Visual factors should be assessed in older people presenting with falls or hip fracture

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Abstract

Visual impairment, although not routinely assessed, is an important risk factor for falls and hip fracture in older people. Impaired vision is highly prevalent and commonly unreported in the elderly population particularly in women and those living in nursing homes. Measurement of visual functions such as visual acuity, contrast sensitivity and depth perception may identify older people at risk of falls and hip fracture. Visual loss in older people is correctable in most cases. Intervention strategies, for example, change of glasses or cataract extraction may have the potential of improving visual function and preventing falls in older people.

Keywords: older people, visual impairment, falls, hip fracture

Introduction

Falls occur frequently among older people. Although more than half of all falls result in no injury, falls may result in various fractures especially of the hip. Accidents are a leading cause of death among older persons, and falls account for approximately half of accident related deaths [1]. Visual impairment is believed to be associated with falls and hip fracture in older people. We have explored the relationship between visual impairment as a risk factor for falls and hip fracture through a MEDLINE review of the relevant literature from 1966 to present. Descriptive terms used for searching MEDLINE were visual impairment; older people; falls; hip fracture.

Visual impairment

Impaired vision is highly prevalent and commonly unreported in the elderly population [2]. In a screening study of the senior citizens in the community, the visual acuity was measured with a standard Snellen’s chart. Nearly 72% had impaired vision. There was a significant association between visual impairment and female sex, history of diabetes or glaucoma, cataract, and infrequent eye examination [3]. In a recent study visual acuity was measured in population based nationwide samples of British elderly people. Such measurements were carried out in the context of the national diet and nutrition survey (NDNS) of people aged 65 years or over. NDNS participants were visited at their home by a nurse who measured visual acuity at 3 meters, using the Glasgow acuity card (GAC) method. Prevalence of visual impairment increased significantly with age (65–74 years 3.1%; 75–84 years 11.6%; 85+ years 35.5%, \( P < 0.001 \)). Impaired vision was more common in subjects living in a nursing home (odds ratio adjusted for age 2.59, 95% CI 2.23–2.96) and in women (odds ratio adjusted for age 1.55, 95% CI 1.21–1.89) [4]. The prevalence of visual impairment of people in nursing homes is higher than in corresponding age groups in the general population [5]. We studied 403 residents of nursing homes and hostels in the Visual Impairment Project (VIP) urban cohort. Participants completed a standardised orthoptic and dilated ophthalmic examination, including measurement of visual acuity and visual fields. The age-adjusted rate of blindness or profound visual impairment in the VIP institutional cohort of 5.2% (95% CI 1.8, 8.6) was significantly greater than in the VIP urban and rural cohorts of 0.13% (95% CI 0.25) and 0.29% (95% CI 0.57), respectively [6].
In summary, visual impairment exists in a substantial part of the elderly community, particularly in women and those living in nursing homes.

**Falls and hip fracture**

Up to one-third of people over age 65 living in the community fall each year [7, 8]. More than half of those living in institutions fall every year, and about half of those who fall do so repeatedly [9]. In hospitals, falls consistently make up the largest single category of reported incidents [10].

The high incidence of falls, combined with the fact that over 30% of older women have osteoporosis, has led to an increased incidence of fractures [11, 12]. For example, 16% of postmenopausal women will have a hip fracture and up to 40% will have some type of osteoporotic fracture during their lifetime [13, 14]. The majority of hip fracture patients did not return to pre-fracture levels of performance in activities of daily living or instrumental activities of daily living [15, 16]. A number of studies [17–21] have found that 10–39% of patients admitted from home are placed permanently in nursing homes 6–12 months after the hip fracture. The 1-year postfracture mortality rate ranges from 12–40% and annual healthcare costs are estimated at 7–10 billion dollars [22, 23].

**Visual impairment and falls**

There is some evidence that poor vision is related to falls. Elderly patients admitted to hospital with falls, have a high prevalence of visual impairment. Visual impairment may be compounding or causing falls [24]. Standard tests of visual acuity have been most commonly used to measure vision. In a prospective study of visual impairment and its aetiology in older people admitted to hospital with acute medical illness, visual acuity was assessed on the ward with a Snellen chart read at 6 m using binocular vision and current glasses. Those patients identified with impaired vision on initial screening were formally assessed in the ophthalmology department to identify the cause. Two hundred patients were examined, 101 (50.5%) had impaired vision. In these patients, correctable refractive errors were present in 40%, cataract in 37% and senile macular degeneration in 14%. Of the 101 patients with impaired vision 79% had a reversible cause. There was a particularly high prevalence in those elderly patients who were admitted with falls (76%, p=0.0003) [24]. In a 2-year follow-up population-based study, impaired visual acuity was a risk factor for fall in disabled elderly (odds ratio 2.3) [25].

While some studies had identified visual impairment as one of the predictors of falls in older people [26–28], others have found that poor visual acuity is not related to falling [29–33]. Most of these studies evaluated only limited aspects of vision, such as visual acuity.

Visual factors are thought to play a major role in the successful negotiation of stairs. Templer [34] outlined a ‘Stair Behavior Model’ in which visual input is required at several phases, including the initial conceptual scan for sensory input, detection of hazards, choice of route, visual perception of step location, and continuous monitoring scans. Interruption of these processes puts the user at increased risk of falling. Templer [34] has reported that most stairway incidents occur on the top three or bottom three steps, which seems to implicate problems with visual input.

Little is known about which visual abilities are the most important in the control of postural sway and falling when standing. In a recent prospective study to determine the tests most predictive of falls in community dwelling older people from a range of visual screening tests, 156 people age 63–93 (mean 76.5) were included and followed up for 12 months. Multiple fallers had decreased vision, as indicated by all visual tests, with impaired depth perception, contrast sensitivity, and low-contrast visual acuity being the strongest risk factors [35]. In another study, visual tests were performed to determine whether specific visual abilities predict stability when standing on firm and compliant surfaces. One hundred and fifty-six community-dwelling men and women aged 63–90 years were included. The visual tests included high- and low-contrast visual acuity, contrast sensitivity, depth perception, stereopsis and lower visual field size. Postural sway was measured with eyes open on a firm and a compliant foam rubber surface. On the firm surface, sway was not significantly associated with visual measures. In contrast, on the compliant surface, sway was associated with all of the visual measures. Multiple regression analysis revealed that contrast sensitivity and stereopsis were independent predictors of total sway when subjects stood on the compliant surface. The study findings confirm the importance of vision, in particular contrast sensitivity and stereopsis, in the control of posture under challenging conditions, and suggest some mechanisms for the association between impaired vision and falls in older people [36].

The Blue Mountain eye study was designed to examine the association between visual impairment and falls in older people. Cross-sectional survey of eye disease with retrospective collection of falls data was performed in two postcode areas in the Blue Mountains west of Sydney, Australia. All people 49 years of age and older were invited to participate, 3,654 (82.4%) of 4,433 eligible residents took part, and 3,299 answered questions about falls. Subjects had a detailed eye examination and answered questions about health and vision status, use of medication, and number of falls in the previous 12 months. Visual impairment was strongly associated with two or more falls. However only visual acuity and contrast sensitivity were significantly associated with two or more falls per 1 standard deviation decrease. The presence of posterior sub-capsular cataract
A. H. Abdelhafiz, C. A. Austin

had a statistically significant association with two or more falls; however presence of age-related macular degeneration, diabetic retinopathy, and cortical or nuclear cataract did not [37].

The relationship between visual acuity, depth perception, contrast sensitivity, and the ability of older women living at home to perform instrumental activities of daily living independently was assessed [38]. Data on self-reported physical disability and objective measures of functional vision and physical ability were collected from a sample of 1,210 community-dwelling women aged 75 years and older. Women with low visual acuity or low contrast sensitivity were significantly more likely to be physically dependent than women with good vision. Contrast sensitivity was, however, a better predictor than functional acuity, after controlling for age, education level, motor limitations and chronic medical conditions (adjusted odds ratio 5.1, 95% CI 2.0–12.9). Depth perception was not related to physical disability [38].

**Visual impairment and hip fracture**

Most hip fractures result from falls. However, the role of fall-related factors has seldom been examined. The predictive value of visual acuity was compared with that of bone mineral density (BMD) in a prospective study, which included 775 women, aged 75 years or older, with no history of hip fracture. Femoral-neck BMD was assessed by dual-photon X-ray absorptiometry and visual acuity by Snellen chart. During an average of 1.9 years of follow-up 154 women suffered a first hip fracture. Reduced visual acuity was an independent fall-related predictor of hip fracture. After adjustment for femoral-neck BMD poor vision remained significantly associated with an increased risk of subsequent hip fracture. The authors concluded that visual impairment, as well as femoral-neck BMD, is a significant and independent predictor of the risk of hip fracture in elderly mobile women, and that their combined assessment improves the prediction of hip fractures [39].

In a 5-year follow up of 3,722 persons in the community, the relationship between visual functions, falls, and hip fracture was assessed. The visual functions measured at the examination were best-corrected visual acuity, current binocular acuity, near acuity, contrast sensitivity, and visual threshold to light. Information on falls and hip fractures was obtained by structured interview. In persons 60 years of age and older, hip fractures were significantly related to all measures of visual function. There was a consistent relationship between falls, fractures, and visual functions [40]. This has been confirmed in a recent epidemiological review of hip fracture [41]. The Framingham study found that for women with poor or moderately impaired vision, the risk of hip fracture was doubled, but cataract and other common eye diseases did not have an independent effect on fractures of the hip after adjusting for visual acuity [42]. However, the Study of Osteoporotic Fractures found that although poor contrast sensitivity and depth perception were associated with fractures, poor visual acuity was not [43]. As part of a case-control study, the Auckland Hip Fracture Study (1991–1994), the authors examined associations between impaired vision and risk of hip fracture. Subjects (911 cases and 910 controls aged 60 years or older) completed a questionnaire and had vision measurements taken, including measurements of visual acuity and stereopsis. Binocular visual acuity worse than 20/60 was statistically significantly associated with increased risk of hip fracture after adjustment for age, sex, proxy response, hours of activity per week, and height (OR 1.5; 95% CI 1.1, 2.0), as was having poor vision (less than 20/100) in both eyes (OR 2.4; 95% CI 1.0, 6.1). Having no depth perception was associated with increased risk (OR 6.0; 95% CI 3.2, 11.1), as were categories of decreasing stereopsis ($P=0.001$), self-reported poor vision (OR 1.4; 95% CI 1.0, 1.9), not wearing glasses at the time of the fall (OR 1.2; 95% CI 1.0, 1.6), and increasing time since the last eye examination ($P=0.03$). The population attributable risk of hip fracture due to poor visual acuity or stereopsis was 40%. Risk of hip fracture may be decreased by correcting refractive error, improving stereopsis, and administering regular eye examinations [44]. There is some evidence to support the idea that cataract extraction improves visual function in older people [45] and correcting visual impairment results in improved mobility orientation and the avoidance of falls [46].

Activities of Daily Vision Scale (ADVS) may be a useful tool to assess fall risk in older people with visual impairment in outpatient medical clinics. A randomly selected sample of 143 patients $\geq 65$ years was included. These patients had one or more of five ocular conditions: refractive errors ($n=90$), cataracts ($n=77$), glaucoma ($n=29$), diabetic retinopathy ($n=19$), and/or macular degeneration ($n=6$). Visual function, assessed using the ADVS, demonstrated scores ranging from 0 (marked visual disability) to 100 (no visual difficulty). Fall history was assessed retrospectively over a 1-year period from the time of the interview. Thirteen percent of the subjects reported having one or more falls during the 1-year period before the time of the interview. These subjects scored significantly lower on the ADVS compared with the scores of the group that did not report falls ($74 \pm 22$ vs $85 \pm 14$, $P<0.01$). Among the patients with glaucoma and those with diabetic retinopathy, the ADVS had a 100% sensitivity in identifying those patients who reported a history of falls. In patients with cataracts and refractive errors, the ADVS had a sensitivity of 82% and 64%, respectively, in identifying patients with a history of falls. The results from this study suggest that the ADVS may prove to be a useful tool to assess fall risk in older adults with vision impairment, especially in those persons with glaucoma, diabetic retinopathy, and/or cataracts [47]. Also ophthalmic assessment of elderly inpatients...
Visual factors and falls

≥75 years was feasible as reported by Whittaker et al. [48]. The time taken to complete the examination ranged from 6 to 20 minutes (mean 7.5 minutes).

Conclusion

It appears that visual impairment, although not routinely assessed, is an important risk factor for falls and hip fracture in older people. It is unfortunate that recently published guidelines for the prevention of falls in people over 65 did not contain any references to improving visual function [49]. Visual acuity as a single measure of visual impairment may not be enough to identify older people at risk of falls, as other measures of visual impairment e.g. contrast sensitivity and depth perception are important. An ophthalmologist should assess patients with potentially treatable eye disease. Because it has been found that visual loss in older people is correctable in most cases [24], intervention strategies e.g. change of glasses or cataract extraction may have the potential of improving visual function and preventing falls in older people [45, 46]. Doctors looking after elderly patients should be encouraged to assess visual function particularly in those presenting with falls or hip fracture. More research is needed to look at the prevalence of poor vision among older patients who have fractured their hip following a fall and ways of identifying which of these patients would benefit from ophthalmological referral.

Key points

- Visual impairment, although not routinely assessed, appeared to be associated with falls and hip fracture in older people.
- Visual acuity as a single measure of visual impairment may not be enough to identify older people at risk of falls, as other measures of visual impairment e.g. contrast sensitivity and depth perception are important.
- There is some evidence to support that correcting visual impairment results in improved mobility orientation and the avoidance of falls.
- Systematic ophthalmologic examination should be performed in patients with treatable eye disease.
- Simple intervention strategies e.g. change of glasses or cataract extraction may have the potential of improving visual function and preventing falls in older people.

References


