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Mini review article

VISUAL IMPAIRMENT AND FALLS AS RISK FACTORS OF ORTHOPAEDIC FRACTURES

POREMEĆAJ VIDA I PADOVI KAO FAKTORI RIZIKA ZA ORTOPEDSKE PRELOME

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Abstract

The musculoskeletal system represents one of the most affected systems in general traumatology. Fractures of the locomotor system and their effects are among the most severe and demanding injuries for the community in general and for the health system in particular. There are different factors that have been established as risk factors for fractures, with falls representing the main cause. Given the fact that vision has a key role in preserving gait and balance, various conditions of visual impairments have been related to an increase in fall-related injuries, and fractures of the locomotor system, especially in older population. Indeed, with an increased life expectancy, there is a rise in the number of visually impaired individuals and subsequently a rise in the number of falls and fractures. In this study, a review of the incidence and risk factors of musculoskeletal system fractures and falls was conducted, with the incidence of visual impairments in the general population. Another review of different types of visual impairments was done that included potential risk factors for fractures, falls and soft tissue injuries of the hand and if there has been any association between these specific visual impairments and the risk of falling, getting a fracture or a soft tissue injury of the hand.

Keywords:
visual impairment,
falls,
fractures,
musculoskeletal system,
soft tissue injuries of the hand

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Sažetak

Lokomotorni sistem je jedan od sistema koji je najviše pogođen u opštoj traumatologiji. Prelomi lokomotornog sistema i njihove posledice predstavljaju jedne od najtežih i najzahtevnijih povreda sa velikim uticajem na javno zdravlje i na samu zajednicu. U poslednje četiri decenije utvrđeni su različiti faktori rizika za nastanak preloma. Padovi predstavljaju najčešći uzrok preloma, naročito kod starijih. S obzirom na činjenicu da vid igra ključnu ulogu u održavanju ravnoteže, dokazano je da su različita stanja poremećaja vida povezana sa povećanjem učestalosti padova, povreda povezanih sa padom i učestalosti preloma. Sa povećanjem očekivanog trajanja života rastu i broj osoba sa poremećajem vida, broj padova, kao i učestalost preloma muskuloskeletnog sistema. U ovoj studiji smo uradili pregled literature učestalosti i faktora rizika za nastanak preloma lokomotornog sistema i padova i incidencije poremećaja vida u opštoj populaciji, zatim pregled različitih poremećaja vida koji su istraživani kao faktori rizika za nastanak preloma, pada ili povreda mekih tkiva šake i da li postoji povezanost između tih poremećaja sa nastankom preloma, pada ili povreda mekih tkiva šake.

Ključne reči:
poremećaj vida,
padovi,
prelomi,
lokomotorni sistem,
povrede mekih tkiva
šake

Introduction

Injuries, in general, are still the dominant cause of death in the population younger than 44 years of age in developed countries and the third main cause of death regardless of age. Injuries are the leading cause when it comes to years of life lost (YLL), in front of malignant neoplasms, heart diseases, and cerebrovascular diseases. The musculoskeletal system is the most affected system in general traumatology, as it is involved in even 85% of all blunt traumas (1,2).

Among injuries of the locomotor system, the most demanding and serious injuries are fractures. They are followed by a high rate of comorbidities and mortalities, particularly in elderly, which significantly impairs the social aspect of the patient's quality of life, and constitutes a burden for the society and health care system. The duration and treatment of orthopaedic fractures are usually lengthy and costly. The manpower is affected due to invalidity, missed days at work and lower performance, especially in younger patients. Older individuals are most often unable to go back to normal life due to loss of independence and reduced mobility, so they become dependent on their relatives or third person in institutional cares for elderly (3). Some fractures may require specialized hospitals, which are not always available due to the lack of human and material resources. Despite new modalities in the treatment of fractures, the outcome is still unpredictable.

Falls represent one of the major causes of skeletal fractures. Furthermore, various visual impairments (VIs) have been linked to a high incidence of falls and fractures.

Fractures of the musculoskeletal system and injuries of the hand

Definition and epidemiology

A fracture per definition is a "condition where there is a partial or complete loss of continuity of the bone tissue, with damage to the muscles, blood vessels, nerves and sometimes with damage of the skin, i.e., open fractures".

In one epidemiological study from the United States in 2009, fractures of the upper extremity accounted for 67.6 fractures per 10,000 people per year. The most frequent fractures were fractures of the radius and ulna, followed by fractures of the hand, proximal humerus fractures, and fractures of the clavicle (4). In the wrist, the most common are fractures of the distal end of the radius with an incidence of 60% - 75%, followed by fractures of the scaphoid. Distal radial fractures are found in about 3% of all upper extremity injuries, and fractures of the humerus are more frequently found in women after the age of 65 due to osteoporosis (5,6).

A total of 30% of all visits in the emergency department are injuries to the hand and the wrist (e.g., contusion, crush injuries, avulsion, abrasions, laceration, fractures, dislocations, burns) (7). The most common are tendon injuries, skin loss, and amputations. Of all fractures of the locomotor system, 10% are fractures or dislocations of the hand (6,8).

Traumatic injuries of the spine account for 4% - 23% of all traumatic fractures largely due to traffic injuries, especially in the younger population (9). Fractures to the pelvis represent 1.5% - 3% of all fractures of the locomotor system, mainly in younger males, and they are generally a result of high-energy injuries such as traffic accidents, falls from height or injuries inflicted by heavy objects (10). Hip and ankle fractures are largely found in older patients and represent the most encountered fractures of the lower extremity. It is estimated that hip fractures affect around 1.5 million people worldwide with the highest and lowest incidence found in Scandinavia and in Africa, respectively (11). On the other hand, the incidence of femoral shaft and distal femoral fractures is lower and ranges between 10 and 21 per 100,000 people per year and 8.7 per 100,000 people per year, respectively (12,13).

There is a lack of epidemiological data when it comes to fractures of different parts of the tibia. In one study from Sweden, tibial fractures accounted for 51.7 per 100,000 people per year, whilst the incidence of fractures of the proximal part of the tibia, diaphysis, and distal

part accounted for 26.9, 15.7, and 9.1 per 100,000 people a year, respectively (14). Ankle fractures are the fourth most frequent fracture in orthopaedics after hip, wrist, and hand fractures, and they account for every 10th fracture with an incidence of 71 to 187 per 100,000 people per year (15). Foot fractures are present in about 40% of all fractures in lower limbs with an overall incidence of 142.3 per 100,000 a year; the fractures of hind, mid and fore foot account for 13.7, 6.5 and 123.5 per 100,000, respectively (16). Fractures to the calcaneus, talus, metatarsal and phalangeal bones are frequent (17%) compared with fractures of the cuboid, navicular, and cuneiform bones, with an average age of 43.9 ± 19.2 years (**table 1**) (17).

Causes and risk factors

Apart from traffic accidents (18), fall-related injuries, occupational injuries, sport injuries and those related to interpersonal violence, there are many risk factors that have been linked to different types of fractures, and these include age, sex, ethnicity, sedentary lifestyle, genetics, smoking, history of previous fractures, alcohol, weight or body mass index (BMI), drugs (glucocorticoids, antiepileptic drugs, proton pump inhibitors, aromatase inhibitors, etc), nutrition (19), and different diseases (osteoporosis, visual impairment, diabetes mellitus, asthma, chronic kidney and chronic liver diseases, different conditions of heart diseases, neurological damages, hypothyroidism, HIV, lupus and rheumatoid arthritis) (20).

Falls

Definition and epidemiology

By definition, a fall is "an inadvertently coming to rest on the ground, floor or other lower level, excluding intentional change in position to rest in furniture, wall or other objects". In International Classification of Disease (ICD) - 10, it is coded as W00 - W19 (21).

According to the World Health Organization, falls are the second leading cause of accidental deaths worldwide with an estimated 684,000 individuals dying from falling (80% coming from low- and middle-income countries) and 37.3 million non-fatal falls requiring medical care (22).

Risk factors related to falls

In addition to the abovementioned risk factors for fractures (advanced age, sex, chronic diseases,

Table 1. Epidemiology of musculoskeletal fractures.

Fractures	Frequency	Studies
Upper extremity fractures	67.6 per 10,000 people/year	Karl JW, Olson PR, Rosenwasser MP. The epidemiology of upper extremity fractures in the United States, 2009. J Orthop Trauma. 2015; 29(8):e242–4.
Distal radius fractures	25.42 persons 10,000 people/year	
Proximal humerus fractures	6 fractures per 10,000 people/year	
Spine fractures	4% - 23% of all traumatic fractures	Oliver M, Inaba K, Tang A, Branco BC, Barmparas G, Schnüriger B, et al. The changing epidemiology of spinal trauma: A 13-year review from a Level i trauma centre. Injury. 2012; 43(8):1296–300.
Pelvis fractures	1.5% - 3% of all fractures of the locomotor system	Ghosh S, Aggarwal S, Kumar V, Patel S, Kumar P. Epidemiology of pelvic fractures in adults: Our experience at a tertiary hospital. Chin J Traumatol. 2019; 22(3):138–41.
Hip fractures	1.5 million people worldwide	Cheng SY, Levy AR, Lefaivre KA, Guy P, Kuramoto L, Sobolev B. Geographic trends in incidence of hip fractures: A comprehensive literature review. Osteoporosis Int. 2011; 22:2575–86.
Femoral shaft and distal femoral fractures	10 and 21 per 100,000 people/year and 8.7 per 100,000 people/year	Femoral Shaft Fractures - StatPearls - NCBI Bookshelf [Internet]. [cited 2021 May 5]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK556057/ Elsoe R, Ceccotti AA, Larsen P. Population-based epidemiology and incidence of distal femur fractures. Int Orthop. 2018; 42(1):191–6.
Tibial fractures	51.7 per 100,000 people/year	Wennergren D, Bergdahl C, Ekelund J, Juto H, Sundfeldt M, Möller M. Epidemiology and incidence of tibia fractures in the Swedish Fracture Register. Injury. 2018; 49(11):2068–74.
Ankle fractures	71 to 187 per 100,000 people/year	Thur CK, Edgren G, Jansson KÅ, Wretenberg P. Epidemiology of adult ankle fractures in Sweden between 1987 and 2004. Acta Orthop. 2012; 83(3):276-81.
Foot fractures	142.3 per 100,000 people/year	Shibuya N, Davis ML, Jupiter DC. Epidemiology of foot and ankle fractures in the United States: An analysis of the national trauma data bank (2007 to 2011). J Foot Ankle Surg. 2014; 53(5):606–8.

polypharmacy or use of some specific drugs), which are similar to risk factors for falling, other factors that are linked to falls are the fear of falling, physical activities, previous falls, gait and balance disturbances, mental and cognitive impairments. About 50% of falls are influenced by the place, surrounding or environment in which one lives. In 70% cases, it is the combination of different factors that will lead to falls (23).

Falls and public health

Falls constitute one of the most frequent geriatric syndromes and public health issues in the older population. It is estimated that the disability-adjusted life years (DALYs) due to falls are more than 17 million DALYs, leading to reduced quality of life such as reduced physical activity, fear of falling, increased risk of falling again, social isolation, depression, loss of daily living activities, and increased mortality due to fall-related injury (22).

Nevertheless, apart from elderly, as stated by WHO, "the other vulnerable groups are young adults between 15 and 29 years old and children under 15 years of age: for instance, in the People's Republic of China, for every death due to a fall in children, there are 4 cases of permanent disability, 13 cases requiring hospitalization for more than 10 days, 24 cases requiring hospitalization for 1 - 9 days and 690 cases seeking medical care or missing work or school" (22).

Falls and fractures of the musculoskeletal system

With an increase of life expectancy, there is a growing number of falls and fall-related injuries along with the rate of musculoskeletal system fractures. Generally, most falls do not result in injuries, 20% - 30% lead to mild or severe injuries and 10% - 15% result in fractures, particularly hip fractures in elderly (24).

Approximately 90% of hip fractures and over 90% of wrist fractures are due to a fall from one's own or lower height (25). In 20% of cases, hip fractures caused by falls in the elderly population result in mortality, with a higher rate in men within the first six months of surgery (26).

The most common fall-related fractures in lifespan are at the distal radius, totalling one sixth of all fractures, for the most part in women (27). Fall-related spinal injuries have increased in the last three decades by 131%. If no measures are taken, fall-related injuries will increase by 100% in 2030 (28).

Visual impairment (VI)

Visual impairment is classified in two groups, near and distance VI by the ICD - 11. It is defined as "the best-corrected visual acuity in the better-seeing eye of less than 20/60". Different conditions such as uncorrected refractive errors, corneal opacity, glaucoma, cataract, age-related macular degeneration, diabetic retinopathy, and trachoma have been identified as leading cause of VI (29). Visual impairment can be congenital, hereditary or acquired. It can be manifested as reduced contrast sensitivity, reduced visual acuity, reduced visual field, photophobia, diplopia, depth perception difficulties, or any combination of aforementioned conditions.

Nowadays, the increased life expectancy is leading to an increase in the number of visually impaired individuals, especially in older population. With an increasing number of the population in general and of older people in particular, a massive rise of the visually impaired population is to be expected: approximately 1 in 9 people above 60 will be blind or will have mild or severe VI, and 1 in 3 above the age of 80 will be blind or have mild or severe VI (30). Vision has an indispensable role in maintaining gait and balance.

Visual impairment and locomotor system fractures

The association between different types of VI and fractures of the musculoskeletal system has been controversial. There are 7 main potential risk factors of ocular origin that are regarded as risk factors for fractures: reduced visual acuity and depth perception, reduced visual field and contrast sensitivity, self-reported low vision, old or inappropriate glasses prescriptions and non-attendance in a regular ophthalmologic check-up at least once in two years (31).

Reduction in depth perception and contrast sensitivity are frequently present in patients with cataract, glaucoma, and diabetic retinopathy. While visual field loss, apart from glaucoma, cataracts and retinal diseases, is also seen in tumour or vascular occlusion found throughout the length of the cerebral visual pathway (32).

In older women, a high risk of hip fractures has been associated with impairment in depth perception and contrast sensitivity whilst wrist fractures were associated with impairment in visual acuity (33). A significant risk (1.6 times higher risk) of non-spine, non-hip fractures was found in women with severe binocular visual field loss than in women without visual field loss. In the same study, women who had better visual acuity and higher contrast sensitivity had less risk of not only hip fractures but also of non-spine, and non-hip fractures (32). In the Study of Osteoporotic Fractures (SOF), loss in visual acuity was seen in fractures of distal forearm, and poor depth perception was associated with a risk of foot fractures (34).

In the Blue Mountains Eye study, visual field loss was associated with increased risk of ankle fractures (35). Furthermore, a high risk of fractures was found in younger Caucasian subjects with visual field loss in at least one eye (36).

However, there have been conflicting conclusions concerning the relationship between visual field loss and the risk of hip and wrist fractures. In some studies, visual field loss in Caucasians was not associated with a higher risk of hip fracture (36) and in others they couldn't find any

association between visual field loss and wrist fractures (35). Another study found that the association between visual field loss and hip fracture in the Caucasian population decreased with a longer follow-up time (37).

Important associations between VIs and higher risk of falls and fractures, in different cross-sectional and longitudinal studies with a longer period of follow up, have been demonstrated (38). And yet, some studies found that the association between VI and fractures was lost after some period of follow-up. For instance, in the longitudinal study from the Blue Mountain Eye study, a short to midterm association between unilateral VI and fractures was found with an increased risk of fractures of 30% in 5 years but that association was lost in 10 years. Similar results were reported in the Framingham study; in the population with moderate VI in at least one eye, there was non-significantly increased risk of fractures over a 10-year period (39).

In this review, there were no findings that dealt with VI as a risk factor for soft tissue injuries of the hand.

Visual impairment and falls

Diverse visual disturbances, particularly those that affect visual acuity, contrast sensitivity, depth perception, and visual field, have been recognized as independent risk factors for falls, though with mixed findings. For some authors, it is the reduction of contrast sensitivity and depth perception that represent an important risk factor for falling than the impairment of visual acuity, while for others it is the disturbance in visual acuity that plays an important role in falling. Also, there are other VI conditions that have been linked to falling (40).

In some studies, reduced stereoscopic vision was found to be the major risk factor in causing falls (41) whilst, in others, there was no association between depth perception impairment and a higher risk for falling (42). There have been studies that consistently demonstrated an association between visual field loss and an increased risk of falls (43). Moreover, an increased risk of repeated falls was found in older Caucasian females with binocular visual acuity impairment (44).

A study that was conducted in Auckland on 1,774 patients that had in total 1,832 hip fractures in a period of 2 years showed that visual acuity is only a risk factor of falling when present in both eyes. No significant impact was found when it is only one eye which is impaired (41).

In a longitudinal study that was conducted in 2014, during the follow-up period, older persons who developed bilateral or unilateral VI more likely had 2 falls within the 5 years from the time when VI was diagnosed, in comparison to those who did not develop a VI during the same period (45).

Opposite findings were found when trying to find the relationship between falls and VIs such as reduced contrast sensitivity, stereopsis and visual field loss in a clinic-based study by Lamoureux and collaborators. No significant association was found (46).

Furthermore, there has been no connection between self-reported VI and falls in certain studies, and also subjective reports on VI were found to have no important influence in determining the risk of multiple falls (47).

Conclusion

Fractures of the musculoskeletal system are one of the most common injuries in general traumatology, particularly in the elderly, with the hips and distal radius being the most commonly affected parts. The leading cause of fractures is falling. Visual impairments such as reduced visual acuity, reduced contrast sensitivity and depth perception, and loss in visual field remain an important cause of falls and fractures in older population. In this review, there were no findings that dealt with VI and soft tissue injury of the hand. Regarding limitations, in numerous studies, there was a problem of controlling confounders, a lack of interventional studies and studies that would assess the role of VI in different specific fractures of the locomotor system. In most cases, the samples were too small to draw any conclusions.

A well-organised ophthalmic systematic screening and risk factors screening, as well as close collaboration among ophthalmic and orthopaedic specialists, geriatric and public health workers are of outmost importance.

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