Hip fracture in patients with cognitive impairment

Epidemiology and Patient-Reported Outcome Measures.
Data from the Norwegian Hip Fracture Register

Målfrid Holen Kristoffersen

Thesis for the degree of Philosophiae Doctor (PhD)
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UNIVERSITY OF BERGEN

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Scientific environment

This PhD thesis is based on studies and research work initiated by the former leader of the Norwegian Hip Fracture Register, Professor Emeritus Lars Birger Engesæter, and my main supervisor, Jan-Erik Gjertsen, Associate Professor in Orthopaedic Surgery at the Department of Clinical Medicine, University of Bergen.

Eva Dybvik, MSc, PhD, statistician of the Norwegian Hip Fracture Register, and Anette H Ranhoff, Professor in Geriatric Medicine, have been my co-supervisors.

The project was initiated by a three-month scholarship from the Kavli Foundation for Geriatric Research, in order to prepare and begin the studies.

This thesis is part of the PhD programme at the Department of Clinical Medicine, Faculty of Medicine, University of Bergen. I received a six plus two-week scholarship from the Norwegian Arthroplasty Register in 2018 and 2020 to complete the papers. I also have received a three-month scholarship funded by the Western Norwegian Regional Health Authority to complete the article based on patient-reported outcome measures.

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Contents

List of abbreviations

ASA	American Society of Anaesthesiologists
AO	Arbeitsgemeinschaft für Osteosynthesefragen *(Association for the Study of Internal Fixation)*
AO/OTA	The AO Foundation/Orthopaedic Trauma Association
BMI	Body Mass Index
CI	Confidence Interval
CCI	Chronic Cognitive Impairment
CSF	Cerebrospinal Fluid
CT	Computer Tomography
DH	Diakonhjemmet Hospital
EQ-5D-3L	the Five-Dimensional Scale of EuroQol
EQ-VAS	the Visual Analogue Scale of EuroQol
FNF	Femoral Neck Fracture
HA(s)	Hemiarthroplasty(ies)
HDH	Haraldsplass Deaconess Hospital
HRR	Hazard Rate Ratio
HR-QoL	Health-Related Quality of Life
ICD-10	International Classifications of Diseases, version 10
IQCODE	Informant Questionnaire on Cognitive Decline in the Elderly
MCID	Minimal Clinically Important Difference

MD	Medical Doctor
MRI	Magnetic Imaging Resonance
N	Number
NAR	Norwegian Arthroplasty Register
NHFR	Norwegian Hip Fracture Register
NICE	National Institute for Health and Care Excellence
NPR	Norwegian Patient Registry
PhD	Philosophiae Doctor
Prof	Professor
PROMs	Patient-Reported Outcome Measures
QALYs	Quality-Adjusted Life Years
RCT	Randomized Controlled Trial
(RECORD)	REporting of studies Conducted using Observational Routinely collected health Data
THA	Total Hip Arthroplasty
TSH	Thyroid Stimulating Hormone
VAS	Visual Analogue Scale

List of publications

I Kristoffersen MH, Dybvik E, Steihaug OM, Bartz-Johannesen CA, Martinsen MI, Ranhoff AH, Engesæter LB, Gjertsen JE. **Validation of orthopaedic surgeons´ assessment of cognitive function in patients with acute hip fracture.** *BMC Musculoskelet Disord 2019; 20:268*

II Kristoffersen MH, Dybvik E, Steihaug OM, Kristensen TB, Engesaeter LB, Ranhoff AH, Gjertsen JE. **Cognitive impairment influences the risk of reoperation after hip fracture surgery: results of 87,573 operations reported to the Norwegian Hip Fracture Register.** *Acta Orthop 2020; 91 (2): 146-151.*

III Kristoffersen MH, Dybvik E, Steihaug OM, Kristensen TB, Engesaeter LB, Ranhoff AH, Gjertsen JE. **Patient-reported outcome measures after hip fracture in patients with chronic cognitive impairment. Results from 34,675 patients in the Norwegian Hip Fracture Register** *(accepted in Bone and Joint Open 12 April 2021)*

Abstract

Norway has one of the highest incidences of hip fractures in the world. Every year around 9000 persons are operated for a hip fracture. The mean age of the patients is over 80 years and this injury is often accompanied by important consequences and sequelae for the patient. There are different types of hip fractures and there are different methods of surgery.

The Norwegian Hip Fracture Register (NHFR) has registered most hip fractures operated in Norway since 2005. The orthopaedic surgeon fills in a form reporting fracture type, operation method, operation time, complications, choice of implants and information on the patient, including cognitive function. Any reoperation is registered using the same form. The NHFR receives information on deaths from the National Population Register and analyses end with emigration or death (or at the end of a study). After four, 12 and 36 months, the NHFR sends questionnaires to the patients with questions on health-related quality of life.

About a quarter of hip fracture patients have cognitive impairment. Cognitive impairment is defined as a decline in cognitive functioning beyond normal ageing. Cognitive impairment is more common with older age.
The aim of this thesis was to compare hip fracture treatment in patients with and without cognitive impairment, using data from the NHFR.
In *Paper I* we validated orthopaedic surgeons' assessment of cognitive impairment of hip fracture patients, using information in quality databases where geriatricians had assessed cognitive function, as the gold standard. We found that the orthopaedic surgeons had an acceptable assessment of hip fracture patients with cognitive impairment.
In *Paper II* we found the prevalence of cognitive impairment in hip fracture patients to be 27%. There were no differences in types of hip fractures or in treatment of the different types according to cognitive function. However, when analysing reoperations, we found differences based on cognitive function. There were more

reoperations due to dislocation of hemiarthroplasty in patients with cognitive impairment, particularly when a posterior approach was used. Uncemented hemiarthroplasties had a higher risk of revision due to periprosthetic fracture in patients with cognitive impairment than in those without cognitive impairment. There were few revisions to total hip arthroplasty (THA) in patients with cognitive impairment.

Mortality was higher in patients with cognitive impairment. After 30 days, 13% of patients with cognitive impairment had died compared to 4.6% of non-cognitively impaired patients. After one year, 38% of cognitively impaired patients had died compared to only 16% of the patients without cognitive impairment.

In *Paper III* we analysed data on health-related quality of life in hip fracture patients according to cognitive impairment. Most hip fracture patients had a decrease in health-related quality of life after the hip fracture. There were large differences in quality of life both before the fracture and four and 12 months postoperatively. In hip fracture patients with cognitive impairment there was an increase in those confined to bed from 2% preoperatively to 14% 12 months postoperatively. In patients without cognitive impairment, the corresponding increase was from 0.8 to 1.9%. We found that only 28% of hip fracture patients with cognitive impairment returned to pre-fracture functioning, compared to 33% of patients without cognitive impairment, one year after surgery.

The conclusions of our studies were that orthopaedic surgeons had an acceptable ability to identify and report cognitive impairment in hip fracture patients. Presence of cognitive impairment did not influence the choice of surgical treatment of these patients. The reoperation rates varied according to cognitive impairment. Mortality was higher in patients with cognitive impairment and health- related quality of life lower.

Sammendrag på norsk

Norge ligger på verdenstoppen når det gjelder antall hoftebrudd. Hvert år blir ca. 9000 personer operert for hoftebrudd i Norge. Gjennomsnittsalderen for hoftebruddpasienter er over 80 år og denne type skade får ofte store konsekvenser og senfølger for hoftebruddpasienten. Det finnes ulike typer hoftebrudd og som trenger ulike typer operasjon.

Nasjonalt Hoftebruddregister har siden 2005 registrert hoftebrudd operert i Norge. Kirurgen som opererer bruddet, fyller ut et skjema med informasjon om bruddtype, operasjonsmetode, operasjonstid, komplikasjoner, implantatvalg og informasjon om pasienten, inkludert kognitiv funksjon. Reoperasjoner blir rapportert på samme type skjema. Nasjonalt Hoftebruddregister får informasjon om død fra Folkeregisteret og analysene avsluttes ved emigrasjon eller død (eller ved studieslutt). Etter 4, 12, og 36 måneder sender Nasjonalt Hoftebruddregister ut skjema til pasientene med spørsmål om helse relatert livskvalitet.

Omtrent en fjerdedel av hoftebruddpasientene har kognitiv svikt. Kognitiv svikt regnes som svikt i kognitive funksjoner, hvor svikten er større enn svikten som tilskrives normal aldring.

I denne doktorgradsavhandlingen ønsket vi å sammenlikne hoftebrudd behandling hos pasienter med og uten kognitiv svikt, med utgangspunkt i data fra Nasjonalt Hoftebruddregister (NHBR).

I *artikkel I* validerte vi ortopedenes vurdering av pasientenes kognitive funksjon rapportert til NHBR ved å sammenlikne med informasjon om pasienten i lokale kvalitetsdatabaser der geriatere hadde vurdert pasientenes kognitive funksjon. Vi fant at ortopedene hadde en akseptabel evne til å fange opp hoftebruddpasienter med kognitiv svikt.

I *artikkel II* fant vi at prevalensen av kognitiv svikt blant hoftebruddpasienter var 27%. Det var ingen forskjell på bruddtype hos pasienter med eller uten kognitiv svikt. Det var heller ingen forskjell i behandlingen av disse bruddene mellom pasienter med

og uten kognitiv svikt. Vi fant ulik risiko for reoperasjon med hensyn på kognitiv svikt. Det var flere luksasjoner etter operasjon med hemiprotese hos pasienter med kognitiv svikt, spesielt hos pasienter operert med bakre tilgang. Dersom det var brukt en usementert protese, fant vi økt risiko for reoperasjoner på grunn av periprostetisk fraktur hos de med kognitiv svikt, sammenliknet med kognitivt velfungerende pasienter. Det var langt færre reoperasjoner av totalprotese for pasienter med kognitiv svikt sammenlignet med pasienter uten kognitiv svikt.

Dødelighet for hoftebruddpasienter med kognitiv svikt var høyre enn hos hoftebrudd pasienter uten kognitiv svikt. Etter 30 dager var dødeligheten 13% hos pasienter med kognitiv svikt, mens den var 4,6% hos pasienter uten kognitiv svikt. Etter ett år var dødeligheten 38% hos pasienter med kognitiv svikt, mens den var bare 16 % hos pasienter uten kognitiv svikt.

I *artikkel III* undersøkte vi helse relatert livskvalitet hos hoftebrudd pasienter med og uten kognitiv svikt. De fleste hoftebruddpasienter hadde en reduksjon i helserelatert livskvalitet etter hoftebruddet. Vi fant at det var store ulikheter i livskvalitet både før hoftebruddet og fire og tolv måneder etter operasjonen for pasientene. Hos pasienter med kognitiv svikt var det en økning i andel sengeliggende pasienter etter 12 måneder fra 2 til 14 %, mens tilsvarende økning for pasienter uten kognitiv svikt var fra 0,8 til 1,9%. Vi fant at bare 28 % av pasientene med kognitiv svikt kom tilbake til funksjonsnivået de hadde før bruddet, mens tilsvarende andel av pasienter uten kognitiv svikt var 33 % etter ett år.

Konkusjonen av våre studier er at ortopediske kirurger har en rimelig god evne til å oppdage kognitiv svikt hos hoftebruddpasienter. Kognitiv svikt påvirker ikke behandlingsvalg for hoftebrudd. Reoperasjonsraten varierte imidlertid med hensyn på kognitiv svikt. Pasienter med kognitiv svikt hadde høyere mortalitet og lavere helserelatert livskvalitet sammenlignet med pasienter uten kognitiv svikt.

1. Introduction

1.1. Epidemiology of hip fractures

In Norway approximately 9000 patients are operated for a primary hip fracture every year [1]. The country has one of the highest incidences of hip fractures in the world [2-4]. It is estimated that for people over 50 years of age, the yearly incidence of hip fractures is 76-82 per 10 000 for women and 35-39 per 10 000 for men in Norway [4, 5]. The age-specific incidence of hip fractures in Norway, Finland and North America has decreased in recent decades [4, 6-8]. With an ageing population worldwide the overall incidence has increased [9-11]. It is estimated that 4.5 million people sustain a hip fracture every year and that around 21 million people will be living with sequelae after a hip fracture during the next 40 years [12]. Despite the decrease in incidence, both the health and economic burdens of hip fractures are expected to increase [13].

There is also a high risk of sustaining a hip fracture, if the person has had a previous fragility fracture or hip fracture, although the risk around the world varies [11].

Osteoporosis, tendency to fall, old age, Alzheimer's disease and use of anxiolytic or hypnotic drugs are also risk factors for hip fracture [14-17].

Hip fracture patients in Norway are on average 83.2 years old and over 70% are female. The majority of hip fracture patients (63%) have several comorbidities (ASA class 3 and 4) [18].

Figure 1 shows the incidence of primary operations for hip fractures in realtion to age and gender in Norway[19].

Figure 2 shows the ASA classification in relation to different years for the hip fracture population in Norway [19].

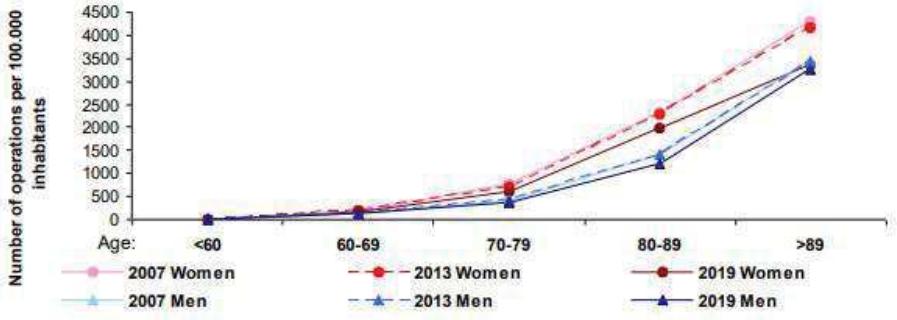

Figure 1: Incidence of primary operations for hip fractures in Norway (From: Annual Report, Norwegian Hip Fracture Register 2020)

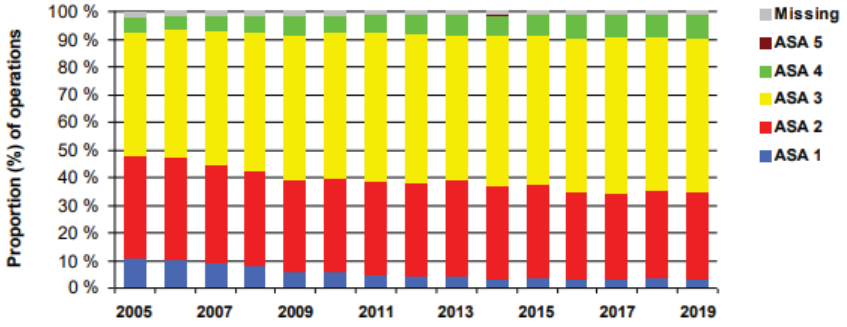

Figure 2: ASA classifications of patients with primary operations for hip fractures in Norway (From: Annual Report, Norwegian Hip Fracture Register 2020)

ASA 1 - Healthy patients

ASA 2 - Patients with asymptomatic conditions

ASA 3 - Patients with conditions that can cause symptoms

ASA 4 - Patients with conditions out of control

ASA 5 - Moribund patients

1.2. Classification of hip fractures

A hip fracture is a fracture near the hip joint, only affecting the femur. It is often classified according to the anatomical location.

1. Intracapsular
-Femoral head fractures (Pipkin) (rare)
-Femoral neck fractures (Garden and possibly posterior tilt)
2. Extracapsular
-Basocervical femoral neck fractures
-Trochanteric fractures (AO/OTA A1-3)
- Subtrochanteric fractures

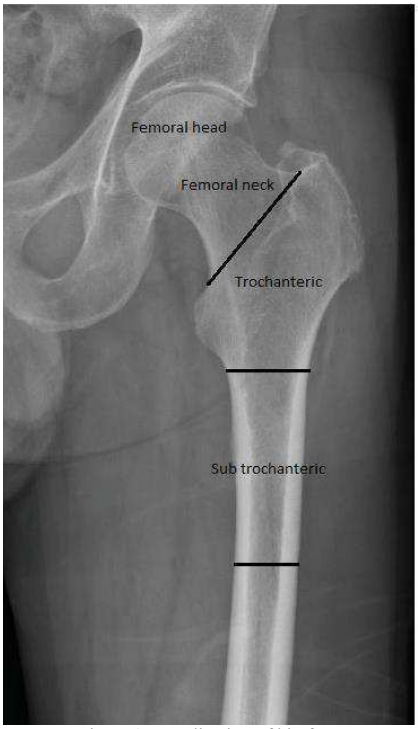

Figure 3: Localization of hip fractures.

Intracapsular fractures are mainly cervical fractures or femoral neck fractures (FNFs), divided into displaced or non-displaced.

A common classification is the Garden classification [20]. The use of the Garden classification from I to IV is based on the displacement in the anterio-posterior view in the x-ray.

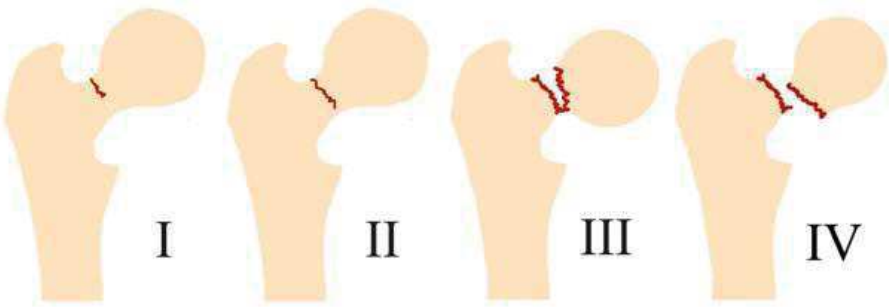

Figure 4: Garden classification of femoral neck fractures (I-IV). Illustration by Sunniva Leer-Salvesen (reprinted with permission).

Garden I is an undisplaced, incomplete fracture (including valgus impaction). Garden II is an undisplaced and complete fracture. Garden III is a complete fracture, but with incomplete displacement, while Garden IV is a complete fracture with complete displacement [21].

Inter-observer reliability has been questioned and found to be poor [22, 23]. Therefore, many simplify the classification into undisplaced and displaced, grouping Garden I and II together and Garden III and IV together [24, 25]. Posterior tilt over 20 degrees has been found to increase risk of reoperation compared to posterior tilt under 20 degrees in undisplaced fractures (Garden I and II) [26-28].

Extracapsular fractures are located laterally to the joint capsule and can be classified by their location according to the AO/OTA classification [29]. They are divided into basocervical, trochanteric fractures and subtrochanteric fractures (up to 5 cm distal to the trochanter minor). This classification has been shown to have poor intra- and inter-observer reliability [30].

1.3. Treatment of hip fractures

1.3.1. Historical treatment

The oldest documented case of a femoral fracture is believed to be that of Charles IV, King of Bohemia and Roman emperor (1378). He died of pneumonia, bedridden, and a detailed post-mortem x-ray of his skeleton found a non-healed fracture of his left femoral neck [31].

Dr John Brikett (1815-1904) was the first to describe a fracture of the proximal femur [32, 33]. The patient, a 35-year-old woman, had fallen from the second floor of a house to the pavement, approximately twenty to twenty-five feet. She had sustained a broken skull, and severe brain laceration. Post mortem, the left leg was described as "slightly shorter than the right leg and the whole limb was rotated. An autopsy showed that a portion of the head of the femur had been broken off".

Most hip fractures were treated with bedrest and casts, and mortality was high.

Baron Joseph (1827-1912) introduced the "Antiseptic Principle in the Practice of Surgery" in 1867 [34, 35] which, in combination with the development of anaesthesia [36, 37], made operative treatment possible.

The first hip fracture operation documented was performed by Bernhard von Langenbeck (1810-1887) in the 1850s, using a gimlet to stabilize a non-united femoral neck fracture. The patient did not survive, but died of sepsis [38, 39].

The first successful operation (i.e. the fracture healed), was performed by Franz König (1832-1910) in 1875 [38].

The use of x-rays, discovered by Wilhelm Konrad Röntgen (1845-1923), became common in hip fracture surgery much later, and Pridie describes methods of reducing the fracture blinded and with the use of x-rays during surgery [40].

Different types of implants were introduced. Prof Dr Med Julius Nicolaysen (1831-1909) presented a steel nail, introduced without the need of general anaesthetics [41].

Marius Nygaard Smith-Petersen (1886-1953) was a Norwegian orthopaedic surgeon living in the USA. He was known for developing the Smith-Petersen Pin, which was

introduced using a guide wire [40]. He also introduced mould arthroplasty in the hip in 1923 [42].

In 1942 Austin T Moore (1899-1963) replaced a giant cell tumour with a hemi-prosthesis made from vitallium in the upper end of the femur. The surgery was extensive and recovery took time. The bone healed and the patient could walk again after nine months. Almost two years after the operation the patient died of a heart attack [43].

From 1950, Sir John Charnley (1911-1982) started to develop total hip replacement and the low-friction arthroplasty that forms the basis of modern principles of hip arthroplasty today [44].

1.3.2. Modern treatment

Early surgical treatment is the state of art in hip fracture treatment today. The NICE guidelines recommend surgery within the first 36-48 hours [45, 46], and others advocate even earlier surgery (6-12 hours) to minimize possible complications such as pneumonia, pressure ulcers, reduced hospital stay, and even mortality [47-51]. Leer-Salvesen has also found that a delay in surgery over 48 hours was associated with increased three-day mortality, using data in the NHFR [52].

In the case of intracapsular femoral neck fractures (FNFs) non-displaced fractures are normally treated with screws [1, 12, 53]. If the posterior tilt is over 20 degrees in patients over 65 years, hemiarthroplasty could be considered [54]. Displaced FNFs are normally treated with hemiarthroplasty if the patient is over 70 years old and has symptomatic comorbidities, while THA is often preferred if the patient had a prior condition in the hip such as rheumatoid arthritis or is healthy and ambulates independently [12, 55, 56]. The question of whether to use total or hemiarthroplasty for a displaced FNF in older people is debated [57-60]. The HEALTH study reported only small differences in adverse outcomes after two years [56]. There was a slightly better functional outcome with THA, but a higher risk of dislocation. This can probably be compensated by increasing the size of the head and using a dual mobility cup [61, 62].

As for trochanteric fractures, there have been discussions about the choice of implant, between the sliding hip screw (extramedullary fixation) and an antegrade intramedullary nail (intramedullary fixation) [63, 64]. For subtrochanteric fractures, intramedullary nails are most often used [12]. Matre et al. found that intramedullary nails caused less pain postoperatively, but not after three and twelve months. The study concluded that results for both implant types were similar in terms of pain, function, reoperation and complications after one year [65]. This concurs with results from other studies and systematic reviews [66, 67].

Figure 5 shows one of the suggested treatment algorithm for hip fractures [53].

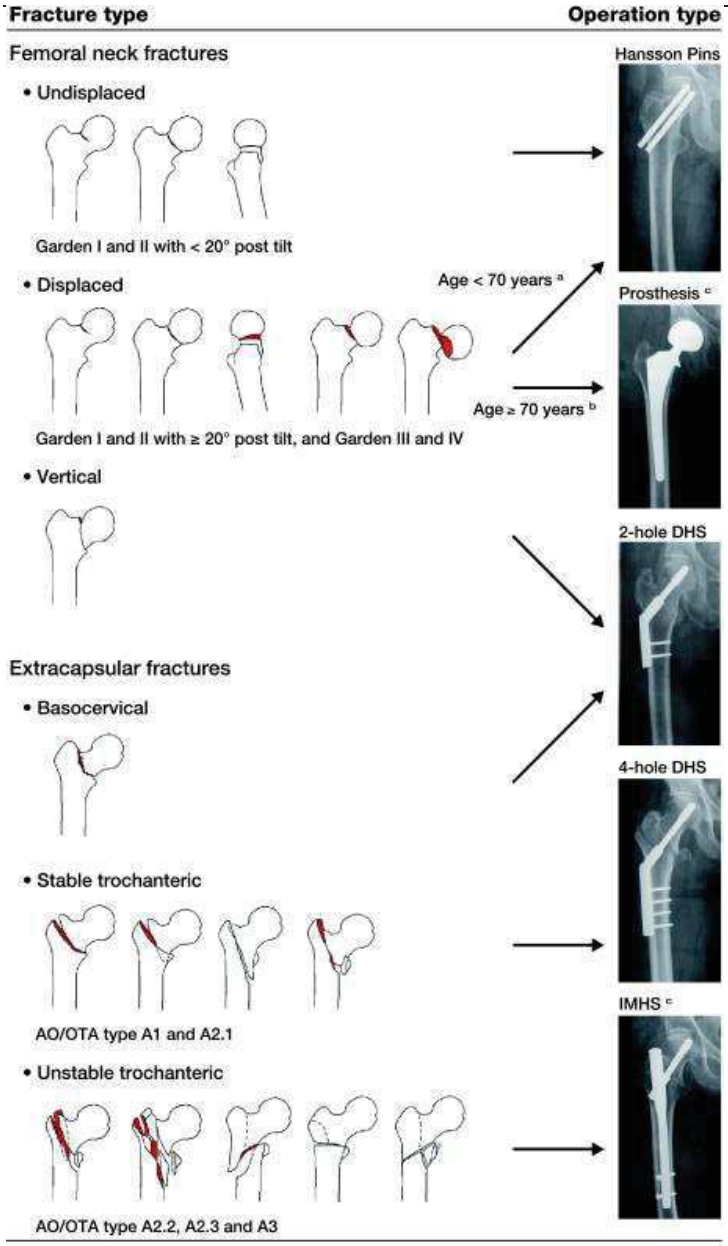

Figure 5: A new algorithm for hip fracture surgery. (From: H Palm, Acta Orthopedica 2012. Reprinted with permission.)

The key goal is to create an early weight-bearing situation to facilitate early mobilization [68].

Pain assessment, anaesthesia, thrombotic treatment, delirium prophylaxis, nutrition and consideration of the patient's other medical issues are key factors in optimizing the outcome after a hip fracture incident. Interdisciplinary teams are necessary to assess all these important considerations [69].

1.4. Outcomes after hip fractures

Reoperation, mortality, walking ability and quality of life are the most commonly used outcomes when studying patients with hip fracture.

Reoperation rates differ depending on the fracture type and surgical method used. After one year the reoperation rate after undisplaced femoral neck fractures operated with screws was 11-20%. Displaced femoral neck fractures operated with hemiarthroplasty had a one-year reoperation rate of 3-24% [53, 70-72].

Mortality after 30 days and one year has been found to be around 8% and 24-30%, respectively, after a hip fracture incident [73-75]. High age, low BMI, male gender, socioeconomic deprivation, comorbidities, dementia and nursing home residency are established risk factors for short-term death in hip fracture patients [76-80].

In Norway, there have been changes in treatment methods for the different hip fractures over time. More displaced fractures are now treated with hemiarthroplasty instead of screw fixation, while more subtrochanteric fractures have been treated with intramedullary nails, compared with plate osteosynthesis. There has also been a decrease in reoperation rates for all fractures from 2006 to 2014 and one-year mortality adjusted for age, sex, and comorbidity has decreased[81].

Other factors found to affect hip fracture recovery are the number of medications used by the patient, oxygen levels, fracture type and location, time from fracture to surgery and length of hospital stay [82].

Functional recovery takes time. Most studies find that it takes from four to six months to recover functioning [83].
Reduced health-related quality of life and increased dependency are common after hip fractures [84], and these factors represent major changes in the person's life. Studies have shown reduced walking ability, increased dependence and even changes in cognition following a hip fracture [84-86].

The risk of being institutionalized one year after a hip fracture is high. Studies show that 20-30% of hip fracture patients living independently before the injury are unable to live at home one year later [85, 87, 88].

Bertram et al. showed that 42% of the hip fracture population had not returned to their pre-fracture mobility level after one year, and 29% had lifelong disability [83].

1.5. Cognitive impairment

1.5.1. Definition of cognitive impairment and dementia

Cognitive impairment means a reduction in cognitive abilities such as memory, abstract thinking, planning or organizing [89]. It can be acute or chronic. Normal ageing also involves some reduction in cognitive abilities, but should not affect everyday life [90]. Cognitive impairment is more common with increasing age, and can occur as mild, moderate or severe [89]. Acute cognitive impairment is often defined as delirium. Delirium is an acute disorder/failure of attention and cognition often seen in older hospitalized patients [91, 92]. It has specific precipitating causes and is usually reversible [93]. In hip fracture patients, delirium is common and occurs both pre- and postoperatively [86, 94-97]. The incidence varies, however, and a meta-analysis of hip fracture studies has found that 34-92% of delirium cases had a preoperative onset [95].

Chronic cognitive impairment can be categorized as dementia or mild cognitive impairment. Mild cognitive impairment does not meet the diagnostic criteria of dementia, and typically does not affect everyday functioning [89].

Dementia is a criteria-based diagnosis for chronic neurodegenerative or vascular illness affecting the brain and its functions. Dementia causes problems with memory, executive functions and behaviour and affects functioning in everyday life. In order to diagnose dementia, other diseases must be ruled out, the person's consciousness must not be affected, and the symptoms must have been present for six months [98].

In this thesis, we choose to use the general term cognitive impairment, although we believe that most of these patients have chronic cognitive impairment and not acute cognitive impairment/delirium.

1.5.2. Epidemiology of cognitive impairment and dementia

It is estimated that the incidence of dementia is slowly decreasing in developing countries, but with increasing longevity, more persons with dementia live longer and

the prevalence will still increase [99, 100]. Based on a recent report, approximately 100 000 persons are living with dementia in Norway [101, 102].

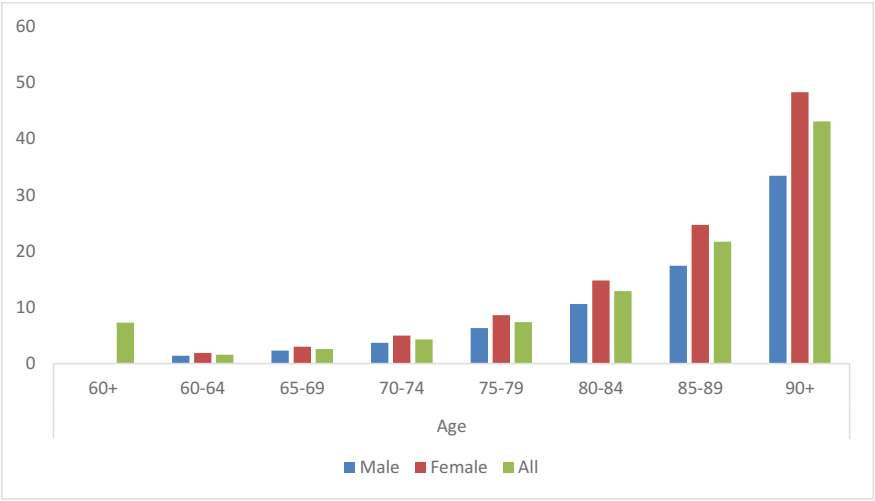

Figure 6: Age- and gender-specific prevalence of dementia (%) in Western Europe Based on "Dementia. A Public Health Priority", WHO, 2012

Persons with dementia have a lower life expectancy, and are especially prone to early onset of cognitive impairment [103]. At 80 years, life expectancy was ten years in the general population, six years in the population with mild cognitive impairment and five years in the population with dementia, according to Strand et al. [103].

1.5.3. Assessment of cognitive impairment

For formal assessment of a person's cognitive function, validated cognitive tests have to be used. However, in a conversation with the patient it is possible to gain an impression of cognitive problems, and information from a proxy about cognitive symptoms and change over time is crucial.

In a situation involving acute illness or injury, such as a hip fracture, this assessment is challenging and poor results on cognitive tests are often not representative of the habitual status of the patient. It is always important to consider the test environment, the patient's condition, and medication. Language skills, vision and hearing impairment can also affect scores. One example of a test to indirectly assess cognitive

impairment is the IQCODE, Informant Questionnaire on Cognitive Decline in the Elderly (see Chapter 3.3.2).

The accuracy of screening tests has been described by Patnode et al. [104]. Screening can adequately detect cognitive impairment and may help improve treatment decision making, but Patnode et al. found no empirical evidence of improved patient outcome.

There is, however, a value in diagnosing cognitive impairment early, including revealing other treatable conditions [105]. Assessment of cognitive impairment is usually a two-step procedure. The first evaluation should be performed when the patient is in a habitual state without acute health problems. A full assessment covers mental status including cognitive testing, a clinical examination including a neurological examination, blood sample analyses (a general screening including B12 and TSH), depression assessment and brain imaging using CT or MRI scans. The aim of the assessment is to diagnose dementia (or mild cognitive impairment), to grade the severity and to find the underlying disease, i.e. Alzheimer's disease, cerebrovascular disease or rarer forms of dementia. Such an assessment will also rule out possible other underlying conditions such as a tumour or hydrocephalus.

Screening for cognitive impairment is recommended in particular settings such as for older inpatients in hospital, and is derived from clinical experience and practical guidelines [106, 107].

Identifying persons with cognitive impairment can improve outcome after hip fracture, as staff can better meet the person's needs and maybe enhance care [108].

1.5.4. Cognitive impairment and hip fractures

The presence of cognitive impairment is common among patients with hip fracture. In the NHFR about a quarter of the patients are reported to have cognitive impairment [1]. In large review studies, the percentage reported to have cognitive impairment ranges from 15-40% [109, 110]. Cognitive impairment increases the risk of hip fracture [111-113]. This is probably caused by an increased risk of falling due to reduced motor

skills including coordination and balance [114, 115]. Many hip fracture patients with dementia or other cognitive impairment also have lower bone mineral density [116]. Cognitive impairment can make it difficult to process and understand information. This can make rehabilitation after a hip fracture challenging, if there are restrictions in movement or load bearing after surgery. One should always try to make the construction after hip surgery as stable as possible, to enable the patient to start to move as freely as possible following a hip fracture. It can be difficult for a patient with cognitive impairment to express pain or discomfort [117, 118]. Such patients might need extra assistance in rehabilitation, and they are vulnerable and react differently to medications (e.g. analgesics) [119]. Finally, persons with cognitive impairment have a higher risk of delirium [86, 94, 95, 120].

Several countries now have guidelines for treatment of hip fractures that include patients with cognitive impairment [46, 69, 121, 122]. Intervention studies including patients with cognitive impairment imply a potential for rehabilitation for all hip fracture patients [123-125].

1.6. Orthogeriatric care

Orthogeriatric care is defined as collaboration between orthopaedic surgeons and geriatricians in treating complex elderly patients with fractures [126, 127]. The treatment is an interdisciplinary cooperation using both orthopaedic and geriatric approaches. In addition to the treatment of the fracture, focus should also be on comorbidities, preventing and treating possible complications including delirium, decubitus wounds, malnutrition, osteoporosis assessment, as well as prevention of falls and early mobilization and rehabilitation [128].

There are different ways of organizing orthogeriatric care [69, 129, 130]. One model involves treatment of patients in orthopaedic wards with geriatric consultation for polypharmacy and fall prevention. An alternative model involves treating these patients in orthopaedic wards preoperatively and transferring them to a geriatric ward post-surgery to start the rehabilitation process. A third model involves treating

patients in a geriatric ward both pre- and postoperatively, where the orthopaedic surgeons operate on and follow up the patient concentrating on pre- and post-surgery issues [131].

St. Olavs Hospital in Trondheim and Oslo University Hospital have conducted randomized controlled studies to find the effects of this form of organization of care. They have shown better mobility, fewer hospital days and increased survival with orthogeriatric care for persons who were living at home and able to walk at least a distance of 10 metres before the fracture [132, 133]. In Paper I we studied assessment in Diakonhjemmet Hospital in Oslo and Haraldsplass Deaconess Hospital, which have organized orthogeriatric care with geriatricians and an interdisciplinary team attending hip fracture patients in orthopaedic wards [134].

1.7. Patient-Reported Outcome Measures (PROMs)

Patient-reported outcome measures (PROMs) provide the patient's perspective on the impact of the disease and/or the treatment, as a direct measure of treatment benefit beyond survival and major morbid events. PROMs are often argued to be the outcomes of most significance to patients [135, 136]. It is important to combine clinical observations and examinations with patients' own assessment of their well-being [137].

There are different kinds of PROMs: they can be divided into generic and disease-specific PROMs [138].

A generic PROM questionnaire can assess and compare outcomes from different populations, medical conditions, and social and economic groups. The EuroQol (EQ-5D-3L) is an example of a generic PROM questionnaire [139].

A disease-specific PROM questionnaire has more detailed questions about the specific disease and treatment and gives more precise feedback about the particular treatment, but does not allow comparison to other diseases. The Harris Hip Score is

an example of a disease-specific PROM questionnaire; it was designed in 1969 to standardize assessment of patients following hip fracture and osteoarthritis [140].

The Oxford Hip Score is another example of a disease-specific PROM questionnaire. It was designed in 1996 to assess patient views of the outcome of hip arthroplasties [141].

When using PROMs it is important to consider the minimal clinically important difference (MCID) [142, 143] . The questionnaire needs to have validity and reliability [144]. It is important to consider the burden for the responder and the administrator, and cultural and linguistic adaptations, and also the interpretability [145].

"Floor" and "ceiling" effects are also important to consider [146]. Ideally, a PROM should measure the whole scale of a parameter. A ceiling effect occurs if the scale is unable to discriminate between the highest scores. A floor effect occurs if the scale is unable to discriminate between the lowest scores [147, 148].

EuroQol (EQ-5D-3L) is a multi-country, multi-centre and multi-disciplinary non-disease-specific PROM questionnaire [144]. It measures health-related quality of life in five dimensions: mobility, self-care, usual activities, pain/discomfort and anxiety/depression. There are three levels of responses for each dimension: level 1 (indicating no problems or best state) to level 3 (indicating severe problems or worst state) [149].

Patient-reported outcome measures are also used in patients with cognitive impairment [150]. Several studies have concluded that persons with cognitive impairment are capable of expressing health-related quality of life via EQ-5D[151-153]. Studies have reported that EQ-5D is a useful tool for reporting health-related quality of life, also in patients with cognitive impairment [154, 155].

The reliability and validity of using a proxy to answer a questionnaire have been debated [156-158].

2. Aims of the study

The overall aim of this project was to evaluate the treatment and outcomes of hip fracture patients with cognitive impairment, using data from the Norwegian Hip Fracture Register.

The specific aims of the studies were:

Paper I: To investigate orthopaedic surgeons' ability to determine cognitive function in patients with an acute hip fracture and thereby to validate the information on cognitive function reported to the Norwegian Hip Fracture Register.

Paper II: To investigate the prevalence of cognitive impairment in the NHFR.

To investigate whether the presence of cognitive impairment affects the type of fracture and the choice of surgical treatment for the different types of hip fractures, and to evaluate whether patients with cognitive impairment have different risks of reoperation and mortality compared with cognitively fit patients.

Paper III: To investigate health-related quality of life in hip fracture patients with cognitive impairment using patient-reported outcome measures four and 12 months postoperatively.

On this basis, to evaluate whether results from hip fracture patients with cognitive impairment should as often as possible be included in hip fracture studies.

3. Methods

3.1. The Norwegian Hip Fracture Register (NHFR)

The Norwegian Orthopaedic Association founded the Norwegian Hip Fracture Register (NHFR) in 2005. The NHFR collects data from all the hospitals in Norway performing hip fracture surgery [159]. The main goal of the NHFR is to collect epidemiological data on the patient and the surgery and to evaluate results of different treatment methods. The register publishes annual nation-wide reports and provides each reporting hospital with its own specific data, to help improve treatment [19]. Several studies and PhDs have based their research on data from the NHFR [160-162]. There is also collaboration with other national hip fracture registries [109, 163].

Annually around 8400 primary hip fracture operations are reported by the surgeon on a one-page paper form (Appendix I). The form contains such details as the patient's personal identification number, time of injury and surgery, type of fracture and surgical method as well as intraoperative complications. Any reoperation is reported on a similar form. The completeness of the NHFR has been compared with the Norwegian Patient Register (NPR), where hospitals report types of operations and ICD-10 codes [1]. It was found to be 88% for osteosynthesis, 94% for hemiarthroplasty and 91% for THA. For reoperations the completeness was 80% for osteosynthesis, 73% for hemiarthroplasty and 84% for THA [19]. Patients receive a questionnaire from the NHFR at 4, 12, and 36 months postoperatively to evaluate their health-related quality of life [164].

3.2. Local quality databases

Some hospitals have in addition a local quality database to evaluate trends in patient characteristics, different treatment methods, and results achieved in their own wards. These databases are used locally to evaluate and improve care and may contain

different and additional parameters than the NHFR. The local quality databases contain information on hip fracture patients operated at the hospital, operation data, comorbidity, cognitive impairment, medical complications and length of stay. A research nurse records data on the hip fracture patients and the IQCODE is used to assess cognitive impairment by interviewing their family members [165].

3.2.1. Diakonhjemmet Hospital, Oslo

Diakonhjemmet Hospital (DH) treats around 500 patients with hip fractures annually. The hospital covers a population of around 250 000 inhabitants in Oslo. The hospital has a 20-bed ward for older patients with fractures and four additional beds for pre- and postoperative observation of patients. A geriatrician and nurses specialized in geriatrics work in a multidisciplinary team with the orthopaedic staff. Since 2007 all hip fracture patients over 65 years have been included in a local quality database for research and quality improvement [134].

3.2.2. Haraldsplass Deaconess Hospital, Bergen

Haraldsplass Deaconess Hospital (HDH) treats around 180 hip fracture patients every year and had a separate area in one of the wards dedicated to hip fracture patients in the study period. HDH has a local quality database, established in 2009. Kavli Research Centre for Ageing and Dementia is located at Haraldsplass Deaconess Hospital in Bergen and several research papers and dissertations have come from this research group [166-168].

3.3. Assessment of cognitive function

3.3.1. The clock-drawing test

In the NHFR, assessment of cognitive function involves a simple method. The surgeon is advised to use the clock-drawing test if there is uncertainty about the

patient's cognitive function [169, 170]. When performing the clock-drawing test the investigator gives the patient a piece of paper with a circle on. The patient is told that a circle represents a clock and asked to draw a clock face showing "ten past eleven". It is a test of visuospatial function, memory, abstract thinking, organizing and planning. This is a screening test and if the patient tests positive (i.e. cannot draw it correctly), the patient should be considered for further testing and may be assessed for further cognitive evaluation.

3.3.2. IQCODE

The Informant Questionnaire of Cognitive Decline in the Elderly is a questionnaire to be answered by a close relative [171 172, 173]. Its long version contains 26 questions. The short form version (which was used in Paper I) deals with changes in cognitive ability in everyday tasks now compared to 10 years ago. The scores are from 1 to 5. A score below 3 indicates better cognitive performance than 10 years ago, 3 indicates the same cognitive performance, while scores above 3 indicate cognitive impairment. A cut-off point of 3.3–3.6 in IQCODE has been used for detecting dementia in community settings, while 3.44– 4.0 has been used in hospital settings [172]. IQCODE has been translated into Norwegian by H. A. Nygaard and A. Bragason and has been validated [174].

3.4. Validation of data on cognitive impairment in the NHFR

To validate the data on cognitive impairment from the orthopaedic surgeons reporting to the NHFR in ***Paper I***, we used data from the local quality databases of HDH in Bergen and DH in Oslo, which are described in detail in Chapter 3.2. These quality databases were used as a reference standard since they are operated by geriatricians. The information on cognitive impairment was either assessed using IQCODE or information on advanced dementia (Dementia? YES or NO) from the medical charts, or from both records.

Data from the quality databases were compared with the information on cognitive impairment reported to the NHFR. Sensitivity, specificity, positive predictive value, and negative predictive value of the surgeons' reports were calculated. We used three different cut-off points:

1) Presence of dementia in the patient's medical journal

2) IQCODE over 3.44 and/or dementia

3) IQCODE over 4.0 and/or dementia

The different cut-off points led to somewhat different results regarding sensitivity, specificity, and positive and negative predictive value.

The patients for whom the surgeon had marked "uncertain" on chronic cognitive impairment were grouped together with patients classified as without cognitive impairment.

3.5. Reoperations and mortality

In the NHFR all subsequent reoperations, including closed reduction after dislocation of the prosthesis and soft tissue debridement, should be reported. Reoperations are reported on a similar form to that used for the primary operation, except for THA,

which are reported on the form used in the Norwegian Arthroplasty Register (NAR). The completeness of reoperations has been validated and found to be 80% for osteosynthesis, 73% for hemiarthroplasty, and 84% for THA [19]. In ***Paper II*** we analysed both the total number of reoperations and those after the two main categories of primary operations, hemiarthroplasty and osteosynthesis. Since it is possible to tick off a number of reasons for reoperation, we made a hierarchy of diagnoses when analysing reasons for reoperation. In ***Paper II*** we used the same hierarchy as that used by Kristensen et al. when studying reasons for reoperations in hemiarthroplasty [175]. We adapted the hierarchy to osteosynthesis using clinical experience to rank the different reasons for reoperations [175]. If a deep or superficial infection was present, this was always defined as the main reason for reoperation. Hemiarthroplasties were also analysed by fixation (cemented vs. uncemented) and by approach (anterior, lateral and posterior).

Patients reoperated with a THA were reported to the NAR. The NAR has less information on reasons for reoperation and these reoperations were recorded as "sequelae after proximal femoral fracture".

The NHFR receives information on dates of death and emigration from the National Population Register [159]. In ***Paper II*** mortality was assessed at 30 days, 90 days and one year. Overall mortality was also assessed.

3.6. Patient-Reported Outcome Measures (PROMs)

To assess health-related quality of life, the NHFR uses the Norwegian translation of EuroQol (EQ-5D-3L), which is a standardized non-disease-specific instrument [144]. An EQ-5D index score converts health profiles into a single summary score, where a score of 1 indicates the best possible state of health, and 0 indicates a state of health equal to death. The lowest score is -0.217, indicating a state of health worse than death. The questionnaire also contains a visual analogue scale (EQ-VAS). This is a 100 mm vertical line where patients can score their health from best possible to worst possible. We chose to exclude this question from our analysis, acknowledging the uncertainty in interpreting spatial tasks for persons with cognitive impairment [151, 176].

Each patient questionnaire includes information on who filled in the form, with the following options: the patient, a relative (including the relative's relationship to the patient), home care personnel, health care personnel, close friend or other. In ***Paper III*** we merged home care personnel and health care personnel into health personnel, and close friend and other into other.

The NHFR sends out a questionnaire after four, 12 and 36 months. Questions on preoperative health-related quality of life are included in the four-month questionnaire [164].

3.7. Statistics

The Pearson chi-square test was used for comparison of categorical variables in independent groups. The independent Student's t-test and analysis of variance (ANOVA) were used for continuous variables in independent groups. We did not adjust for patients who were operated on both sides. P-values <0.05 were considered statistically significant.

In ***Paper II*** we used the Kaplan-Meier method and Cox regression to examine time from primary surgery to reoperation. Patients were followed from primary operation until reoperation, death or end of study, whichever occurred first. Differences in reoperation risk between the groups were calculated using the Cox regression model, after adjusting for sex, age, ASA classification, fracture type and operation method. Hazard rate ratios (HRRs) were presented with 95% confidence intervals. We also used the Cox regression model to analyse differences in mortality, using the hip fracture patients without cognitive impairment as a reference. The 30-day, 90-day and one-year mortality were calculated after adjusting for the same factors. Proportional hazard assumptions were fulfilled when investigating visually using log-minus-log plots.

A Fine and Gray analysis was also used to examine whether mortality could be a competing risk to reoperation.

We used the IBM SPSS Statistics software, version 23.0-26.0, (IBM Corp, Armok, NY, USA) and the R statistical package, version 3.6.0 (R Foundation for Statistical Computing, Vienna, Austria). The studies were performed in accordance with the REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) statement [177].

4. Summary of Papers I-III

4.1. Paper I:

Validation of orthopaedic surgeons´ assessment of cognitive function in patients with acute hip fracture.

Kristoffersen MH, Dybvik E, Steihaug OM, Bartz-Johannesen CA, Martinsen MI, Ranhoff AH, Engesæter LB, Gjertsen JE. *BMC Musculoskelet Disord; 2019(20) 268.*

Background

About a quarter of patients with hip fracture have cognitive impairment. These patients are at higher risk of surgical and medical complications and are often excluded from participating in clinical research. The aim of this study was to investigate orthopaedic surgeons' ability to determine the cognitive status of patients with acute hip fracture and to compare the treatment given to patients with and without cognitive impairment.

Patients and methods

The cognitive function of 1474 hip fracture patients reported by the orthopaedic surgeons to the nationwide Norwegian Hip Fracture Register (NHFR) was compared with data recorded in quality databases in two hospitals with orthogeriatric care. Cognitive function recorded in the quality databases was determined either by the short form of the Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE) or by pre-fracture diagnosis of dementia. The information recorded in the quality databases was defined as the reference standard. Cognitive function in the NHFR was reported as: Chronic cognitive impairment? "Yes", "Uncertain" or "No" by the orthopaedic surgeons. Sensitivity, specificity, negative and positive predictive values for chronic cognitive impairment reported to the NHFR by the orthopaedic surgeons was calculated. Baseline data and treatment of hip fractures in patients with and without cognitive impairment in the NHFR were compared.

Results

Orthopaedic surgeons reporting to the NHFR reported chronic cognitive impairment in 31% of the patients. Using documented dementia or IQCODE > 4.0 as the reference, the assessment of cognitive impairment by the orthopaedic surgeons had a sensitivity of 69%, a specificity of 90%, a positive predictive value of 78%, and a negative predictive value of 84% compared to information recorded in the two hospital quality databases. There were no differences in type of hip fracture or type of surgical treatment by cognitive function.

Conclusion

The treatment of hip fractures was similar in patients with chronic cognitive impairment and cognitively well-functioning patients. The surgeons had an acceptable ability to identify and report chronic cognitive impairment in the peri-operative period, indicating that the NHFR is a valuable resource for future registry-based research including hip fracture patients with chronic cognitive impairment.

4.2. Paper II:

Cognitive impairment influences the risk of reoperation after hip fracture surgery: results of 87,573 operations reported to the Norwegian Hip Fracture Register.

Kristoffersen MH, Dybvik E, Steihaug OM, Kristensen TB, Engesaeter LB, Ranhoff AH, Gjertsen JE. *Acta Orthop 2020; 91 (2): 146-151.*

Background

A large number of hip fracture patients have cognitive impairment. We investigated whether patients' cognitive function affects surgical treatment, risk of reoperation, and mortality after hip fracture, based on data in the Norwegian Hip Fracture Register (NHFR).

Patients and methods

This prospective cohort study included 87 573 hip fractures reported to the NHFR in 2005-2017. Hazard rate ratios (HRRs) for risk of reoperation and mortality were calculated using Cox regression adjusted for sex, age, ASA class, fracture type, and surgical method.

Results

Cognitive impairment was reported in 27% of patients. They were older (86 vs. 82 years) and had higher ASA class than non-impaired patients. There were no differences in fracture type or surgical method. Cognitively impaired patients had a lower overall reoperation rate (4.7% vs. 8.9%, HRR 0.71; 95% CI 0.66–0.76) and lower risk of reoperation after osteosynthesis (HRR 0.58; CI 0.53–0.63) than non-impaired patients. Cognitively impaired hip fracture patients had an increased reoperation risk after hemiarthroplasty (HRR 1.2; CI 1.1–1.4), mainly due to dislocations (1.5% vs. 1.0%, HRR 1.7; CI 1.3–2.1). Risk of dislocation was particularly high following the posterior approach (4.7% vs. 2.8%, HRR 1.8; CI 1.2–2.7). Further, these patients had a higher risk of reoperation due to peri-prosthetic fracture after uncemented hemiarthroplasty (HRR 1.6; CI 1.0–2.6). Cognitively

impaired hip fracture patients had higher one-year mortality than those without cognitive impairment (38% vs. 16%, HRR 2.1; CI 2.1–2.2).

Conclusion

Our findings support the same surgical treatment for cognitively impaired patients as for healthy patients. But since the risk of hemi-prosthesis dislocation and peri-prosthetic fracture was higher in cognitively impaired patients, they should probably not have posterior approach surgery or uncemented implants.

4.3. Paper III:

Patient-reported outcome measures after hip fracture in patients with chronic cognitive impairment. Results from 34,675 patients in the Norwegian Hip Fracture Register

Kristoffersen MH, Dybvik E, Steihaug OM, Kristensen TB, Engesaeter LB, Ranhoff AH, Gjertsen JE. *Accepted in Bone and Joint Open 12 April 2021*

Background

Hip fracture patients have high morbidity and mortality. Patient-reported outcome measures (PROMs) assess the quality of care of patients with hip fracture, including those with chronic cognitive impairment (CCI). Our aim was to compare PROMs from hip fracture patients with and without CCI, using the Norwegian Hip Fracture Register (NHFR).

Patients and methods

PROM questionnaires at four months (n=34 675) and twelve months (n=24 510) after a hip fracture reported from 2005 to 2018 were analysed. Pre-injury score was reported in the four-month questionnaire. The questionnaires included the EuroQol (EQ-5D-3L), and information about who responded to the questionnaire.

Results

Of the 34 675 included patients, 5643 (16%) had CCI. Patients with CCI were older (85 vs. 81 years) ($p<0.001$), and had a higher ASA classification than patients without CCI. CCI was unrelated to fracture type and treatment method. EQ-5D index scores were lower in patients with CCI after four months (0.37 vs. 0.60, $p<0.001$) and 12 months (0.39 vs. 0.64, $p<0.001$). Patients with CCI had lower scores for all dimensions of the EQ-5D-3L, pre-fracture and at four and 12 months.

Conclusion

Patients with CCI reported lower health-related quality of life pre-fracture, and at four and twelve months after the hip fracture. PROM data from hip fracture patients with CCI are valuable in the assessment of treatment. Patients with CCI should be included in future studies.

5. Discussion

5.1. Register data and methodological considerations

Large health registers are a valuable source of information to study rare complications and trends over time [178]. Registers can also often be used for the study of rare interventions over time at a low cost [179]. The main purpose is to collect information on patients, implants and procedures in order to monitor and improve the path and outcome of a specific procedure [179].

5.1.1. Strengths of register studies

There are several advantages of a register study. Firstly, many complications occur very infrequently, and a high number of implants or patients are needed to detect a statistically significant difference. The large numbers of patients included in registries gives high statistical power and makes it possible to study even rare complications. Secondly, for both patients and researchers registries are less costly and time-consuming and can be used to verify results from RCTs in larger and natural clinical settings. Thirdly, in a register-based study the data are often collected over a longer period than in an RCT, which makes it easier to investigate trends and to collect epidemiological data.

Fourthly, all hospitals in Norway performing hip fracture surgery report to the NHFR. This gives the registry high external validity, because studies represent the treatment of all hip fracture patients in the whole country, treated by the average surgeon, not merely results from a single area or a single hospital.

The completeness of the NHFR is high [1, 180]. Together with coverage, the completeness of many variables and accuracy of the recorded variables give the Register high external validity.

5.1.2. Limitations of register studies

Register studies have also several limitations. Data quality can vary and affect the results, and lead to selection bias by unknown confounding factors [179]. The register may contain limited information. For example, the NHFR does not contain information on body mass index, comorbidities such as diabetes, socio-economic status, or smoking. These and other factors may affect hip fracture treatment and outcomes [181-183].

In the NHFR, difference in completeness for different surgical methods and variations in completeness of reporting from different hospitals can create bias. Poor completeness of response forms like the PROM questionnaires can also create selection bias, and results may only be representative of a certain type of responders.

Since the PROM questionnaires are sent out four months post-surgery and the questions on life quality before the hip fracture incident are thus answered four months later, this could lead to recall bias. Further, to collect all PROMs could require considerable effort to maintain an adequate response rate in trials. A study by Gjertsen et al. found that non-responders were older, had a higher ASA classification and more cognitive impairment [164]. We found similar results when analysing the baseline data of responders and non-responders in Paper III.
Because of the large number of participants in register studies, even differences that are not clinically important could be statistically significant. The clinical relevance of any statistically significant difference must therefore be taken into account.
Statistical relationships in observational studies, such as register studies, cannot be assumed as causality, due to the potential risk of unknown confounders [184]. Results should therefore be described as associations between the aim and the outcome.

5.1.3. Register-based studies versus randomized controlled trials (RCTs)

Randomized controlled trials (RCTs) represent the gold standard in clinical research, because of their high level of evidence [185]. However, RCTs can be both expensive and time-consuming to conduct, often involving a heavy workload. To answer some research questions a very large number of patients is needed, which makes it impossible to conduct an RCT. There are also research questions that are seen as unethical to randomize, and sometimes well-designed observational studies can be acceptable alternatives to RCTs [186, 187].

Register studies can, however, never be as conclusive as an RCT, because of the possible confounders. Despite this, an attempt is made to adjust for known confounders by using Cox regression analysis and logistic regression.

Another way of dealing with possible selection bias in observational studies is to use a propensity score to create matched patient cohorts [188].

To try to make the best of different research methods, registry-based randomized clinical trials have been introduced [189]. By including the principle of randomization in a large clinical register, the researcher can combine prospective randomization with a large-scale registry to enhance cost-effectiveness and increase power. There is a need for both RCTs and register studies as these two methods complement each other, rather than competing. Results from both RCTs and register studies should be taken into account when seeking answers from medical literature.

5.1.4. Patient-reported outcome measures (PROMs) in registers

The traditional outcomes in most register studies have been adverse events, secondary procedures, and mortality. It is, however, important to study the patients' own experiences and perspectives of the hip fracture incident and recovery. EQ-5D is

widely used with hip fracture patients, even those with cognitive impairment [151, 154, 190, 191].

PROM questionnaires can be used in clinical practice [192], in registries to monitor quality of care and in research [193, 194]. The International Society of Arthroplasty Registries (ISAR) Patient-Reported Outcome Measures (PROMs) Working Group has conducted an in-depth evaluation of how and which PROMs to use [195]. They recommend the use of EQ-5D, which is a validated questionnaire available in many languages [190, 196]. When using PROMs, missing data, minimally important differences and minimally detectable changes are important to take into account. Information about non-responders completes the picture. Response rates and minimally important changes provide information on how to interpret the data presented.
Minimal clinical important difference (MCID) is important to detect when using scales and indexes. MCID for the EQ-5D index score has been found to be 0.06-0.07 [197, 198].

PROMs from registers have provided important knowledge that has affected the surgical approach in hip arthroplasty. Many surgeons have changed from lateral to posterior approach when performing THA following the register study by Amlie et al. presenting PROM data and showing worse outcomes of a direct lateral approach than a posterior approach [199]. Ekegren et al. showed that PROMs reporting pain and discomfort six months after hip fracture, linked to register data, were associated with increased risk of revision [200].

Pre-injury PROM data are collected together with the four-month post-surgery questionnaire. This could lead to recall bias [201]. On the other hand, other studies have found participant recall to be accurate and recalled data to be trustworthy [202].

5.2. Research on patients with cognitive impairment

In hip fracture research there is a selection bias in the findings of most studies because they exclude hip fracture patients with cognitive impairment [203]. One reason could be that cognitively impaired patients may find it challenging to cooperate with the study protocol and may be unable to respond adequately to questions. Further, researchers may have concerns about patients with cognitive impairment and their ability to provide consent and therefore not plan for their inclusion, not screen them for inclusion or avoid asking them for written consent. Finally, in cases where proxies are necessary to provide consent for participation, the process of inclusion or consent may be more complicated and time-consuming.

5.2.1. Informed consent

For patients to be included in research, the basic principle is that they need to give their informed consent [204]. The benefit of participation must outweigh the possible risk of harm [205]. In some studies an exception is made, so that if a person is unable to give informed consent, a relative can provide consent [206]. One potential risk is that persons with cognitive impairment are excluded from studies because they might not have a near proxy who is able to give informed consent for them [207] and proxies may not consent because they emphasize that the person's well-being outweighs the research and community interests [204]. On the other hand, seen from the perspective of the researcher's and the community's interests, it might be unethical to exclude this large group of hip fracture patients from research [206].

The Norwegian National Research Ethics Committees have drawn up guidelines for considerations to be taken in cases of reduced ability to provide informed consent. They emphasize the importance of acknowledging the significance of ethically important moments with regard to informed consent [208]. According to Section 17 of the Norwegian Health Research Act, relatives can give consent on behalf of persons who lack competence to consent.

5.2.2. Validation

To validate the data on cognitive function in the NHFR, we chose to use sampling theory [209].

By randomly choosing individuals (simple random sampling), one can estimate the proportion of incorrectness and extrapolate to the whole population. This is easy but not necessarily representative.

By dividing a population into different strata (stratified random sampling), some strata can be selected and extrapolated to the whole population. Here, correctness can be estimated. It is a simple procedure, but all the participants in the strata need to participate. If information about the error distribution is known, the design can be improved.

By dividing the population into clusters and selecting some clusters (cluster sampling), one can estimate the proportion of incorrect data, and extrapolate to populations. Then only some parts will be represented in the validation and this procedure requires more patients than simple random sampling to achieve the same precision [210].

We chose to use cluster sampling. HDH and DH had information on cognitive impairment from the "dementia"? Yes/No response, or IQCODE 1-5.

The term "Uncertain" cognitive impairment in the NHFR was combined with the term "no cognitive impairment" in ***Paper I.***

When using IQCODE, different cut-offs can be used. A cut-off point of 3.3–3.6 in IQCODE has been used for detecting dementia in community settings, while 3.44–4.0 has been used in hospital settings [172].

In ***Paper I***, we showed the different ways of setting an endpoint in calculating sensitivity and specificity. Finally, we chose to present the IQCODE with a cut-off point of 4 and/or a known diagnosis of dementia as a reference standard, because hip fracture patients are quite old and in a hospital setting. This conservative reference standard might have resulted in undetected cases of cognitive impairment.

5.2.3. Cognitive assessment

It is challenging for an orthopaedic surgeon to assess cognitive function in an acutely admitted hip fracture patient. There are numerous screening tests available, but few of them have been validated in such a setting. The clock drawing test is used to test a wide variety of skills from memory to executive and spatial function [169]. It can be used if there is no information from either proxy or patient records, and is easy to use, needing no more than a piece of paper and a pen. However, the clock drawing test is merely a screening tool, and does not diagnose dementia or chronic cognitive impairment. Because it is sensitive to concentration, it will easily be affected by pain and discomfort, which are common in hip fracture patients. It is thus not an ideal screening tool in this setting.

The IQCODE is a questionnaire where a close relative answers questions on cognitive decline over a period of years. It can provide information on whether cognitive decline was present prior to the fracture and whether dementia may be present. It gives useful information particularly in acute settings where delirium is common and affects cognitive tests.

Some decline in cognition is normal in older age, but according to the criteria for the dementia diagnosis it should not affect self-care ability. Patient age and education level will have an effect in cognitive tests, which is why normative data for cut-off points of cognitive tests are available. However, these normative data are probably not used by orthopaedic surgeons in their daily clinical work.

4-AT

The four ‘A’s test (Arousal, Attention, Abbreviation Mental Test 4, and Acute change) is a rapid screening test of delirium and cognitive impairment in older patients [211]. It has been validated and found sensitive to identify delirium in

hospitalized older people [212-216]. Bellini found a sensitivity of 89.7 and a specificity of 84.1% [211].

It is an easy and straightforward test, which requires little training.

For hip fracture patients it has been found to be a useful tool in predicting immobility, prolonged length of stay, in-hospital death and change of residence on discharge [217].

It would be a simple screening tool for delirium and cognitive impairment in acute hip fracture patients, and easier to evaluate than the clock drawing test.

5.2.4. Patient-reported outcome measures in patients with cognitive impairment

The assessment of health-related quality of life in hip fracture patients with cognitive impairment presents challenges. Are such patients able to complete a PROM questionnaire? Studies have shown that patients with mild and moderate cognitive impairment could complete the EQ-5D [150, 152]. Parsons et al. found that EQ-5D reported by proxies of patients with cognitive impairment and hip fracture could also be trusted [154]. Different types of proxies may lead to different construct validity. Bryan et al. found that clinicians had higher validity for mobility and self-care (more observable dimensions). For family carers, construct validity was higher for less observable dimensions, such as usual activities and anxiety/depression [157]. Hounsome et al. found in their review that even after discussing the possible pitfalls of using proxies, such as different proxies, the ceiling effect and intra- and inter-proxy gaps, the EQ-5D was still useful for measuring health-related quality of life in patients with cognitive impairment [151].

5.3. Discussion of results

5.3.1. Paper I

In ***Paper I***, we found that the surgeons had an acceptable ability to identify chronic cognitive impairment.

To our knowledge, this is the first study to evaluate orthopaedic surgeons' assessment of cognitive function in hip fracture patients and their ability to identify chronic cognitive impairment.

Pre-fracture cognitive impairment has been found in 38% of hip fracture populations (IQ-CODE >3.6) in previous studies [134]. However, it is difficult to find other studies comparing cognitive assessment from different medical specialities. Smith et al. assessed nine eligible studies in their review of reliability and validity of different assessments of cognitive impairment in hip fracture patients, but there were significant methodological weaknesses. Only five of the studies described the recruitment methods clearly [105].

When screening elderly patients in the emergency department with the 4-AT screening tool, Evensen et al. found that 30% had cognitive impairment, but the method did not discriminate between acute and chronic impairment [218]. Jackson et al. found that 17% of patients over 70 had delirium when arriving at hospital. When screening these patients after three months, 38% of the patients with delirium were found to have a previously undiagnosed cognitive impairment upon arrival at hospital [219].

Our results showed high specificity and high negative predictive value. This indicated that it was easier for the orthopaedic surgeon to recognize the patients without cognitive impairment than those with cognitive impairment. We have to interpret this assessment as screening more than diagnostic. The acute injury may affect many older patients' level of cognition even when they do not have chronic cognitive impairment. Acute confusion or delirium can be misinterpreted as cognitive

impairment and dementia. Dementia can also be graded from mild to severe, and our screening does not differentiate according to grade.

Different cut-offs led to different results when reporting sensitivity/specificity, and positive and negative predictive values. For example, if only the criterion “dementia” was used, sensitivity was higher than if dementia and/or IQCODE were used (79.5% vs. 62.4%). We chose to include all the different cut-offs in our study, to show that sensitivity and specificity vary when using different cut-offs.

Based on our results we concluded that there is reason to have confidence in orthopaedic surgeons’ ability to recognize cognitive impairment. The results from Paper I show the unreliability of the data on cognitive impairment in the NHFR. To avoid over-interpretation of very small differences, one needs to understand these limitations. This reflects the uncertainty in classifying cognitive impairment in an acute setting.

5.3.2. Paper II

In ***Paper II***, we found no difference in fracture type or in treatment for different fracture types in relation to cognitive impairment. Reoperation rates differed, with higher rates for patients without cognitive impairment, especially when converting to THA. Further, as expected, mortality was higher for patients with cognitive impairment [18].

For patients undergoing hemiarthroplasty, the risk of dislocation was higher for patients with cognitive impairment, especially after the posterior approach. Further, risk of reoperation was higher after fracture in uncemented hemiarthroplasties. This is supported by other register studies and clinical studies [220-223]. Based on the results from ***Paper II***, we do not recommend the use of the posterior approach and uncemented stems in hip fracture patients with cognitive impairment.

Our study did not include hip fracture patients treated with a primary THA. These operations are reported to the Norwegian Arthroplasty Register, and therefore do not contain information on cognitive function. However, this is a rather small group of operations (n=2873). Studies have shown higher risk of dislocation in hip fracture patients undergoing THA [56]. Therefore, the use of THA in the primary treatment of hip fracture patients with cognitive impairment cannot be recommended.

Patients with cognitive impairment undergoing osteosynthesis had a lower risk of reoperation than non-impaired patients. In particular, patients with cognitive impairment had a reduced risk of reoperation with conversion to THA, probably because this method is less common in older, frail and multimorbid patients.

In orthopaedic surgery, a conversion to THA is an elective procedure with considerable preparation pre-operatively. It is also important that both patient and surgeon understand the limitations and risks of reoperations. Often cognitive impairment is considered as a contraindication for THA because of higher risk of dislocation [224].

We found that the risk of revision due to infection and dislocation was similar in patients with and without cognitive impairment. However, patients with cognitive impairment had a reduced risk of revision with relative indications, such as pain and sequelae after osteosynthesis, compared to those without cognitive impairment. Nonetheless, even with fewer reoperations, this does not necessarily mean that the results of primary surgery in patients with cognitive impairment are better. They probably have similar levels of sequelae, but the stress and strain of a reoperation might be too burdensome for cognitively impaired patients.

Mortality is doubled in patients with cognitive impairment, even after adjusting for age, comorbidity, and different treatments, after 30 and 90 days and one year. One-year mortality in our study was 16% for patients without cognitive impairment and 38% for patients with cognitive impairment. This is in line with previous studies [225-228]. Statistics Norway publishes mean figures for risk of death among Norwegians of different ages. The one-year probability of death is 5% for an 82-year old (the same age as the average hip fracture patient without cognitive impairment), and 7.4% for an 85-year old (the same age as for a patient with cognitive impairment) [229]. Accordingly, our study demonstrates excess mortality associated with both the hip fracture and cognitive impairment.

5.3.3. Paper III

In ***Paper III***, we found reduced health-related quality of life in hip fracture patients four and 12 months postoperatively. Hip fracture patients with cognitive impairment had the lowest health-related quality of life at baseline, and also the greatest decline. This was particularly due to a reduction in walking function, self-care capacity, and the ability to perform usual activities.

To our knowledge, this is the largest study ever conducted using PROM data from hip fracture patients with cognitive impairment. The data represent nationwide results with almost all types of hip fractures included, making the findings more representative of all hip fracture patients and increasing external validity. THA is excluded from the study, since this type of surgery does not include information on cognitive function. However, these patients only represent 2.4% of patients in the NHFR and we assume that very few of them have cognitive impairment.

We found that the EQ-5D-3L index score was 0.64 for patients without cognitive impairment after one year, and 0.39 for patients with cognitive impairment. Milte et al. found an EQ-5D-3L index score of 0.545 for hip fracture patients with cognitive impairment, but this was 1-3 weeks after surgery and the findings are not directly comparable [230]. However, our results showing a decrease in health-related quality of life are in line with several studies of all hip fracture patients [155, 164, 231].

Hansson et al. found that 29% of all hip fracture patients regained previous mobility and that patients with dementia had lower EQ-5D index scores [232]. In our study, 28.4% of hip fracture patients with cognitive impairment and 33.1% of hip fracture patients without cognitive impairment regained their pre-fracture EQ-5D scores.

We found a sevenfold increase in the numbers confined to bed one year after surgery among patients with cognitive impairment. A high increase in non-walkers was also reported in a study by Mukka et al., but only 36 patients with cognitive impairment remained after one year in their study [233]. Søderqvist et al. also studied the influence of cognitive impairment on hip fracture outcome and found that hip fracture patients

with cognitive impairment had a lower quality of life, reduced walking ability, and reduced functioning in activities of daily living [228].

There are limitations in assessing HR-QoL in hip fracture patients with cognitive impairment. Our studies do not take into account different levels or types of cognitive impairment. Despite discrepancies in mobility and self-care, the studies have shown high validity, and EQ-5D remains useful [151].

The response rate at four months was low and the non-responders included a large number of patients with cognitive impairment. This could have led to selection bias, since our study thus included the most healthy (lower ASA class) and youngest patients. This could indicate that the results for all hip fracture patients might be even poorer than the results we present.

We have no information on post-operative rehabilitation in our study. This could be a confounder, since there could be differences in the rehabilitation offered to hip fracture patients according to cognitive function, and this could lead to bias in walking ability.

6. Conclusions

Paper I:

- Orthopaedic surgeons had an acceptable ability to identify and report chronic cognitive impairment in the peri-operative period, indicating that the NHFR is a valuable resource for research on hip fracture patients, including those with chronic cognitive impairment.

Paper II:

-The prevalence of cognitive impairment in hip fracture patients reported to the NHFR was 27%. In 10% of the cases the orthopaedic surgeons were uncertain of the cognitive function and in 63% the hip fracture patients were found to be without cognitive impairment.

-The presence of cognitive impairment did not influence the choice of surgical treatment for different types of hip fractures.

- Compared to cognitively fit patients, cognitively impaired patients had

- a lower overall reoperation rate after hip fracture
- a lower risk of reoperation after osteosynthesis
- higher one-year mortality

- Cognitively impaired patients treated with hemiarthroplasty with an uncemented stem or using a posterior approach had a notably higher risk of periprosthetic fracture and dislocation, respectively. Uncemented stems and the posterior approach should therefore probably be avoided in cognitively impaired patients.

Paper III:

- Patients with cognitive impairment reported significantly lower health-related quality of life before and four and 12 months after a hip fracture than non-impaired patients.

Results from hip fracture patients with cognitive impairment, who represent a particularly vulnerable group, should be included in future studies.

7. Clinical implications

Based on the findings in this thesis, alternative tests could be considered, like the 4-AT test for delirium and cognitive impairment for assessment in the NHFR instead of the clock drawing test.

Further, we cannot recommend the use of the posterior approach and uncemented stems for hip fracture patients with cognitive impairment.

For patients treated with osteosynthesis it is important to perform a solid, weight-bearing fixation, to enable the patient to start rehabilitation as early as possible after a hip fracture. This is especially important for hip fracture patients with cognitive impairment who have difficulty complying with restrictions and might not report pain and discomfort as easily as hip fracture patients without cognitive impairment.

Due to the high number of non-walkers among hip fracture patients with cognitive impairment, it is beneficial to focus on rehabilitation for this group. Including hip fracture patients with cognitive impairment in hip fracture studies might yield more relevant results, also when studying PROMs.

8. Future research

8.1. Quality-Adjusted Life Years (QALYs) after hip fractures

The trend to attempt to measure health outcome in terms of quality-adjusted life years is also appearing in hip fracture research [231, 234]. Fleurence et al. have measured the cost-effectiveness of fracture prevention treatments in hip fractures [235]. Using data from the NHFR, it is possible to examine the cost-effectiveness of different treatments of hip fractures and also to investigate QALYs in different groups, including patients with cognitive impairment.

8.2. Comparing orthogeriatric and conventional hip fracture wards

There are different models of orthogeriatric care in different hospitals in Norway [129]. A comparison of traditional orthopaedic wards and orthogeriatric wards in single-centre studies has been published [236]. It would be interesting to compare results from hospitals with different models of orthogeriatric care and orthopaedic wards with and without geriatricians, by using data from the NHFR. It would be useful to explore whether different orthogeriatric care settings resulted in differences for hip fracture patients with cognitive impairment.

8.3. Further research on PROM data in hip fracture patients

In ***Paper III*** we analysed PROM data comparing patients with and without cognitive impairment. It would be interesting to explore the possibility of predicting reoperations by examining PROM data, and whether mortality varied based on PROM data, or whether PROM data changed after a reoperation. In an Australian study the authors found that PROMs reporting pain and discomfort six months after a hip fracture were associated with a 9.5-fold greater risk of a later arthroplasty [200].

8.4. Randomized controlled trials in registry- based studies

It is possible to combine the advantage of a registry in including many patients and the associated logistics with randomized controlled trials. By including randomization modules in the NHFR the advantages of both randomization and large scale could be realized [178, 189, 237].

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10. Appendices

Appendix I: Operation form from the Norwegian Hip Fracture Register (in Norwegian)

Appendix II: PROMS questionnaire, EQ-5D-3L (in Norwegian)

Appendix III: Clock-drawing test

Appendix IV: IQCODE

Appendix V: 4-AT

Papers I-III

NASJONALT HOFTEBRUDDREGISTER
Nasjonalt Register for Leddproteser
Helse Bergen HF, Ortopedisk klinikk
Haukeland universitetssjukehus
Møllendalsbakken 11
5021 BERGEN
Tlf: 55976452

F.nr. (11 sifre).....

Navn:.....

(Skriv tydelig ev. pasientklistrelapp – **spesifiser sykehus**.)

Sykehus:.....

HOFTEBRUDD

PRIMÆRE OPERASJONER PÅ BRUDD I PROKSIMALE FEMURENDE og ALLE REOPERASJONER, inkludert lukket reponering av hemiproteser. Ved primæroperasjon med totalprotese og ved reoperasjon til totalprotese brukes kun hofteproteseskjema. Alle produktklistrelapper settes i merket felt på baksiden av skjemaet.

AKTUELLE OPERASJON
☐1 Primæroperasjon ☐ 2 Reoperasjon

SIDE (ett kryss) (Bilateral opr.= 2 skjema)
☐1 Høyre ☐2 Venstre

OPR TIDSPUNKT (dd.mm.åå) |__|__| |__|__| |__|__| kl |__|__|

BRUDD TIDSPUNKT (dd.mm.åå) |__|__| |__|__| |__|__| kl |__|__|
Dersom det er usikkerhet om bruddtidspunkt, fyll ut neste punkt.

TID FRA BRUDD TIL OPERASJON I TIMER
☐1 0-6 ☐2 >6-12 ☐3 >12-24 ☐4 >24-48 ☐5 >48

KOGNITIV SVIKT
☐0 Nei ☐1 Ja (Se test på baksiden) ☐2 Usikker

ASA-KLASSE (se bakside av skjema for definisjon)
☐1 Frisk
☐2 Asymptomatisk tilstand som gir økt risiko
☐3 Symptomatisk sykdom
☐4 Livstruende sykdom
☐5 Moribund

TYPE PRIMÆRBRUDD (ÅRSAK TIL PRIMÆROPERASJON) (Kun ett kryss)
Se baksiden for klassifikasjon
☐1 Lårhalsbrudd udislokert (Garden 1 og 2)
☐2 Lårhalsbrudd dislokert (Garden 3 og 4)
☐3 Lateralt lårhalsbrudd
☐4 Pertrokantært tofragment (AO klassifikasjon A1)
☐5 Pertrokantært flerfragment (AO klassifikasjon A2)
☐9 Intertrokantært (AO klassifikasjon A3)
☐6 Subtrokantært
☐7 Annet, spesifiser.....

TYPE PRIMÆROPERASJON (Kun ett kryss)
(Fylles ut bare ved primæroperasjon - eget skjema for totalproteser)
(Fest produktklistrelapp på baksiden eller spesifiser nøyaktig produkt)
☐1 To skruer eller pinner
☐2 Tre skruer eller pinner
☐3 Bipolar hemiprotese
☐4 Unipolar hemiprotese
☐5 Glideskrue og plate
☐6 Glideskrue og plate med trokantær støtteplate
☐7 Vinkelplate
☐8 Kort margnagle uten distal sperre
☐9 Kort margnagle med distal sperre
☐10 Lang margnagle uten distal sperre
☐11 Lang margnagle med distal sperre
☐12 Annet, spesifiser.....

Navn / størrelse og katalognummer.....

ÅRSAK TIL REOPERASJON (Flere enn ett kryss kan brukes)
☐1 Osteosyntesesvikt/havari
☐2 Ikke tilhelet brudd (non-union/pseudartrose)
☐3 Caputnekrose (segmentalt kollaps)
☐4 Lokal smerte pga prominerende osteosyntesemateriale
☐5 Brudd tilhelet med feilstilling
☐6 Sårinfeksjon – overfladisk
☐7 Sårinfeksjon – dyp
☐8 Hematom
☐9 Luksasjon av hemiprotese
☐10 Osteosyntesematerialet skåret gjennom caput
☐11 Nytt brudd rundt implantat
☐12 Løsning av hemiprotese
☐13 Annet, spesifiser.....

TYPE REOPERASJON (Flere enn ett kryss kan brukes)
(Fest produktklistrelapp på baksiden eller spesifiser nøyaktig produkt)
☐1 Fjerning av implantat (Brukes når dette er eneste prosedyre)
☐2 Girdlestone (= fjerning av implantat og caput)
☐3 Bipolar hemiprotese
☐4 Unipolar hemiprotese
☐5 Re-osteosyntese
☐6 Debridement for infeksjon
☐7 Lukket reposisjon av luksert hemiprotese
☐8 Åpen reposisjon av luksert hemiprotese
☐9 Annet, spesifiser.....

Navn / størrelse og katalognummer.....

FIKSASJON AV HEMIPROTESE
(For totalprotese sendes eget skjema til hofteproteseregisteret)
☐1 Usementert ☐1 med HA ☐2 uten HA
☐2 Sement med antibiotika Navn.....
☐3 Sement uten antibiotika Navn.....

PATOLOGISK BRUDD (Annen patologi enn osteoporose)
☐0 Nei ☐1 Ja, type.....

TILGANG TIL HOFTELEDDET VED HEMIPROTESE (Kun ett kryss)
☐1 Fremre (mellom sartorius og tensor)
☐2 Anterolateral (mellom gluteus medius og tensor)
☐3 Direkte lateral (transgluteal)
☐4 Bakre (bak gluteus medius)
☐5 Annet, spesifiser.....

ANESTESITYPE
☐1 Narkose ☐2 Spinal ☐3 Annet, spesifiser.....

PEROPERATIVE KOMPLIKASJONER
☐0 Nei ☐1 Ja, hvilke(n).....

OPERASJONSTID (hud til hud).....minutter.

ANTIBIOTIKAPROFYLAKSE ☐0 Nei ☐1 Ja

	Navn	Dosering	Varighet i timer
Medikament 1			.....timer
Medikament 2			.....timer
Medikament 3			.....timer

TROMBOSEPROFYLAKSE
☐0 Nei ☐1 Ja: Første dose ☐1 Preoperativt ☐2 Postoperativt
Medikament 1 ..... Dosering opr.dag.....
Dosering videre ..... Varighet ..... døgn
Medikament 2 ..... Dosering ..... Varighet ..... døgn

FAST TROMBOSEPROFYLAKSE
☐0 Nei ☐1 Ja, type: .....

FIBRINOLYSEHEMMER
☐0 Nei ☐1 Ja, medikament : ..... Dosering .....

OPERATØRERFARING
Har en av operatørene mer enn 3 års erfaring i hoftebruddkirurgi? ☐0 Nei ☐1 Ja

Lege.....
Legen som har fylt ut skjemaet (navnet registreres ikke i databasen).

202 038 Bergen Grafisk as - 01.2016

RETTLEDNING

Registreringen gjelder alle operasjoner for hoftebrudd (lårhals, pertrokantære og subtrokantære) og alle reoperasjoner, også reposisjoner, på pasienter som er primæroperert og reoperert for hoftebrudd. **Ved primæroperasjon med totalprotese og ved reoperasjon til totalprotese sendes bare skjema til hofteproteseregisteret.**
Ett skjema fylles ut for hver operasjon. Originalen sendes Haukeland universitetssjukehus og kopien lagres i pasientens journal. Pasientens fødselsnummer (11 sifre) og sykehuset må være påført. Aktuelle ruter markeres med kryss. Pasienten skal på eget skjema gi samtykke til registrering i Nasjonalt hoftebruddregister.

Kommentarer til enkelte punkt:
OPERASJONS- OG BRUDDTIDSPUNKT
Operasjonstidspunkt (dato og klokkeslett) må føres opp på alle primæroperasjoner. Det er også sterkt ønskelig at dato og klokkeslett for *bruddtidspunkt* føres opp. Dette bl.a. for å se om tid til operasjon har effekt på prognose. (Hvis en ikke kjenner klokkeslettet for bruddtidspunkt lar en feltet stå åpent. En må da prøve å angi omtrentlig tidsrom fra brudd til operasjon på neste punkt).
Ved reoperasjon er ikke klokkeslett nødvendig.

KOGNITIV SVIKT
Kognitiv svikt kan eventuelt testes ved å be pasienten tegne klokken når den er 10 over 11. En pasient med kognitiv svikt vil ha problemer med denne oppgaven.

ASA-KLASSE (ASA=American Society of Anesthesiologists)
ASA-klasse 1: Friske pasienter som røyker mindre enn 5 sigaretter daglig.
ASA-klasse 2: Pasienter med en asymptomatisk tilstand som behandles medikamentelt (f.eks hypertensjon) eller med kost (f.eks diabetes mellitus type 2) og ellers friske pasienter som røyker 5 sigaretter eller mer daglig.
ASA-klasse 3: Pasienter med en tilstand som kan gi symptomer, men som holdes under kontroll medikamentelt (f.eks moderat angina pectoris og mild astma).
ASA-klasse 4: Pasienter med en tilstand som ikke er under kontroll (f.eks hjertesvikt og astma).
ASA-klasse 5: Moribund/døende pasient

GARDENS KLASSIFISERING AV LÅRHALSBRUDD
Garden 1: Ikke komplett brudd av lårhalsen (såkalt innkilt)
Garden 2: Komplett lårhalsbrudd uten dislokasjon
Garden 3: Komplett lårhalsbrudd med delvis dislokasjon. Fragmentene er fortsatt i kontakt, men det er feilstilling av lårhalsens trabekler. Caputfragmentet ligger uanatomisk i acetabulum.
Garden 4: Komplett lårhalsbrudd med full dislokasjon. Caputfragmentet er fritt og ligger korrekt i acetabulum slik at trabeklene er normalt orientert.

AO KLASSIFIKASJON AV TROKANTÆRE BRUDD


A1: Pertrokantært tofragment brudd


A2: Pertrokantært flerfragment brudd


A3: Intertrokantært brudd


Subtrokantært brudd*

*Subtrokantært brudd: Bruddsentrum er mellom nedre kant av trokanter minor og 5 cm distalt for denne.

REOPERASJONSÅRSAK
Dyp infeksjon defineres som infeksjon som involverer fascie, protese, ledd eller periprotetisk vev.

IMPLANTAT
Implantattype må angis entydig. Produktklistrelapp er ønskelig for å angi katalognummer for osteosyntesematerialet eller protesen som er brukt.

PEROPERATIVE KOMPLIKASJONER
Vi ønsker også å få meldt dødsfall på operasjonsbordet og peroperativ transfusjonstrengende blødning.

ANTIBIOTIKAPROFYLAKSE
Her føres det på hvilket antibiotikum som er blitt benyttet i forbindelse med operasjonen. Det anføres dose, antall doser og profylaksens varighet. F.eks. Medkament 1: Keflin 2g x 4, med varighet 4,5 timer.

TROMBOSEPROFYLAKSE
Medikament, dose og antatt varighet av profylaksen skal angis separat for oprerasjonsdagen og senere. Det skal også oppgis om pasienten står fast på tromboseprofylakse (AlbylE, Marevan, Plavix ol).

FIBRINOLYSEHEMMER
Her føres det på om en benytter blødningsreduserende legemidler i forbindelse med operasjonen (f.eks. Cyklokapron).

Kontaktpersoner vedrørende registreringsskjema er:
Overlege Jan-Erik Gjertsen, Ortopedisk klinikk, Haukeland universitetssjukehus. Tlf. 55 97 56 86 (email: jan-erik.gjertsen@helse-bergen.no)
Prosjektkoordinator Nasjonalt Hoftebruddregister: Lise B. Kvamsdal. Tlf. 55 97 64 52 (email: nrl@helse-bergen.no)
Internett: http://nrlweb.ihelse.net/

PRODUKTKLISTRELAPPER:

NASJONALT HOFTEBRUDDREGISTER
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Helse Bergen HF, Ortopedisk klinikk
Haukeland Universitetssykehus
Møllendalsbakken 11
5021 BERGEN

PASIENTSPØRRESKJEMA NASJONALT HOFTEBRUDDREGISTER

1. Dato for utfylling av skjema: |__|__| |__|__| |__|__|

2. Spørreskjemaet er besvart av:

☐ [1] Meg selv

eller ved hjelp av….(kryss av i ruten som gjelder)

☐ [2] Slektning (ektefelle, barn)
☐ [3] God venn eller annen nærstående
☐ [4] Annen privat person
☐ [5] Hjemmesykepleier/hjemmehjelp
☐ [6] Annen person, angi hvem:_____

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I de neste 5 spørsmålene ønsker vi å vite hvordan livssituasjonen din var FØR du fikk hofte/lårhalsbruddet som du ble operert for.

3. Hvordan opplevde du gangevnen din?

- ☐ [1] Jeg hadde ingen problemer med å gå omkring
- ☐ [2] Jeg hadde litt problemer med å gå omkring
- ☐ [3] Jeg var sengeliggende

4. Hvordan klarte du personlig stell?

- ☐ [1] Jeg hadde ingen problemer med personlig stell
- ☐ [2] Jeg hadde litt problemer med å vaske meg eller kle meg
- ☐ [3] Jeg klarte ikke å vaske meg eller kle meg

5. Hvordan klarte du dine vanlige gjøremål (f.eks. arbeid, studier, husarbeid, familie- og fritidsaktiviteter)?

- ☐ [1] Jeg hadde ingen problemer med å utføre mine vanlige gjøremål
- ☐ [2] Jeg hadde litt problemer med å utføre mine vanlige gjøremål
- ☐ [3] Jeg var ute av stand til å utføre mine vanlige gjøremål

6. Smerter eller ubehag?

- ☐ [1] Jeg hadde verken smerte eller ubehag
- ☐ [2] Jeg hadde moderat smerte eller ubehag
- ☐ [3] Jeg hadde sterk smerte eller ubehag

7. Angst eller depresjon?

- ☐ [1] Jeg var verken engstelig eller deprimert
- ☐ [2] Jeg var noe engstelig eller deprimert
- ☐ [3] Jeg var svært engstelig eller deprimert

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Nasjonalt Register for Leddproteser
Helse Bergen HF, Ortopedisk klinikk
Haukeland Universitetssykehus
Møllendalsbakken 11
5021 BERGEN

I de 5 neste spørsmålene ønsker vi å vite hvordan livssituasjonen din er NÅ:

8. Hvordan opplever du gangevnen din?

- ☐ [1] Jeg har ingen problemer med å gå omkring
- ☐ [2] Jeg har litt problemer med å gå omkring
- ☐ [3] Jeg er sengeliggende

9. Hvordan klarer du personlig stell?

- ☐ [1] Jeg har ingen problemer med personlig stell
- ☐ [2] Jeg har litt problemer med å vaske meg eller kle meg
- ☐ [3] Jeg klarer ikke å vaske meg eller kle meg

10. Hvordan klarer du dine vanlige gjøremål (f.eks. arbeid, studier, husarbeid, familie- og fritidsaktiviteter)?

- ☐ [1] Jeg har ingen problemer med å utføre mine vanlige gjøremål
- ☐ [2] Jeg har litt problemer med å utføre mine vanlige gjøremål
- ☐ [3] Jeg er ute av stand til å utføre mine vanlige gjøremål

11. Smerter eller ubehag?

- ☐ [1] Jeg har verken smerte eller ubehag
- ☐ [2] Jeg har moderat smerte eller ubehag
- ☐ [3] Jeg har sterk smerte eller ubehag

12. Angst eller depresjon?

- ☐ [1] Jeg er verken engstelig eller deprimert
- ☐ [2] Jeg er noe engstelig eller deprimert
- ☐ [3] Jeg er svært engstelig eller deprimert

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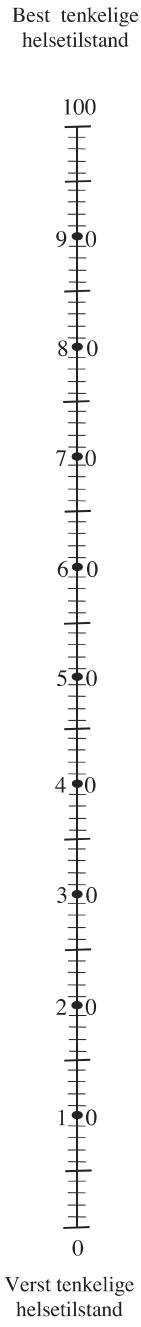
13. Din helsetilstand i dag.

For å hjelpe folk til å si hvor god eller dårlig en helsetilstand er, har vi laget en skala (omtrent som et termometer) hvor den beste tilstanden du kan tenke deg er merket 100 og den verste tilstanden du kan tenke deg er merket 0.

Vi vil gjerne at du viser på denne skalaen hvor god eller dårlig helsetilstanden din er i dag, etter din oppfatning. Vær vennlig å gjøre dette ved å trekke en linje fra boksen nedenfor til det punktet på skalaen som viser hvor god eller dårlig din helsetilstand er i dag.

Din egen helsetilstand i dag



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SMERTE

14. Sett ett kryss på den streken som du synes tilsvarer din gjennomsnittlige smerteopplevelse fra den opererte hoften den siste måneden:

Ingen smerte — Maksimal smerte

lett | moderat | middels | sterk | uutholdelig

TILFREDSHET

15. Sett ett kryss på den streken som du synes tilsvarer hvor fornøyd du er med operasjonsresultatet:

Fornøyd — Misfornøyd

svært fornøyd | fornøyd | middels fornøyd | misfornøyd | svært misfornøyd

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16. Har du besvær fra den andre hoften?

☐ 1 Ja ☐ 2 Nei

17. Er det andre årsaker til at du har problemer med å gå?
(For eksempel smerter fra andre ledd, ryggsmerter, hjerte-karsykdom eller andre sykdommer som påvirker gangevnen din)

☐ 1 Ja ☐ 2 Nei

18. Har du hatt nye operasjoner i den samme hoften som ble operert for hoftebrudd?

☐ 1 Ja ☐ 2 Nei

Takk for at du tok deg tid til å svare på spørsmålene. Dine svar er svært nyttige for oss. Vennligst send spørreskjemaet i retur til oss i den ferdig frankerte svarkonvolutten.

Aldring og helse
Nasjonal kompetansetjeneste

Helsedirektoratet

NORSK REVIDERT KLOKKETEST (KT-NR2)

Carsten Strobel, Hans Johansen, Peter Bekkhus-Wetterberg og Knut Engedal, 2014

Klokketest er en kognitiv screeningtest som ofte benyttes som ledd i utredning og forløpskontroll av demens, hjerneslag, egnethet for bilkjøring o.l. Testen kan avdekke svikt i semantisk hukommelse, rom-/retning- og tidsorienteringsevne, visuopersepsjon (f.eks. vansker med visuell identifisering og analyse eller visuell agnosi), visuell oppmerksomhet (f.eks. visuell neglekt) samt evnen til abstrakt tenkning, organisering og planmessig utføring av testresponser (eksekutiv funksjon). Administrasjon forutsetter at pasienten (PAS) behersket klokken før sykdom. Synssvekkelse, tremor, nedsatt førlighet, høy alder og lav utdanning kan påvirke testutførelse negativt. Prestasjonsnivå kan endre seg ved flere psykiatriske og somatiske sykdomstilstander/-faser, som tidvis skåringsbedring ved vellykket behandling av depresjon og delirium/akutt forvirring, eller lavere skåre over tid som ved demens.

Instruksjon

Utfør testing en-til-en, uten pårørende til stede. Sørg for at PAS ikke kan se på egen/andres klokke eller veggklokke ved utførelse og at PAS ikke roterer arket ved tallinnsettelse. Les fet skrift (**bold**) høyt, tydelig og langsomt. Hvert instruksjonsledd kan gis 3 ganger.

1. Legg arket med trykt sirkel, blyant og viskelær på bordet foran PAS.
   Si: **Denne sirkelen forestiller en helt vanlig klokke. Jeg vil nå at du, uten å se på en annen klokke, setter inn alle tallene som er på en vanlig klokke. Gjør det så nøyaktig som mulig.**

Setter PAS kun inn noen tall (f.eks. 3, 6, 9, 12), gjenta instruksjon og legg vekt på ordet *alle*. Små markeringsstreker for hvor tallene skal stå aksepteres, men settes hjelpestreker tvers igjennom klokkeskiven for å lage sektorer eller tegnes en stoppeklokke (tall fra 1–60 eller kun 15, 30, 45, 60) skal dette stoppes av testleder (TL). Readministrer i slike tilfeller KT-NR på nytt klokketestark, gjenta instruksjon og legg vekt på ordet *vanlig*. Fortsetter PAS likevel å inndele klokken i sektorer eller på nytt tegner en stoppeklokke, avbryt testen.

2. Etter at PAS har satt inn tallene på klokkeskiven (uavhengig av om tall er utelatt eller feilplassert),
   si: **Tegn nå inn viserne slik at klokken er nøyaktig ti over elleve.** Bruk alltid samme klokkeslett ved retesting.

Er PAS misfornøyd med utførelse, oppfordre til å korrigere. Vil PAS korrigere mye, bruk nytt klokketestark, maks. 3 ark. Er TL i tvil om utførelse er korrekt eller valid/gyldig, readministrer KT-NR på nytt klokketestark. Settes visere korrekt, men kun tall fra 12–23 eller 13–24, readministrer KT-NR med følgende instruksjon: **Sett inn tall på nytt. Jeg vil nå at du *kun* setter inn de timetallene som er på en helt *vanlig* klokke.** Etter tallinnsettelse, si: **Tegn nå inn viserne slik at klokken er nøyaktig ti over elleve.** Settes visere korrekt ved readministrasjon, men kun tall fra 12–23 eller 13–24, gi 3 poeng og kommenter utførelse. Settes derimot visere og alle tall på rett plass 1–12 eller 1–24 (korresponderende tall i 2 sirkler/doble tallsett) gi 5 poeng. Ved korrekt klokkeslett, men lik lengde på visere, be PAS presisere hva som er lang og kort viser: Gi 5 poeng om korrekt, 4 poeng om visere er byttet om.

Vær oppmerksom på «vanlige» feil blant funksjonsfriske som *ikke* gir poengtrekk (alle tall konsekvent på utsiden av klokkeskiven, visere går ikke helt inn til senter av sirkelen) slik at skåring og funksjonsvurdering ikke overdiagnostiserer kognitiv funksjonsnedsettelse. Ikke godkjent klokke (0–3 poeng) betyr at det foreligger en mulig kognitiv svikt som må undersøkes nærmere.

For vurdering og videreformidling av resultat gir kvalitativ beskrivelse av utførelse mer informasjon enn kun poeng eller oppsummeringer som «Patologisk Klokketest». Bemerk påfallende forhold som forsøk på arkrotasjon, blanding arabiske/romertall, byttet lang/kort viser, mange korrigeringer, lang tidsbruk, usikkerhet, behov for gjentakelse av instruksjon eller readministrasjon, årsaker til testavbrudd e.l.

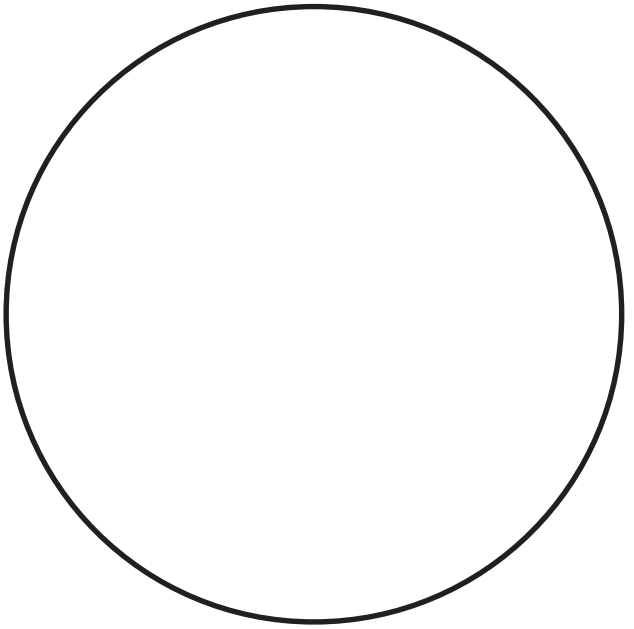
Pasient: _____ Testleder: _____ Dato: _____

Satte PAS i første forsøk visere korrekt, men kun inn tall fra 12–23 eller 13–24? Ja ☐ Nei ☐
Hvis ja, gjentok det samme seg ved readministrasjon med supplerende instruksjon? Ja ☐ Nei ☐

Skåring KT-NR2 (0–5):	Godkjent klokke: 4–5 poeng. Ikke godkjent klokke: 0–3 poeng
5 ☐	Klokke med korrekt angitt klokkeslett og alle tallene på rett plass 1–12/I–XII, alternativt 1–24 i doble tallsett/2 sirkler
4 ☐	Små plasseringsfeil tall/visere. Tall/visere rett, men tall kombinert ut-/innside eller arabiske/romertall. Byttet lang/kort viser
3 ☐	Tallene er riktig/omtrent riktig plassert, men visere klart feilplassert. Visere korrekt, men kun tall fra 12–23 eller 13–24
2 ☐	Tallene er så feilplassert eller forskjøvet at det er vanskelig å plassere visere riktig. 1–24 med tallene i én sirkel
1 ☐	Uttalt feilplassering av tall, tall stokket om på eller utelatt tross gjentatt instruksjon. PAS fortsetter med tall over 24
0 ☐	Ser ikke ut som en klokke, PAS skriver ev. bokstaver på arket, eller gjør ikke noe forsøk på å skrive inn tall

Spesielt å bemerke: _____

Versjon 2, 18.05.2014



Aldring og helse
Nasjonal kompetansetjeneste

Revidert 2019
INTERN-NR: 00008

IQCODE – Spørreskjema til pårørende

IQCODE (Informant Questionnaire on Cognitive Decline in the Elderly, short version). Jorm, 1994.
Til norsk ved H.A. Nygaard og A. Bragason.

Pasientens navn: _____ Dato for samtale: _____

Pårørendes navn: _____ Slektskap: _____

Utfylt av: _____

Når du besvarer spørsmålene, tenk på hvordan din slektning eller venn var for ti år siden, og sammenlign med situasjonen i dag. Nedenfor er angitt noen situasjoner hvor vedkommende må bruke sitt intellekt. Vurder om dette er blitt bedre, er uforandret eller har forverret seg **i løpet av de siste ti årene**. Hvis din slektning eller venn ikke husket hvor han/hun la fra seg ting for ti år siden og det samme er tilfelle i dag, skal dette besvares med ikke særlig forandret.

SVARALTERNATIV
1 Mye bedre
2 Litt bedre
3 Ikke særlig forandret
4 Litt verre
5 Mye verre

		1	2	3	4	5
1.	**Huske ting som gjelder familie og venner, f.eks. yrke, fødselsdager og adresser**	☐	☐	☐	☐	☐
2.	**Huske ting som nylig har hendt**	☐	☐	☐	☐	☐
3.	**Huske samtaler noen dager etterpå**	☐	☐	☐	☐	☐
4.	**Huske egen adresse og eget telefonnummer**	☐	☐	☐	☐	☐
5.	**Huske hvilken dag og måned det er**	☐	☐	☐	☐	☐
6.	**Huske hvor ting vanligvis er oppbevart**	☐	☐	☐	☐	☐
7.	**Huske hvor ting ligger selv om de ikke er lagt på vanlig sted**	☐	☐	☐	☐	☐
8.	**Vite hvordan en bruker kjente husholdningsapparater**	☐	☐	☐	☐	☐
9.	**Lære seg å bruke et nytt redskap eller apparat i huset**	☐	☐	☐	☐	☐
10.	**Lære seg nye ting i sin alminnelighet**	☐	☐	☐	☐	☐
11.	**Følge handlingen i en bok eller på TV**	☐	☐	☐	☐	☐
12.	**Ta avgjørelser i hverdagen**	☐	☐	☐	☐	☐
13.	**Håndtere penger ved innkjøp**	☐	☐	☐	☐	☐
14.	**Ta hånd om personlig økonomi, pensjon, bank osv.**	☐	☐	☐	☐	☐
15.	**Regneferdigheter i dagliglivet, f.eks. å vite hvor mye mat en skal kjøpe inn, hvor lang tid det går mellom besøk fra familie og venner osv.**	☐	☐	☐	☐	☐
16.	**Bruke sin intelligens til å forstå ting som skjer og resonnere fornuftig**	☐	☐	☐	☐	☐
	Gjennomsnittsskåre					

Skåringsveiledning: Summer skårene på hvert spørsmål til en totalsum. Totalsum deles på antall besvarte spørsmål for å få gjennomsnittsskår.

www.bk.no 03.2019 TS/TAA

4AT

Screening for delirium og kognitiv svikt

(etikett)

Pasientens navn:

Fødselsdato:

Pasientnummer:

Dato: **Tidspunkt:**

Testen er utført av:

[1] ÅRVÅKENHET (forholder seg normalt til omgivelsene)

Pasienten virker tydelig døsig (dvs. vanskelig å vekke og/ eller er åpenbart søvnig ved undersøkelsen) eller motorisk urolig/hyperaktiv. Observer pasienten. Hvis pasienten sover, forsøk å vekke pasienten med vanlig stemme eller ved varsom berøring på skulderen. Be pasienten oppgi navn og adresse til hjelp med vurderingen.

Normal (helt årvåken, ikke urolig ved undersøkelse)	**0**
Lett søvnig < 10 sekunder etter oppvåkning, deretter normal	**0**
Tydelig unormal(t)	**4**

[2] AMT4 (Forkortet mental vurdering)

Alder, fødselsdato, sted (navnet på sykehuset eller bygning), årstall

Ingen feil	**0**
1 feil	**1**
2 feil eller flere/ikke testbar	**2**

[3] OPPMERKSOMHET

Spør pasienten: "Kan du i baklengs rekkefølge nevne for meg årets måneder, begynn med desember»
Å hjelpe pasienten med et innledende spørsmål «hva er måneden før desember?» er tillatt

Rekkefølgen av årets måneder baklengs	Oppgir 7 måneder eller flere korrekt	**0**
	Begynner, men klarer <7 måneder/ avslår å begynne	**1**
	Ikke testbar (er uvel, døsig, uoppmerksom)	**2**

[4] AKUTT ENDRING ELLER FLUKTUASJON I TILSTAND

Holdepunkter for betydelige endringer eller fluktuasjoner knyttet til: årvåkenhet, kognisjon, annen mental funksjon
(F.eks. paranoide symptomer, hallusinasjoner) oppstått i løpet av de siste to uker og fremdeles tilstede de siste 24 timer

Nei	**0**
Ja	**4**

≥4: mulig delirium og eller kognitiv svikt
1-3: mulig kognitiv svikt
0: delirium eller alvorlig kognitiv svikt usannsynlig (men fremdeles mulig delirium hvis informasjon under punkt [4] er ufullstendig)

4AT SKÅR ☐

VEILEDNING Versjon 1.2. Informasjon og nedlasting: **www.the4AT.com**

Instrumentet 4AT er utformet for en rask førstegangsvurdering av delirium og kognitiv svikt. En skår på 4 eller mer antyder delirium, men er ikke diagnostisk. En mer detaljert vurdering av mental status kan være aktuelt før en setter diagnosen. En skår på 1-3 antyder kognitiv svikt. Mer detaljert kognitiv testing og informasjon om pasienten er påkrevd. En skår på 0 ekskluderer ikke sikkert delirium eller kognitiv svikt. Mer detaljert testing kan være påkrevd, avhengig av den kliniske situasjonen. Vurderinger under punkt 1-3 er kun basert på observasjon av pasienten når undersøkelsen gjøres. *Punkt 4 krever informasjon fra én eller flere kilder*, som din egen kunnskap om pasienten, annet personell som kjenner pasienten, fastlege, dokumentasjon, pårørende. Den som utfører vurderingen bør ta hensyn til kommunikasjonsutfordringer (hørselsnedsettelse, dysfasi, mangel på språk) når vurderingen gjennomføres og resultatene tolkes.

Årvåkenhet: Endret nivå av årvåkenhet er sannsynligvis delirium i en generell sykehus-setting. Hvis pasienten viser betydelig endret årvåkenhet ved undersøkelsen, sett skår 4 på dette punktet.

AMT4 (Forkortet mental vurdering - 4): Denne skåren kan overføres fra AMT10 hvis denne er gjort rett før 4AT. **Akutt endring eller fluktuerende tilstand:** Fluktuerende tilstand kan oppstå uten delirium i noen tilfeller hos personer med demens, men tydelig fluktuerende tilstand indikerer delirium. For å avdekke hallusinasjoner og/ eller paranoide tanker, spør pasienten spørsmål som: "Er du bekymret for hva som skjer her?"; "Er du redd for noe eller noen?"; "Har du sett eller hørt noe uvanlig?"

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BMC Musculoskeletal Disorders

RESEARCH ARTICLE Open Access

Validation of orthopaedic surgeons' assessment of cognitive function in patients with acute hip fracture

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Abstract

Background: About one fourth of patients with hip fracture have cognitive impairment. These patients are at higher risk of surgical and medical complications and are often excluded from participating in clinical research. The aim of the present study was to investigate orthopaedic surgeons' ability to determine the cognitive status of patients with acute hip fracture and to compare the treatment given to patients with and without cognitive impairment.

Methods: The cognitive function of 1474 hip fracture patients reported by the orthopaedic surgeons to the nationwide Norwegian Hip Fracture Register was compared with data registered in quality databases in two hospitals with orthogeriatric service on the same patients. Cognitive function registered in the quality databases was determined either by the short form of the Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE) or by pre-fracture diagnosis of dementia. The information registered in the quality databases was defined as the reference standard. Cognitive function in the Norwegian Hip Fracture Register was reported as: Chronic cognitive impairment? "Yes", "Uncertain" or "No" by the orthopaedic surgeons. Sensitivity, specificity, negative and positive predictive values for chronic cognitive impairment reported to the Norwegian Hip Fracture Register by the orthopaedic surgeons was calculated. Baseline data and treatment of hip fractures in patients with and without cognitive impairment in the Norwegian Hip Fracture Register were compared.

Results: Orthopaedic surgeons reported chronic cognitive impairment in 31% of the patients.
Using documented dementia or IQCODE > 4.0 as the reference, this assessment of cognitive impairment by the orthopaedic surgeons had a sensitivity of 69%, a specificity of 90%, a positive predictive value of 78%, and a negative predictive value of 84% compared to information registered in the two hospital quality databases.
There were no differences in type of hip fracture or type of surgical treatment by cognitive function.

Conclusion: The treatment of hip fractures was similar in patients with chronic cognitive impairment and cognitively well-functioning patients. The surgeons had an acceptable ability to identify and report chronic cognitive impairment in the peri-operative period, indicating that the Norwegian Hip Fracture Register is a valuable resource for future registry-based research also on hip fracture patients with chronic cognitive impairment.

Keywords: Hip fracture, Orthopaedic surgeon, Mental status, Dementia tests

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Background

Norway, with 5.3 million inhabitants, has one of the highest incidences of hip fractures in the world [1]. Annually, about 9000 patients sustain a hip fracture in Norway with an average age of 80 years and less than 40% of these patients were classified to be in the healthiest groups (ASA 1 and 2) [2]. Studies have reported that 19–37% of hip fracture patients have cognitive impairment [3, 4]. Cognitive impairment is a known risk factor for sustaining a hip fracture [5–7]. Previous studies have reported lower quality of life after hip fracture in patients with cognitive impairment compared to cognitively well-functioning patients [8–10].

With an ageing population, there will also be an increase in the proportion of people with cognitive impairment [11]. Still, patients with cognitive impairment and dementia are excluded from 8 of 10 hip fracture studies [7]. One reason may be the difficulty of evaluating the patients' cognitive function in the peri-operative period. Cognitive impairment is a term used for both acute and chronic impairment in cognitive function. Delirium is an acute state of confusion that frequently occurs during hospitalization for hip fracture and which makes it challenging to determine the patients` habitual cognitive function [12]. Nordic studies have reported an overall incidence of delirium of 21–50% in hip fracture patients [12, 13]. Bitsch et al. reported an overall incidence of delirium of 36% in hip fracture patients [14]. A diagnosis of dementia requires a cognitive impairment of more than 6 months duration and of sufficient severity to interfere with activities of daily living. Patients with a hip fracture are at risk of developing dementia postoperatively and delirium can play an important role in this development [15, 16]. A study on hip fracture patients without pre-fracture cognitive impairment reported that 38% of the patients that developed delirium during hospitalization were diagnosed with dementia 6 months later [16]. Hip fracture patients with cognitive impairment have higher risk of both surgical complications such as surgical site infections, and non-surgical complications such as respiratory complications [11], as well as delirium [12]. Further, patients with delirium have increased risk of post-operative complications such as infection, dislocation of hip prostheses and new fractures due to falls [17]. Both patients with dementia and delirium therefore need extra attention during their hospital stay and it is important that surgeons and other health professionals are able to identify these patients early to optimize care and try to minimize risk for complications [12, 18, 19].

The Norwegian Hip Fracture Register (NHFR) has registered hip fractures on a national basis since 2005 [20], and cognitive function is reported to the registry by the surgeon after each operation for a hip fracture. Our aim was to investigate the surgeons' ability to determine cognitive function in the peri-operative period in patients with acute hip fractures. We compared chronic cognitive function reported by the surgeons to the NHFR with data on chronic cognitive function assessed by special trained nurses and geriatricians and registered in two local hospital quality improvement databases as the reference standard for the same patients.

Our aim in the present study was to investigate orthopaedic surgeons' ability to determine cognitive function in patients with an acute hip fracture, and thereby also to validate the information on cognitive function reported to the NHFR.

Methods

Data from hospital quality databases

Data from two hospital quality databases for hip fracture patients, Haraldsplass Deaconess Hospital (HDH) in Bergen, Norway and Diakonhjemmet Hospital (DH) in Oslo, Norway were used as the reference standard for the patients` cognitive function. Both hospitals had orthogeriatric units, staffed by orthopaedic surgeons and geriatric consultants. The databases contain data such as date of operation, comorbidity, chronic cognitive impairment, medical complications and length of stay. The databases are managed by special trained nurses in cooperation with geriatricians and information is registered during the patients' hospital stay. The patients' pre-fracture cognitive function was assessed by short form of the Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE) [21].

The IQCODE is an instrument containing 16 questions about change in everyday tasks related to cognitive ability compared to 10 years previously [22, 23]. The form is filled in by a close relative. Each question is scored from 1 to 5 with values less than 3 indicating better cognitive performance, while a score of 3 indicates similar performance and values greater than 3 indicate cognitive impairment. The form containing IQCODE was usually collected postoperatively by the non-surgical staff of the orthogeriatric ward. Gold standard evaluation of cognitive impairment requires a detailed history and assessment by trained health care personnel. IQCODE is a validated assessment tool that can give an indication of cognitive impairment prior to the hip fracture when the patient was in her/his habitual state. However, IQCODE on its own is not sufficient to diagnose dementia [21].

At DH, the quality database in addition to the IQCODE contained information on dementia diagnosis (Dementia: Yes or No) obtained from the patients` medical charts. Consequently, at this hospital some patients with information on advanced dementia in the medical chart were not assessed using the IQCODE.

Peri-operatively collected data on cognitive impairment in the quality databases were considered the reference standard. The surgeons' ability to determine cognitive function was validated against these data, based on their reporting of cognitive function to the NHFR.

The Norwegian hip fracture register

The NHFR collects epidemiological data and evaluates treatment methods of hip fractures in Norway. Data is reported by the surgeons on a one-page form containing information on the patient, including cognitive status, fracture and type of operation [20]. The form is usually filled in by the surgeons immediately postoperatively. The patients' comorbidity is classified by the American Society of Anaesthesiologists (ASA) score, normally provided to the surgeons on request by an anaesthesiologist [20]. The surgeons have the following alternatives when answering the question on chronic cognitive impairment: "Yes", "No" or "Uncertain". Information on cognitive function is based on preoperative assessment of the patients or on information from the medical chart. Assessment of cognitive function in the operating theatre is usually limited by verbal interactions. The large majority of patients are operated for acute hip fracture in spinal anaesthesia. If the surgeon is in doubt of the cognitive function preoperatively, use of the Clock Drawing Test is recommended [24]. As hip fracture surgery often is performed as an emergency procedure, by the surgeon on call and during evenings/weekends, the surgeon may have had limited time to study the patients' medical chart. Further, peri-operative presence of delirium may complicate the assessment of cognitive function.

Patient selection and case definition

In the period 2010–2013, 1888 primary hip fracture operations were reported to the quality databases at HDH ($n = 242$) and DH ($n = 1646$). Patients with missing data on cognitive status were excluded from further analysis ($n = 264$) (Fig. 1).

After exclusion of cases not found in the NHFR ($n = 117$) and cases with no information on cognitive status in the NHFR ($n = 33$), 1474 patients with fractures were included in the validation analyses. This included hip fracture patients with the information on dementia in the medical chart and/or IQCODE-score in the hospital quality database. Of these, 1290 patients had information on dementia from the medical chart and 507 patients had IQCODE registered in the quality databases (Fig. 1).

A cut-off point of 3.3–3.6 on IQCODE has been used for detecting dementia in community settings, while 3.44–4.0 has been used in hospital settings [23]. Accordingly, separate analyses were conducted with three different definitions of cognitive impairment in the local databases: 1) Presence of dementia documented in patient's medical chart. 2) IQCODE > 3.44 and/or dementia. 3) IQCODE > 4 and/or dementia.

Statistical analysis

Validation analyses were performed on the 1474 fracture patients where we had information on cognitive function in the NHFR and information on cognitive status in the local databases, either from the IQCODE score, a dementia diagnosis from medical charts, or both records. Information in the local databases was defined as a reference standard which the surgeons' reports were validated against. Sensitivity, specificity, positive predictive value, and negative predictive value for the surgeons` reports were calculated. The patients for whom the surgeon had marked "uncertain" on chronic cognitive impairment were grouped together with patients classified with no cognitive impairment.

Pearson's chi-square test was used for comparison of categorical variables and analysis of variance (ANOVA) was used for continuous variables. P-values < 0.05 were considered statistically significant. We used the statistical software packages IBM SPSS Statistics, version 23.0, for Windows and the statistical analyses.

Results

Baseline data and operation methods

Of the 1474 hip fracture patients included from the NHFR, 457 (31%) were classified by the surgeon as cognitively impaired and 870 (59%) as cognitively well-functioning. In 147 cases (10%), the surgeon had been uncertain of the patients´ cognitive function. The patients with chronic cognitive impairment were on average 3.6 years older and had a higher ASA score than the patients without cognitive impairment (Table 1). Most (74%) of the patients with chronic cognitive impairment were classified as ASA 3 or higher.

There were no statistically significant differences in the surgical methods used or type of fracture between the groups (Table 1).

The mean IQCODE score was 3.47 for hip fracture patients classified as not having cognitive impairment and 4.56 for hip fracture patients classified as cognitively impaired (Table 2).

Validation of data on cognitive function reported by orthopaedic surgeons

We used three different methods to identify chronic cognitive impairment. First, a diagnosis of dementia in the hospital chart was used as the reference for chronic cognitive impairment. In this analysis, the sensitivity of the orthopaedic surgeons` evaluation of chronic cognitive impairment reported to the NHFR was 80%. Secondly, when defining chronic cognitive impairment as a diagnosis of dementia and or an IQCODE > 4, the sensitivity was 69%. Lastly, when the reference for chronic cognitive impairment was a diagnosis of dementia or an IQCODE > 3.44, the sensitivity was 62%.

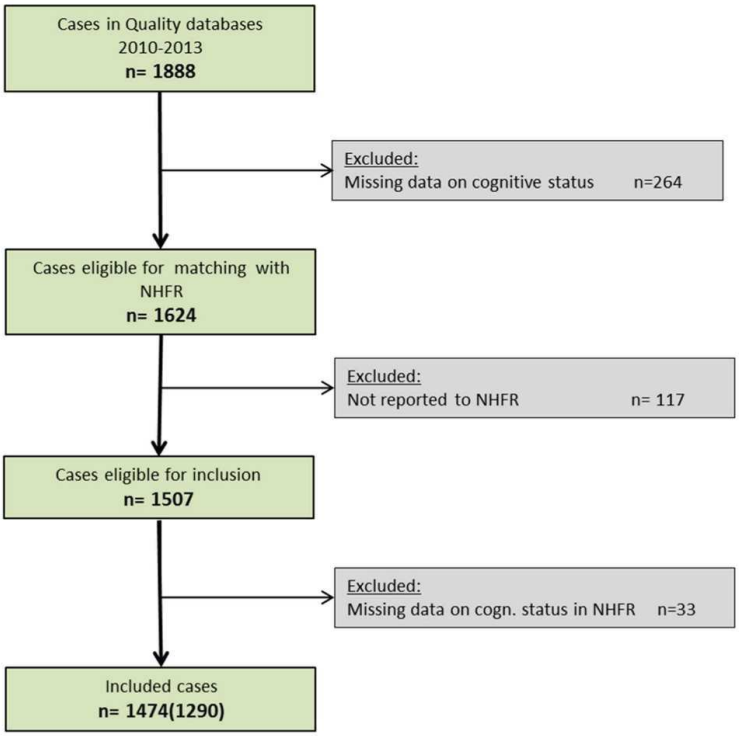

Fig. 1 Flowchart of patient selection using dementia and/or IQCODE (using only documented dementia in parentheses)

The specificity of the data in the NHFR increased from 88% using dementia diagnosis to 90% also using IQCODE (both > 4.0 and > 3.44). The positive predictive value increased from 72% using dementia diagnosis as a validation criterion to 78 and 79% including IQCODE > 4.0 and > 3.44. The negative predictive value decreased from 92% using dementia diagnosis as validation criteria to 84 and 79% using IQCODE > 4.0 and > 3.44 (Tables 3 and 4).

Sensitivity and negative predictive value increased with higher IQCODE cut-off and were highest when using dementia diagnosis as a reference. Specificity remained the same in all definitions. Positive predictive value decreased with increasing values for the cut-off on the IQCODE and with a previous diagnosis of dementia.

Discussion

The orthopaedic surgeons reported chronic cognitive impairment to the NHFR in 31% of the hip fracture patients. Comparison of data on cognitive function from the hospital databases with data reported by the orthopaedic surgeons to the Norwegian Hip Fracture Register on the same patients showed high specificity and high negative predictive value. This indicates that it is easier to recognize patients without cognitive impairment among hip fracture patients and that the numbers of false positive and false negative results were low. The orthopaedic surgeons had an acceptable and clinically relevant ability to identify chronic cognitive impairment, and they did better in identifying patients with more severe cognitive impairment.

Dementia is a diagnosis with specific criteria in the ICD-10 system [25]. It is a chronic disorder characterized by an impairment of cognitive function of at least six months' duration. A sound dementia assessment cannot be conducted during acute illness, such as during a hospitalization for a hip fracture. Delirium is an acute state of confusion which can be triggered by causes such as a fracture or an infection in vulnerable patients. Dementia can be mild or more severe and may be difficult to differentiate from delirium in an acute peri-operative setting. Our analysis does not consider the different types and different stages of cognitive impairment. Young patients in an early stage of dementia and living at home might differ from patients living in nursing homes with end stage dementia, with regard to rehabilitation potential

Table 1 Baseline data according to cognitive function in the Norwegian Hip Fracture Register

	Total	Cognitive impairment			*p*-value
		No	Uncertain	Yes	
Total n (%)	1.474	870 (59.0)	147 (10.0)	457 (31.0)	
Women (%)	1.111 (75.4)	651 (74.8)	100 (68.0)	360 (78.8)	0.026
Mean age (SD)	84.2 (7.9)	82.8 (8.3)	85.4 (7.2)	86.4 (6.8)	< 0.001#
Age group (%)					< 0.001*
< 75	196 (13.3)	153 (17.6)	13 (8.8)	30 (6.6)	
75–79	181 (12.3)	124 (14.3)	16 (10.9)	41 (9.0)	
80–84	265 (18.0)	161 (18.5)	25 (17.0)	79 (17.3)	
85–89	430 (29.2)	239 (27.5)	47 (32.0)	144 (31.5)	
≥ 90	402 (27.3)	193 (22.2)	46 (31.3)	163 (35.7)	
ASA class (%)					< 0.001*
ASA 1	26 (1.8)	26 (3.0)	0 (0)	0 (0)	
ASA 2	546 (37.0)	392 (45.1)	39 (26.5)	115 (25.2)	
ASA 3	847 (57.5)	425 (48.9)	102 (69.4)	320 (70.0)	
ASA 4	52 (3.5)	26 (3.0)	6 (4.1)	20 (4.4)	
Missing ASA	3 (0.2)	1 (0.1)	0 (0)	2 (0.4)	
Fracture type (%)					0.458
Undisplaced FNF	220 (14.9)	138 (15.9)	20 (13.6)	62 (13.6)	
Displaced FNF	606 (41.1)	352 (40.5)	62 (42.2)	192 (42.0)	
Trochanteric fracture	550 (37.3)	319 (36.7)	61 (41.5)	170 (37.2)	
Subtrochanteric	67 (4.5)	42 (4.8)	4 (2.7)	21 (4.6)	
Other[a]	31 (2.1)	19 (2,2)	0 (0)	12 (2.6)	
Primary operation (%)					0.909
Screw osteosynthesis	230 (15.6)	142 (16.3)	23 (15.6)	65 (14.2)	
Hemiarthroplasty	598 (40.6)	349 (40.1)	59 (40.1)	190 (41.6)	
Sliding hip screw	630 (42.7)	367 (42.2)	65 (44.2)	198 (43.3)	
Other[b]	16 (1.1)	12 (1.4)	0 (0)	4 (0.9)	

* = ANOVA # = Pearson's chi square
ASA American society of anaesthesiologists
FNF Fracture of femoral neck
AO/OTA AO/Orthopaedic Trauma Association
Other [a]fracture types including basocervikal fractures
Other [b]operation methods including intramedullary nail

[26]. Ranhoff et al. have reported that the rehabilitation potential in older hip fracture patients varies and that different care pathways are needed in the rehabilitation process [27]. We did not find any clinically relevant difference in surgical treatment of cognitively well-functioning and cognitively impaired patients.

Table 2 Baseline IQCODE

Cognitive impairment in NHFR	Numbers	Mean	Min	Max	Std.Deviation
No	340	3.47	2.87	5.00	0.567
Uncertain	58	3.98	3.00	5.00	0.652
Yes	109	4.56	3.00	5.00	0.616
Total	507	3.76	2.87	5.00	0.738

Strengths and weaknesses

The major advantage of the present study is the large number of patients. We had data from two different hospitals located in two different cities and compared the data reported from the orthopaedic surgeons with the data reported by specialized geriatric teams in the same hospitals. As both hospitals had orthogeriatric teams, the findings in the present study may, however, not be representative of results that could be achieved at other orthopaedic wards without orthogeriatric services. Surgeons at these two hospitals might be more attuned to discovering chronic cognitive impairment compared to surgeons in hospitals without orthogeriatric resources. Using data from only two hospitals increases the risk of selection bias. However, validation is dependent on

Table 3 Validation comparison of surgeons' reporting of cognitive impairment and information on cognitive function in local databases

Local Databases	Norwegian Hip Fracture Register		
	Cognitive impairment	Uncertain	No cognitive impairment
Dementia			
Cognitive impairment (%)	279 (71.5)	23 (17.7)	49 (6.4)
No cognitive impairment (%)	111 (28.5)	107 (82.3)	721 (93.6)
Total (%)	390 (100)	130 (100)	770 (100)
Dementia and/or IQCODE > 3.44			
Cognitive impairment (%)	363 (79.4)	60 (40.8)	159 (18.3)
No cognitive impairment (%)	94 (20.6)	87 (59.2)	711 (81.7)
Total (%)	457 (100)	147 (100)	870 (100)
Dementia and/or IQCODE > 4.0			
Cognitive impairment (%)	357 (78.1)	52 (35.4)	107 (12.3)
No cognitive impairment (%)	100 (21.9)	95 (64.6)	763 (87.7)
Total (%)	457 (100)	147 (100)	870 (100)

correct data from established databases. We decided to use data from these two specific hospitals since both had long experience in orthogeriatric care and had developed good and complete quality databases prior to our study. An alternative method to validate the orthopaedic surgeons` ability to determine cognitive function would have been to perform a retrospective chart review. We were unable to do this due to resource constraints and we are uncertain of the extent to which the charts of hip fracture patients would contain the information necessary to evaluate cognitive function. Taking advantage of already existing quality databases with information on cognitive function enabled us to produce valid estimates of cognitive impairment, and represented a method for validating the surgeons' ability to determine the patients' chronic cognitive function in these hospitals.

The percentage of chronic cognitive impairment reported from the two hospitals was similar to the percentage of chronic cognitively impaired patients at all hospitals reporting to the NHFR in the observed period. Further, the baseline data for these two hospitals were similar to the baseline data found for all patients registered in the NHFR [28]. This indicates that patients in the two hospitals are representative for all Norwegian hospitals treating patients with hip fractures.

Our results on prevalence of chronic cognitive impairment are similar to epidemiological studies, showing a high number of hip fracture patients having cognitive impairment and dementia [4].

To our knowledge, no previous studies on orthopaedic surgeons' ability to determine cognitive function in hip fracture patients have been performed. Clinicians often have a higher correlation of agreement for negative than positive diagnoses. de Vet advocates using measurement of agreement rather than Cohen's kappa, and that there will always be more agreement in the largest group of any analysis, which in our study was the patients without cognitive impairment [29].

We analysed the data with different cut-off points of IQCODE, to show the variation in the results using different methods. Finally, we chose the results using both dementia and IQCODE > 4.0. This reflects the heterogeneity in the material and IQCODE > 4.0 is normally used in inpatient settings such as hospitals, where our patients were located.

Table 4 Validation of cognitive impairment reported by the surgeons using dementia and/or IQCODE

	Validation criteria		
	Dementia[a]	Dementia and/or IQCODE > 3.44[b]	Dementia and/or IQCODE > 4.0[b]
Sensitivity (CI)	79.5%	62.4%	69.2%
Specificity (CI)	88.2%	89.5%	89.6%
Positive predictive value (CI)	71.5%	79.4%	78.1%
Negative predictive value (CI)	92.0%	78.5%	84.4%

[a]Dementia registered in patients` medical journal
[b]Dementia registered in patients` medical journal and/or IQCODE> 3.44 vs. > 4.0 registered in the local hospital database

Comparing the data on chronic cognitive impairment from the two quality databases with the information in the NHFR using three different methods (diagnosis of dementia, diagnosis of dementia and/or IQCODE > 3.44, and diagnosis of dementia and/or IQCODE > 4.0) led to somewhat different results. This demonstrates the need to know the prevalence in the population when considering positive and negative predictive value. In our population of hip fracture patients, the prevalence of chronic cognitive impairment is high and therefore gives higher positive and negative predictive values than in other populations [30].

Our results showed that surgeons identified cognitively well-functioning patients with a high negative predictive value. On the other hand, one out of five patients reported as chronic cognitively impaired to the NHFR by surgeons had no cognitive impairment according to the diagnosis in the database, and the positive predictive value of chronic cognitive impairment using dementia diagnosis and/or IQCODE > 4 as reference was 78.1%. This reflects the uncertainty in classifying patients' chronic cognitive function in an acute setting following a hip fracture. Presence of delirium probably increases this uncertainty.

Alternative methods to detect cognitive impairment and delirium in hip fracture patients could be the Abbreviated Mental Test (AMT) and the 4 'A's Test (4AT) [31–33]. AMT and 4AT can be performed by nurses after brief training [34] . These tests are recommended in the recently published Norwegian interdisciplinary guidelines on hip fracture care [35].

Conclusion

By comparing data on chronic cognitive function reported by orthopaedic surgeons in the NHFR with data from hospital quality databases on the same patients, we found the orthopaedic surgeons' ability to determine chronic cognitive function in hip fracture patients to be satisfactory.

Cognitively well-functioning patients were easier to identify than patients with chronic cognitive impairment. The surgical treatment of hip fractures was similar in patients with chronic cognitive impairment and cognitively well-functioning patients. The surgeons had an acceptable ability to identify and report chronic cognitive impairment in the peri-operative period, indicating that the NHFR is a valuable resource for future registry-based research on hip fracture patients, including those with chronic cognitive impairment.

Abbreviations

4AT: 4 'A's Test; AMT: Abbreviated mental test; ANOVA: Analysis of variance; ASA: American Society of Anaesthesiologists; DH: Diakonhjemmet Hospital; HDH: Haraldsplass Deaconess Hospital; IQCODE: Informant Questionnaire on cognitive decline in the elderly; NHFR: Norwegian hip fracture register

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Availability of data and materials

The regulations of the Norwegian Data Protection Authority and the Norwegian personal protection laws prohibit the publication of the complete dataset.

Authors' contributions

MHK, JEG and LBE planned the study. MHK and JEG wrote the first draft and performed the statistical analysis. ED and CAB-J gave statistical advice on the statistical analysis of the validation part. OMS and MM were responsible for data analysis in the local databases. AHR was responsible for designing the local databases. All authors contributed to the interpretation of the results, improvement of the manuscript, and approved the final draft.

Ethics approval and consent to participate

The NHFR has permission from the Norwegian Data Protection Authority to collect and store data on hip fracture treatment (permission granted on 3 January 2005: reference number 2004/1658–2 SVE/–). The patients have signed a written, informed consent, and in case they were not able to sign, their next of kin could sign the consent form on their behalf. The patients were not asked to give informed consent to be included in the quality databases at the two local hospitals. The Data Protection Officer for Research and the hospital research board have approved the databases.
The Regional Ethics Committee in Western Norway gave permission to link the local databases with the NHFR database for quality measures (permission granted on 10 October 2014: reference number 2014/1492/REK sør-øst C).

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Publisher's Note

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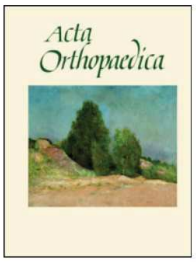

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Cognitive impairment influences the risk of reoperation after hip fracture surgery: results of 87,573 operations reported to the Norwegian Hip Fracture Register

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Cognitive impairment influences the risk of reoperation after hip fracture surgery: results of 87,573 operations reported to the Norwegian Hip Fracture Register

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Background and purpose — About one-fourth of hip fracture patients have cognitive impairment. We investigated whether patients' cognitive function affects surgical treatment, risk of reoperation, and mortality after hip fracture, based on data in the Norwegian Hip Fracture Register (NHFR).

Patients and methods — This prospective cohort study included 87,573 hip fractures reported to the NHFR in 2005–2017. Hazard rate ratios (HRRs) for risk of reoperation and mortality were calculated using Cox regression adjusted for sex, age, ASA class, fracture type, and surgical method.

Results — Cognitive impairment was reported in 27% of patients. They were older (86 vs. 82 years) and had higher ASA class than non-impaired patients. There were no differences in fracture type or operation methods. Cognitively impaired patients had a lower overall reoperation rate (4.7% vs. 8.9%, HRR 0.71; 95% CI 0.66–0.76) and lower risk of reoperation after osteosynthesis (HRR 0.58; CI 0.53–0.63) than non-impaired patients. Cognitively impaired hip fracture patients had an increased reoperation risk after hemiarthroplasty (HRR 1.2; CI 1.1–1.4), mainly due to dislocations (1.5% vs. 1.0%, HRR 1.7; CI 1.3–2.1). Risk of dislocation was particularly high following the posterior approach (4.7% vs. 2.8%, HRR 1.8; CI 1.2–2.7). Further, they had a higher risk of reoperation due to periprosthetic fracture after uncemented hemiarthroplasty (HRR 1.6; CI 1.0–2.6). Cognitively impaired hip fracture patients had higher 1-year mortality than those without cognitive impairment (38% vs. 16%, HRR 2.1; CI 2.1–2.2).

Interpretation — Our findings support giving cognitively impaired patients the same surgical treatment as non-impaired patients. But since the risk of hemiprosthesis dislocation and periprosthetic fracture was higher in cognitively impaired patients, they should probably not have posterior approach surgery or uncemented implants.

In Norway, with a population of 5.2 million, about 9,000 patients are treated for a hip fracture each year (Gjertsen et al. 2008). A high proportion of hip fracture patients have cognitive impairment (Mundi et al. 2014, Mukka et al. 2017, Kristoffersen et al. 2019). Cognitive impairment is defined as a decrease in cognition beyond normal aging (Hugo and Ganguli 2014). It can be mild, it can include dementia, or it might be temporary such as in delirium (Petersen et al. 2001, Holsinger et al. 2007). Dementia is usually diagnosed according to ICD-10 criteria in Norway (Naik and Nygaard 2008), and is dependent on a history of cognitive impairment of at least 6 months' duration in activities of daily living.

Despite high prevalence of cognitive impairment among hip fracture patients, these patients are often excluded from research (Mundi et al. 2014).

We investigated whether the presence of cognitive impairment affects the choice of surgical treatment for different types of hip fractures, and evaluated whether patients with cognitive impairment have a different risk of reoperation and mortality compared with cognitively fit patients.

Patients and methods

Study design

This is a prospective observational study based on data from the Norwegian Hip Fracture Register (NHFR).

The NHFR collects data from all hospitals in Norway treating hip fractures (Gjertsen et al. 2008). Data are reported by the surgeon on a 1-page form with information on the fracture type, the operation method, and the patient, including assessment of cognitive impairment. Femoral neck fractures are classified according to the Garden classification. Trochanteric fractures are classified according to the AO/OTA classification.

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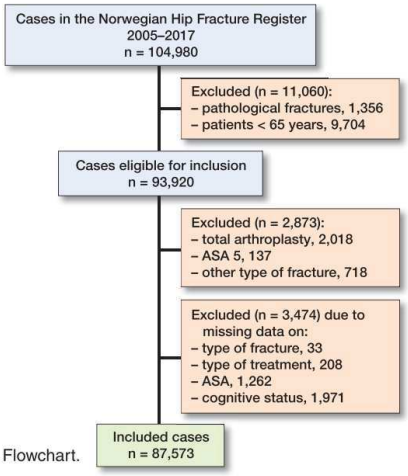

Figure 1. Flowchart.

The surgeon evaluates patients' cognitive function by examining their medical chart, asking them or their relatives, or using the Clock Drawing Test (Amodeo et al. 2015). Since the form is completed immediately after the operation, the information on cognitive function must be collected preoperatively. The NHFR has no data on the methods the surgeons used to obtain information on cognitive function. The question concerning cognitive impairment on the form is: "Does the patient have cognitive impairment?" Surgeons answer "Yes," "No," or "Uncertain." The data on cognitive impairment reported to the NHFR have been validated against external quality databases. The positive predictive value of the data reported to the NHFR on cognitive impairment was 78% (Kristoffersen et al. 2019).

The completeness of reporting of primary hip fracture operations to the NHFR has been found to be 88% for osteosynthesis and 94% for hemiarthroplasty when compared with the Norwegian Patient Register (Furnes et al. 2017).

Reoperations are linked to the primary operation by the unique identification number assigned to each inhabitant in Norway. Total hip arthroplasty revisions are reported on separate operation forms to the Norwegian Arthroplasty Register and later duplicated to the files of the NHFR.

It is possible to report several reasons for each reoperation, and a hierarchy of reasons was drawn up. If a deep or superficial infection was present, this was defined as the main reason for reoperation.

Patient selection

In the period 2005–2017, 104,980 primary hip fracture operations were reported to the NHFR. For the present study, pathological fractures and fractures in patients younger than 65 years of age were excluded (n = 11,060). Total hip arthroplasty for hip fracture was also excluded, since these operations are reported on separate forms to the Norwegian Arthroplasty Register with no information on cognitive function (n = 2,018). Further, fractures in ASA 5 patients, other fracture types than femoral neck, trochanteric or subtrochanteric fractures, operations with missing data on type of fracture, type of surgery, ASA classification, and cognitive status were excluded (n = 4,329) (Figure 1). Finally, 87,573 operations were included in the analysis.

Statistics

The patients were analyzed in groups according to their cognitive function: cognitively impaired, cognitively fit, and uncertain cognitive function (where the surgeon was uncertain of the patient's cognitive function). Pearson's chi-square test was used to compare categorical variables. Independent samples t-tests and analyses of variance (ANOVA), were used to compare the means for continuous variables. P-values < 0.05 were considered statistically significant. The Kaplan–Meier method was used to calculate time from primary surgery to reoperation. Hazard rate ratios (HRRs) are presented with 95% confidence intervals (CIs). Differences in reoperation risks between the groups were calculated using a Cox regression model with adjustments for sex, age, ASA class, fracture type, and operation method. Separate analyses were conducted for reoperations after primary osteosynthesis and those following hemiarthroplasty. Sub-analyses were performed for reoperations after hemiarthroplasty by surgical approach and fixation method. Further, the Cox regression model was used to analyze differences in mortality between the different patient groups with patients with no cognitive impairment as reference. 30-day, 90-day, and 1-year mortality were calculated with adjustments for sex, age, ASA, fracture type, and operation method. The proportional hazards assumption was fulfilled when investigated visually using log-minus-log plots. Fine and Gray analysis was also used to determine whether mortality was a competing risk in reoperation.

The statistical software package IBM SPSS Statistics, version 24.0 (IBM Corp, Armonk, NY, USA) and the statistical package R, version 3.6.0 (R Foundation for Statistical Computing, Vienna, Austria) were used for the statistical analysis. The study was performed in accordance with the REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) statement (Benchimol et al. 2015).

Ethics, funding, and potential conflict of interest

The NHFR has permission from the Norwegian Data Protection Authority to collect and store data on hip fracture patients (permission issued January 3, 2005; reference number 2004/1658-2 SVE/-). The patients signed a written, informed consent declaration, and when unable to understand or sign, their next of kin could sign the consent form on their behalf. The Norwegian Hip Fracture Register is financed by the Western Norway Regional Health Authority. No competing interests were declared.

Table 1. Baseline data for patients by cognitive function. Values are frequency (%) unless otherwise specified

Factor	Total	Cognitive impairment		
		No	Uncertain	Yes
Total	87,573	54,859 (63)	8,985 (10)	23,729 (27)
Women	62,751 (72)	39,182 (71)	6,332 (71)	17,237 (73)
Mean age (SD)	83.2 (7.5)	82.0 (7.8)	84.8 (7.0)	85.5 (6.4)
Age group				
65–74	12,611 (14)	10,388 (19)	793 (8.8)	1,430 (6.0)
75–79	12,837 (15)	9,120 (17)	1,099 (12)	2,618 (11)
80–84	20,309 (23)	12,727 (23)	2,028 (23)	5,554 (23)
85–89	23,494 (27)	13,247 (24)	2,754 (31)	7,493 (32)
≥ 90	18,322 (21)	9,377 (17)	2,311 (26)	6,634 (28)
ASA class				
ASA 1+2	32,293 (37)	24,298 (44)	2,485 (28)	5,510 (23)
ASA 3+4	55,280 (63)	30,561 (56)	6,500 (72)	18,219 (77)
Fracture type				
Undisplaced FNF	12,782 (15)	8,166 (15)	1,223 (14)	3,393 (14)
Displaced FNF	37,006 (42)	22,978 (42)	3,780 (42)	10,248 (43)
Basocervical FNF	3,112 (3.6)	1,918 (3.5)	328 (3.7)	866 (3.6)
Trochanteric A1 [a]	14,768 (17)	9,168 (17)	1,549 (17)	4,051 (17)
Trochanteric A2 [a]	14,012 (16)	8,743 (16)	1,512 (17)	3,757 (16)
Trochanteric A3 [a]	1,439 (1.6)	931 (1.7)	143 (1.6)	365 (1.5)
Subtrochanteric	4,454 (5.1)	2,955 (5.4)	450 (5.0)	1,049 (4.4)
Primary operation				
Screw osteosynthesis	16,938 (19)	10,483 (19)	1,707 (19)	4,748 (20)
Hemiarthroplasty	32,667 (37)	20,522 (37)	3,284 (37)	8,861 (37)
Sliding hip screw	27,161 (31)	16,956 (31)	2,827 (31)	7,378 (31)
Short IM nail	7,265 (8.3)	4,529 (8.3)	815 (9.1)	1,921 (8.1)
Long IM nail	3,542 (4.0)	2,369 (4.3)	352 (3.9)	821 (3.5)
Surgical approach				
Anterior/anterolateral	2,495 (7.6)	1,604 (7.8)	254 (7.7)	637 (7.2)
Lateral	26,401 (81)	16,596 (81)	2,680 (82)	7,125 (80)
Posterior	3,286 (10)	2,008 (9,8)	308 (9.4)	970 (11)
Other/missing data	485 (1.5)	314 (1.5)	42 (1.3)	129 (1.4)
Fixation of HA				
Cemented	24,278 (74)	15,353 (75)	2,408 (73)	6,517 (74)
Uncemented	7,851 (24)	4,854 (24)	804 (25)	2,193 (25)
Missing data	538 (1.6)	315 (1.5)	72 (2.2)	151 (1.7)

FNF = femoral neck fracture, IM = intramedullary, HA = hemiarthroplasty.
[a] AO/OTA classification.

Table 2. Number of reoperations and risk of reoperation after hip fracture surgery by cognitive function using Cox regression model and Fine and Gray model with adjustments for age, sex, ASA classification, fracture type, and treatment

Cognitive impairment	Total n	Reoperation n (%)	Cox regression Hazard Rate ratio (95% CI)	Fine and Gray Hazard Rate ratio (95% CI)
Total	87,573	6,568 (7.5)		
No	54,859	4,860 (8.9)	1 Reference	1 Reference
Uncertain	8,985	598 (6.7)	0.91 (0.83–0.99)	0.91 (0.84–0.99)
Yes	23,729	1,110 (4.7)	0.71 (0.66–0.76)	0.69 (0.65–0.74)
Hemiarthroplasty	32,667	1,425 (4.4)		
No	20,522	873 (4.3)	1 Reference	1 Reference
Uncertain	3,284	169 (5.1)	1.3 (1.1–1.6)	1.3 (1.1–1.6)
Yes	8,861	383 (4.3)	1.2 (1.1–1.4)	1.2 (1.0–1.3)
Osteosynthesis	54,906	5,143 (9.4)		
No	34,337	3,987 (11)	1 Reference	1 Reference
Uncertain	5,701	429 (7.5)	0.81 (0.73–0.89)	0.85 (0.77–0.94)
Yes	14,868	727 (4.9)	0.58 (0.53–0.63)	0.62 (0.57–0.67)

Results

In the 87,573 hip fracture operations, 27% of the patients had been classified by the surgeon as cognitively impaired and 63% as cognitively fit. In 10% of the operations the surgeon had evaluated the patient's cognitive function as "uncertain." The mean follow-up time was 3.0 years (3.0–3.0). Patients with cognitive impairment had a mean follow-up time of 1.8 years (1.8–1.9), non-impaired patients 3.6 years (3.5–3.6) and "uncertain" patients 2.5 years (2.5–2.6).

Baseline data

There were 72% women among the patients. The patients with cognitive impairment were on average 3.5 years older and had more severe comorbidity (higher ASA score) than non-impaired patients (Table 1).

Displaced femoral neck fractures (FNFs) constituted 42% of all fractures. Only small differences in the distribution of fractures and operation methods were found between the groups but, due to the large numbers, some of these small differences were statistically significant (Table 1).

Surgical methods for each fracture type were not influenced by the patients' cognitive function (Figure 2, see Supplementary data). The most common operation methods were hemiarthroplasty (37%) and osteosynthesis with a sliding hip screw (31%) (Table 1). Most hemiarthroplasties were performed with a lateral approach (81%) and three-quarters of hemiarthroplasties were cemented (Table 1).

Reoperations

Cox regression analysis and the Fine and Grey method showed a similar risk of reoperation (Ranstam and Robertsson 2017) (Table 2).

The overall reoperation rate for all patients was 7.5% (n = 6,568) (Table 2). Patients with cognitive impairment had an overall reoperation rate of 4.7%, compared with 8.9% for cognitively fit patients (HRR 0.71; CI 0.66–0.76). Patients with "uncertain" cognitive function had a reoperation rate of 6.7% (HRR 0.91; CI 0.83–0.99).

The overall reoperation rates for all patients were 4.4% after hemiarthroplasty and 9.4% after osteosynthesis. The reoperation risk for patients with cognitive impairment was

slightly higher for hemiarthroplasty (HRR 1.2; CI 1.1–1.4) but lower for osteosynthesis (HRR 0.58; CI 0.53–0.63) than for those without cognitive impairment (Table 2).

There were small differences in risk of reoperation between patients with and without cognitive impairment for those operated with hemiarthroplasty due to infection and periprosthetic fracture.

Analysis by fixation of the hemiprosthesis showed that patients with cognitive impairment treated with uncemented hemiarthroplasty had a higher risk of reoperation for any reason (HRR 1.3; CI 1.1–1.7) and a particularly high risk due to periprosthetic fracture (HRR 1.6; CI 1.0–2.6), compared with patients without cognitive impairment. No such differences could be found for cemented hemiarthroplasty. Further, cognitively impaired patients treated with hemiarthroplasty had a higher risk of reoperation because of dislocation than non-impaired patients (1.5% vs. 1.0%, HRR 1.7; CI 1.3–2.1) (Table 3). Analysis by surgical approach showed that this risk was higher with the posterior approach (4.7% vs. 2.8%, HRR 1.8; CI 1.2–2.7) and lower with the lateral approach (1.1% vs. 0.8%, HRR 1.5; CI 1.1–2.0).

Few patients with cognitive impairment were reoperated due to osteosynthesis failure and local pain (Table 3). Only 0.5% of cognitively impaired patients treated with osteosynthesis had revision total hip arthroplasty, compared with 4.6% of cognitively fit patients.

Table 3. Reasons for reoperation after hemiarthroplasty and osteosynthesis. Reoperations appear in the order of our hierarchy. Values are frequency (%)

Factor	Total	Cognitive impairment		
		No	Uncertain	Yes
All reoperations	6,568 (7.5)	4,860 (8.9)	598 (6.7)	1,110 (4.7)
Reoperation after hemiarthroplasty	1,425 (4.4)	873 (4.4)	169 (5.1)	383 (4.3)
Infection	672 (2.1)	416 (2.0)	81 (2.5)	175 (2.0)
Periprosthetic fracture	151 (0.5)	90 (0.4)	17 (0.5)	44 (0.5)
Dislocation of prosthesis	395 (1.2)	206 (1.0)	55 (1.7)	134 (1.5)
Loosening of hemiarthroplasty	18 (0.1)	17 (0.1)	0 (0.0)	1 (0.0)
Sequelae of femoral neck fracture [a]	31 (0.1)	24 (0.1)	2 (0.1)	5 (0.1)
Other reason	158 (0.5)	120 (0.5)	14 (0.4)	24 (0.3)
Reoperation after osteosynthesis	5,143 (9.4)	3,987 (12)	429 (7.5)	727 (4.9)
Infection	225 (0.4)	136 (0.4)	29 (0.5)	60 (0.4)
Peri-implant fracture	363 (0.7)	247 (0.7)	34 (0.6)	82 (0.6)
Avascular necrosis	346 (0.6)	248 (0.7)	29 (0.5)	69 (0.5)
Osteosynthesis failure	1,541 (2.8)	1022 (3.0)	172 (3.0)	320 (2.2)
Cut-out	142 (0.3)	107 (0.3)	12 (0.2)	23 (0.2)
Non-union	276 (0.5)	212 (0.6)	27 (0.5)	37 (0.2)
Sequelae of proximal femoral fracture [a]	1,744 (3.2)	1,568 (4.6)	96 (1.7)	80 (0.5)
Local pain due to osteosynthesis material	360 (0.7)	318 (0.9)	15 (0.3)	27 (0.2)
Other reason	173 (0.3)	129 (0.4)	15 (0.3)	29 (0.2)

[a] Reoperation with total hip arthroplasty reported to the Norwegian Arthroplasty Register.

Mortality

30-day mortality was 13% for cognitively impaired patients and 4.6% for cognitively fit patients (HRR 2.2; CI 2.1–2.3). 90-day mortality was 23% for cognitively impaired patients and 8.5% for cognitively fit patients (HRR 2.2; CI 2.1–2.3). Finally, 1-year mortality was 38% for cognitively impaired patients and 16% for cognitively fit patients (HRR 2.1; CI: 2.1–2.2) (Table 4, see Supplementary data). Patients with cognitive impairment had a greater overall mortality risk than cognitively fit patients (HRR 2.1; CI 2.0–2.1).

Discussion

There was no difference in type of fracture or type of initial treatment among hip fracture patients in relation to cognitive function in NHFR. This supports the idea of equal treatment for all hip fracture patients. The lower reoperation rate for patients with cognitive impairment found in our study does not necessarily imply that these patients do better than those without cognitive impairment.

Patients with cognitive impairment have been reported to have a higher risk of poorer functional outcome after hip fracture incidents (Sheehan et al. 2018). Hip fracture patients with cognitive impairment are older and have comorbidities that increase the risk of any reoperation. It is easier for cognitively fit patients to tolerate the peri- and postoperative strain and stress of revision surgery. Patients with cognitive impairment might not be offered surgical revision due to a higher risk of complications such as prosthesis dislocation and shorter life expectancy than in non-impaired patients.

An infection is probably the most feared complication after hip fracture surgery. In most cases, an infection leaves no other options than surgical debridement. Notably, cognitive impairment, in our study, did not seem to increase the risk of reoperation due to infection. Cognitively impaired patients treated with hemiarthroplasty had an increased risk of prosthesis dislocation, especially when the posterior approach had been used. Our results concur with those in the study by Svenøy et al. (2017), who reported an 8-fold increase in risk of dislocation after the posterior approach compared with the lateral. Our results suggest that the use of the posterior approach in cognitively impaired patients should be avoided.

It is well established that uncemented hemiarthroplasties have a higher risk of revision than cemented (Langslet et al. 2014, Kristensen et al. 2020).

In our study, cognitively impaired patients treated with uncemented hemiarthroplasty had a higher risk of reoperation for any reason and for periprosthetic fracture than non-impaired

patients. No such differences were found for cemented hemiarthroplasties. Thus, uncemented hemiarthroplasties seem to yield inferior results and should not be used in cognitively impaired patients who may have a particularly high risk of recurrent falls and periprosthetic fracture.

Very few patients with cognitive impairment were reoperated with a total hip arthroplasty, which may be contraindicated in these patients because of lack of compliance and increased risk of dislocation. However, the risk of dislocation can be reduced with the use of a dual-mobility cup (Jobory et al. 2019).

Our study also included patients where the orthopedic surgeon had been in doubt whether the patient had cognitive impairment or not. These patients performed as an intermediate group in our analysis. One explanation could be that these patients may have had delirium, which is common in patients with hip fracture and complicates the assessment of chronic cognitive impairment and dementia. Delirium is also a risk factor for developing dementia after a hip fracture (Krogseth et al. 2011).

Mortality increased 2-fold for patients with cognitive impairment, both from 30 to 90 days and from 90 days to 1 year. This finding is in line with previous studies (Söderqvist et al. 2006, Mukka et al. 2017). Our study does not include information on causes of mortality. Holvik et al. (2010) found that predictors of mortality in older hip fracture patients were admission from a nursing home, comorbidity, and frailty. All these predictors are associated with cognitively impaired patients.

We have not analyzed patient-reported outcomes, and therefore have no information on how the hip fractures influenced the patients' quality of life and how the patients performed who were not reoperated.

Strengths and limitations

The large number of patients in our study is an advantage and enabled us to analyze rare complications and causes of reoperation. One should, however, be careful to draw conclusions based on very small differences even if they reach statistical significance. One important limitation of the study is the accuracy of the surgeon's assessment of cognitive function. An earlier study from the NHFR found that orthopedic surgeons identified cognitive impairment with a specificity of 90%, a sensitivity of 69%, positive predictive value of 78%, and negative predictive value of 84%, compared with information recorded in local hospital databases (Kristoffersen et al. 2019).

The completeness of the reported reoperations has been found to be lower than the reporting of primary hip fracture operations in the NHFR when compared with the Norwegian Patient Register (Furnes et al. 2017). We have, however, no indication that the reporting of reoperations differs between the patient groups according to cognitive function. Accordingly, the hazard rate ratios in this study are probably reliable, but the crude number of reoperations may represent a best-case scenario and the actual number of reoperations may be higher. Follow-up time and mortality differed between the treatment groups. Many of the causes of reoperations, such as pain and loosening of the implant, may occur a long time after primary surgery. When comparing the treatment groups, one should therefore be aware that patients with cognitive impairment might die before the complications occur.

Conclusion

The results suggest that patients with cognitive impairment should be treated with the same surgical procedures as patients without cognitive impairment. However, hemiarthroplasty with uncemented stem and a posterior approach should probably be avoided in cognitively impaired patients due to the increased risk of periprosthetic fracture and dislocation.

Supplementary data

Figure 2 and Table 4 are available as supplementary data in the online version of this article, http://dx.doi.org/10.1080/17453674.2019.1709712

MHK, JEG, and LBE planned the study. MHK wrote the manuscript. MHK and ED performed the statistical analyses. All authors contributed to the interpretation of the results, and improvement of the manuscript.

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Patient-reported outcome measures after hip fracture in patients with chronic cognitive impairment

Results from 34,675 patients in the Norwegian Hip Fracture Register

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Key points:

- A hip fracture has a dramatic impact on patients' quality of life
- Hip fracture patients with chronic cognitive impairment have lower quality of life than those without cognitive impairment both before and after the hip fracture
- one in seven hip fracture patients with chronic cognitive impairment are confined to bed one year postoperatively four in ten hip fracture patients with chronic cognitive impairment are unable to wash or dress one year postoperatively

Abstract

Background and purpose/aim

Hip fracture patients have high morbidity and mortality. Patient-Reported Outcome Measures (PROMs) assess the quality of care of patients with hip fracture, including those with chronic cognitive impairment (CCI). Our aim was to compare PROMs from hip fracture patients with and without CCI, using the Norwegian Hip fracture Register (NHFR).

Patients and methods

PROM questionnaires at four months (n=34,675) and twelve months (n=24,510) after a hip fracture reported from 2005 to 2018 were analysed. Pre-injury score was reported in the 4 months questionnaire. The questionnaires included the EuroQol (EQ-5D-3L) questionnaire, and information about who responded to the questionnaire.

Results

Of the 34,675 included patients, 5,643 (16%) had CCI. Patients with CCI were older (85 vs. 81 years) ($p<0.001$), and had a higher ASA classification compared to patients without CCI. CCI was unrelated to fracture type and treatment method. EQ-5D index scores were lower in patients with CCI after four months (0.37 vs. 0.60, $p<0.001$) and 12 months (0.39 vs. 0.64, $p<0.001$). Patients with CCI had lower scores for all dimensions of the EQ-5D-3L pre-fracture and at four and 12 months.

Interpretation/conclusion

Patients with CCI reported lower health-related quality of life pre-fracture, at four and twelve months after the hip fracture. PROM data from hip fracture patients with CCI are valuable in the assessment of treatment. Patients with CCI should be included in future studies.

Introduction

Hip fracture patients with chronic cognitive impairment (CCI) represent up to 37% of the hip fracture population [1], and are often vulnerable [2]. Patients with CCI are often excluded from studies because of the difficulty in obtaining informed consent from patients or proxies. Excluding these patients can lead to systematic bias in existing knowledge of hip fracture patients [3]. The traditional method of assessing outcome after hip fracture has been to measure physical functioning, reoperations, complications and mortality [4, 5]. A hip fracture also has a considerable impact on patients' health-related quality of life [6-8]. Several studies have therefore advocated including patient-reported outcome measures (PROMs) in the assessment of outcomes following a hip fracture [5, 9].

There are few published studies on hip fracture patients using PROMs that include patients with CCI and there is thus a need for more studies to explore the relevant outcomes [10, 11].

The Norwegian Hip Fracture Register (NHFR) is one of the few registries that routinely collect PROM data from patients, including cognitively impaired patients. Information on who filled in the form is also available.

Our aim was to compare PROM data after hip fracture in patients with and without CCI.

Methods

Study design

This study was a prospective observational study based on data from the NHFR.

The NHFR has collected data from all hospitals in Norway treating patients with hip fractures since 2005 [12]. On a one-page form, the surgeon reports information such as fracture type, operation method and patient information, including assessment of CCI. The surgeon evaluates patients' chronic cognitive

function by examining their medical chart, asking them or their relatives, or using the Clock Drawing Test [13]. The information on chronic cognitive function is based on preoperative information. No other standardised diagnostic tools for assessment of cognitive function are normally used in this setting. The question on CCI on the form is 'Does the patient have cognitive impairment?' with the following options: 'Yes', 'No', or 'Uncertain'. The data on CCI in the NHFR have been previously validated against two hospital quality databases and the positive predictive value of the data reported to the NHFR on CCI was 78% [14].

Fractures were classified as undisplaced femoral neck, displaced femoral neck, basocervical, throchanteric A1, A2, A3 or subtrochanteric. Primary operations were classified as screw osteosynthesis, hemiartroplasty, sliding hip screw, short / long intramedullary nail.

PROMs questionnaires were sent from the NHFR by mail directly to patients. Patients responded with use of a pre-stamped envelope. No reminders were sent to patients not responding. PROMs reported in questionnaires at four and twelve months were analysed. The questionnaires include the Norwegian translation of EuroQol (EQ-5D-3L) which covers five dimensions of health-related quality of life: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression [15]. There are three levels of response for each dimension: from level 1 (indicating no problems or best state) to level 3 (indicating severe problems or worst state) [15]. Pre-fracture EQ-5D-3L data were collected retrospectively together with the EQ-5D-3L data in the four-month questionnaire. The preference scores (EQ-5D index scores) were generated from a large European population [16]: they range from a score of 1 indicating the best possible state of health to a score of -0.217, indicating a state of health worse than death, while 0 indicates a state of health equal to death.

Each questionnaire also includes information on who filled in the form with the following options: the patient, a relative, a clinician, or other.

Patient selection

Between 1 January 2005 and 31 December 2018, 113,447 patients were reported to the NHFR. Patients with pathological fractures and patients below 65 years were excluded (Fig. 1). Patients treated with total hip arthroplasty (THA) were excluded because they were reported on forms that did not include information on cognitive status. Patients recorded in the NHFR with missing information on chronic cognitive status and patients with 'uncertain' cognitive status were also excluded. Patients who died within four months were also excluded. Finally, 60,847 patients received and 34,675 patients (57%) completed the four-month questionnaire.

We primarily analysed the data from patients responding to the four-month questionnaire. Pre-fracture EQ-5D data were answered together with the 4 months questionnaire.

Out of these patients, 32,484 received and 24,510 (75%) answered the twelve-month questionnaire. Secondly, we examined the group answering both the four- and twelve-month questionnaires in order to analyse information on changes in a long-term perspective.

Thus, 24,510 patients could be included in the analysis comparing PROMs at four and twelve months (Fig 1).

Statistics

Pearson's chi-square test was used to compare categorical variables, while an independent samples t-test (Student's t-test) was used for continuous variables in independent groups.

The number of patients reaching their pre-fracture EQ-5D status was calculated in percentages.

Δ EQ-5D was calculated for each patient as the difference between EQ-5D index score and EQ-5D index score pre-fracture. Sub analyses with stratification on men/women and different age groups were performed.

The statistical software package IBM SPSS Statistics, version 26.0 was used for statistical analysis. This study was performed in accordance with the REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) statement [17].

Ethics, funding and potential conflict of interest

The NHFR has authorization from the Norwegian Data Protection Authority to collect and store data on hip fracture patients (authorization issued on 3 January 2005: reference number 2004/1658-2 SVE/-). The patients provided written, informed consent; if unable to understand or sign, a relative could sign the consent form on their behalf. The Norwegian Hip Fracture Register is financed by the Western Norway Regional Health Authority. No competing interests were declared by the authors.

Results

The four-month questionnaire was completed by 34,675 patients, and 24,510 patients completed both the four- and twelve-month questionnaires. The majority of the questionnaires from patients with CCI were filled in by a proxy (four months: 84%, twelve months: 78.2%) whereas most questionnaires from patients without CCI were filled in by the patients themselves (four months: 67.2%, twelve months: 73.0%) (Table I).

The baseline characteristics of responders and non-responders of the four-month questionnaire are presented in Table II. The non-responders of this questionnaire were older (mean age 83 years vs. 82 years) ($p<0.001$), included more females (75% vs. 73%) ($p<0.001$) and more patients with CCI (38% vs.

16%) (p<0.001), and had higher ASA scores (ASA 3+4: 66 % vs. 54%) (p<0.001) compared to the responders. There were no clinically important differences in fracture type or operation method of the different fracture types between responders and non-responders, but due to the high number of cases the differences reached statistically significance (Table II).

Patients answering the four-month questionnaire (n=34,675)

Of the 34,675 patients answering the four-month questionnaire, 5,673 (16.3%) had CCI. Patients with CCI were older (85 vs. 81 years) (p<0.001), there were more females (77% vs. 73%) (p<0.001), and they had higher comorbidity (ASA 3+4: 73% vs. 50%) (p<0.001) compared to patients without CCI.

All five dimensions of the health profiles deteriorated from pre-fracture to four months regardless of cognitive function (Table III), but the patients with CCI reported greater problems in this respect.

The hip fracture had a dramatic impact on patients' mobility. The proportion of patients with CCI confined to bed increased five-fold from 3% to 16%, whereas patients without CCI showed an increase of 0.9% to 3.0% after four months (p<0.001). The proportion of patients with CCI unable to wash or dress almost doubled from 25% to 48%. Further, the proportion of patients with CCI unable to perform usual activities increased from 45% to 63%. Hip fracture patients with CCI also reported an increase in both moderate and extreme pain/discomfort from 44% to 64% and 5.7% to 8.9%. Regarding anxiety and depression, hip fracture patients with CCI reported increased symptoms from 7.4 to 9.7% after four months (Table III).

Patients answering both the four- and twelve-month questionnaire (n=24,510)

The patients with CCI were older (85 vs. 81 years) (p<0.001), were more often female (77 vs. 72%) (p <0.001), and had higher comorbidity (ASA 3+4: 71 vs. 47%)(p<0.001) than patients without CCI. There

were no differences in fracture type (p=0.48) or operation method (p=0.52) between patients with and without CCI (Table IV).

The changes in responses in the EQ-5D-3L from preoperative to twelve months postoperative are shown in Figure 2 (walking ability), Figure 3 (self-care) and Figure 4 (usual activities).

The patients with CCI had a lower EQ-5D index score after both four months (0.37 vs. 0.60, p<0.001) and twelve months (0.39 vs. 0.64, p<0.001) compared to patients without CCI (Table V). Stratifying into age groups, the youngest patient groups had higher EQ-5D index scores, both among patients with and without CCI (Table VI). There were statistically significant differences in EQ-5D index scores between patients with and without CCI for all age groups both at four and twelve months. The ΔEQ-5D was higher among patients without CCI than among patients with CCI at four months (-0.19 vs. -0.17)(p<0.001), but not at twelve months (p=0.35) when investigating all patients. There were, however, differences between the patients with and without CCI at 65-74 years at both four (-0.13 vs. -0.19 (p=0.002)) and twelve months (-0.11 vs. -0.14(p=0.003)), and among patients over 90 years at four months (-0.16 vs -0.20 (p<0.001)). There was no difference between patients with and without CCI in the proportion who achieved their pre-fracture EQ-5D status after four months (p=0.074). After twelve months, a lower proportion of patients with CCI had reached their preoperative EQ-5D than those without CCI (28% vs. 33%) (p<0.001) (Table V). The proportion of patients who reached their preoperative EQ-5D at four and twelve months decreased with age (Table VI).

Discussion

Postoperatively, health-related quality of life decreased for all hip fracture patients. Patients with CCI showed an even greater decline than those without CCI following a hip fracture. This was particularly due to a reduction in walking function, self-care capacity, and the ability to perform usual activities.

Our results concur with a previous review reporting that CCI has a negative impact on health-related quality of life after a hip fracture [18].

The seven-fold increase in the number of patients with CCI who were confined to bed one year after a hip fracture is dramatic. Mukka et al. reported that 28% were non-walkers one year after the hip fracture [19]. Milte et al. also found a decrease in walking ability, but their study measured the EQ-5D only one month postoperatively [10].

The tendency was the same for self-care capacity, where the proportion of hip fracture patients with CCI unable to wash or dress almost doubled after twelve months, which is in accordance with a previous study by Osnes et al. [20].

The decrease in EQ-5D index according to age found in our study concur with earlier studies of all hip fractures [5]. The decrease in hip fracture patients reaching their pre-fracture HRQoL could be a sign of general decrease in physical and mental status. Peeters et al also found inferior results for female gender[21].

Few studies have included hip fracture patients with CCI [3]. One reason could be challenges in including patients that might not understand the purpose of the study. It can be difficult to obtain informed consent. The researcher might also find it difficult to trust and interpret answers from patients with CCI. However, patients with CCI represent a significant proportion of the hip fracture population, and should not be excluded from studies.

PROMs at four months were completed by a proxy in 86% of the cases with CCI and 41% of cases without CCI. At twelve months the corresponding proportions were 80% and 33%. Some would argue that PROMs collected from patients with CCI are unreliable. However, several studies have found that persons with CCI are capable of expressing their health-related quality of life via EQ-5D [22-24]. Further, studies have reported that the EQ-5D is a good tool for measuring outcome for patients recovering from hip fracture, including patients with CCI [21-23, 25]. It has also been shown that responses given by a proxy can be trusted. However, a closer relationship to the patient led to more agreement in the proxies' answers [24, 26]. We would argue that a proxy can normally judge the patient's walking ability and ability to perform self-care and usual activities using the simple three-level categorization in the EQ-5D-3L. However, it is important to acknowledge that the results presented in this study is, to a certain extent, represent a comparison between PROMS by patients without CCI and PROMS competed by proxy for patients with CCI.

The EuroQol also contains a visual analogue scale (EQ-VAS). We chose to exclude these data, acknowledging the uncertainty in interpreting visual analogue scales for persons with CCI [22].

There was no substantial change in quality of life between four months twelve months despite improvement in walking ability. This finding might be an argument for only measuring PROMs at four months, thereby reducing the burden of data collection by researchers and those responsible for monitoring PROMs.

Strengths and limitations

One strength of our study is the high number of patients included, and the inclusion of a large number of patients with CCI. To our knowledge, this is the largest study on PROM data from hip fracture patients with CCI ever reported.

Our data represent nationwide results, including all types of hip fractures and operation methods, except fractures treated with a THA. This makes the data more representative than a small sample of patients and accordingly increases the external validity.

The NHFR has high completeness of data: 88% for cases of osteosynthesis and 94% for hemiarthroplasties [27].

The main limitation of the study is nevertheless the methods used to identify cognitive impairment. The surgeon assessed the patient's cognitive function by use of different sources of information, including the patient's medical journal and discussion with relatives or with the patient. However, no standardised tool/approach to diagnose cognitive impairment were normally used. Cognitive function was assessed preoperatively, and in cases where this assessment was based solely on conversation with the patient presence of delirium could have complicated this assessment. The data on CCI and reporting have also been previously validated against two local hospital databases with a sensitivity of 69% and a specificity of 90% [14]. Still, we acknowledge some uncertainty in our classification of cognitive function, and that the results, in particular where small differences were found, must be interpreted with some caution.

The response rates for the PROM questionnaires were low and they were lower for patients with CCI than for those without CCI. This is to be expected, as it is presumably difficult, and in severe cases impossible, for patients with CCI to respond adequately to the questionnaire themselves. Due to the combination of high mortality and low response rate among patients with CCI only 16% and 10% of patients responding to the four and twelve months questionnaires respectively had CCI. These proportions were lower than the equivalent proportion for the total population recorded in the NHFR [27]. Further, the responders were younger and healthier than the non-responders. Our data on quality of life after hip fracture therefore probably represent a best-case scenario, including patients expected to have better quality of life than non-responders.

EQ-5D-3L is a validated and frequently used questionnaire measuring health-related quality of life. This makes our results comparable to other studies of hip fracture patients and other illnesses [25].

Finally, we present the descriptive health profiles of the EQ-5D-3L questionnaire to provide more complete information on the patients' quality of life, not only the EQ-5D index. Presenting both the four- and twelve-month PROM data allows us to examine trajectories in long-term follow-up.

We cannot conclude that the changes in health-related quality of life occurred only because of the hip fracture. Patients with dementia are expected to deteriorate in daily functioning during a one-year follow-up. The response rate of our study was low, as could be expected due to high age and comorbidities. We did not send out reminders to the patients, which might have led to a greater response rate.

The pre-fracture PROM data were collected retrospectively in the four-month questionnaire. This could have led to recall bias. However, studies have reported moderate to good correlation when comparing recalled data to prospective data following arthroplasty [28].

Only 6% of the patients responding to the four-month questionnaire died between distributions of the four- and twelve-month questionnaires. Previous studies have reported 90-day mortality of 13% and one-year mortality of 23% [2]. The low mortality rate between four and twelve months could be an expression of selection bias, meaning that only the healthiest patients responded to the four-month questionnaire. This is also supported by the differences found in the baseline data between responders and non-responders at four months.

Our study did not assess the severity of the CCI. In the acute setting, cognitive function can be difficult to evaluate due to delirium and acute injury. Some patients were probably misclassified as having chronic CI because they were delirious.

One previous study has confirmed that self-report is not sufficient to assess pain in elderly people with cognitive impairment [17]. Still, it has been shown that patients with mild to moderate dementia are able to complete 99% of the EQ-5D domains [23]. A ceiling/floor effect of patients' ratings has been found as a limitation of the three response alternatives of the EQ-5D questionnaire.

We have no information on rehabilitation in our study. This could be a confounder, since there could be differences in rehabilitation offered to patients with and without CCI after a hip fracture, which could affect outcomes such as walking ability and anxiety and depression.

Our study did not include THA patients, due to missing information on cognitive function. However, THA patients only represent 2.4% of patients in the NHFR and we assume that very few of these patients have CCI.

In conclusion, this study found that patients with CCI reported lower health-related quality of life four and twelve months after a hip fracture compared with hip fracture patients without CCI. PROM data from hip fracture patients with CCI is valuable in the assessment of the treatment of this particular vulnerable group. Patients with CCI should be included in future studies and for an orthopaedic registry it is important to establish good and simple methods to facilitate collection of PROMs from frail and cognitively impaired patients.

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Table I.

Completion of four-month questionnaires (n=34,675) and twelve-month questionnaires (n=24,510) by cognitive function

	4 months			12 months		
		Chronic cognitive Impairment			Chronic cognitive Impairment	
	Total	No	Yes	Total	No	Yes
Total (%)	34,675	29,032	5,643	24,510	21,852	2,658
Patient	20,280(59)	19,517(67)	763(14)	16,464(67)	15,943(73)	521(20)
Proxy						
-Relative	9,828(28)	7,121(25)	2,707(48)	5,777(24)	4,495 (21)	1,282(48)
-Clinician	3,616(10)	1,604(5.5)	2,012(36)	1,703(6.9)	920(4.2)	783(30)
-Other	582(1.6)	479(1.6)	103(1.8)	342(1.4)	296(1.4)	46(1.7)
Wrong/Missing	369 (1.0)	311(1.1)	58(1.0)	224(0.9)	198(0.9)	26(1.0)

Table II.

Characteristics of patients who received the four-month PROM questionnaire

	Total	Answered 4m PROM	PROM not returned	p-value
Total	60,847	34,675(57%)	26,172(43%)	
Mean age (min-max)(SD)	82(65 to106)(7.7)	82(65 to105)(7.7)	83(65 to106)(7.6)	<0.001*
Gender (% female)	44,817(74%)	25,280(73%)	19,537(75%)	<0.001†
Chronic cognitive impairment (%)	15,517(26%)	5,643(16%)	9,874(38%)	<0.001†
ASA score				<0.001†
-ASA 1	2,219(3.6%)	1,643(4.7%)	576(2.2%)	
-ASA 2	22,322(37%)	14,144(41%)	8,178(31%)	
-ASA 3	32,645(54%)	17,112(49%)	15,533(59%)	
-ASA 4+5	3,661(6.0%)	1,776(5.1%)	1,885(7.2%)	
Fracture type, n (%)				<0.001†
Undisplaced FNF	8501(14.0)	5027 (14.5)	3474(13.3)	
Displaced FNF	24741(40.7)	14420(41.6)	10321(39.4)	
Basocervical FNF	2018(3.3)	1098(3.2)	920(3.5)	
Trochanteric A1‡	9959(16.4)	5401(15.6)	4558(17.4)	
Trochanteric A2‡	10284(16.9)	5697(16.4)	4587(17.5)	
Trochanteric A3‡	1219(2.0)	723(2.1)	496(1.9)	
Subtrochanteric	3543(5.8)	2010(5.8)	1553(5.9)	
Primary operation, n (%)				<0.001†
Screw osteosynthesis	10495(17.2)	6123(17.7)	4372(16.7)	
Hemiarthroplasty	22649(37.2)	13233(38.1)	9416(36.0)	
Sliding hip screw	18205(29.9)	10000(28.8)	8205(31.4)	
Short IM nail	6013(9.9)	3328(10.1)	2685(10.3)	
Long IM nail	3379(5.6)	1936 (5.6)	1443(5.5)	
Other	106(0.2)	55(0.2)	51(0.2)	

ASA, American Society of Anesthesiologists; FNF, femoral neck fracture; IM, intramedullary

*Student´s t-test

†Pearson's chi-square test

‡AO/OTA classification

Table III.

EQ-5D results before the fracture and at four months by chronic cognitive function (CCI) (n=34,675)

	Before operation				4 months postoperatively			
	Total	No CCI	CCI	p-value†	Total	No CCI	CCI	p-value†
Total (%)	34,675	29,032	5,643		34,675	29,032	5,643	
Mobility(%)				0.001				0.001
No problems in walking around	19,183(55)	17,148(59)	2,035(36)		5,753(17)	5,261(18)	492(8.7)	
Some problems in walking around	14,512(42)	11,206(38.6)	3,306(59)		26,386(76)	22,356(77)	4,030(71)	
Confined to bed	442(1.3)	273(0.9)	169(3.0)		176(5.1)	860(3.0)	901(16)	
Wrong/Missing	538(1.5)	405(1.4)	133(2.3)		775(2.2)	555(1.9)	220(3.9)	
Self-care				0.001				0.001
No problems with self-care	24,044(69)	22,386(77)	1,658(29)		15,780(46)	15,096(52)	684(12)	
Some problems with self-care	7,813(23)	5,383(19)	2,430(43)		13,132(38)	10,981(38)	2,151(38)	
Unable to wash or dress	2,309(6.7)	891(3.1)	1,418(25)		5,187(15)	2,504(8.6)	2,683(48)	
Wrong/Missing	509(1.5)	372(1.3)	137(2.4)		576(1.6)	451(1.6)	125(2.2)	
Usual activities				0.001				0.001
No problems in performing usual activities	17,766(51)	16,824(58)	942(17)		7,529(22)	7,214(25)	315(5.6)	
Some problems in performing usual activities	11,435(33)	9,464(33)	1,971(35)		17,335(50)	15,756(54)	1,579(28)	
Unable to perform usual activities	4,819(14)	2,291(8)	2,528(45)		9,003(26)	5,450(19)	3,553(63)	
Wrong	655(1.9)	453(1.6)	202(3.6)		808(2.3)	612(2.1)	196(3.4)	
Pain/ discomfort				0.001				0.001
No pain or discomfort	19,660(57)	16,960(58)	2,700(48)		9,063(26)	7,697(27)	1,366(24)	
Moderate pain or discomfort	12,591(36)	10,134(35)	2,457(44)		21,870(63)	18,272(63)	3,598(64)	
Extreme pain or discomfort	1,767(5.1)	1,446(5.0)	321(5.7)		3,023(8.7)	2,522(8.7)	501(8.9)	
Wrong/Missing	657(1.9)	492(1.7)	165(2.9)		719(2.1)	541(1.9)	178(3.2)	
Anxiety/ depression				0.001				0.001
Not anxious or depressed	23,658(68)	21,159(73)	2,499(44)		19,830(57)	17,759(61)	2,071(37)	
Moderately anxious or depressed	9,042(26)	6,547(23)	2,495(44)		12,252(35)	9,476(33)	2,776(49)	
Extremely anxious or depressed	1,184(3.4)	768(2.6)	416(7.4)		1,741(5.0)	1,192(4.1)	549(9.7)	
Wrong/Missing	791(2.3)	558(1.9)	233(4.1)		852(2.5)	605(2.1)	247(4.4)	

†Pearson's chi-square test

The sum in each column is not the same, because not all patients answered all questions correctly.

Table IV.

Baseline characteristics of patients answering both four- and twelve-month PROM questionnaire by chronic cognitive function

	Chronic cognitive Impairment			
	Total	No	Yes	p-value
Total	24,510	21,852(89.2)	2,658(10.8)	
Mean age (min-max) (SD)	81(65 to106)(7.7)	81(65 to 106)(7.7)	85(65 to 101)(6.8)	<0.001*
Gender (% female)	73%	72%	77%	<0.001†
ASA score (%)				<0.001†
-ASA 1	1,334(5.4)	1,306(6.0)	28(1.1)	
-ASA 2	10,850(44)	10,133(46)	717(27)	
-ASA 3	11,280(46)	9,549(44)	1,731(65)	
-ASA 4+5	758(3.1)	605(2.8)	153(5.7)	
Missing ASA	288(1.2)	259(1.2)	29(1.1)	
Fracture type, n (%)				0.48†
Undisplaced FNF	3587(14.6)	3219(14.7)	368(13.8)	
Displaced FNF	10351(42.2)	9179(42.0)	1172(44.1)	
Basocervical FNF	762(3.1)	688(3.1)	74(2.8)	
Trochanteric A1 ‡	3719(15.2)	3326(15.2)	393(14.8)	
Trochanteric A2 ‡	3937(16.1)	3500(16.0)	437(16.4)	
Trochanteric A3 ‡	500(2.0)	452(2.1)	48(1.8)	
Subtrochanteric	1449(5.9)	1303(6.0)	146(5.5)	
Primary operation, n (%)				0.52†
Screw osteosynthesis	4315(17.6)	3855(17.7)	460(17.1)	
Hemiarthroplasty	9558(39.0)	8488(38.9)	1070(40.2)	
Sliding hip screw	6527(26.6)	5835(26.7)	692(26.0)	
Short IM nail	2271(9.4)	2003(9.2)	268(10.1)	
Long IM nail	1404(5.7)	1275(5.8)	129(4.9)	
Other	435(1.8)	395(1.9)	39(1,5)	

ASA, American Society of Anesthesiologists; FNF, femoral neck fracture; IM, intramedullary

*Student's t-test

†Pearson's chi-square test

‡AO/OTA classification

Table V.

Comparison of PROMs four and twelve months after hip fracture by sex (n=24,510)

Patient-reported outcome measures	4 months			12 months		
	Chronic cognitive impairment			Chronic cognitive impairment		
	No	Yes	p-value	No	Yes	p-value
EQ-5D index	**0.60**	**0.37**	**<0.001***	**0.64**	**0.39**	**<0.001***
EQ-5D index men	0.61	0.38	<0.001*	0.64	0.41	<0.001*
EQ-5D index women	0.60	0.37	<0.001*	0.63	0.39	<0.001*
ΔEQ-5D	**-0.19**	**-0.17**	**<0.001***	**-0.15**	**-0.14**	**0.35***
ΔEQ-5D men	-0.20	-0.19	0.61*	-0.16	-0.15	0.007*
ΔEQ-5D women	-0.17	-0.16	0.89*	-0.14	-0.14	0.69*
% reached pre-fracture EQ-5D	**28.0%**	**29.6%**	**0.074†**	**33.1%**	**28.4%**	**<0.001†**
% reached pre-fracture EQ-5D men	27.1%	27.5%	0.82†	31.8%	29.5%	0.25†
% reached pre-fracture EQ-5D women	28.3%	30.2%	0.069†	33.6%	28.0%	<0.001†

*Student's t-test

†Pearson's chi-square test

Table VI.

Comparison of PROMs four and twelve months after hip fracture by age (n=24,510)

Patient-reported outcome measures	4 months			12 months		
	Chronic cognitive impairment			Chronic cognitive impairment		
	No	Yes	p-value	No	Yes	p-value
EQ-5D index	**0.60**	**0.37**	**<0.001***	**0.64**	**0.39**	**<0.001***
65-74 years	0.64	0.43	<0.001*	0.69	0.45	<0.001*
75-79 years	0.63	0.39	<0.001*	0.67	0.42	<0.001*
80-84 years	0.61	0.39	<0.001*	0.64	0.41	<0.001*
85-89 years	0.57	0.37	<0.001*	0.61	0.40	<0.001*
>=90 years	0.53	0.34	<0.001*	0.56	0.35	0.007
ΔEQ-5D	**-0.19**	**-0.17**	**<0.001***	**-0.15**	**-0.14**	**0.32***
65-74 years	-0.19	-0.13	0.002*	-0.14	-0.11	0.003*
75-79 years	-0.17	-0.16	0.13*	-0.14	-0.13	0.063*
80-84 years	-0.18	-0.16	0.74*	-0.14	-0.14	0.46*
85-89 years	-0.19	-0.18	0.71*	-0.15	-0.15	0.82*
>=90 years	-0.20	-0.16	<0.001*	-0.17	-0.15	0.63*
% reached pre-fracture EQ-5D	**28.0%**	**29.6%**	**0.074†**	**33.1%**	**28.4%**	**<0.001†**
65-74 years	29.7	35.6	0.06†	35.3	32.4	0.39†
75-79 years	29.9	32.6	0.29†	34.8	30.1	0.07†
80-84 years	28.6	31.5	0.13†	33.0	29.9	0.12†
85-89 years	26.2	26.3	0.94†	31.2	27.4	0.03†
>=90 years	23.6	28.2	0.15†	29.8	25.8	0.04†

*Student's t-test

†Pearson's chi-square test

Figure 1

Flowchart of the study

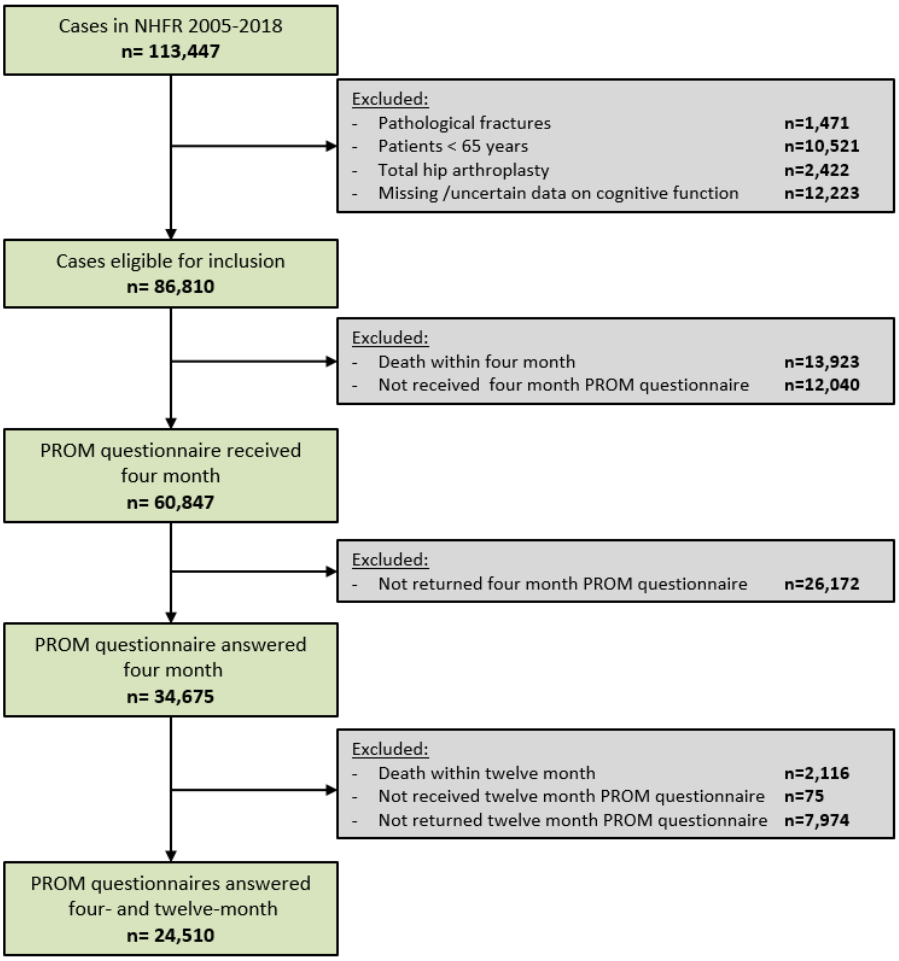


Figure 2

Changes in the mobility dimension of EQ-5D-3L from pre-fracture to 4 and 12 months postoperatively:

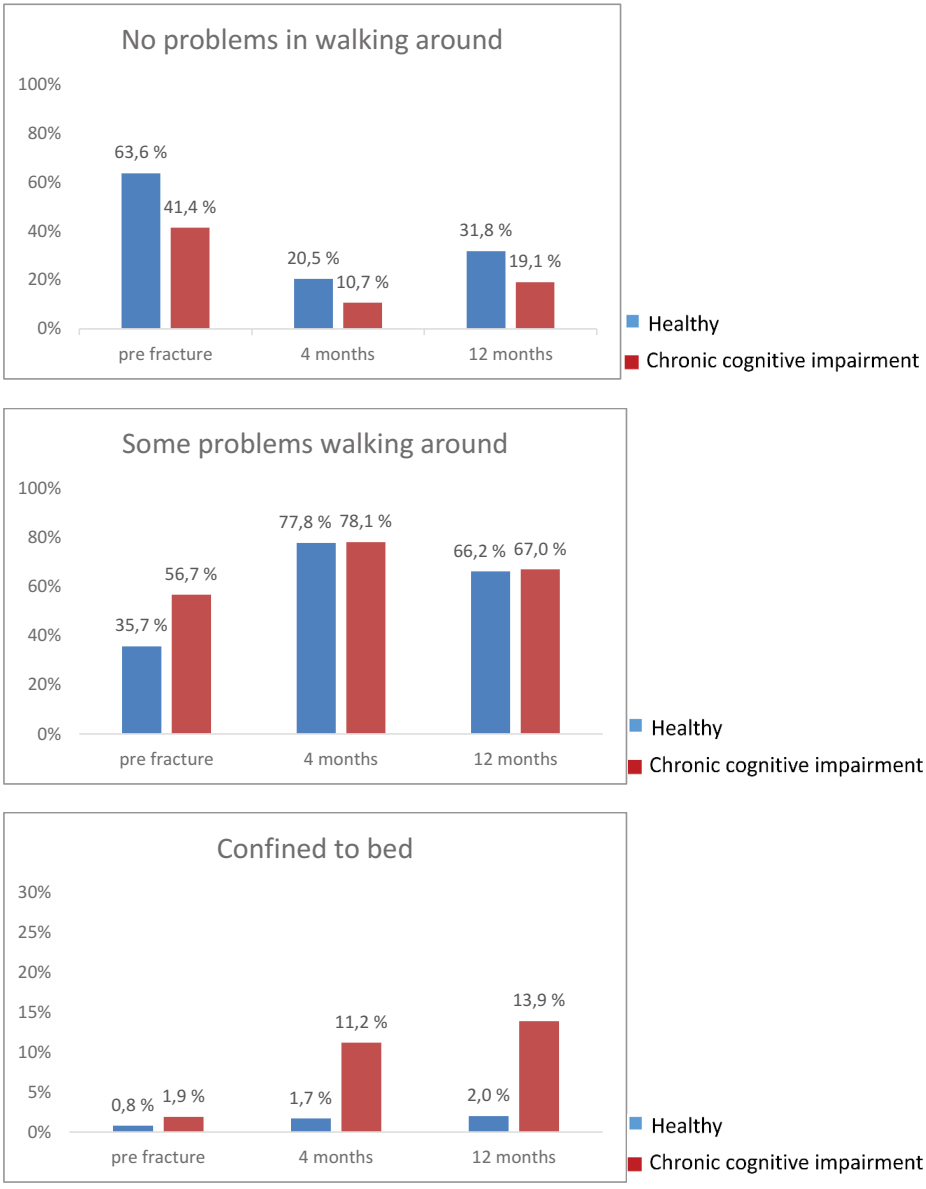


Figure 3

Changes in the self-care dimension of EQ-5D-3L from pre-fracture to 4 and 12 months postoperatively:

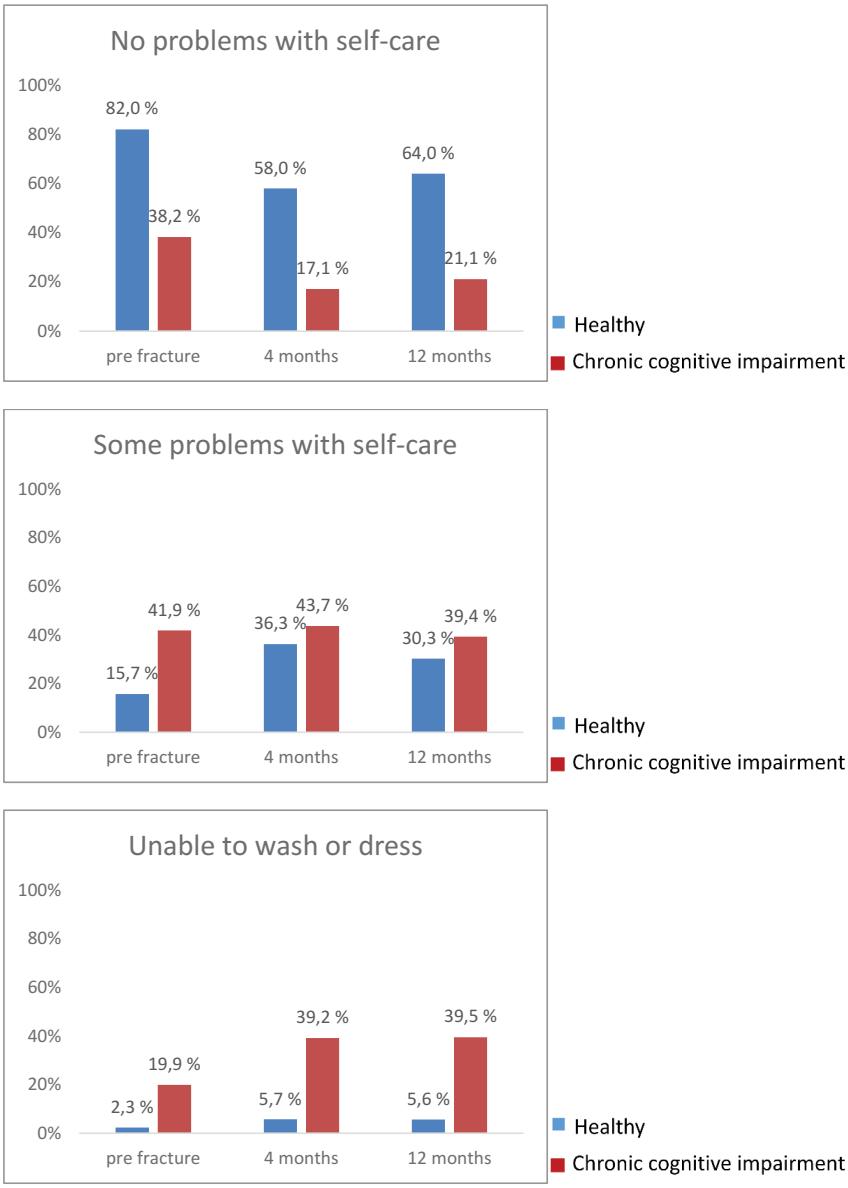
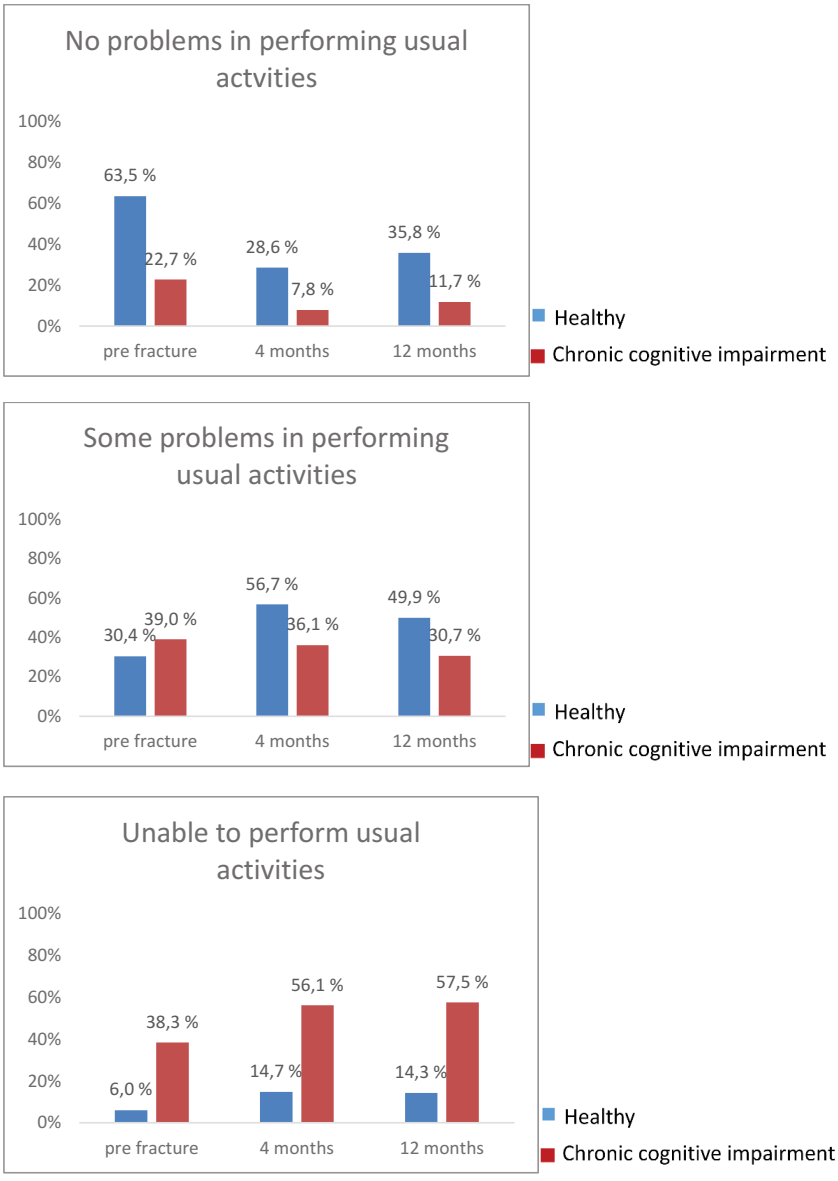


Figure 4

Changes in the usual activities dimension of EQ-5D-3L from pre-fracture to 4 and 12 months postoperatively:



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