Risk Factors for Proximal Humerus Fractures

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Introduction

Fractures of the proximal humerus belong to the second most common fractures of the upper extremity. Only fractures of the distal radius occur more often according to the current literature [1]. Through continuous improvement and development of different therapeutical options, the injured patients can be offered many different curative solutions nowadays.

However long term effects such as loss of motion or development of arthritis with corresponding negative impact on the outcome even after ideal conservative or surgical treatment still exist in the course of the healing.

Therefore it would be eligible to minimize the incidence of proximal humerus fractures, so that problems as just mentioned cannot arise or can be at least reduced to a minimum. For this purpose it is helpful to understand the risk factors for proximal humerus fractures to counteract them preemptively.

The following chapter provides an overview of the different risk factors for the development of proximal humerus fractures and the relevant prevention options shall be explained (Table 3.1).

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Falls

More than 90 % of the proximal humerus fractures result from falls. The pathomechanism is in most cases the same, with the most common direction of the fall being forward to the fracture site, falling either on the outstretched arm, or directly onto the shoulder [2]. Correspondingly in patients who tend to suffer from frequent falls the risk of proximal humerus fractures is higher [1]. A history of at least one fall within the last 6 months increases the fracture risk of the patient in the future which becomes clear considering that 30 % of the patients of 65 years or older fall

Table 3.1 Risk for proximal humerus fractures [1]

Falls	Low bone mass/ Osteoporosis	Frailty
Diabetes mellitus	BMD	Control of falls
Epilepsy	Age	Physical activity
Handedness	Female gender	
Visual impairment	Nutrition	
Deafness	Glucocorticoids	
	BMI	
	Ethnical differences	

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at least once per year with 50 % of them suffering from recurrent falls. In this context it should be mentioned that people with recurrent falls tend to have general physical disabilities affecting their daily life also increasing their personal risk for a proximal humerus fracture [3, 4].

Besides the personal history of falling a history of maternal hip fracture also increases the personal fracture risk most likely being related to the predisposition of suffering from osteoporosis later [3].

Factors that go along with a higher fall risk are exemplarily listed below:

- Diabetes mellitus
- Epilepsy
- handedness
- visual impairment
- deafness

Diabetes Mellitus (DM)

Ivers et al. describe DM as risk factor to suffer from fractures, particularly in terms of fractures of the proximal humerus. Two different pathological explanations exist: on the one hand lower bone mineral density (BMD) scores are described in people with DM (especially type I DM) compared to healthy people. A low BMD results in higher fracture rates in patients with type I DM because of the higher bone fragility. On the other hand Ivers et al. showed different associations between the late-onset complications of DM, particularly in terms of diabetical retinopathy and neuropathy, and a higher risk for falls. Patients with diabetical retinopathy have a higher risk of falling as soon as DM affects their visual ability simply overlooking obstacles in daily life. This is similar to patients with diabetical neuropathy. An increasing loss of proprioception can lead to an impairment of balance resulting in falls. Hereby the possibility of suffering from a proximal humerus fracture is increased. The longer the patients suffer from DM and the worse the patients are adjusted to the diabetical medication, the higher is the probability of the occurrence of proximal humerus fractures. Preemptively attention should be paid to the guidelines of the "international diabetes federation" (http://www.idf.org/) [5, 6].

Epilepsy

About 50 million people worldwide suffer from epilepsy [7]. Most of them take antiepileptic drugs (AEDs) as prevention from seizures and to improve their quality of life.

A research group lead by Carbone tried to establish an association between the use of AEDs and the fracture risk. In a prospective study they were able to show that there is a significant correlation between taking AEDs and a higher risk to fall along with a higher fracture risk. There was no evidence of a correlation between changes in the bone mineral density though [7].

A combination of AEDs and antidepressants shows an increased fall risk and an increased fracture rate compared to a monotherapy with only AEDs [8].

However, not only the side effects of antiepileptic drugs lead to a higher fracture risk, but the acute seizure correlates with higher fracture rates as well. This might be due to falls in the beginning of the seizure and because of the enourmous forces affecting the patient during a generalized tonic clonic seizure (grand mal). The typical seizure induced fracture pattern is a bilateral locked posterior fracture dislocation of the shoulder [9, 10].

To minimize the fracture risk regular checkups and an ideal adjustment to the antiepileptic medication is needed. Current guidelines can be found at the "American Epilepsy Society" (http://www.aesnet.org/).

Handedness

Left handed people have a higher fracture risk compared to right handed persons [11]. The reason for this phenomenon is not completely understood by now. It is supposed that left handed people do not get along well in a world created mostly for right handed people leading to a higher fall risk and thus a higher fracture risk [11, 12].

Visual Impairment/Deafness

Visual impairment is assumed as an indicator for a higher risk to fall since reduced vision leads to an possible overlooking of obstacles in the daily life on the one hand. On the other hand there are different comorbidities that go along with visual impairment e.g. DM going along with higher risk of falling. In the current literature a higher fracture risk is described for both explanations [13, 14].

Chu et al. describe a correlation between reduced hearing capability and risk of falling. Patients that suffer from hearing problems have a higher risk to fall. An explanation for this is the limited awareness of the environment that conciliates an insecurity in the daily routine. Above all presbyakusis, resulting of a degenerative process of the corti organ in the old age, is deemed to be a risk factor for recurrent falls [1].

Osteoporosis and Bone Mineral Density (BMD)

Osteoporosis is known as a systemic skeletal disease with corresponding higher fracture risk caused by microarchitectonical changes of the bone tissue [15]. A general greater average life expectancy explains the growing importance and relevance of osteoporosis in traumatology [16].

In the literature there are more than nine million fractures reported worldwide per year caused by osteoporosis [17] with fractures of the proximal humerus presenting the forth most common fracture entity [18].

The major risk factors for developing fractures due to osteoporosis are (see Table 3.2):

- BMD
- age
- female gender
- nutrition
- hormonal changes
- glucocorticoids
- BMI (body mass index)
- ethnic differences

BMD

The level of BMD is an indicator for fracture risk in osteoporosis. There is a negative correlation between BMD and fracture risk: the lower the BMD the higher the fracture risk being substantified by the EPIDOS study and a study of Keegan et al. [3, 19].

Age

Since over 70 % of the people suffering from a proximal humerus fracture are 60 years and older, a correlation of the age and fracture risk can be assumed [18]. This might be due to an age-depending distribution of the bone mass with a peak being reached in females at the age of thirty. From the beginning of the menopause the bone mass decreases continuously in most of the women [20]. Taking this into consideration the chances for proximal humerus fractures, even in low-energy injuries are increased whereas usually a high-energy injury is essential to cause such fractures in healthy bone [18].

Besides the risk of falling increases as well with increasing age leading especially in combination with low BMD to a higher fracture risk per se [15, 21].

Table 3.2 Risk factors for osteoporotic fractures [15]

Female sex	Low bone mineral density	Neuromuscular disorders
Premature menopause	Glucocorticoid therapy	Cigarette smoking
Age	High bone turnover	Excessive alcohol consumption
Primary or secondary amenorrhoea	Family history of hip fracture	Long-term immobilisation
Primary and secondary hypogonadism in man Asian or white ethnic origin	Poor visual acuity	Low dietary calcium intake
Previous fragility fracture	Low bodyweight	Vitamin D deficiency

Gender

As described above the chance to suffer from an osteoporosis related fracture is several times higher in women compared to men. On the one hand, the postmenopausal changes, on the other hand the overall lower bone mineral density are responsible for this fact. Due to the increasing age of the population the percentage of men developing osteoportic fractures increases as well since men lose about 1 % of their bone mass starting at the age of sixty with a raised conspicuously fracture risk [15, 22].

Nutrition

In general, nutrition plays an important role in the development of osteoporosis related fractures. The risk of suffering from a proximal humerus fracture is increased by low dietary calcium and vitamin D intake [1].

In accordance the literature provides evidence that an appropriate calcium intake combined with and without vitamin D significantly decreases the fracture risk among older patients [23, 24].

Following current guidelines of the "International Osteoporosis Foundation" an intake of 1000 mg calcium per day is recommended for women and men. For women at the beginning of the menopause and for men at the age of 65 the calcium intake should be increased to 1300 mg per day [24].

In this context it should be mentioned that alcohol consumption has an influence on BMD and fracture risk correspondingly. While alcohol abusus is known to inhibit bone formation and bone growth, moderate alcohol consumption seems to have a certain positive influence on BMD by metabolizing Aldosteron into Ostrogen which is needed to prevent osteoporosis related fractures [25].

Immoderate smoking has a negative impact on BMD. The higher rate of bone resorption in smokers is due to the lower circulation of estradiol in the blood. Lower levels of estradiol lead to an increase of FSH and LH production and thus increased bone resorption [26].

Hormonal Changes

When talking about hormonal changes influencing the fracture risk especially menopausal changes are considered. Ostrogens inhibit the apoptosis of osteoblastic cells and promote the apoptosis of osteoclastic cells at the same time. This has a positive impact on the bone formation. Because of the decrease of the oestrogen levels in the postmenopausal periode, the risk of developing osteoporosis and concomitant the risk of osteoporotic fractures is increased [27].

To minimize the fracture risk postmenopausal hormone therapy can be helpful. Keagen et al. showed that hormone replacement therapy (HRT) has a beneficial effect on the fracture risk. In contrast, the fracture risk among women who have not been treated with HRT in their postmenopausal period increases from year to year [19].

Glucocorticoids

An important factor for developing osteoporosis related fractures like proximal humerus fractures is the therapy with glucocorticoids. Glucocorticoid therapy is majorly used to treat allergies or systemic inflammatory and/or immunological diseases. There are several known side effects of a glucocorticoid therapy to name the most common muscular distrophy, glaucoma and immunosuppression as well as the induction of osteoporosis. Pathophysiologically glucocorticoids result in a reduced number of osteoblastic cells so that the bone production rate is lower than the bone resorption rate resulting in a higher fracture risk.

Body Mass Index/Body Weight

Another factor, which has an influence on the incidence of proximal humerus fractures is the body weight. The body mass index (BMI) helps to determine the ideal body constitution in relation to the patient's height.

Since there exists no adequate explanation for the correlation between body weight and

proximal humerus fractures, yet, there are two different [28] possible approaches discussed in literature. In this context Holmberg et al. found out that a higher BMI is associated with a higher fracture risk in women, but a lower fracture risk in men [1, 29]. It is believed, that there is an increased risk of falling and clumsiness among people suffering from obesity leading to a higher fracture risk. A bad nutritional condition could be the reason for a bad bone quality with a higher fracture risk as well.

Hagino et al. propose that a low BMI is a significant risk factor for loss of bone mass which leads to a higher fracture risk, especially after falls [30]. However, there is no significant positive or negative correlation found between body weight and incidence of proximal humeral fractures.

Ethnical Differences

There are also ethnical differences having an impact on the fracture risk. In general black people have a minor fracture risk compared to white people. As an explanation for these findings, the bone conditions of Blacks and Caucasians had been analysed by several groups. It had been found that black people present with a higher BMD compared to white people lowering the fracture risk especially in low energy accidents [31–33].

Frailty

Frailty is another important risk factor to suffer from a proximal humerus fracture. There are two aspects in frail people. One is, that the risk of falling is higher than in people in a good health state. The other fact is, that if frail people fall, they can usually barely control the fall so that they can not avoid serious trauma. This leads to a higher fracture risk in general. Physical activity may have a positive effect on the bone mass, it also can be supposed, that physically inactive patients are in a bad medical health status which leads to a higher fall risk [1, 34].

Summary

To sum it up, proximal humerus fractures are severe fractures of the upper extremity that cause many problems for the injured patient. These fractures usually affect older people with altered bone structure. As mentioned above, the major risk factors for proximal humerus fractures are falls, osteoporosis and frailty. To reduce the number of these fractures it is necessary to treat the problems that lead to their development. Therefore an ideal medication status and regular check-ups are needed, when suffering from diseases such as diabetes, epilepsia or other chronic disorders. In addition the fracture risk especially in the osteoporotical bone can be reduced by ideal nutritional conditions and good physical activity of the patients.

References

1. Chu SP, et al. Risk factors for proximal humerus fracture. Am J Epidemiol. 2004;160(4):360–7.
2. Palvanen M, Kannus P, Parkkari J. The injury mechanisms of osteoporotic upper extremity fractures among older adults: a controlled study of 287 consecutive patients and their 108 controls. Osteoporos Int. 2000;11(10):822–31.
3. Lee SH, Dargent-Molina P. Risk factors for fractures of the proximal humerus: results from the EPIDOS prospective study. J Bone Miner Res. 2002;17(5):817–25.
4. Center JR, Bliuc D, Nguyen TV, Eisman JA. Risk of subsequent fractures. Am Med Assoc. 2007;297(4):387–94.
5. Schwartz AV, Sellmeyer DE, Ensrud KE, Cauley JA. Older women with diabetes have an increased risk of fracture: a prospective study. J Clin Endocrinol Metab. 2001;86(1):32–8.
6. Ivers RQ, Cumming RG, Mitchell P, Peduto AJ. Diabetes and risk of fracture, the blue mountains eye study. Diabetes Care. 2001;24(7):1198–203.
7. Carbone LD, et al. Antiepileptic drug use, falls, fractures, and BMD in postmenopausal women: findings from the women's health initiative (WHI). J Bone Miner Res. 2010;25(4):873–81.
8. Shiek Ahmad B, et al. Falls and fractures in patients chronically treated with antiepileptic drugs. Neurology. 2012;79(2):145–51.
9. Engel T, Lill H, Korner J, Josten C. Die beidseitige verhakte hintere Schulterluxationsfraktur. Unfallchirurg. 1999;102(11):897–901.
10. Heckmann JG, Stangl R, Erbguth F, Rutherford H, Neundörfer B. Nontraumatic seizure- associated bilat-

eral fractures of the head of the humerus. Intensive Care Med. 1999;25(5):B548–9.
11. Luetters CM, et al. Left-handedness as a risk factor for fractures. Osteoporos Int. 2003;14(11):918–22.
12. Hemenway D, Azrael DR, Rimm EB. Risk factors for wrist fracture: effect of Age, cigarettes, alcohol, body height, relative weight, and handedness on the risk for distal forearm fractures in Men. Am J Epidemiol. 1994;140(4):361–7.
13. Klein BEK, et al. Associations of visual function with physical outcomes and limitations 5 years later in an older population. Ophthalmology. 2003;110(4):644–50.
14. Salonen L, Kivela SL. Eye diseases and impaired vision as possible risk factors for recurrent falls in the aged: a systematic review. Curr Gerontol Geriatr Res. 2012;2012:271481.
15. Kanis JA. Diagnosis of osteoporosis and assessment of fracture risk. Lancet. 2002;359(9321):1929–36.
16. Grifka J, Kuster M. Orthopädie und Unfallchirurgie. Berlin: Springer DE; 2011.
17. Borrelli J. Taking control: the osteoporosis epidemic. Injury. 2012;43(8):1235–6.
18. Lill H, et al. Osteoporotic fractures of the proximal humerus. Chirurg. 2012;83(10):858–65.
19. Keegan TH, et al. Hormone replacement therapy and risk for foot, distal forearm, proximal humerus, and pelvis fractures. Osteoporos Int. 2003;14(6):469–75.
20. Reeve J, Walton J, Russel LJ, Lunt R, Wolman R. Determinants of the first decade of bone loss after menopause at spine, hip and radius. Q J Med. 1999;92(5):261–73.
21. Ivers RQ, Cummings RG. Risk factors for fractures of the wrist, shoulder and ankle: the blue mountains eye study. Osteoporos Int. 2002;13(6):513–8.
22. Drake MT, Murad MH, Mauck KF. Risk factors for low bone mass-related fractures in men: a systematic review and meta-analysis. J Clin Endocrinol Metabol. 2012;97(6):1861–70.
23. Zhu K, Prince RL. Calcium and bone. Clin Biochem. 2012;45(12):936–42.
24. Baron JA, et al. Basic epidemiology of fractures of the upper and lower limb among Americans over 65 years of age. Epidemiology. 1996;7(6):612–8.
25. Eleftheriou KL, Rawal JS, James LE. Bone structure and geometry in young men: the influence of smoking, alcohol intake and physical activity. Bone. 2013;52(1):17–26.
26. Rapuri PB, Gallagher JC, Balhorn KE, Ryschon KL. Smoking and bone metabolism in elderly women. Bone. 2000;27(3):429–36.
27. Silbernagel S, Lang F. Taschenatlas Pathophysiologie. Stuttgart/New York: Georg Thieme Verlag; 2009.
28. Berry SD, Miller RR. Falls: epidemiology, pathophysiology, and relationship to fracture. Curr Osteoporos Rep. 2008;6(4):149–54.
29. Holmberg AH, et al. Risk factors for fragility fracture in middle age. A prospective population-based study of 33,000 men and women. Osteoporos Int. 2006; 17(7):1065–77.
30. Hagino H, et al. Case–control study of risk factors for fractures of the distal radius and proximal humerus among the Japanese population. Osteoporos Int. 2004;15(3):226–30.
31. Griffin MR, Ray WA. Black-white differences in fracture rates. Am J Epidemiol. 1992;136(11):1378–85.
32. Curtis JR, et al. Population-based fracture risk assessment and osteoporosis treatment disparities by race and gender. J Gen Intern Med. 2009;24(8): 956–62.
33. Cauley JA. Defining ethnic and racial differences in osteoporosis and fragility fractures. Clin Orthop Relat Res. 2011;469(7):1891–9.
34. Kelsey JL, Browner WS, Seeley DG, Nevitt MC, Cummings SR. Risk factors for fractures of the distal forearm and proximal humerus. Am J Epidemiol. 1992;135(5):477–89.