Review article/Pregledni prispevek

THE HIP FRACTURE IS AN INJURY AND A DISEASE AT THE SAME TIME

ZLOM KOLKA JE POŠKODBA IN BOLEZEN HKRATI

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Abstract

Background *Low bone mineral density (BMD) can not accurately differentiate between those who will experience a hip fracture and those who will not after the fall from standing high. It influences the predicted success of future fracture prevention in less than 50 %. Bone strength explains the ratio between applied force that act to deform the bone in the counter and the reduced ability of osteoporotic bone to resist some more than the physiologic load in the denominator. The Nevitt's bone fragility factor explains a hip fracture at the same time as an accident (counter) and a disease (denominator).*
The dominant factor in a hip fracture is the fall of the elderly patient. Falls are not only accidents, but are also a consequence of the normal aging process. Falls are preventable by the multifactorial interdisciplinary prevention program (MIPP). Unfortunately as much as 75 % of women and 90 % of men at high risk in nursing homes are not investigated, and 75 % of those affected are not treated.

Conclusions *Very useful is Charlson's comorbidity index with 19 typical geriatric diseases, predicting death in hospitalized elderly with fragility fracture (heart, lung, kidneys, vessels, DM, tumor, liver, dementia, coagulopathies). If the patient has not any comorbidity, his one year mortality is estimated to be 12 %. With 1–2 comorbidities estimated mortality is 26 %, with 3–4 comorbidities 52 %, with 5 or more comorbidities the mortality is above 85 %. In hip fracture Charlson index is on average 3.4. All comorbidities benefit from early operation and early mobilization.*

Key words *hip fractures; bone strength; Nevitt's factor of bone fragility*

Izvleček

Izhodišča *Z bolezensko znižano mineralno kostno gostoto (BMD) ne moremo ostro ločiti starostnikov, ki si pri padcu s stojne višine zlomijo kolk, od tistih, ki si ga ne. Bolezensko znižana BMD ima pri tem manj kot 50 % napovedno vrednost. Večjo napovedno vrednost ima kostna čvrstost, zapisana kot ulomek med silo, ki deluje pri padcu od zunaj (števec) in zmanjšano odpornostjo osteoporotične kosti, da se upre tej le nekoliko več kot fiziološki obremenitvi (imenovalec). Ulomek se imenuje Nevittov količnik kostne čvrstosti. Zlom kolka razlaga kot nezgodo (števec) in bolezen (imenovalec) hkrati.*
Brez padca se kolk pri starostniku ne zlomi. Značilni je padec s stojne višine, ki se ne dogodi le zaradi zunanjih nezgodnih dejavnikov (spolzka tla, arhitektonske ovire, ...), temveč tudi zaradi starostnih sprememb (slab vid, vrtoglavica, ortostatizmi, mišična šibkost, ...). Padce pri starostniku skušajo preprečiti z interdisciplinarnim multifaktorskim preventivnim programom (MIPP). Program je primeren za domove za starostnike. Žal kar 75 % žensk in 90 % moških s povečanim tveganjem za padec ni deležnih ustrezne preventive, 75 % starostnikov, ki so padec preživeli brez posledičnega zloma (in bodo kmalu zopet padli), ni obravnavanih.

Zaključki *Za napoved povečane umrljivosti ob sočasno prisotnih 19 tipičnih bolezni starostnikov, ki so sprejeti v bolnišnico z zlomom, uporabljamo Charlsonov indeks komorbidnosti (bolezni srca, pljuč, ledvic, žil, sladkorna bolezen, rak, demenca, koagulopatije, ...). Brez sočasnih*

bolezni je pričakovana umrljivost po zlomu kolka v prvem letu 12 %, z eno ali dvema sočasnima boleznima je umrljivost v prvem letu že 26 %, s tremi ali štirimi 52 %, s 5 ali več že preko 85 %. Starostniki z zlomljenim kolkom imajo povprečen Charlsonov indeks komorbidnosti 3,4. Zgodnja operacija in zgodnja mobilizacija dokazano zmanjšujeta umrljivost v prvem letu po doživetem zlomu kolka.

Ključne besede *zlom kolka; kostna čvrstost; Nevittov količnik kostne čvrstosti*

Bone strength

In Europe, osteoporosis causes a fracture every 30 seconds. Every fifth woman and every eighth man will experience one of the typical osteoporotic fractures in their lifetime. Osteoporosis is therefore by no means an old wives' disease: it does not only affect every third postmenopausal woman, but also every fifth man above 50 years of age. Specific forms of osteoporosis can be observed in younger women and even in children.

Osteoporosis is typically localised in bulbar expansions of long tubular bones (metaphyses) adjacent to joints and in the vertebrae (everywhere that bone in healthy young adults is filled with large quantities of spongy bone tissue), and energy needed for the bone to break is low (falls from standing height).[1]

What is also very important is the realisation of orthopaedic and traumatologic surgeons, who treat osteoporotic fractures, that new fractures require referral of patients to an appropriate physician during or after fracture treatment, to address the underlying disease, which caused the fracture. To neglect the treatment of underlying disease would be a medical error, *vitium artis*.[2]

What scares us the most among fragility fractures are the upper femoral/hip fractures. While all other osteoporotic fractures mostly cause several weeks of severe pain and then stabilise in a deformed position, hip fractures may pose a direct threat to patients' lives. A text from the beginning of the 19th century says: »We come into the world under the bream of the pelvis and go out through the neck of the femur.« Hip fracture was called the unsolved fracture and this is partly still true today.[3] We find that those elderly patients whose medical history already includes falls from standing height are much more predisposed to osteoporotic fractures than those without experience with falling: fracture risk is 13-fold higher (relative risk 26 versus 2). But surgeons notice that 39 % of elderly patients with characteristic osteoporotic fractures have BMD more than 2.5 standard deviations lower than young adults of the same gender and meet the criteria for the diagnosis of osteoporosis. 50 % of patients with osteoporotic fractures have osteopenia. 11 % have normal bone according to densitometric criteria, but it breaks nevertheless when falling!

Prevalence of hip fractures is increasing, and the same is true for all other osteoporotic fractures, and consequently for the costs that burden the health insurance in developed countries. The cost increase is enormous and when we keep in mind the aging population in the developed nations, we could consider this an epidemic of gerontologic traumatology. According to some estimates European Union countries spent 36 billion € in the year 2000 for osteoporotic fractures, and this figure will triple by 2050 when every third European will be older than 60 years.

Recently, the paradigm for diagnosis and treatment of osteoporosis has undergone changes due to new findings on this disease. With the arrival of densitometers that could measure BMD we started using medications that block further degradation of density and repair the densitometric results. More recent findings however suggest that the BMD value influences the predicted success of future fracture prevention in less than 50 %. The remainder is attributed to bone quality. Bone quantity and bone quality together illustrate bone strength.

Bone strength comes from inorganic mineral bone components, which are fragile, yet resistant to compression, and from collagen, the organic component, which gives bone its elasticity. Bone strength is a sum of BMD and collagen, and it represents the force that opposes external forces that act to deform and break the bone. Bone strength is therefore a function of BMD, bone turnover (bone remodelling, microarchitectural structure of trabeculae), and material properties (mineralisation rate, collagen quality, ability to spontaneously repair trabecular microfractures).[4]

There are a number of risk factors for osteoporotic fractures, some of greater, some of lesser significance.[5,6] Major risk factors clearly include age, low BMD, low weight and previous fractures. As osteoporotic fractures require very little external force to be applied against the bone, history of recent falls is also very important. Such patients have sharply increased fracture risk. In comparison with normal BMD, prevalent osteoporosis is linked to 2.8 times higher fracture risk. In elderly recent fallers, this relative risk is as much as 24.8 times higher.[7] Densitometric results explain less than half of all risk, which means that there are other factors in addition to low BMD that influence fracture occurrence.

Risk factors for osteoporotic fractures that cannot be modified include:

- Previous fractures in adulthood
- Osteoporotic fractures in close blood relatives
- Caucasian ethnicity
- Age
- Female gender
- Dementia

– Concomitant diseases that diminish patients' overall capacity

Risk factors for osteoporotic fractures that can be modified include:

– Low BMD
– Excessive smoking
– Excessive alcohol consumption
– Low weight
– Estrogen deficiency with menopause before 45 years of age
– Glucocorticoid abuse
– Low calcium intake
– Frequent falls (psychophysical characteristics, poor vision)
– Poor exercise tolerance

Biomechanics of osteoporotic fractures

(Nevitt's bone fragility coefficient)

A small external force is necessary to cause an osteoporotic fracture otherwise the osteoporotic bone still does not break. The dominant factor in a fracture is therefore the fall of the elderly patient. According to Nevitt, the hazard coefficient is the ratio of a given load on the bone, and the load that actually causes a fracture. If the numerator is the weight of the patient, and the denominator the reduced ability of osteoporotic bone to resist more than the physiologic load, we come to the conclusion that osteoporotic fractures are at the same time an injury and a disease.[8] The phenomenon of falls in the elderly is difficult to analyse because we are not testing healthy bone, falls have complex multicause etiology and so far we have not been able to physically define the difference between accidental and nonaccidental falls.

Exponential increase of hip fracture frequency with decades of age corresponds to BMD decrease. This could be proven in cadaver studies, so all attention was directed towards the prevention of BMD decrease. However, patients with significantly decreased BMD have only 2 % risk of fracture within the next year, and only 2 % of falls in the elderly result in hip fractures. Randomised studies failed to fully prove a significant reduction of hip fracture risk despite of inhibition of BMD loss.[9] Studies that proved the efficacy of BMD loss inhibition mostly included younger, postmenopausal women, and not those aged 80 or 90, in whom the frequency increases exponentially!

At the same time, low BMD measurements cannot accurately differentiate between those who will experience a fracture, and age- and gender-matched control group. To sum up, a hip fracture is at the same an accident (numerator) and a disease (denominator).

More than 90 % of hip fractures involve falls from a standing height, however they occur only in 2 % of the elderly who fall![10] The cause lies in the concomitant diseases of the elderly patients (dementia, neurovascular disease, atherosclerotic disease) that may inhibit the protective reaction during the fall, and in the direction of the fall, ground impact near the trochanter, higher or lower absorptive capacity of soft tissue at the impact site, and the like.[11] In a prospective multiyear study in a Boston nursing home Cummings and Nevitt observed that women with fractures had approximately 10 % lower BMD than those who did not suffer fractures during falls.[12] Same difference was observed in men with or without fractures. They took into account 0.55 of body weight (gravity centre in the standing position), and with the average BMD for age groups they were able to calculate the ϕ factor of 1.35. This means that the external load force during the fall of an elderly patient from standing height on the trochanter exceeds the skeletal fragility in the denominator by 35 %!

Known resorption inhibitors are not able to improve the denominator in the elderly patients by 35 %! In the best case, BMD can be increased by 5 % in the first year of treatment, exceptionally by 10 %. Later on BMD does not continue to increase. We can act on the side of the numerator: with increased muscle mass and mobility the patients can use their arms to dampen the fall, and various hip protectors can increase the absorptive capacity of supertrochanteric tissues. Effective hip fracture prevention could be planned by calculating the ϕ factor (height, weight, BMD) individually, even though currently we do not have the means to increase BMD in the denominator by 20 % or more.[9] Lauritzen reported a successful reduction of hip fractures by more than a half in a nursing home population who wore padded underwear (denominator).[13, 14]

Fractures happen when the force acting on the bone causes its critical deformation. Studies of greater (osteomalacia) and lesser deformation (osteopetrosis) in animal models and cadavers showed that the 1990 definition of osteoporosis with BMD must be updated, and instead of bone quantity and microarchitectural structure of trabeculae, the total bone strength should be considered. This is a sum of BMD (bone brittleness) and collagen (elasticity), and it couples bone quantity measured by BMD, with bone quality (measured partly by ultrasound, and mostly by histomorphometry, more recently by Quantitative micro-computed tomography), thus more precisely defining the denominator of the Nevitt's bone fragility factor ϕ. Nevitt's factor facilitates our understanding of possible methods of prevention of osteoporotic fractures, for example, increase of bone strength (increasing as much as possible the peak bone mass by the end of skeletal maturation in the third decade), inhibition of bone loss with healthy load on the bone, diet with sufficient calcium and vitamin D, early detection of disease, and as a rule long-term pharmacotherapy.[15]

Upper femoral fractures

(Hip fractures)

Hip fractures were first described by Hippocrates. First treatment instructions are attributed to Ambrois Paré and were recorded in 1572. In the year 1823, Sir

Astley Paston Cooper wrote with resignation that the femoral neck fractures never heal: »We come into the world under the bream of the pelvis and go out through the neck of the femur.« In 1858 Langenbeck performed the first hip fracture osteosynthesis. The patient died due to an infection. With increasing life expectancy, hip fractures have become the major issue of geriatric traumatology, where in addition to the injury, physicians are facing patients' atherosclerosis, muscle adynamia and atrophy, osteoporosis, spondylosis and arthrosis, senile dementia, respiratory and circulatory failure and more. Once the treatment was hopeless, as illustrated by the phrases »frattura senza speranza« and »unsolved fracture«. Mortality was 75 %. In the last 100 years, the medical science has intensively studied all factors involved in fracture occurrence and healing: anatomical characteristics of bone, and femoral head and neck vascularisation. Osteoporosis was the suspected main culprit for fractures. Biomechanics as a science actually developed during the research of physiological and pathological phenomena in the hip. In 1854 Robert Smith observed that intracapsular femoral neck fractures heal if they are impacted. After the invention of Smith-Peterson nails in 1931 the mortality fell from 75 to 28 %. With the advancement of anaesthesiology and use of antibiotics it dropped to below 20 % for the first postoperative year. Today all hip fractures are treated surgically, except for impacted abductive femoral neck fractures. Osteosynthesis and endoprosthetics successfully complement each other. »Aging is the only method for a long life and we physicians must make this process as bearable as possible, also by solving the unsolved fractures.« Recently, the prolonged average life expectancy in Western countries has again increased the mortality in the first postoperative year to over 30 %.[3]

80 % of injured patients with broken hips are older than 65 years. In 1930 the grouping of population by age formed a pyramid and only 2 % of hospitalised surgical patients were older than 65 years. Today, the proportion of such patients in surgical wards reaches 40 %. In Slovenia, the population above 55 years of age increased by a third from 1967 to 1987, and from 1977 to 1987 by as much as 29 %. Proportion of Slovenian population older than 65 years exceeded 13 % already before the year 2000, which according to the WHO criteria is the limit for classifying population of a country as old. High standard of living favourably influences survival and thus the problem of gerontologic traumatology is coming in the forefront in the developed countries because of astronomical cost increases for the typical spine, wrist and hip fractures. Half of all the funds spent by Western countries for gerontologic traumatology goes to hip fractures. It is estimated that the costs of treatment of hip fractures in the elderly patients in the USA have risen to between 8 and 20 billion $ annually. In 1990, half of all the hip fractures in the world took place in Europe and North America. Patients with femoral neck fractures are 6 to 10 years younger than those with pertrochanteric fractures, and patients with subtrochanteric fractures are even older. Ratio between women and men is between 2 : 1 and 8 : 1. Several studies showed that the fracture incidence is rising exponentially with age and in both genders. Underdeveloped regions of Asia, South America and Africa are approaching Europe and North America in hip fracture incidence due to rapid population growth. It is expected that these regions will account for 70 % of all hip fractures by 2050. As the costs of treatment are extremely high, effective prevention is the only way to avoid this looming social disaster. Hip fractures are thus more frequent in the elderly than in the young, in women than in men, in the most developed countries, and in Caucasians.[16]

Classifications of femoral proximal fractures

Modern fracture classifications combine fracture description with prognosis and options for fixation.[17] Numerous classifications have been proposed, which shows that we have been battling this problem for a long time, and it still is not solved to a satisfactory degree. According to anatomical height proximal femoral fractures are divided into capital, subcapital, extraarticular in the trochanteric region and subtrochanteric fractures. Intracapsular subcapital fractures and fractures in the pertrochanteric region are by far the most common in the elderly, while the rarer subtrochanteric fractures with lower BMD and technical complexity represent a challenge for experienced traumatologists. When discussing femoral neck fractures, some authors mention subcapital fractures that are supposed to be located above transcervical fractures, which lie by the base of the neck already in part extraarticularly. X-ray image analysis however showed that such differences originate from the parallaxis of X-rays. As the rift in femoral neck fractures runs spirally, the direction of the fracture line on the X-ray image depends on patient's position during the investigation and on the direction of X-rays. This is the basis for the criticism of the Pauwel's classification with three types of femoral fractures. In type I, the angle that the fracture line makes with the horizontal is visible at the X-ray line of 30°. In type II the angle is up to 50°, and in type III 70° or more. In type I, the fracture line is therefore much more horizontal than in type III, which is related to a higher incidence of pseudoarthrosis and aseptic capital necrosis in femoral neck fractures. Garden's classification of femoral neck fractures is based on the degree of displacement of bone fragments at the fracture site. Various types of femoral neck fractures are in fact supposed to be the same type with different degrees of displacement. Garden type I is the incomplete or impacted femoral neck fracture. On X-ray, trabeculae in the lower femoral neck appear uninterrupted. Garden type II fracture is fully visible on X-ray without displacement, and the trabeculae appear interrupted also in lower regions of the femoral neck. Garden type III is a partly dislocated fracture in varus malalignment. Trabeculae are visible on X-ray and in the head of femur they are no longer parallel with the acetabular trabeculae, confirming an incomplete displacement between broken femoral fragments. Garden type IV is a

fracture with total dislocation of fragments. Trabeculae in the head of femur are again in parallel with those in the acetabulum. There are also a number of classifications of fractures in the trochanteric region. In the commonly used Evans' classification fractures are graded as stable or unstable, and unstable fractures are further divided into those where stability can be regained with anatomical or near-anatomical repositioning, and those where anatomical repositioning would not lead to stabilisation. Trochanteric fractures are stable if good contact in the medial cortex can be restored: lesser trochanter is therefore the key for evaluation of trochanteric fracture instability. A very useful grading system for upper femoral fractures is the Russel-Taylor classification, which takes into account the involvement of the piriformis fossa and the breakage of lesser trochanter. In type 1 the fracture does not extend into the piriformis fossa, while in type 2 it does. Lesser trochanter is not fractured in type A, while type B does involve it. This allows for 4 combinations of fractures: 1A runs below the lesser trochanter towards the greater trochanter without fracture in the piriformis fossa region, 1B involves the lesser trochanter and extends towards the greater trochanter but not to the piriformis fossa, 2A runs below the unfractured lesser trochanter to a fracture in the piriformis fossa region, and 2B are fractures of the lesser trochanter that extend upwards to the piriformis fossa. The AO (Arbeitsgemeinschaft für Osteosynthesefragen) classification is alphanumeric and uses letters A, B, C and digits 1, 2, 3 to denote the distance of fracture from the joint surface, number of bone fragments, and their interactions. Femoral head fractures are always a part of a complex hip joint injury, and are often a consequence of posterior luxation of the femur. Impression femoral head fractures are common, their location is anterior, posterior or cranial, and they may be combined with avulsion breaks of the insertion of ligamentum teres and shear stress fractures. All of these fractures are characteristic of younger patients. The most unfavourable combination is a capital fracture combined with femoral neck fracture, as the main intermediary fragment remains undisplaced. C1 is the avulsion of a part of the head of femur along or with the insertion of ligamentum teres, C2 is impression capital fracture, and C3 is a combination of avulsion of a part of the head of femur and capital depression. Femoral neck fractures are intraarticular, and their stability is determined by the angle formed by the projection of the fracture plane with the horizontal on the anteroposterior X-ray. B1 denotes subcapital fractures with valgisation or without displacement, B2 are the transcervical fractures with varisation, and B3 stands for dislocated subcapital fractures with varisation or translation. Dislocated subcapital fractures greatly increase the risk of avascular capital necrosis, whereas there is no such risk in impacted abduction fractures. Retroversion of the head of femur in the lateral projection is very important for evaluation. Fractures in the trochanteric region are extraarticular, so they do not cause avascular capital necrosis: A1 stands for simple trochanteric fractures with the fracture line running from the greater trochanter distally and medially towards the lesser trochanter, and the medial cortex is fractured only at one site, A2 fractures have the same direction, but the medial cortex is broken at least at two sites, and A3 denotes fractures of the lateral cortex below the level of the greater trochanter. Fractures directed medially and proximally are called reverse fractures. These are unstable and are difficult to realign and stabilise. According to the AO classification, subtrochanteric fractures belong among the diaphyseal fractures, however as they extend to the trochanteric region, they must be managed in the same manner as pertrochanteric fractures.

Treatment options for proximal femoral fractures

Current treatment of femoral neck fracture is surgical as a rule. Outcome of conservative treatment carries a burden of a 30 to 60 % mortality rate. With modern anaesthesiology options, the patients are operated upon as soon as possible after the injury, mostly in the first day after admission. Of course surgical treatment cannot be performed in debilitated patients. In such case the patients can only be nursed with regular turning in bed until the pain phase resolves, then they are made to sit up as soon as possible, and to use the wheelchair and walking frames. In the past femoral neck fractures were considered unsolved, because if unoperated, they usually heal with pseudoarthrosis. Unoperated pertrochanteric fractures have better prognosis and can heal on their own. Nevertheless, the patients are mostly elderly and are exposed to numerous respiratory and uropoetic complications. Malrotations, limited mobility and shortenings are common in conservatively healed pertrochanteric fractures.

Surgical treatment of femoral neck fractures

Several options are available: fixation with spongious screws when BMD is satisfactory, osteosynthesis with a 130° rigid plate – now being abandoned, telescopic screws, partial or total endoprosthesis, endomedullary fixation. Younger and certain elderly patients require valgisation osteotomy. Last chance of surgical therapy is the hanging hip or the Girdlestone procedure.

Surgical treatment of pertrochanteric fractures

The available options are rigid 130° plates, rigid 95° plates, telescopic screws with 130° and 95° angles, endomedullary fixation with anchored nails, Ender nails and dynamic axial fixation with external fixator. Comminuted pertrochanteric fractures can be treated with tumor prostheses. Most traumatologists choose between dynamic hip screws (DHS) or a variant of endomedullary nails. Both give good results in trained hands. A more current method is intramedullary nailing, as it is biomechanically more favourable due to smaller torque. Its robustness enables early load, however it is significantly costlier in comparison with DHS and often more technically demanding. As all

previous methods, intramedullary fixation cannot be applied to every type of fracture and an ideal method is yet to be discovered.

Surgical treatment of subtrochanteric fractures

Subtrochanteric fractures are treated as diaphyseal femoral fractures, but as they extend to the trochanteric region, they must be managed according to the rules for the treatment of pertrochanteric fractures. The established 95° or condylar plates and dynamic condylar screws with the same 95° angle have competition in the DHS, which with its telescopic properties enables interfragmentary compression along the longer screw axis. The 130° plate is slowly going out of use. The most popular method for the treatment of subtrochanteric fractures in modern traumatology is the second generation intramedullary nails: the reconstruction nails. They have lesser torque in comparison with extramedullary fixation methods with different angle plates or DHS. As with pertrochanteric fractures, the intramedullary implant is more robust and allows the elderly patients, who are often unable to use the crutches to relieve the stress, to partly or fully load the operated limb more early. In selected cases we can use third generation external fixators with telescopic bodies, but the use of such technology requires preserved BMD at the locations where fixator screws are anchored.

Three spongious screws that were the most commonly used method in the past for the treatment of femoral neck fractures, represent a minimally invasive procedure, which does not cause further stress for the already weakened bodies of the elderly patients. Perfusion of the head of femur can be evaluated intraoperatively with exploratory drill holes, which is simpler than to search for perfusion disorders with selective angiography and magnetic resonance imaging. On the other hand, the advantage of endoprosthetics with cementing is that load can be immediately placed on the operated limb. However, with current experience and materials it is likely that cemented prostheses will weaken in 10 years, and the condition for implantation is sufficient age (biological and chronological!) with expected 10-year survival. Similar considerations apply to treatment of per- and subtrochanteric fractures, where the choice of more robust intramedullary nailing implants enables the elderly to load the operated leg immediately after surgery.

Because hip fracture patients are usually elderly and have concomitant diseases, at least brief preoperative preparation is always necessary. Risks of surgery include intraoperative blood loss and stress on the system during anaesthesia. Postoperative rehabilitation is managed in line with the success of the osteosynthetic procedure. If the osteosynthesis is stable, the patient can begin to load the limb early. In case fractures are anatomically realigned, but unstable, load must not be placed on the operated leg until bone healing is established on X-ray. Early postoperative mobilisation of the patient avoids potentially fatal pulmonary complications, thromboembolic complications, urinary tract infections and the like. Anatomic restitution serves to prevent potential shortening of the limb and malrotation, which were common in the more distant past especially in pertrochanteric fractures. With the osteosynthesis of femoral neck fractures we try to avoid pseudoarthrosis, while the choice of surgical method in itself does not protect from aseptic capital necrosis. For these reasons, we usually choose the partial double-cup cemented hip prosthesis for the femoral neck fracture patients above 65 years of age. Recently, increased incidence of pulmonary embolism has been reported with endomedullary nailing of femoral fractures, however it does not exceed the incidence of complications in conservative treatment. Final aim of surgical treatment is to rehabilitate the patient physically, mentally and socially as quickly as possible, to allow him to return to his home environment. However, the success of surgical treatment is always hampered by osteoporosis.

Very useful is Charlson's comorbidity index with 19 typical geriatric diseases, predicting death in hospitalized elderly with fragility fracture (heart, lung, kidneys, vessels, DM, tumor, liver, dementia, coagulopathies). If the patient has not any comorbidity, his one year mortality is estimated to be 12 %. With 1–2 comorbidities estimated mortality is 26 %, with 3–4 comorbidities 52 %, with 5 or more comorbidities the mortality is above 85 %. In hip fracture Charlson index is on average 3.4. All comorbidities benefit from early operation and early mobilization.[18]

Fall phenomenon

Fall is unintentionally coming to rest on the ground or floor.[19] Falls can happen at any age, but in the elderly they have outcomes that would not be expected in the young.[20] Only in the recent decade we have started to pay attention to the fall phenomenon, which does not only involve accidents, but is also a consequence of the normal aging process. Falls are preventable, although most are benign and injury free. In 1987 the Kellogg International Work Group showed that the fall phenomenon is a consequence of physical illness, effects of medications, and environmental and social factors, and it can be studied and prevented. This opened a new field of research with longitudinal studies of falls and the Nevitt's biomechanical model in 1989.[21]

Fallers do not differ apparently from non-fallers except by falling at least once per year. Falls result in injuries that are classified according to the Abbreviated Injury Scale (AIS) into minor (superficial abrasions, contusions), moderate (larger lacerations of soft tissue, wrist fractures, dislocations of minor joints) and major (hip fractures).

Incidence

Residential patients fall three times more often than their independently living peers. Incidence varies among institutions: in rehabilitation centres it is one half, and in nursing homes one fifth of that in psycho-

geriatric institutions. One third of independently living suffers one fall per year. Half of those who fall experience recurrences. This is linked to their agility, vitality and cognitive function – their mobility. Two thirds of nursing home residents suffer one fall per year, and in half of them falling repeats. Incidence is therefore greater in residential patients and there are no established differences between men and women.[20]

Consequences

In independently living elderly patients one half of falls has consequences: one third causes contusions, one tenth moderate injuries (soft tissue lacerations ...) and one twentieth results in fracture.
In residential patients consequences are twice more frequent, with even greater incidence of hip fractures and with major head injury.
Incidence of osteoporotic fractures is three times greater in women than in men, which is linked to the severity of osteoporosis and slightly longer average life expectancy.

Common risk factors for falls

- The Masud study (2001) lists at least 400 risk factors for fall, intrinsic (disease, age, insecure gait, medications...) and extrinsic (obstacles, social factors ...).[22] Incidence of falls and hip fractures in residential elderly patients can be reduced with a multifactorial interdisciplinary prevention program (MIPP).[23–33]
- Staff training
- Adaptation of environment
- Gait and mobility exercise
- Technical accessories
- Revision of pharmacotherapy (psychotropics)
- Hip protectors
- Post-fall problem-solving conferences

MIPP is helpful for the elderly with preserved cognitive function and hip fracture rate is reduced also in those with cognitive decline. Mobility exercise is useful in both cognitive function groups; however, maintenance of mobility is not linked to a reduction of fall risk.
Hip protectors are protective pads designed to cover the greater trochanter and attenuate or disperse the force of fall sufficiently to prevent a hip fracture.[34]
A number of cost-benefit studies between 2004 and 2006 proved the efficacy of MIPP and hip protectors in residential elderly patients, and some studies did so also in the independently living.[35–40] There were also studies where the question of efficacy remained unresolved: the main reasons for failure were always low compliance and adherence, which are higher in care-dependent residential patients, thus leading to better results.[41–45]
Unfortunately as much as 75 % of women and 90 % of men at high risk in nursing homes are not investigated, and 75 % of those affected are not treated![46, 47]
Data from studies powered to evaluate hip protectors is consistent: hip protectors reduce hip fracture incidence by more than a half (best results were reported in Norwegian nursing homes, 69 %).[48] They have no influence on other fractures. Hip protectors virtually always help, but only if the patients wear them. MIPP increases compliance and adherence, and hip protectors are therefore most effective as a part of a comprehensive strategy for hip fracture prevention in nursing homes.

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