 1989 [35]	Thompson/Moore	6.5	50
	Monk/Hastings	4.8	
Rae, 1989 [30]	Bipolar (Hastings)	6.1	
Raine, 1974 [2]	Thompson/Moore	7.7	
Sikorski, 1981 [7]	Thompson Anterior	2	
	Thompson Posterior	2	
Soreide, 1979 [6]	Christiansen	6	
Steen Jensen, 1975 [33]	Uncemented Moore	0.6	
Stewart, 1983 [9]	Thompson	8	60
van Vugt, 1994 [4]	Bipolar (Stanmore)	0	
van Dortmont, 1995	Cemented Thompson	0.7	

Mortality within 6 months after hemi-arthroplasty ranges from 8.8 to 33%.

Only 47% of our patients experienced a totally uncomplicated postoperative course. Peroperative fractures of the proximal femur, wound complications, decubital ulcers and urinary tract infections appeared relatively often and caused a serious delay in recovery. Comparative figures from the literature are shown in Table III (peroperative complications) and Table IV (general complications). Wound complications, like a superficial infection with a positive culture or a deep infection form a serious threat to the prosthesis. Although the majority of superficial wound infections can be cured by conservative measures, deep infections are devastating to endoprosthetic surgery. In most cases, the prosthesis has to be removed, and the ensuing mortality is high. Comparative figures from the literature are given in Table V.

Placement of the Thompson prosthesis can be done by way of the anterior or posterior approach. The anterior approach was described by Smith-Petersen in 1957 and is associated with a higher rate of trochanteric fracture and perforation of the femoral cortex. The posterior (southern) approach was described by Moore in 1959 and is associated with a higher rate of dislocation of the prosthesis and sciatic

TABLE VII.—*Late complications of hemiarthroplasty (%).*

Author, year	Number of patients	Ectopic ossification	Protrusion of prosthesis in acetabulum	Loosening of prosthesis	Erosion of acetabulum
Binns, 1985 [19]	100	3		3	
Browett, 1981 [15]	324	57			35
D'Arcy, 1976 [12]	361			6.1	11
Devas, 1983 [21]	161				0
Kwasny, 1993 [28]	621		6.1	0.8	
Lausten, 1987 [16]	183			2.6	
(cemented)	59	14	0		
(uncemented)	124	18	4.2		
Sikorski, 1981 [7]	108				
(ant)	54	13	7	12	
(post)	54	7	11	11	
Soreide, 1979 [6]	53				
van Vugt, 1994 [4]	22		13.6	9	
van Dortmont, 1995	543	0.9	0.4	0.2	

nerve palsy. The posterior incision carries a higher risk of infection because it is sited in a contaminated area. Chan and Hoskinson (1975) [20] compared the anterior and posterior surgical approach to the hip. They concluded that the dislocation rate was primarily influenced by the surgical approach. Following the anterior approach, they found a dislocation rate of 0.9%, compared to a dislocation rate of 14% after the posterior approach. The infection rate was almost three times higher in the posterior approach group. After dislocation of the prosthesis they found an infection rate of 45%. Two fractures of the greater trochanter and four penetrations of the lateral cortex by the prosthesis occurred in the anterior approach group only. Dislocation rates after hemiarthroplasty in other series are given in Table VI. Mortality after dislocation is very high (43-80%).

Late complications such as acetabular erosion, ectopic ossification and loosening of the prosthesis were not seen very often in our study. This is an effect of the relatively short follow-up period and the limited life expectancy of the patients. Weight bearing is one of the causal factors. The onset of symptoms is usually in the second or third year after operation. We reported a mortality rate of 45% two years after hemiarthroplasty for a femoral neck fracture.[31] Phillips (1989) [17] concluded that the risk of acetabular erosion can be predicted, depending on the longevity of the patient and the level of activity. Of the patients in his series who were less than eighty years old and lived in private homes, two-thirds were inactive after the fracture, and none had acetabular erosion. Of the one-third who remained active, acetabular erosion developed in most. In contrast, all patients admitted from nursing homes were inactive after hemiarthroplasty, regardless of age. All of these patients were free of acetabular erosion.

In our study, we reported a significant difference in weight bearing mobilisation 4 months postoperatively for demented (mostly institutionalised) and mentally sane patients. Fifty of the 121 demented patients (41%) and 16 of the 220 mentally sane patients (7%) who were alive at 4 months postoperatively, became immobile.[31]

Browett (1981) [15] found 35% acetabular erosion and 57% heterotopic bone formation in 83 patients, who had an uncemented Thompson prosthesis for a displaced femoral neck fracture, after an average follow-up of 38 months. D'Arcy and Devas (1976) [12] found 11% acetabular erosion and 6.1% loosening after hemiarthroplasty with the Thompson prosthesis in 161 patients. In 1983, Devas [21] introduced a new bipolar prosthesis. No acetabular erosion was seen after four years. Comparative figures from the literature are given in Table VII.

Conclusions

Hemiarthroplasty is an accepted method of treatment for displaced subcapital femoral neck fractures. One of the major advantages of replacement surgery with the cemented Thompson prosthesis is immediate weight bearing mobilisation after surgery. Considering mortality and complication rates, hemiarthroplasty is major surgery. Our conclusion is that such a major surgical procedure should not be performed on patients with a limited life expectancy and who are not expected to be mobilised after hemiarthroplasty. The most important aim of treatment after an intracapsular femoral neck fracture for these patients is an efficient form of analgesia, which can be achieved by simpler techniques of stabilisation of the fracture, for example percutaneous placement of cannulated screws.

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CHAPTER 6. CANNULATED SCREWS VERSUS HEMIARTHROPLASTY FOR INTRACAPSULAR FEMORAL NECK FRACTURE IN DEMENTED PATIENTS.

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Published in: Annales Chirurgiae et Gynaecologiae 2000; 89: 132-137.

CANNULATED SCREWS VERSUS HEMIARTHROPLASTY FOR DISPLACED INTRACAPSULAR FEMORAL NECK FRACTURES IN DEMENTED PATIENTS

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ABSTRACT

Backgrounds and Aims: There are no randomised trials comparing internal fixation and hemiarthroplasty for a displaced intracapsular femoral neck fracture in relation to mental state.

Material and Methods: To establish what should be the treatment of first choice, a prospective randomised clinical study was performed on 60 demented patients with displaced intracapsular femoral neck fractures, comparing internal fixation (n = 31) with hemiarthroplasty (n = 29).

Results: There was no significant difference in the mortality rate of both groups. Hemiarthroplasty was associated with significantly more loss of blood and more wound complications. Reoperation for secondary displacement of the fracture after internal fixation occurred in four patients. Although not statistically significant, failure of internal fixation seemed to be higher after an inadequate osteosynthesis.

Conclusion: Postoperative mortality is high and the chance of successful rehabilitation very small for both types of treatment in this group of patients. In our opinion, demented patients should not be treated with a major surgical procedure like hemiarthroplasty. Internal fixation should be considered the treatment of choice, because it is a smaller operation than prosthetic replacement, with less morbidity. If adequate reduction can not be achieved, a primary hemiarthroplasty should be performed.

Key words: Femoral neck fracture; internal fixation; hemiarthroplasty; senile dementia

INTRODUCTION

A major consequence of the increased life expectancy is the growing morbidity of the ageing population. Geriatric surgery has become of major importance and hip fractures make up a large proportion of cases. The number of people suffering from impaired mental health will also continue to rise. As a consequence, a lot of hip fracture patients suffer from senile dementia.

There is still a lot of controversy in literature about the treatment of displaced intracapsular hip fractures in elderly patients. Survival and functional outcome of treatment after hip fracture is associated with many factors, like age, preoperative medical conditions and preoperative level of functioning. Impaired cognitive status is significantly associated with increased mortality (1–5). Only a few prospective studies have been performed comparing internal fixation and prosthetic replacement (6–10) and so far, there

TABLE 1

DSM-III-R-criteria for the diagnosis of dementia. (American Psychiatric Association 1987).

A.	Demonstrable evidence of impairment in short- and long-term memory.	
B.	At least one of the following:	
	1)	impairment in abstract thinking
	2)	impaired judgement
	3)	other disturbances of higher cortical function
	4)	personality change
C.	The disturbance in A and B significantly interferes with social functioning.	
D.	Not occurring exclusively during the course of Delirium.	
E.	Either 1) or 2):	
	1)	evidence of a specific organic factor etiologically related to the disturbance
	2)	the disturbance cannot be accounted for by any non-organic mental disorder

TABLE 2

Questions asked and points given in the Cognitive Screening Test. The maximum test score is 14 points; the cut-off score is 10 points.

Question		Score
What year is it?	1. Correct year	1
What month is it?	2. Correct month	1
	± 1 month	½
Which day of the month is it?	3. Correct day (± 3)	1
Which day of the week is it?	4. Correct day	
	± 1 day	½
Where do you live?	5. Correct place	1
	6. Correct street	1
	Correct institution	½
How old are you?	7. Correct age	1
	± 1 year	½
What is your birth date?	8. Correct year	1
	9. Correct month	1
	10. Correct day	1
What is the name of our queen?	11. Correct name	1
Who was the queen before her?	12. Correct name	
	13. Correct sequence	1
What is the time?	14. Correct ± 15 min	1
	Correct ± 30 min.	½
0–10 vs. 11–14	SCORE CST-14 =	

have been no randomised trials, comparing both techniques of treatment in relation to cognitive state. Despite of this, hemiarthroplasty has been recommended as the treatment of choice for patients with a limited life expectancy (11–13).

The aim of the present study was to determine if internal fixation or hemiarthroplasty should be the treatment of first choice in the elderly, demented patient with a displaced intracapsular femoral neck fracture.

MATERIAL AND METHODS

Between April 1991 and January 1995 all patients over 70 years of age with displaced (Garden type III or IV) intracapsular femoral neck fractures and who were known with the diagnosis 'senile dementia' were included in a clinical trial. The diagnosis 'senile dementia' already had been made before the time of admission by a professional Geriatric Assessment team, according to the DSM-III-R-criteria (14). According to these criteria, the diagnosis 'senile dementia' requires a demonstrable evidence of impairment in both short- and long-term memory, associated with at least one other symptom of dementia (table 1). On admission, the Cognitive Screening Test was performed in all patients (CST-14, table 2). This is a bedside dementia-screening instrument, derived from the Short Portable Mental Status Questionnaire (SPMSQ) with specific adjustments for the Dutch situation. It is a brief questionnaire with 14 items covering the most important symptoms of dementia. Per item 0, ½ or 1 point is given, with a maximum of 14 points (cut-off-score 10 points). From several reports it appeared that a significant distinction could be made between elderly patients with or without cognitive impairment (15–17).

We included 60 consecutive patients, who were randomly allocated to internal fixation (n = 31) or hemi-arthroplasty (n = 29). We performed hemiarthroplasty with a cemented Thompson prosthesis by anterior approach. Patients treated with internal fixation were placed on the fracture table and closed reduction was obtained. Fixation was achieved with three cannulated AO/ASIF screws. The accuracy of reduction and fixation of the fracture was measured by the following criteria: Garden's angle within 170–179°, lateral angle not exceeding 20° and the Western Infirmary Glasgow (WIG) angle within 140–149° (18). The site for the screws was defined as optimal when situated within the middle or caudal segment of the femoral head on AP projection and in the central or posterior part on the lateral view. The distance between the screwtips and articular margin of the femoral head was seen as optimal when between 0 and 10 mm. All operations were performed under spinal anaesthesia. Antimicrobial prophylactics consisted of Cefazolin intravenously 30 minutes before the incision. Thrombo-embolism prophylactics consisted of heparin 5000 IU subcutaneously on admission and were continued until the patient was mobilised. In case of prolonged immobilisation over 7 days acenocoumarol was given. All patients had operative fracture treatment and followed a similar postoperative protocol consisting of patient mobilisation out of bed on the first postoperative day with unrestricted weight bearing.

After discharge from the hospital, all patients were reviewed by visiting them in their own environment at four months, one year and two years postoperatively. Patients were followed for a minimum of two years or until death.

Statistical analysis was performed with the use of the Statistical Package for Social Sciences (SPSS/PC+) and the Epidemiological GRaphics, Estimation, and Testing package (EGRET). Survival was assessed using the Kaplan-Meier technique. Differences in survival between groups were tested using the log rank test and Cox's proportional hazards survival analysis method. Differences in categoral nominal variables were tested using Fisher's exact test; differences in at least ordinally scaled variables between groups were tested using the Mann-Whitney-Wilcoxon test. Statistical significance was defined as $p < 0.05$.

RESULTS

Patient characteristics are shown in table 3. Preoperative medical conditions are outlined in table 4. The

TABLE 3

Patient characteristics. Figures are number (%) of patients.

	Cannulated screws (n = 31)	Hemi-arthroplasty (n = 29)	Total (n = 60)
Male	1 (3)	7 (24)	8 (13)
Female	30 (97)	22 (76)	52 (87)
Mean age (range) (years)	84 (72–92)	84 (71–96)	84(71–96)
Side of fracture:			
Right	8 (26)	11 (38)	19 (32)
Left	23 (74)	18 (62)	41 (68)
Surgeon operating:			
Staff surgeon	6 (19)	4 (14)	10 (17)
Resident assisted by staff surgeon	8 (26)	11 (38)	19 (32)
Resident	17 (55)	14 (48)	31 (52)

TABLE 4

Coexisting conditions in 60 patients with fractured neck of femur. Figures are number (%) of patients.

Coexisting condition	Cannulated screws (n = 31)	Hemi-arthroplasty (n = 29)	Total (n = 60)
Neurological	10 (31.3)	7 (24.1)	17 (28.3)
Cardiovascular	10 (31.3)	6 (20.7)	16 (26.6)
Metabolic	6 (19.4)	5 (17.2)	11 (18.3)
Pulmonary	2 (6.5)	5 (17.2)	7 (11.7)
Rheumatoid	0 (0.0)	1 (3.4)	1 (1.7)
Malignancy, treated	4 (12.9)	2 (6.9)	6 (10.0)
Other	7 (22.6)	6 (20.7)	13 (21.7)
No. of coexisting conditions:			
None	8 (25.8)	12 (41.4)	20 (33.3)
One	11 (35.5)	6 (20.7)	17 (28.3)
Two	9 (29.0)	8 (27.6)	17 (28.3)
Three	2 (6.5)	2 (6.9)	4 (6.7)
Four	1 (3.2)	1 (3.4)	2 (3.3)

median (interquartile range) time between admission and operation was 1.0 day (1.0–2.0) in both groups. The mean score on admission on the CST-14 was 1.1 points for patients in the hemiarthroplasty group (median 0 points, range 0–4) and 1.0 points for patients in the internal fixation group (median 0 points, range 0–5).

The mean (range) follow-up time for all 60 patients was 16.5 months (0.167–69.5). The mean (range) follow-up time for the 29 patients treated with hemiarthroplasty and for the 31 patients treated with internal fixation was respectively 19.7 months (0.167–69.5) and 13.5 months (0.467–60.3).

The 30-day postoperative mortality rate for all patients was 11.7 %. The 30-day postoperative mortality rate was 13.8 % for patients, treated with hemiarthroplasty and 9.7 % for patients, treated with internal fixation. The cumulative four-month mortality rate for all patients was 35.0 %. The four-month mortality rate was 34.5 % in the hemiarthroplasty group, and 35.5 % in the internal fixation group. After one year the cumulative mortality was 56.7 % for all patients. The one-year mortality for the HAP group was 48.3 % and 64.5 % for internal fixation. The mortality hazard ratio for internal fixation relatively to hemiarthroplasty was 1.4 (95 % confidence interval 0.8 – 2.5). The difference in mortality between the two groups was not statistically significant (log rank test: χ^2 (1) = 1.691; p = 0.193).

The mean (interquartile range) loss of blood was 300 ml (175–400) for hemiarthroplasty and 85 ml (0–150) for internal fixation, respectively. The mean (interquartile range) operation time was 80 minutes (60–90) for hemiarthroplasty and 60 minutes (45–60) for internal fixation, respectively. This difference is statistically significant (Mann-Whitney-Wilcoxontest, p < 0.0001).

In the hemiarthroplasty group, a peroperative fissure of the femoral shaft of one patient was treated conservatively. In the internal fixation group, acceptable reduction of the fracture was impossible to achieve in three patients and the operation was converted to a primary hemiarthroplasty. In the remaining 28 cases, reduction and fixation of the fracture was recorded as inadequate in 5 patients. Early secondary displacement of the fracture was seen in two patients, resulting in secondary hemiarthroplasty. One of these patients died within one week. In the remaining three cases, inadequate osteosynthesis did not result in secondary displacement. Two of them died within 30 days, the other remaining patient survived for 20 months. Although in 23 cases reduction and fixation of the fracture was considered as adequate, secondary displacement was seen in three of these cases. Two of them were reoperated and a secondary hemiarthroplasty was performed. In one bedridden patient secondary intervention was abandoned, this patient died within 30 days.

TABLE 5

The adequacy of reduction and fixation related to the risk of secondary intervention.

Reduction and fixation	No secondary intervention	Secondary intervention	Total
Inadequate	3	2	5
adequate	21	2	23
total	24	4	28

p = 0.135 (Fisher's exact test)

The risk of secondary intervention seemed to be higher after an inadequate osteosynthesis, but statistical significance was not yet reached, possibly because of the small numbers (table 5).

A non-union of the fracture was seen only once in this group of patients. Because this patient was already confined to bed and without complaints, no reoperation was performed.

TABLE 6

Points given for Activities of Daily Living.

Activity		Score
Dressing and personal hygiene	Without support	1
	Some support	2
	Total support	3
Eating	Without support	1
	Some support	2
	Total support	3
Visiting toilet	Without support	1
	Some support	2
	Total support	3

There were no wound complications in the internal fixation group. In the hemiarthroplasty group, a wound infection with a positive culture was seen 5 times (17.2 %). One of these patients developed a serious wound abscess. After incision and drainage of the wound a gentamycin-beaded string was left behind and the wound healed without further problems. Six patients (20.7 %) had minor wound problems like a haematoma (10.3 %), wound dehiscence (3.4 %) or a superficial wound infection with a negative culture (6.9 %). The difference in wound complication rate for the two groups is statistically significant (Mann-Whitney-Wilcoxon test, $p = 0.0009$).

In the hemiarthroplasty group, 21 patients were admitted from a psychogeriatric institution and 6 patients from an old people's home. Two patients were admitted from their own homes. Activities of daily living (ADL) were scored according to table 6. The majority of the patients in this group was in need of support on ADL functions with a mean (interquartile range) score for ADL functions of 6.7 (5–9).

Four months after operation, 19 of 29 patients were alive. Seventeen of these 19 patients (89.5 %) had been able to walk with a walking stick or without any aid before operation, but only 4 of them (21.1 %) could move independently four months after operation. Seventeen patients were living in a psychogeriatric institution, one patient returned to the old people's home from which she was admitted and one patient was in hospital. The mean (interquartile range) score for ADL functions was 7.7 (7–9). One year after operation 15 of 29 patients were alive. Fourteen of these 15 patients (93.3 %) had been able to walk before operation. At one year only three of them (20 %) were mobile.

In the internal fixation group, 17 patients were admitted from a psychogeriatric institution, 11 patients from an old people's home and three patients were admitted from their own homes. The majority of the patients in this group was ADL-dependent with a mean (interquartile range) score of 7.2 (5–9). Four months after operation, 20 of 31 patients were alive. Before operation, 19 of these 20 patients (95 %) had been able to walk with a walking stick or without any aid, but only 7 (35 %) of them were mobile four months after operation. Fifteen patients were living in a psychogeriatric institution, three patients returned to their old people's home and two patients were in hospital. The mean (interquartile) score for ADL functions was 7.9 (7–9). One year after operation 11 of 31 patients were alive. Before operation, 10 patients had been mobile (90.9 %). At one year 4 of these 10 patients (36.4 %) were mobile.

In other words, of the 17 surviving patients in the hap group who had been mobile before operation, 13 were not mobile four months after operation. Of the 19 surviving patients in the if group who had been mobile before operation, 12 were not mobile four months after operation. There was no significant difference between groups (Fisher's exact test, $p = 0.480$).

DISCUSSION

The choice between internal fixation and hemiarthroplasty for the treatment of displaced intracapsular femoral neck fractures in the elderly is still a controversial subject in trauma surgery. Although prosthetic replacement is associated with a higher mortality rate when compared to internal fixation (13, 19–23), more recent reports fail to show a difference in mortality rate (7–9, 24, 25). The most common complications leading to reoperation after internal fixation are secondary dislocation, non-union and avascular necrosis. Subsequent surgery after failure of internal fixation is avoided by primary prosthetic replacement. Surgical complications like peroperative fractures of the proximal femur, luxation of the prosthesis and wound infections are the most important disadvantages of primary hemiarthroplasty. There are only very few prospective, randomised trials comparing primary prosthetic replacement with internal fixation. Söreide et al (8) compared internal fixation (von Bahr screws) with endoprosthetic replacement (Christiansen). They found that the postoperative mortality rate was similar in the two groups. Internal fixation proved to be a less time-consuming operation, gave a shorter hospitalisation time and was associated with a significantly reduced morbidity rate compared to prosthetic replacement. There were significantly more failures after internal fixation, but the final outcome at 1-year follow-up was comparable in both groups. According to Söreide, primary prosthetic replacement probably gave a more definitive treatment with fewer reoperations and with better results at 1-year follow-up. Sikorski and Barrington (7) compared Garden screws with Thompson hemiarthroplasty. The technical results of operation were worse in the group with internal fixation, with only 40 % being satisfactory. They concluded that Thompson hemiarthroplasty was the safest operation in elderly patients. Bray et al (6) compared pinning (Knowles, Neufeld) with cemented bipolar hemiarthroplasty. They found a higher morbidity in the hemiarthroplasty group, but two-year observations showed better functional results compared to internal fixation. Skinner et al (9) compared internal fixation with a sliding compression screw plate with

an uncemented Moore hemiarthroplasty with a cemented Howse II total hip replacement. One year after operation there was little difference between the three groups in mortality or general complications. The revision rate within the first year was highest for internal fixation. Total hip replacement resulted in the least pain and most mobility at 1 year, while hemiarthroplasty was worst in these respects. They concluded that internal fixation and particularly total hip replacement should be given serious consideration in the management of the elderly patient with a displaced subcapital fracture. Van Vugt et al (10) compared dynamic hip screw fixation with a bipolar hemiarthroplasty in independent, healthy elderly patients. No differences could be demonstrated in the mortality rates, complications or the need for secondary intervention. Comparable results were obtained with both methods up to 24 months. They concluded that internal fixation was justified as primary treatment for elderly patients in good physical and mental health.

Postoperative mortality after an intracapsular femoral neck fracture is significant and increases at a rate significantly above that of the general population for about one year after operation (1, 5, 26). Prognostic factors are age, general medical condition and social circumstances (26, 27). Mental health state appears to be a significant prognostic factor for operative treatment for intracapsular femoral neck fractures (1–5). In our earlier work we came to the conclusion that hemiarthroplasty seems a too major operation for demented patients compared to mentally healthy patients, considering mortality, functional outcome and complication rate (5).

There are no randomised trials, comparing internal fixation and prosthetic replacement in patients, suffering from cognitive disorders. Therefore, we performed this randomised study, comparing internal fixation with hemiarthroplasty for patients, suffering from senile dementia.

The mortality rate for our patient group was very high as expected (5), but there was no statistical significant difference in mortality between the internal fixation and hemiarthroplasty group.

Early discharge to the referring geriatric institutions is highly favourable for patients, suffering from senile dementia. A wound infection means a significant prolongation of hospital stay. In the hemiarthroplasty group, wound healing was disturbed in almost 40 % of patients. A wound infection with a positive culture occurred in 17 % of the patients. In a retrospective study of 543 unselected patients treated by hemiarthroplasty, we found the same wound complication rate (28). In this study, the difference in wound complication rate is very significant. A possible explanation for this finding is that hemiarthroplasty is a major surgical procedure with a longer operation time and more haematoma compared to internal fixation. There were no wound complications in the internal fixation group. This finding is in accordance with the literature (table 7).

Internal fixation had a significantly lower loss of blood and was less time-consuming. Secondary displacement of the fracture after internal fixation was seen in 5 patients. One bedridden patient was treated conservatively. In four patients, a secondary hemiarthroplasty was performed. Although not statistically significant, failure of internal fixation seemed to be higher after an inadequate osteosynthesis. Avascular necrosis of the femoral head and non-union of the fracture is no major topic because of the very limited life expectancy of our patients.

TABLE 7

Wound complications for hemiarthroplasty and internal fixation.

Author	Year	Wound complications for internal fixation	Wound complications for hemiarthroplasty
Johnson	1975	0	7.4
Raine	1974	2.4	5.8
Sikorski	1981	4	14 [1]
			7 [2]
Söreide	1979	3.9	5.7
van Vugt	1994	0	9.1
Zindrick	1985	3	7

[1] posterior approach
[2] anterior approach

The ability of patients to walk deteriorated dramatically after operation. Four months after operation most patients in both groups had either died or were bed- or chair-bound. There was no significant difference in functional outcome between groups.

Devas (29) postulated that to see the patient walk is the most important physical sign in geriatric orthopaedics. However, in this group of patients there is no reasonable expectation of postoperative ambulation.

In demented patients, operative treatment of intracapsular hip fractures should be performed to free them of pain and to facilitate early discharge to the referring institutions. Prosthetic replacement is generally accepted and even recommended in the elderly, less mobile or mentally deranged patients (11–13, 23, 30, 31). In our opinion, demented patients should not be treated with a major surgical procedure like hemiarthroplasty. Postoperative mortality is very high in demented patients with hip fractures, irrespective of the type of treatment and the chance of successful rehabilitation very small. Closed reduction and internal fixation should be the treatment of choice, because it is a much smaller operation than prosthetic replacement, with less morbidity. The risk of failure can be diminished if minimal invasive internal fixation is seen as a major technical procedure in which optimal reduction and fixation should be seen as the goal to achieve. If adequate reduction cannot be achieved, a primary prosthetic replacement should be considered to reduce the risk of early secondary dislocation and the need for reintervention.

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CHAPTER 7. OUTCOME AFTER HEMIARTHROPLASTY FOR INTRACAPSULAR FEMORAL NECK FRACTURE RELATED TO MENTAL STATE

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Published in: Injury 2000; 31: 327-331.

Outcome after hemi-arthroplasty for displaced intracapsular femoral neck fracture related to mental state

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Accepted 20 November 1999

Abstract

This study was performed to assess mortality and functional outcome after hemi-arthroplasty for displaced intracapsular femoral neck fractures in relation to mental state. Between 1991 and 1995, 202 consecutive patients over 70 years of age were followed for at least two years or until death. Thirty-nine patients were known with senile dementia at the time of admission. The four-month mortality rate was 11.7% for the mentally normal patients and 33.3% for the mentally impaired patients. After one year the mortality rate was 19.6% for the mentally normal patients and 43.6% for the mentally impaired patients. This difference is statistically significant ($p < 0.001$). Of the 141 surviving mentally normal patients, who had been mobile before operation, 16 (11.3%) were not mobile four months after operation. Of the 24 surviving mentally impaired patients, who had been mobile before operation, 18 (75.0%) were not mobile four months after operation. This difference is statistically significant ($p < 0.001$). The conclusion of our study is that mental state has a statistically significant effect on mortality and functional outcome after hemi-arthroplasty for displaced intracapsular femoral neck fractures. For demented patients, hemi-arthrplasty is a too major operation and less invasive methods of internal fixation should be considered.

1. Introduction

Because of the increase of the average life expectancy, the incidence of hip fractures will continue to rise in the next century. Another effect of the ageing of our population is that the incidence of senile dementia increases too. As a consequence, the percentage of demented hip fracture patients as a proportion of the total hip fracture population is increasing.

Impaired mental status is associated with an increased mortality rate after hip fracture [1–9].

Hemi-arthroplasty is well accepted for the treatment of intracapsular femoral neck fractures and has even been recommended for patients with a limited life expectancy [10–12]. In our opinion, hemi-arthroplasty is a too major surgical procedure for patients with significant impaired mental state [13].

The objective of this study was to demonstrate the effect of mental state on mortality and functional out-

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Table 1
DSM-III-R-criteria for the diagnosis of dementia (American Psychiatric Association, 1987)

A. Demonstrable evidence of impairment in short- and long-term memory
B. At least one of the following:
(1) Impairment in abstract thinking
(2) Impaired judgement
(3) Other disturbances of higher cortical function
(4) Personality change
C. The disturbance in A and B significantly interferes with social functioning
D. Not occurring exclusively during the course of Delirium
E. Either (1) or (2):
(1) Evidence of a specific organic factor etiologically related to the disturbance
(2) The disturbance cannot be accounted for by any non-organic mental disorder

come after hemi-arthroplasty for a displaced intracapsular femoral neck fracture.

2. Patients and methods

Between April 1991 and January 1995, 202 patients over 70 years of age were treated with hemi-arthroplasty for a displaced (Garden III/IV) intracapsular fracture of the femoral neck.

The number of patients, who were already known with the diagnosis 'senile dementia' before the time of the fracture, was 39. The diagnosis had been made by a professional Geriatric Assessment Team, according to the DSM-III-R criteria, shown in Table 1 [14]. The CST-14 (Cognitive Screening Test, Table 2) was performed in all patients on admission. This is a bedside dementia-screening instrument, derived from the Short Portable Mental Status Questionnaire (SPMSQ) with specific adjustments for the Dutch situation. It is a brief questionnaire with 14 items covering the most important symptoms of dementia: disordered orientation in time and place, short-term and long-term memory and intellectual functioning. From several reports it appears that a significant distinction can be made between elderly patients with or without mental impairment [15–17]. An important advantage of the test is that it is easy and quick and that specific experience from the interviewer is not required. The main drawback is related to the relatively high proportion of false negative errors of diagnosis for patients with early or mild dementia.

Table 2
Questions asked and points given in the cognitive screening test. The maximum test score is 14 points, the cut-off score is 10 points

Question		Score
What year is it?	1. Correct year	1
What month is it?	2. Correct month	1
	±1 month	1/2
Which day of the month is it?	3. Correct day (±3)	1
Which day of the week is it?	4. Correct day	1
	±1 day	1/2
Where do you live?	5. Correct place	1
	6. Correct street	1
	Correct institution	1/2
How old are you?	7. Correct age	1
	±1 year	1/2
What is your birth date?	8. Correct year	1
	9. Correct month	1
	10. Correct day	1
What is the name of our queen?	11. Correct name	1
Who was the queen before her?	12. Correct name	1
	13. Correct sequence	1
What is the time?	14. Correct ±15 min	1
	Correct ±30 min	1/2
0–10 vs. 11–14	Score CST-14 =	

Hemi-arthroplasty was performed with a cemented Thompson prosthesis by an anterior approach. The outcome of treatment in the group of 39 mentally impaired patients was compared with the outcome in the group of 163 patients without mental impairment. Patients were followed for a minimum of two years or until death. Age, sex, preoperative medical conditions, CST-14 test score, complications and postoperative survival were recorded.

2.1. Statistical methods

Analysis of the final results was performed with the use of the Statistical Package SPSS for Windows. Survival was assessed using the Kaplan–Meier technique. Differences in survival between groups were tested using the log rank test and Cox's proportional hazards survival analysis method. Differences in categorical nominal variables between groups were tested using the chi-square test; differences in at least ordinally scaled variables between groups were tested using the Mann–Whitney test. Statistical significance was defined as $p < 0.05$.

3. Results

The comparability of the two groups is shown in Table 3. The median (25th–75th percentile) time between admission and operation was 1.0 day (1.0–2.0) in both groups.

The mean score on admission on the CST-14 was 10.7. In the group of patients without mental impairment the mean (25th–75th percentile) score was 12.8 (13–14), compared with a mean (25th–75th percentile) score of 1.6 (0–3) in the group of mentally impaired patients. Two weeks after operation we repeated the CST-14. In the group of patients without mental

Table 3
Comparibility of the groups. Figures are number (%) of patients except where otherwise stated

	Patients without mental impairment (n = 163)	Patients with mental impairment (n = 39)	Total (n = 202)	p-value (χ^2 test)
Male	23 (14.1)	11 (28.2)	34 (16.8)	0.04
Female	140 (85.9)	28 (71.8)	168 (83.2)	
Mean age (range) in years	82 (70–99)	84 (71–96)	82 (70–99)	0.08
Side of fracture:				
Right	71 (43.6)	14 (35.9)	85 (42.1)	0.38
Left	92 (56.4)	25 (64.1)	117 (57.9)	
Previous hip surgery	16 (9.8)	7 (17.9)	23 (11.4)	0.15
Associated fractures	7 (4.3)	0 (0.0)	7 (3.5)	0.19
Preoperative medical conditions:				
Cardiovascular	46 (28.2)	10 (25.6)	56 (27.7)	0.75
Neurological	37 (22.7)	11 (28.2)	48 (23.8)	0.47
Diabetes mellitus	21 (12.9)	7 (17.9)	28 (13.9)	0.53
Pulmonary	19 (11.7)	6 (15.3)	25 (12.4)	0.41

impairment the mean (25th–75th percentile) score was again 12.8 (13–14), compared with a mean (25th–75th percentile) score of 1.4 (0–2) in the group of mentally impaired patients. This difference is highly significant ($p < 0.001$).

The mean (25th–75th percentile) follow-up time for the 39 mentally impaired patients was 24.6 months (1.5–45.9). The mean (25th–75th percentile) follow-up time for the 163 not mentally impaired patients was 35.9 months (21.7–52.2).

Postoperative complications are given in Table 4. There were no statistical significant differences between the groups.

3.1. Mortality

In the group of the mentally normal patients 57 patients died (35.0%) and in the group of mentally impaired patients 25 patients died (64.1%).

The 30-day postoperative mortality rate for mentally normal and mentally impaired patients was 3.1% and 12.8%, respectively. The cumulative four-month mortality rate for mentally normal patients was 11.7% and 33.3% for the mentally impaired patients. After one year the cumulative mortality rate was 19.6% for the mentally normal patients and 43.6% for the mentally impaired patients. After two years the cumulative mortality rate was 24.5% and 56.4%, respectively. This unadjusted difference in mortality between the two groups is highly statistically significant (log rank test: χ^2 (1) = 15.17, $p = 0.0001$). All explanatory variables (age, sex, mental state, preoperative medical conditions, former hip surgery and associated fractures) were simultaneously included in a Cox's proportional hazards survival analysis as potentially confounding variables. Adjusted for all these other variables, mental state still had a statistically significant effect on mortality. The mortality hazard ratio for mentally impaired patients relatively to mentally normal patients was 1.9 (95% confidence interval 1.1–3.1, $p = 0.01$).

3.2. Functional outcome

One hundred and seventeen of the 163 mentally normal patients (71.8%) were admitted from their own

Table 4
Postoperative complications. Figures are number (%) of patients

	Patients without mental impairment	Patients with mental impairment	Total	p-value
	(n = 163)	(n = 39)	(n = 202)	(χ^2 test)
Haematoma	7 (4.3)	4 (10.3)	11 (5.4)	0.14
Wound dehiscence	6 (3.7)	1 (2.6)	7 (3.5)	0.73
Superficial infection (negative culture)	8 (4.9)	4 (10.3)	12 (5.9)	0.20
Superficial infection (positive culture)	12 (7.4)	5 (12.8)	17 (8.4)	0.27
Early deep infection (< 6 weeks)	3 (1.8)	0 (0.0)	3 (1.5)	0.39
Late deep infection (> 6 weeks)	3 (1.8)	0 (0.0)	3 (1.5)	0.39
Cardiorespiratory	19 (11.7)	4 (10.3)	23 (11.4)	0.81
CVA	2 (1.2)	0 (0.0)	2 (1.0)	0.49
Urinary tract infection	26 (16.0)	6 (15.4)	32 (15.8)	0.93
Decubital ulcer	14 (8.6)	2 (5.1)	16 (7.9)	0.47

homes. Thirty-four patients (20.9%) were living semi-independently in an old people's home. Ten patients (6.1%) were admitted from a geriatric institution and two patients (1.2%) were already admitted at the time of the fracture for other reasons.

Activities of daily living (ADL) functions were scored according to Table 5. The majority of patients in this group was totally self supporting with a mean (interquartile range) score for ADL functions of 3.3 (3.0–3.6).

Four months after operation, 144 of the 163 mentally normal patients were alive. One hundred and forty-one of these 144 survivors (97.9%) had been able to walk with a walking stick or without any aid before operation. Four months after operation, 125 of these 144 survivors could walk with or without a walking stick (86.8%). Ninety-two patients (63.9%) were living in their own homes and had regained independence (Mean score for ADL functions 3.6, interquartile range 3.0–3.6).

The majority of mentally impaired patients (92.3%) was admitted from a psychogeriatric institution, in need of total support on ADL functions with a mean (interquartile range) score of 6.4 (7.0–9.0).

Four months after operation 33.3% of mentally impaired patients had died, all surviving patients were living in a (psycho-)geriatric institution. Before operation, 24 (92.3%) of the 26 surviving mentally impaired patients had been able to walk with a walking stick or without any aid. Four months postoperatively, only 6 of the 26 survivors (23.1%) were able to walk independently.

In other words, of the 24 mentally impaired surviving patients, who had been mobile before operation, 18 (75.0%) were not mobile four months after operation. Of the 141 mentally normal surviving patients who had been mobile before operation, 16 (11.3%) were not mobile four months after operation. This difference is statistically significant (χ^2, $p < 0.001$).

Table 5
Points given for activities of daily living

Activity		Score
Dressing and personal hygiene	Without support	1
	Some support	2
	Total support	3
Eating	Without support	1
	Some support	2
	Total support	3
Visiting toilet	Without support	1
	Some support	2
	Total support	3

4. Discussion

The most important goal of operative treatment for femoral neck fractures is to restore function and to relieve pain. Patients are mobilized as soon as possible to regain their preoperative walking abilities. In spite of the development of many operative techniques, postoperative mortality after an intracapsular femoral neck fracture is still significant and increases at a rate significantly above that of the general population for about one year after operation [2,5,13,18–21]. Prognostic factors on the results of surgical treatment are age, general medical condition and social circumstances [18,22,23]. In this study we analyzed the effect of mental state on mortality after surgical treatment of displaced intracapsular femoral neck fractures and we found that the mentally impaired patients had a far greater risk of dying than the mentally normal patients. The majority of mentally normal patients, admitted from their own homes, could return home within four months after operation. They regained independent walking capacities and could manage ordinary activities of daily living. Mentally impaired patients, who were alive four months after operation, had a significant decrease in walking capacities, most patients being condemned to bed or chair.

Hemi-arthroplasty is an accepted method of treating the displaced intracapsular femoral neck fracture. One of the major advantages of prosthetic replacement of the femoral head is immediate weightbearing mobilization after operation.

The other side of the coin is that postoperative complications like wound infections, decubital ulcers and urinary tract infection occur frequently after hemi-arthroplasty. In this study, the postoperative complication rate was in accordance with the literature [24] and we did not found a statistically significant difference between mentally normal and mentally impaired patients.

From this study it is clear that if elderly patients were mentally normal and independent before fracture of the femoral neck, restoration of that independence is a realistic goal for surgical treatment. In demented patients, operative treatment of intracapsular hip fractures should be performed to free them from pain and to facilitate early discharge to the referring institutions. There is no reasonable expectation of postoperative ambulation. In our opinion, hemi-arthroplasty is a major surgical procedure with significant morbidity. Minimal invasive techniques like cannulated screws or pins seem a very appropriate alternative for hemi-arthroplasty to stabilize the fracture in patients with a very limited life expectancy. Senile dementia is difficult to diagnose and can only accurately be done by a professional Geriatric Assessment Team. However, mental function can easily and immediately be evaluated with

the CST-14, therefore, the test score should be taken into consideration whenever mental impairment is suspected in the elderly patient with an intracapsular femoral neck fracture.

An accurate assessment of mental state at the time of admission can predict survival and functional outcome after operation for a fracture of the intracapsular femoral neck. The results of our study may be helpful in obtaining relevant risk factors on mortality after surgical repair of intracapsular femoral neck fractures and (im-) possibilities for mobilization and functional outcome. This may result in a therapeutic strategy tailored to the patient's condition at the time of the fracture.

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CHAPTER 8. RETROSPECTIVE ANALYSIS OF FACTORS INFLUENCING THE OPERATIVE RESULTS OF INTRACAPSULAR FEMORAL NECK FRACTURES.

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submitted for publication.

8.1. Abstract.

A retrospective analysis of 155 patients with an intracapsular femoral neck fracture showed that in the 106 patients treated with internal fixation, the preoperative fracture classification, the age of the patiënt and the quality of reduction and fixation are predictors for the final outcome. Fractures with a Garden classification of 1 and 2 have significantly better results than Garden 3 and 4 (p=0.001). The same applies for the Pauwels classification 1 and 2 versus 3 (p=0.003). An unsuccessful reduction of the fracture and a poor surgical fixation technique had significant effect on the outcome (p=0.003 resp. p=0.020). If internal fixation is considered, the reduction and the technique of fixation should be perfect. In the age group of 80 years and over failure after internal fixation is very high (50.9%) and hemiarthroplasty should be the first treatment choice in patients with a good rehabilitation capacity. In patients without a reasonable rehabilitation capacity or with a limited life expectancy, a minimal invasive procedure is a good palliative treatment.

8.2. Introduction.

Intracapsular femoral neck fractures are very common in the elderly. A high morbidity and mortality rate is reported in several studies [1, 6, 8-10, 12, 13, 17]. Some surgeons believe that in the elderly population the best treatment option for intracapsular femoral neck fractures is hemiarthroplasty [5, 14, 16]. The advantages of primary hemiarthroplasty are a definite operative treatment and immediate post-operative full weight bearing. Disadvantages are the extent of the surgical procedure, the potential risk of infection of the prosthesis, dislocation and loosening of the prosthesis. Also is hemiarthroplasty contraindicated in younger patients with a long life expectancy. Another treatment option is closed reduction and percutaneous osteosynthesis [1, 4, 7, 10, 12, 17-19]. The advantages are limited surgical trauma and maintenance of the femoral head. The disadvantages are a potential difficult reduction, failure of the osteosynthesis and the possibility of femoral head necrosis. For the surgeon it is difficult to determine preoperatively whether an osteosynthesis will lead to consolidation of the fracture or to failure and secondary intervention. In this study we analysed the results of treatment of femoral neck fractures in the university hospital Rotterdam in the period 1995-1999. Our main interest was to answer the following question: which factors can preoperatively predict the success of minimal invasive internal fixation techniques.

8.3. Patients and methods.

All patients treated for an intracapsular femoral neck fracture in the university hospital Rotterdam in the period 1995-1999 were included in this study. All fractures were classified using the Pauwels and Garden criteria. The degree of osteoporosis was classified using the Singh index. In case an osteosynthesis was performed the following items were scored. The quality of the reduction was judged using the Western Infirmary Glasgow (W.I.G.) angle [2], the lateral angle and the Garden's angle [20]. The optimal W.I.G. angle is within 140-149°. No points were scored if the WIG angle was < 140°, 1 point was scored if the WIG angle was ≥ 150° and 2 points were scored if the WIG angle was optimal. The lateral angle is defined as optimal when not exceeding 20°. No points were scored if the lateral angle was > 20°, 2 points were scored if not. The Garden's angle is defined optimal within 170-179°. No points were scored if the Garden's angle was < 170°, 1 point was scored if the Garden's angle was ≥ 180° and 2 points were scored if the Garden's angle was optimal. The quality of the fixation technique was scored with 1 point for each of the following 6 items (fig. 8.3.1.):

- the angle of the screws or pins and the femur is more than 130°
- positioning of the lowest screw or pin direct over the calcar in AP view
- positioning of the dorsal screw or pins direct over the posterior cortex in the axial view
- the distance between the tip of the screws or pins and the articular margin of the femoral head < 10 mm
- the position of the screws or pins within the central or caudal segment of the femoral head on the AP view
- the position of the screws or pins within the central or dorsal part on the axial view

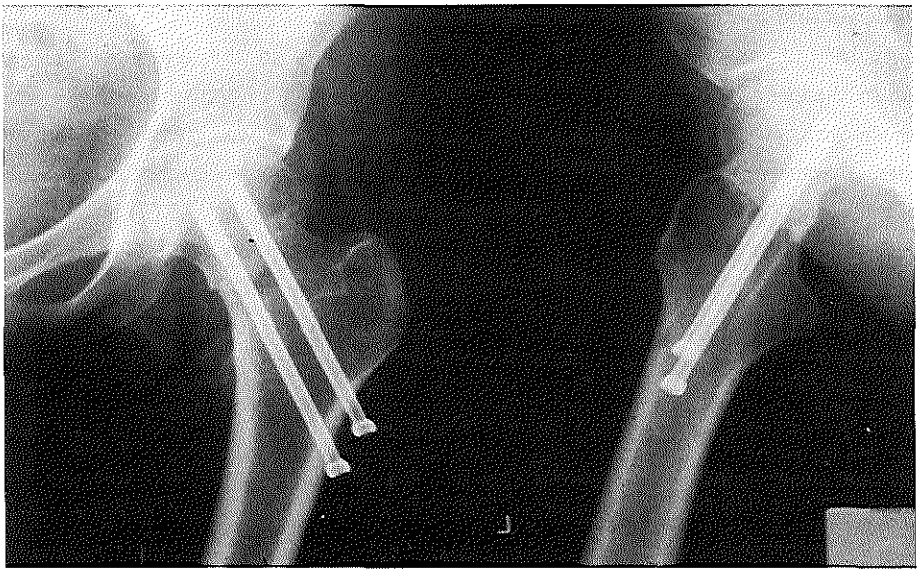

Fig. 8.3.1. Intracapsular femoral neck fracture Garden IV, treated by closed reduction and percutaneous screw fixation with 2 Biomet® cannulated titanium screws (postoperative view; day 1) with optimal score for reduction and fixation (12 points).

In the follow-up period we scored for rontgenological consolidation of the fracture, non-union, femoral head necrosis and secondary intervention.

8.3.1. Statistical methods. Analysis was performed with the SPSS 9.0 statistical package (SPSS, Inc, Chicago, Ill) for windows and Microsoft Excel. A p-value less than 0.05 was considered significant. The tests used were multivariate analysis and descriptive crosstabs.

8.4. Results.

A total of 155 patients were included (121 women and 34 men). 106 patients were treated with a primary osteosynthesis. The mean age of the patients was 76.0 years (range: 19.4 - 95.5 years). The mean follow-up time was 0.85 years (range 0.0 – 5.4 years). 49 patients were treated with hemiarthroplasty (mean age 82.6 years range 68.3 - 95.5 years). The 106 fractures primarily treated with an osteosynthesis and the 49 fractures primarily treated with a hemiarthroplasty were classified as shown in table 8.4.1.

Table 8.4.1. Garden and Pauwels classification of fractures primarily treated with osteosynthesis versus fractures primarily treated with hemiarthroplasty (OS = number of patients primarily treated with an osteosynthesis, HA = number of patients primarily treated with a hemiarthroplasty).

	Pauwels 1 OS / HA	Pauwels 2 OS / HA	Pauwels 3 OS / HA	Total OS / HA
Garden 1	15 / 0	3 / 0	0 / 0	18 / 0
Garden 2	10 / 0	7 / 1	1 / 0	18 / 1
Garden 3	15 / 1	11 / 3	1 / 3	27 / 7
Garden 4	21 / 3	14 /22	8 /16	43 / 41
Total	61 / 4	35 /26	10 /19	06 / 49

A score of 5 or 6 points was considered adequate for both reduction and fixation. In two patients the quality of reduction and fixation and in three patients the quality of fixation could not be scored on all points due to in adequate or missing X-rays. There is a significant decrease in failure rate in increase in points scored for the reduction (P=0.003 Pearson Chi-square). This also applies for the results in an increase in points for the fixation (p=0.020 Pearson Chi-square). The total of points of both (0-12) was used in an analysis to score the technical success of the operation related to the clinical result in the follow-up. Patients with a total score of 9 or more points had a significant better outcome than patients with a score of 8 or less (P=0.029 Pearson Chi-square). (table 8.4.2.)

Table 8.4.2. Total of points for reduction and fixation versus the final outcome after osteosynthesis.

Total of reduction and fixation points	Result		
	No complication	Complication	Total
0 - 8	11	14	25
9 -12	52	24	76
Total	63	38	101

P=0.029 Pearson Chi-square

The final result of the osteosynthesis was compared to the preoperative Garden classification of the fracture (table 8.4.3.) and the Pauwels classification (Table 8.4.4.).

Table 8.4.3. Garden classification versus the end result after osteosynthesis.

Garden classification	Result		
	No complication	Complication	Total
1 and 2	30	6	36
3 and 4	34	36	70
Total	64	42	106

P=0.001 Pearson Chi-square

Table 8.4.4. Pauwels classification versus the end result after operation

Pauwels classification	Result		
	No complication	Complication	Total
1 and 2	61	35	96
3	3	7	10
Total	64	42	106

P=0.035 adjusted Chi-square

Eight of the 106 patients treated with an osteosynthesis (7.5%) developed rontgenological proof of femoral head necrosis after a mean follow-up period of 1.9 years (min 0.21, max 4.1 years). The failure rate was significantly higher in the group of patients with an age of 80 years or more: 28.3% versus 50.9% (p=0.017 Pearson Chi-square). A multi-variate analysis was used to compute the relative risk of failure of osteosynthesis and the significance for: the sum of reduction and fixation points, Garden's classification, reduction points, age above 80 years, fixation points, Pauwels classification, sex, osteosynthesis materials and Singh's index (table 8.4.5.).

Table 8.4.5. multivariate analysis for the risk factors influencing the operative result of osteosynthesis in intracapsular femoral neck fractures. (* Not significant)

Dependent variable	Relative risk	Significance
Sum of reduction and fixation points	11.57	0.001
Garden's classification	9.49	0.003
Reduction points	8.69	0.004
Age ≥ 80 years	6.38	0.013
Fixation points	5.82	0.018
Pauwels classification	4.56	0.035
Sex *	1.41	0.239
Osteosynthesis materials *	0.29	0.589
Singh's index *	0.08	0.778

49 patients were primarily treated with a hemiarthroplasty. The surgeons decided against an osteosynthesis in these patients because of the type of fracture (41 Garden IV) or the age of the patient (mean age was 82.6 years). There were no perioperative deaths. These patients were included to give an adequate overview of the treated population, but the results will not be discussed in this paper. 53 patients were treated with Hansson hook-pins and 49 with percutaneous cannulated screws. We found no statistical difference between the results of these osteosynthesis methods (p= 0.839 in a linear-by-linear association) (Table 8.4.6.).

Table 8.4.6. Osteosynthesis materials used versus the end result after operation.

Osteosynthesis	Result		
	No complication	complication	Total
Hanson pins	31	22	53
Cannulated screws	31	18	49
Dynamic hip screw	2	2	4
Total	64	42	106

P=0.839 in a linear-by-linear association

8.5. Discussion.

The most important drawback of internal fixation techniques is the relative high failure rate and the need for a secondary operation. This study also shows a high overall failure rate for internal fixation (39.6%). In accordance with the literature, our study showed an increase of the failure rate for fracture types Garden 3 and 4 and Pauwels 3 [21]. The mean factors influencing the results of osteosynthesis are the quality of reduction and fixation. A failure rate of 56% was

seen in the group with a cumulative reduction and fixation score of 8 or less, while a failure rate of 32% was seen in the group with a cumulative reduction and fixation score of 9 or more. The importance of adequate fracture reduction is indisputable; it is the first and most important step in the management of displaced femoral neck fractures. Closed reduction on the fracture table is obtained under radiographic control. The ideal position of the fixation device has been the subject of much controversy. Central placement of the fixation device [3], as well as within the caudal segment of the femoral head [11, 15] on the anteroposterior view have been advocated. On the lateral view, the optimal placement is central or slightly posterior to allow impaction and to prevent the nail from cutting out of the head. The distance of the fixation device from the joint surface is also critical. The best results are achieved when the tip of the fixation device lay within half a centimeter of the articular surface. Neither the position, nor the degree of penetration of the femoral head by the fixation device had an appreciable effect on the incidence of late segmental collapse [2]. On the anteroposterior radiograph the weight-bearing medial trabeculae of the head should form an angle of approximately 170 to 180° with the medial cortex of the femoral shaft (Garden's angle). Barnes observed a higher incidence of non-union in fractures where the post-reduction Garden's angle was less than 160°, while more femoral head necrosis was seen when the angle exceeded 180°. Within the range of 170-179° there is always a moderate valgus reduction. On the lateral radiograph, ventral and dorsal trabeculae converge upon an axis which runs in a straight line along the center of the neck. A slight degree of either anteversion or retroversion is tolerated. A lateral angle exceeding 20° is mostly seen with communition of the posterior cortex of the neck, which is the main cause of instability. Posterior communition is an important factor in non-union. The Western Infirmary Glasgow (W.I.G.) angle measures the amount of upward or downward shift of the proximal fragment. After optimal reduction the WIG angle should range from 140 to 149°. Variations in the W.I.G. angle had no consistent impact on the incidence of late segmental collapse [2]. We found that age above 80 years is a significant predictor in univariate and multivariate analysis for the technical success of the osteosynthesis. This makes the choice of osteosynthesis in this age group debatable [7, 14]. Femoral head necrosis was not a common finding in this study. Only eight patients developed a femoral head necrosis. Three patients were treated with an hemiarthroplasty or a total hip. In one patient a Girdlestone procedure was performed. The remaining four patients were free of pain and were functionally not impaired. The mean follow-up period for femoral head necrosis to develop after operation was almost two years. We therefore conclude that the development of femoral head necrosis is not a major disadvantage of internal fixation for femoral neck fractures. Everybody agrees that in the younger patient the femoral head should be preserved, if possible. For the elderly patients, prosthetic replacement of the femoral head and neck is generally accepted and even recommended.

However, in elderly patients with a short life expectancy and no reasonable expectation of postoperative ambulation, operative treatment of intracapsular hip fractures should be performed to free them of pain and to facilitate early discharge to the referring institutions. In our opinion, these patients should not be treated with a major surgical procedure like hemiarthroplasty. Postoperative mortality after an intracapsular femoral neck fracture is very high, irrespective of the type of treatment and the chance of successful rehabilitation is limited. Closed reduction and internal fixation should be the treatment of choice, because it is a much smaller operation than prosthetic replacement, with less morbidity. Up to half of the patients (especially inactive elderly patients) with avascular necrosis and femoral collapse after internal fixation are asymptomatic and require no treatment. The risk of failure can be diminished if minimal invasive internal fixation is seen as a major technical procedure in which optimal reduction and fixation should be seen as the goal to achieve. If adequate reduction cannot be achieved, a primary prosthetic replacement should be considered to reduce the risk of early secondary dislocation and the need for reintervention. In the age group of 80 years and over failure after osteosynthesis is very high (50.9%) and hemiarthroplasty should be the first treatment choice in patients with a good rehabilitation capacity. In patients without a reasonable rehabilitation capacity or with a limited life expectancy a minimal invasive procedure like percutaneous screws is a good palliative treatment [19].

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PART III. GENERAL DISCUSSION

CHAPTER 9. SUMMARY AND CONCLUSIONS.

9.1. Summary.

The study described in this thesis was performed to demonstrate the effect of mental state on survival and functional outcome after surgical treatment for a displaced femoral neck fracture. A second objective was to substantiate a treatment strategy, tailored to patient characteristics.

Chapter 1 presents a review of the literature, concerning specific aspects of femoral neck fractures. The incidence of femoral neck fractures is progressively increasing and causes an enormous impact on health care management.

The introduction of internal fixation techniques significantly improved the results of femoral neck fracture treatment. Nevertheless, high failure rates due to avascular necrosis of the femoral head and non-union remained a serious problem. To avoid these complications, endoprosthetic replacement of the femoral head was introduced as a treatment option.

The mortality rate after operative treatment of femoral neck fractures is increased compared to the age-matched general population. Successful rehabilitation of elderly patients is a major problem for our society. Patients with cognitive disorders seem to have especially a very poor prognosis with respect to mortality and rehabilitation after a femoral neck fracture. There are no randomized trials concerning the best treatment strategy in relation to the mental state of the patient.

Chapter 2 discusses the definition, the diagnosis and the clinical evaluation of senile dementia. The number of elderly patients with senile dementia is also increasing. Acute confusional state and depression are often poorly documented in femoral neck fracture patients and difficult to discriminate from dementia.

Chapter 3 summarizes chapter 1 and 2 and lead to the objective of this thesis.

Chapter 4 describes a retrospective study of 543 unselected intracapsular femoral neck fracture patients. We compared the 215 patients with senile dementia with the 328 patients without senile dementia with respect to mortality and functional outcome. The conclusion of this study was that senile dementia seemed to have a significant effect on mortality.

Chapter 5 evaluates the complications of hemiarthroplasty for displaced intracapsular femoral neck fractures in 543 consecutive patients. Hemiarthroplasty had a significant morbidity and has to be regarded as a major surgical procedure.

These retrospective studies gave rise to the question if hemiarthroplasty should be the treatment of choice for *all* elderly patients with an intracapsular femoral neck fracture, regardless their mental state.

Chapter 6 presents a randomized prospective study to compare hemiarthroplasty to internal fixation with regard to mortality, complications and functional outcome for patients with senile dementia. Sixty patients over 70 years of age with displaced intracapsular femoral neck fractures and who were known with the diagnosis 'senile dementia' were randomly allocated to internal fixation or hemiarthroplasty. Postoperative mortality was high and the functional outcome was poor for both types of treatment in demented patients.

Chapter 7 presents a prospective study of 202 consecutive patients over 70 years of age with displaced femoral neck fractures treated by hemiarthroplasty. The outcome of treatment in the group of mentally impaired patients was compared with the outcome in mentally normal patients. This study confirmed the fact that mental state has a significant effect on mortality and functional outcome after hemiarthroplasty for displaced intracapsular femoral neck fractures.

Chapter 8 analyses the complications of internal fixation in relation to adequacy of the surgical technique. Failure of internal fixation was related to inadequate reduction and inadequate internal fixation.

9.2. Conclusions.

The following conclusions can be drawn from these studies:

- The results of hemiarthroplasty for displaced intracapsular femoral neck fractures in terms of mortality and functional outcome are acceptable in mentally normal patients.
- Mental state has a significant effect on mortality and functional outcome after displaced intracapsular femoral neck fractures, regardless of the type of treatment.
- Hemiarthroplasty is a major surgical procedure and should be avoided in patients with a limited life expectancy and poor mobility.
- The main goal of treatment in patients with a limited life expectancy is an efficient form of analgesia and facilitation of early discharge to a (psycho)geriatric institution. This can be

achieved by simple internal fixation techniques, such as percutaneous pinning or cannulated screws.

- Long term complications of internal fixation such as non-union and avascular necrosis of the femoral head are not relevant in mentally impaired patients because of their limited life expectancy.
- Early complications of internal fixation of displaced femoral neck fractures can be avoided by adequate assessment of displacement, quality of reduction and surgical technique. If adequate reduction can not be achieved, a primary hemiarthroplasty should be considered.

9.3. Future recommendations.

From this thesis we can learn that careful evaluation of mental state, mobility and independence of the elderly patient with an intracapsular femoral neck fracture is essential for fracture management. The probability of survival more than six months can be significantly predicted at the time the patient enters hospital on the basis of age, mental test score, and pre-fracture level of functioning. The surgical procedure must never be considered to be the whole treatment but merely an incident in the general rehabilitation of the patient.

Based on our experience we recommend the following:

- In general, operative treatment of dislocated fractures of the femoral neck is considered superior to conservative treatment.
- In patients, suffering from senile dementia, hemiarthroplasty should be avoided. Internal fixation techniques are adequate to accomplish pain relief and facilitation of nursing care.
- Extended hospital stays should be avoided. Patients should be returned as soon as possible to their own environment.
- Intensive collaboration between the (psycho)geriatric institutions and the surgical staff.

HOOFDSTUK 10. SAMENVATTING EN CONCLUSIES.

10.1. Samenvatting.

De studie, beschreven in dit proefschrift, werd uitgevoerd om het effect van de mentale status op overleving en functioneel resultaat na chirurgische behandeling van een gedisloceerde collumfractuur, aan te tonen. Een tweede doel was het ontwikkelen van een behandelingsplan, waarbij rekening wordt gehouden met de eigenschappen van de populatie.

Hoofdstuk 1 geeft een overzicht van de literatuur, betreffende specifieke aspecten van collumfracturen. The incidentie van collumfracturen neemt progressief toe en heeft grote gevolgen voor de gezondheidszorg.

Door de introductie van interne fixatie technieken zijn de resultaten van de behandeling van collumfracturen significant verbeterd. Desondanks bleef falen van de osteosynthese, ten gevolge van avasculaire necrose van de femurkop en non-union een groot probleem. Om deze complicaties te vermijden, werd endoprosthetische vervanging van de femurkop als alternatieve behandelingsmethode geïntroduceerd.

De sterftekans na operatieve behandeling van collumfracturen is verhoogd ten opzichte van de algemene populatie, waarbij gecorrigeerd is voor leeftijd. Succesvolle revalidatie van oudere patiënten is een groot probleem voor onze maatschappij. Vooral patiënten met een cognitieve stoornis lijken na een collumfractuur een zeer slechte prognose te hebben, met betrekking tot mortaliteit en rehabilitatie. Er zijn geen gerandomiseerde trials betreffende de beste behandelingsmethode in relatie tot de mentale status van de patiënt.

Hoofdstuk 2 behandelt de definitie, de diagnose en de klinische evaluatie van seniele dementie. Het aantal oudere patiënten met seniele dementie neemt ook toe. Verwardheid en depressie wordt vaak slecht gedocumenteerd bij patiënten met een collumfractuur en is vaak moeilijk te onderscheiden van dementie.

Hoofdstuk 3 is een samenvatting van hoofdstuk 1 en 2 en leidt naar de vraagstelling van dit proefschrift.

Hoofdstuk 4 beschrijft een retrospectieve studie van 543 ongeselecteerde patiënten met een intracapsulaire collumfractuur. We vergeleken de 215 patiënten met seniele dementie met de 328 patiënten zonder seniele dementie met betrekking tot mortaliteit en functioneel resultaat.

De conclusie van deze studie was dat seniele dementie een significant effect leek te hebben op de mortaliteit.

Hoofdstuk 5 evalueert de complicaties van hemiarthroplastiek voor gedisloceerde intracapsulaire collumfracturen in 543 opeenvolgende patiënten. Hemiarthroplastiek had een aanzienlijke morbiditeit en moet gezien worden als een grote chirurgische procedure.

Door deze retrospectieve studies rees de vraag of hemiarthroplastiek de behandeling van keuze moet zijn voor *alle* oudere patiënten met een intracapsulaire collumfractuur, ongeacht hun mentale status.

Hoofdstuk 6 beschrijft een gerandomiseerde prospectieve studie waarin de mortaliteit, complicaties en functioneel resultaat voor hemiarthroplastiek en interne fixatie werden vergeleken, voor patiënten met seniele dementie. Zestig patiënten, ouder dan 70, met gedisloceerde collumfracturen en bekend met de diagnose 'seniele dementie' werden gerandomiseerd voor interne fixatie of hemiarthroplastiek. De postoperatieve mortaliteit was hoog en het functionele resultaat was slecht voor beide behandelingsmethoden bij demente patiënten.

Hoofdstuk 7 beschrijft een prospectieve studie van 202 opeenvolgende patiënten, ouder dan 70 jaar, met gedisloceerde collumfracturen, die behandeld werden met een hemiarthroplastiek. Het resultaat van de behandeling van patiënten met cognitieve stoornissen werd vergeleken met het resultaat van de behandeling van patiënten zonder cognitieve stoornissen. Deze studie bevestigde dat de mentale status een significant effect heeft op de mortaliteit en functioneel resultaat na hemiarthroplastiek voor gedisloceerde intracapsulaire collumfracturen.

Hoofdstuk 8 beschrijft een analyse van de complicaties van interne fixatie in relatie tot de nauwkeurigheid van de chirurgische techniek. Het falen van de interne fixatie was gerelateerd aan inadequate repositie en inadequate interne fixatie.

10.2. Conclusies.

De volgende conclusies kunnen uit deze studies worden getrokken:

- De resultaten van hemiarthroplastiek voor gedisloceerde intracapsulaire collumfracturen met betrekking tot mortaliteit en functioneel resultaat zijn acceptabel voor mentaal gezonde patiënten.
- De mentale status heeft een significant effect op de mortaliteit en het functioneel resultaat na een gedisloceerde intracapsulaire collumfractuur, ongeacht de behandelingsmethode.
- Hemiarthroplastiek is een grote chirurgische ingreep en zou vermeden moeten worden bij patiënten met een geringe levensverwachting en slechte mobiliteit.

- Het belangrijkste doel van de behandeling van patiënten met een geringe levensverwachting is een efficiënte manier van pijnbestrijding en het mogelijk maken van een snel ontslag naar een (psycho)geriatrisch instituut. Dit kan worden bereikt door eenvoudige interne fixatie technieken, zoals percutane pennen of gecannuleerde schroeven.
- Late complicaties van interne fixatie zoals non-union en avasculaire necrose van de femurkop zijn niet relevant voor patiënten met cognitieve stoornissen vanwege hun slechte levensverwachting.
- Vroege complicaties van interne fixatie van gedisloceerde collumfracturen kunnen worden vermeden door een adequate beoordeling van de dislocatie, de kwaliteit van de repositie en de chirurgische techniek. Wanneer een adequate repositie niet mogelijk is, moet een primaire hemiarthroplastiek worden overwogen.

10.3. Aanbevelingen voor de toekomst.

Uit dit proefschrift kunnen we concluderen dat zorgvuldige evaluatie van de mentale status, de mobiliteit en de onafhankelijkheid van de oudere patiënt met een intracapsulaire collumfractuur essentieel is voor de fractuurbehandeling. De kans dat de overleving meer dan zes maanden is, kan voorspeld worden op het moment dat de patiënt het ziekenhuis binnenkomt aan de hand van leeftijd, cognitieve test score, en het functioneren van de patiënt. De chirurgische ingreep moet nooit gezien worden als de hele behandeling maar meer als een moment in de algehele rehabilitatie van de patiënt. Gebaseerd op onze ervaringen, doen wij de volgende aanbevelingen:

- In het algemeen heeft operatieve behandeling van gedisloceerde collumfracturen de voorkeur boven conservatieve behandeling.
- Hemiarthroplastiek moet vermeden worden bij patiënten, die lijden aan seniele dementie. Interne fixatie technieken zijn voldoende voor een goede pijnbestrijding en het mogelijk maken van verpleging.
- Langdurige ziekenhuisopnames moeten worden vermeden. Patiënten moeten zo snel als mogelijk terug naar hun eigen omgeving.
- Intensieve samenwerking tussen de (psycho)geriatrische instituten en de chirurgische staf.

VERANTWOORDING en DANKWOORD.

Het onderzoek waarop dit proefschrift gebaseerd is werd grotendeels verricht op de afdeling Heelkunde van het Sint Franciscus Gasthuis en op de afdeling Heelkunde van het Academisch Ziekenhuis Rotterdam. Vele mensen hebben mij geholpen, waarvoor mijn oprechte dank. Een aantal mensen wil ik in het bijzonder noemen:

Mijn co-promotor, **Dr. J.C.J. Wereldsma**, was de initiator van dit promotie-onderzoek. Beste Dr. W, reeds in een zeer vroeg stadium van mijn opleiding in het Sint Franciscus Gasthuis wist U op onnavolgbare wijze mij te motiveren voor dit onderzoek.

De eerste fase van het afronden van het onderzoek werd in eerste instantie begeleid door **Prof.dr. H. van Urk.**

Mijn promotor, **Prof. dr. A.B. van Vugt**, heeft de begeleiding van dit onderzoek direct na zijn komst in het Academisch Ziekenhuis op voortvarende wijze overgenomen.

Prof.dr. J.P.J. Slaets wil ik in het bijzonder bedanken voor de kritische beschouwing van hoofdstuk 2 van dit proefschrift.

De overige leden van de promotiecommissie: **Prof.dr. J.A.N. Verhaar, Prof.dr. H.J. Stam, Prof.dr. P.L.O. Broos, Dr. E.L.F.B. Raaymakers** en **Prof.dr. H. Bonjer** wil ik bedanken voor het feit dat zij plaats wilden nemen in de commissie.

Vandaag wordt ik bijgestaan door **Drs. A.M.A. van Breukelen en drs. C.M. Douw**. Zij zijn co-auteurs van de artikelen in de hoofdstukken 6 en 7 en hebben keihard meegewerkt aan dit onderzoek. Ik vind het een bijzondere eer dat zij mijn paranimfen zijn. Lieve dames, zonder jullie inzet was ik nooit zo ver gekomen.

De overige co-auteurs: **Dr. F.C. Öner, drs. D. L. Laurens, drs. N. Schep, drs. R.J. Heintjes** en **Dr. P.G.H. Mulder**.

De patiënten uit het onderzoek; zonder hen was dit boekje er niet geweest.

Dr. M.B.E. Menke-Pluymers; die met het ontwerp van de omslag er zorg voor heeft gedragen dat ik vandaag een fantastisch mooi boekje aan U mag presenteren.

Mevr. J. W. Drost van der Sanden, die mijn schoolboeken Engels heeft ge-upgraded.

Mevr. M. Smits-Schouten, voor haar steun in de laatste weken voor de promotie.

Verder wil ik graag al mijn **collega's** uit het Sint Franciscus, Dijkzigt en het Vlietland bedanken.

Hans en Rita, Wil, Victor, Niels en Tanja: bedankt voor de enorme geestelijke ondersteuning en de talloze "dlinkies". Ik hoop dat Zeeman nog lang open blijft.

Robbert, bedankt voor alle support in de jaren die wij samen waren.

Lieve **pa en ma**, jullie hadden van jongs af aan een blindelings vertrouwen in me.

Lieve lieve Natascha, je was er altijd al en je zal er altijd zijn. Je bent mijn liefje.
Ik hou van jou helemaal tot aan de maan – en terug.

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