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Evaluating Fall Risk in People with Low Vision: A Case Series

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ABSTRACT

Background: People with low vision have increased risk for falls and preventable health conditions due to sedentary lifestyle and reduced participation in social activities. This case series describes an interprofessional low vision, balance, and mobility evaluation of two patients referred to our low vision optometric clinic.

Case Report: RM, an 82-year-old white female with diabetic retinopathy, and PC, a 55-year-old white female with retinopathy of prematurity, completed a comprehensive low vision eye exam and a selection of screening balance tests: Activities-Specific Balance Confidence Scale questionnaire (ABC), five meter timed walking, Four Square Step Test (FSST), and computerized posturography. Falls were measured historically and prospectively for six months. Visual acuity for RM was OD 20/250, OS 20/80 and for PC was OD NLP, OS 20/400. Confrontation fields were full OD, restricted OS for RM and full OS for PC. Both were slower than age matched norms on a timed walking test. Only RM was outside normal limits for the ABC and FSST. Computerized posturography results were abnormal for both and were used in part to make specific recommendations for fall prevention.

Conclusion: By performing an interprofessional vision and mobility examination it was possible both to identify and to make individualized therapeutic recommendations for fall intervention.

Keywords: accidental fall, gait, low vision, physical activity, postural balance

Background

Fall risk is identified by many professional health care organizations as an essential component of patient care. The American Physical Therapy Association (APTA) has studied falls extensively. APTA issued recommendations for a multifactorial approach to fall prevention, with assessment of risk factors including screening for visual impairment, environmental concerns, cognitive decline, and sensory and motor function.[1] Eye care organizations also provide standards of care regarding mobility and falls in the visually impaired population. The American Optometric Association (AOA) does not specifically identify evaluation for mobility function in a low vision exam, but does note that mobility may be a concern in patients with visual impairment.[2] The American Academy of Ophthalmology (AAO) recommends that questions of fall history and fear of falling be asked. The AAO further states that "fall risk is best addressed using a multidisciplinary approach," encouraging physical exercise to prevent falls.[3] Both the AOA and AAO recommend referral to a certified orientation and mobility specialist (a specialist who provides wayfinding instruction to individuals with a visual impairment, often by using a long cane[4]) or other services for fall prevention, as appropriate.[2-3]

People with low vision are at high risk for mobility problems.[5] Visual problems lead to a more cautious and unstable gait pattern.[6] Additionally, visual impairment is an independent risk factor for falls.[7-12] In particular, poor depth perception and poor low-contrast visual acuity were found to have a strong correlation to risk of falls in the elderly population. There is conflicting evidence that decreased visual acuity, decreased visual field, reduced contrast sensitivity, or discrepant vision may contribute to falls in the elderly as well.[13] People who have visual impairment are optimally referred for a functional low vision eye examination. This often includes screening for fall risk by inquiring about fall history.[3] While it is known that someone who has had a fall is at greater risk of having another fall,[8,14-15] this practice does not adequately prevent falls. Ideally, risk is assessed prior to a fall episode so that preventive measures can be implemented.

Identifying fall risk is ideally done with screening tests.[16-19] Subjective screening measures include self-report of fall history or fear of falling. Objective screening measures include static balance, dynamic balance, and gait. Many of these measures have been validated in other populations to predict fall risk.[2,15,19-21] However, the best predictive tests for the low vision population are not yet well established. The low vision population has different challenges than the sighted population. A person without a visual impairment uses vision to scan the environment and formulate a motor strategy to avoid an obstacle. People with visual impairment use a variety of approaches, including compensatory tactile strategies, to guide their movement plan.[22,23] Few measures of

Figure 1: *Subject performing the NeuroCom Balance Master Sensory Organization Test.*

fall risk require subtle visual perception, and therefore may not adequately reflect fall concerns in the low vision population.

Gait velocity is a robust measure of function used to predict many factors including fall risk.[24] Normative data exists across age groups and conditions.[25] Studies of customary walking speed have been performed across pediatric, adult, and geriatric populations with multiple diagnoses; however, none specifically target low vision.[24-28]

The Four Square Step Test (FSST) is a potentially visually sensitive measure of dynamic balance and coordination.[21] This timed agility test uses vision to assess location of objects placed on the floor. It is validated to predict fall risk in people with amputations, vestibular dysfunction, and after stroke.[29-31]

The successful interaction of vision, somatosensory, and vestibular systems is essential for normal postural function.[32] Vision is the dominant sensory modality for postural control; humans use visual information to assess the environment and plan motion. When vision is removed, the somatosensory system becomes the primary source for mobility choices.[33] The role of the vestibular system in mobility is not fully defined, but it appears to resolve conflict between visual and somatosensory input.[34] Assessing each of the three systems separately is not entirely possible. However, by disadvantaging each system in turn, a rudimentary study of each of the three systems is possible. The gold standard tool for this process is computerized posturography, a method for measuring balance integration.[35,36] The Sensory Organization Test (SOT) measures computerized posturography (Figure 1). The SOT assesses standing static balance by measuring sway of an individual during postural perturbations. This test presents visual, somatosensory, and vestibular disruptions and measures the postural response. Standing postural sway is measured with force plates throughout six conditions (Table 1). During the first condition (1), all three systems (vision, vestibular, somatosensory) are providing sensory input as the subject stands with eyes open on a stable surface. In the second condition (2), visual information is removed as the subject closes her eyes. In the third condition (3), peripheral visual information is minimized as a source of balance feedback because the walls move in tandem with the subject's sway. Next, conditions four through six (4, 5, 6) repeat the first three conditions while the floor is sway referenced; the floor moves in tandem with the subject's sway to reduce somatosensory input from the ankles.

This case series describes the examination and management of two patients referred to our low vision eye clinic and discusses interprofessional care in managing fall risk in people with visual impairments.

Subjects

A convenience sample of two subjects was recruited from the Low Vision Rehabilitation Clinic at the Western University of Health Sciences Eye Care Center. Subjects were initially seen for a low vision examination and agreed to participate in further evaluation of mobility status. The low vision examination was performed by an optometrist, and the mobility testing was performed by a physical therapist. Prior to testing, all procedures were explained, including risks. Each subject gave signed informed consent to participate in the study. Trained examiners assisted with form completion, as well as all tests. This protocol was approved by the Western University Institutional Review Board.

Table 1: Sensory Organization Test conditions

Condition	Vision	Surface	Primary System	Disadvantaged System
1	Stable-Eyes Open	Fixed	Somatosensory	None
2	**Absent**-Eyes closed	Fixed	Somatosensory	Vision - absent
3	**Unstable**-Sway referenced	Fixed	Somatosensory	Vision - incorrect
4	Stable-Eyes open	**Unstable**-Sway referenced	Vision and Vestibular	Somatosensory - absent
5	**Absent**-Eyes closed	**Unstable**-Sway referenced	Vestibular	Somatosensory and vision – both absent
6	**Unstable**-Sway referenced	**Unstable**-Sway referenced	Vestibular	Somatosensory absent, vision incorrect

Figure 2: *Subject performing Walking Speed Test.*

Materials/Procedures

Both subjects completed a low vision eye exam including but not limited to:

- Case history including review of health systems
- Detailed measurement of visual acuity
- Entrance tests including pupil assessment and extraocular motor evaluation
- Evaluation of visual field
- Objective and subjective refraction
- Optical and non-optical device assessment
- Ocular health examination including applanation tonometry

Next, each subject was asked to report her fall history over the past six months.

Subjects then completed a standardized survey, the Activity Balance Confidence scale (ABC), a validated instrument to describe subjects' perceived confidence with mobility.[17,37-38] This tool is validated in multiple populations as predictive of future falls. The ABC scale is a survey of a person's confidence in their ability to perform different physical tasks without falling. It uses a 0-100% Likert scale for each question. A sample question is "How confident are you that you could climb stairs without falling?" A high score indicates a high level of self-confidence when performing activities. The ABC scale was read to each subject and they were instructed to answer each question with a percentage of confidence.

Figure 3: *Subject performing the Four Square Step Test.*

Finally, subjects performed three tests of mobility. Examiners used either a safety belt around the waist or a harness during all mobility tests to prevent falls. Tests included:

- Walking Speed Test
- Four Square Step Test (FSST)
- NeuroCom Balance Master™ Sensory Organization Test (SOT)

The Walking Speed Test is a clinical measure of normal gait velocity.[25] Subjects were asked to walk 10 meters at their normal pace. The middle five meters were timed to minimize acceleration and deceleration and therefore capture constant velocity (Figure 2).

FSST was used to measure dynamic balance directly. Subjects used a pattern to step over four canes placed in an X on the floor (Figure 3). We followed the protocol as described by Dite,[21] with a few clarifications. Subjects were given the following instructions: "Try to complete the sequence as fast as possible without touching the sticks. Both feet must make contact with the floor in each square. If possible, face forward during the entire sequence." For the test, one practice and up to four trials were allowed. Scoring began when the first foot contacted the floor in square two. All trials were timed, with notation of any episodes of contacting a cane on the floor, turning, or loss of balance. Subjects were allowed to use handheld assistive gait devices such as a cane or walker.

SOT was used to measure computerized posturography (Figure 1). Subjects were given the following instructions: "This machine will test your balance. The walls or floor may move around you during the test. Please tell me if you feel uncomfortable and we can take a break." During the test, subjects stood for several minutes while the floor and/or walls moved around them. Postural sway was measured with force plates throughout all six conditions. All conditions were performed three times with the scores averaged. In addition, the scores for each individual measure (visual, somatosensory,

Table 2: Subject RM demographic, survey, and physical data

Gender	Female	
Age	82	
Diagnosis	Diabetic Retinopathy	
Visual Acuity	OD 20/250 OS 20/80	
Visual Field	OD full OS restricted	
Fall History (self-reported)	None	
Screening Measures Performed	Subject Data	Comparison Data
ABC Composite Score	25%	A score of < 67% indicates increased risk for falls
Gait Velocity (meters/second)	0.49m/sec	Walking speed below 1 m/sec indicates increased fall risk Age- and sex-matched normal range: 1.2 -1.4 m/sec
Four Square Step Test (seconds)	58 seconds	Time greater than 15 seconds indicates increased fall risk
SOT Composite Score	28	Age- and sex-matched normal 5th percentile: 63.8
Fall Incidence (during 6 months after testing)	1 fall with injury 8 loss of balance incidents without fall	

and vestibular) were tabulated. Finally, an overall composite score was given for all conditions.

At the end of the session, findings were reviewed with each subject. When test findings indicated greater fall risk, subjects were notified and counseled on strategies to prevent falls. Additionally, each subject was given specific home exercises to address any identified strength or mobility concerns. Monthly follow up occurred for the subsequent six months via home phone calls to determine any incidence of falls or loss of balance. These calls allowed researchers to provide ongoing education and guidance for specific strategies to promote safe functional mobility.

Results

Demographic, survey, and physical data for RM can be found in Table 2. Subject RM was an 82-year-old white female with self-reported proliferative diabetic retinopathy. She also reported dry age-related macular degeneration OD. RM reported a history of laser eye surgery for her diabetes and cataract surgery OU. She was obtaining regular eye care from another provider. Her medical history included type 2 diabetes mellitus without peripheral neuropathy for 30 years, hypertension, elevated cholesterol, bladder spasms, recurrent urinary tract infections, and thyroid dysfunction. Her medications included Glyburide, Lisinopril, Lantus, Neurontin, Tricor, Nitrofurantoin, Oxybutynin, Synthroid, and artificial tears OU as needed. She reported no falls over the previous six months. RM had never undergone orientation and mobility training. Her best visual acuity without optical correction was OD 20/250, OS 20/80, and her confrontation visual fields were OD full, OS restricted. Her pupils were minimally reactive to light without afferent pupillary defect. Extraocular muscles were unrestricted OU. Applanation tonometry was OD 12 mmHg and OS 13 mmHg. Ocular health examination revealed posterior chamber intraocular lenses OU. Dilated fundus examination revealed extensive panretinal photocoagulation laser scars in the periphery OS and dense focal macular laser scars OU. Ocular health exam was otherwise unremarkable. A variety of low vision

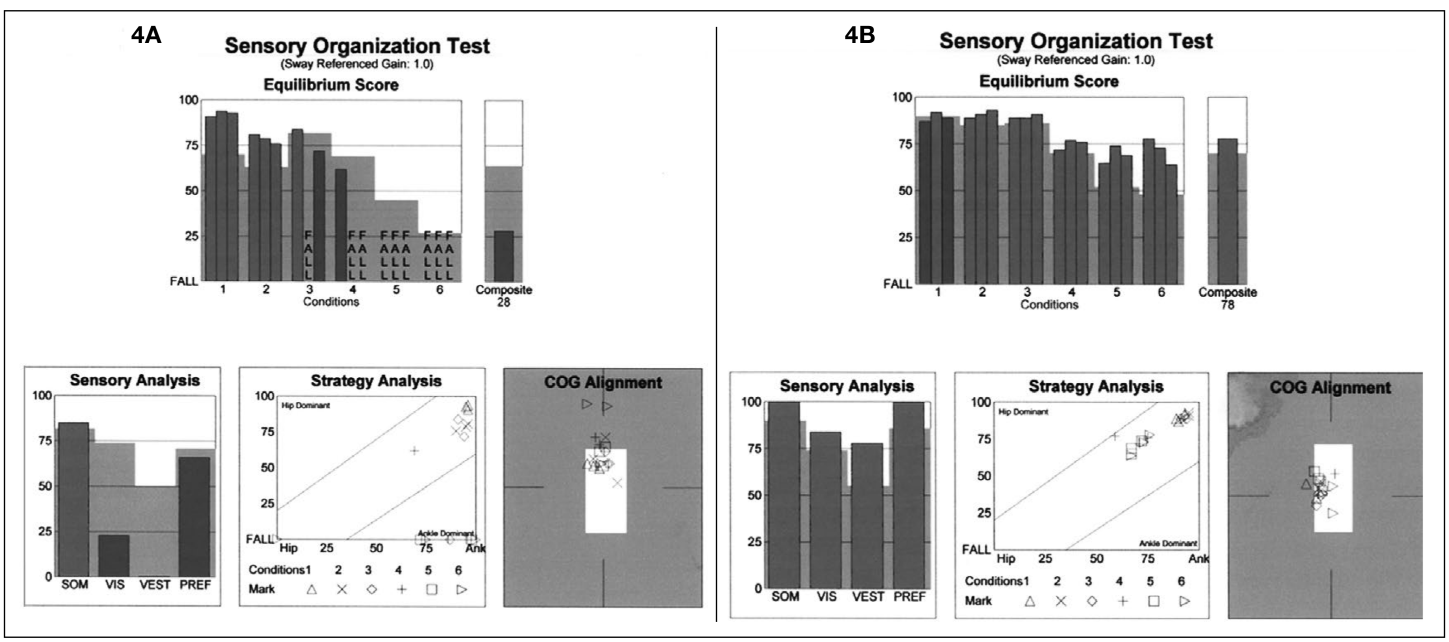

Figure 4A and 4B: *Sensory Organization Test results. Subject RM is Figure 4A and Subject PC is Figure 4B.*

Table 3: Subject PC demographic, survey, and physical data

Gender	Female	
Age	55	
Diagnosis	Retinopathy of Prematurity	
Visual Acuity	OD No light perception OS 20/400	
Visual Field	OD No light perception OS Full	
Fall History (self-reported)	1	
Screening Measures Performed	Subject Data	Comparison Data
ABC Composite Score	92.81%	A score of < 67% indicates increased risk for falls
Gait Velocity (meters/second)	0.47m/sec	Walking speed below 1 m/sec indicates increased fall risk Age- and sex-matched normal range: 1.2 -1.4 m/sec
Four Square Step Test (seconds)	4.8 seconds	Time greater than 15 seconds indicates increased fall risk
SOT Composite Score	78	Age- and sex-matched normal 5th percentile: 70.4
Fall Incidence (during 6 months after testing)	0 falls 1 loss of balance incident without fall	

devices were prescribed for RM including spectacle mounted binocular telescope for seated use, LED lit stand magnifier, and CCTV.

RM was not confident in her balance, as evidenced by a low score of 25 out of 100% on the ABC scale, well below the 67% cutoff indicating increased fall risk.[17] Her physical functions were lower than expected for her age; her walking speed was 0.49 meters/second, well below normal walking speed for her age of 1 meter/second. Her FSST was 58 seconds, above the cutoff of 15 seconds, indicating higher fall risk.[21] Her SOT composite score of 28 was well below the age- and sex-matched normal value of 63.8 (Figure 4A).[39] RM had multiple "falls" (injury prevented by the overhead harness) in conditions 3, 4, 5, and 6, indicating overdependence upon the somatosensory system, with inability to tolerate dependence on her vestibular system or vision to maintain balance. At the end of the session, all findings were reviewed with RM and her caregiver. They were notified of test results indicating increased fall risk due to visual perceptual and vestibular impairments. RM was issued balance exercises to train her somatosensory system, consisting of single leg stance on a foam surface with her eyes open. She was also instructed in a vestibular balance exercise, standing on both legs with her eyes closed. Her caregiver was included in all training and also instructed in safe methods for assisting her during ambulation. RM was taught scanning and peripheral awareness techniques to optimize vision for mobility.

During the first monthly follow-up call to monitor her status, RM reported one fall with injury. She reported follow-up with her primary care physician, who diagnosed her with a low back strain. The following month when she had recovered, RM was given pool-based exercises to perform with caregiver supervision. During all subsequent follow-up calls, she reported continued loss of balance (eight over a five month period) with no further falls or injury, and was re-educated concerning safety and fall prevention. At the end of the six month period, RM was advised to follow up with her primary care provider regarding her continued fall risk secondary to ongoing loss of balance episodes. She was instructed to continue with close supervision from her fulltime caregiver for all activity to remain safe and mobile without falls.

Demographic, survey and physical data for PC can be found in Table 3. Subject PC was a 55-year-old white female with self-reported retinopathy of prematurity OU and ocular trauma OD at age seven, for which she has had a partial prosthetic eye since shortly after the injury. PC had cataract extraction OS many years prior and a recent Nd:YAG laser capsulotomy in that eye. PC received regular eye care from another provider. Her medical history included gastroesophogeal reflux disease. Her medications included Protonix, Tobradex OD as needed, and Patanol OS as needed. She reported one fall over the previous six months, tripping over an obstacle in a parking lot and sustaining bilateral ankle fracture; she stated that she did not see the obstacle. PC had never undergone orientation and mobility training. Her best corrected visual acuity was OD NLP, OS 20/400 with a +2.50 sphere subjective refraction. Her confrontation visual fields were full OS. Her left pupil was irregular and minimally reactive to light. Extraocular motility was full with a horizontal sensory nystagmus present OS. Applanation tonometry OS was 15 mmHg. Ocular health examination revealed deposits on the ocular prosthesis, guttata and pigment on the corneal endothelium OS, and posterior chamber intraocular lens OS. Fundus examination was performed by her regular eye care provider, and reports were not available for this writing. A variety of low vision devices were prescribed for PC including bifocal glasses with polycarbonate lenses for full time wear, portable CCTV, handheld monocular telescope for spotting distance tasks, LED lit handheld magnifier, talking watch, and needle threader.

PC was confident in her balance, and her score on the ABC scale was 92.81%, well above the 67% cutoff, indicating low fall risk.[17] Her physical functions were within normal range for all measures except gait speed. Her walking speed was 0.47 m/sec, which is slower than the 1.2 m/sec expected for her gender and age.[25,26] Her FSST score was 4.8 seconds, faster than the 15 seconds cutoff, indicating low fall risk. Her SOT composite score was 78, above the age- and gender-matched normal value of 70.4 (see Figure 4B).[39] PC had difficulty in condition 1, indicating poor somatosensory system function. She demonstrated a preference for use of her vestibular system to maintain balance. Upon session conclusion PC was issued somatosensory exercises to improve mobility and strength in both ankles. PC was taught scanning and peripheral awareness techniques to optimize vision for mobility . During subsequent follow-up calls, PC reported compliance with exercises and reduction in pain and stiffness in her ankles. She was able to return to regular exercise as well. PC reported no falls with injury and one loss of balance during the six months after initial testing, for which she was advised to continue her exercise program and contact her primary care provider if any new issues arose.

Data analysis was not completed to compare these two subjects to each other statistically . However, each subject's data was qualitatively compared to normative data for sex and age when available.

Discussion

This case series describes an interprofessional approach using functional measures and surveys to define the mobility status of two subjects with low vision and to identify areas for intervention to reduce fall risk. This is an important issue because visual impairment is an independent risk factor for falls.[1,7-10]

Subjects RM and PC were seen for a low vision eye examination by an optometrist. These two subjects then underwent mobility evaluation by a physical therapist using fall screening tests. RM and PC had prospective or historic falls, respectively, and their visual impairment may have contributed. However, it is difficult to distinguish which, if any, visual factor was most related to their falls. Contrast sensitivity was not evaluated in these subjects, and it may have provided more information regarding their fall circumstances. Both subjects were on medications that may have contributed to fall risk. They both had decreased gait velocity, which in other populations is correlated with fall risk. The results of many of the screening tests for RM indicated increased fall risk, and indeed RM went on to have a fall. On the other hand, PC had a history of a fall with injury, but only one mobility screening test showed increased fall risk at the time. It is difficult to draw conclusions on what caused her past fall based on our current assessment; however, she self-reported that the fall was caused by her poor visual assessment of the environment. Additionally, it is possible that the injury altered her performance on all mobility screening tests, and that is why she walked more slowly than her age- and gender-matched norms. Further, it is possible that the individualized education prevented loss of balance or fall in the six month follow-up period.

Results from these two cases are not generalizable to the entire population of people with visual impairments. Both were Caucasian females (different age ranges), had different ocular conditions, and were on medications that have a potential for balance impairment as a side effect (RM-Lisinopril, PC-Xanax). As previously noted, professional health care organizations acknowledge that fall prevention is a concern in the visually impaired population.[3-4,16] Further research needs to be done to demonstrate the importance of additional mobility screening in this population. The authors recommend further research to define best clinical practice for mobility in patients with visual impairment.

Conclusion

By performing an interprofessional vision and mobility examination it was possible both to identify and to make individualized therapeutic recommendations for fall intervention. Each of the professions involved in this case has a different primary role. Aside from visual examination, the role of the optometrist in caring for this population is to identify patients who may be at risk of falls and to coordinate care with a physical therapist. The optometrist can also provide detailed information about visual functioning to inform the therapeutic decision-making process and patient education. Aside from physical examination, the role of the physical therapist is to screen for visual impairment and provide detailed information about physical functioning and other sources of fall risk. Through collaboration we can optimize the interaction and provide a full complement of care in this complex patient population.

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References

1. American Physical Therapy Association, Balance and Fall Prevention Clinical Practice Guideline, http://www.apta.org/BalanceFalls/ Last Accessed May 22, 2012.
2. Freeman KF. American Optometric Association. Optometric Clinical Practice Guideline: Care of the patient with Visual Impairment. Optometric Clinical Practice Guideline, http://bit.ly/YzjBaL Last Accessed November 2, 2012.
3. Mogk LG. American Academy of Ophthalmology. Visual Rehabilitation for Adults. Preferred Practice Pattern, http://bit.ly/ZCPSJy Last Accessed November 2, 2012.
4. Academy for Certification of Vision Rehabilitation and Education Professionals: Certified Orientation and Mobility Specialist Scope of Practice, http://bit.ly/Z5n25I Last Accessed May 15, 2012.
5. Crews JE, Campbell VA. Health conditions, activity limitations, and participation restrictions among older people with visual impairments. J Vis Impair Blind 2001;95:453-67.
6. Helbostad JL, Vereijken B, Hessegerg K, Sletvold O. Altered vision destabilizes gait in older persons. Gait & Posture 2009;30:233-8.
7. Kulmala J, Era P, Pärssinen O, Sakari R, et al. Lowered vision as a risk factor for injurious accidents in older people. Aging Clin Exp Res. 2008;20:25-30.
8. Campbell AJ, Robertson MC, La Grow SJ, Kerse NM, et al. Randomised controlled trial of prevention of falls in people aged ≥ 75 with severe visual impairment: The VIP trial. BMJ 2005; 331(7520):817.

9. Lee HKM, Scudds RJ. Comparison of balance in older people with and without visual impairment. Age and Aging 2003;32:643-9.
10. Lord SR, Dayhew J. Visual risk factors for falls in older people. J Am Geriatr Soc 2001; 49:508-15.
11. Flegal KM, Graubard BI, Williamson DF, Gail MH. Cause-specific excess deaths associated with underweight, overweight, and obesity. JAMA 2007;298:2028-37.
12. Felson DT, Anderson JJ, Hannan MT, Milton RC, et al. Impaired vision and hip fracture: The Framingham Study. J Am Geriatr Soc 1989; 37:495-500.
13. 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; Article ID 271481.
14. Stevens JA. Falls among older adults: Risk factors and prevention strategies. J Safety Res 2005;36:409-11.
15. Hill K, Schwarz J, Flicker L, Carroll S. Falls among healthy, community-dwelling, older women: A prospective study of frequency, circumstances, consequences and prediction accuracy. Aust N Z J Public Health 1999;23:41-8.
16. Ray CT, Wolf SL. Review of intrinsic factors related to fall risk in individuals with visual impairments. J Rehabil Res Dev 2008;45:1117-24.
17. Lajoie Y, Gallagher SP. Predicting falls within the elderly community: Comparison of postural sway, reaction time, the Berg balance scale and the Activities-specific Balance Confidence (ABC) scale for comparing fallers and non-fallers. Arch Gerontol Geriatr 2004;38:11–26.
18. Springer BA, Marin R, Cyhan T, Roberts H, et al. Normative values for the unipedal stance test with eyes open and closed. J Geriatr Phys Ther 2007;30:8-15.
19. Vellas BJ, Wayne SJ, Romero L, Baumgartner RN, et al. One-leg balance is an important predictor of injurious falls in older persons. J Am Geriatr Soc 1997;45:735-8.
20. Panzer VP, Wakefield DB, Hall CB, Wolfson LI. Mobility assessment: Sensitivity and specificity of measurement sets in older adults. Arch Phys Med Rehabil 2011;92:905-12.
21. Dite W, Temple V. A clinical test of stepping and change of direction to identify multiple falling older adults. Arch Phys Med Rehabil 2002;83:1566-71.
22. Moore LW, Miller M. Older men's experiences of living with severe visual impairment. J Adv Nurs 2003;43:10-8.
23. Moore LW. Severe visual impairment in older women. West J Nurs Res 2000;22:571-88.
24. Waters RL, Lunsford BR, Perry J, Byrd R. Energy-speed relationship of walking: Standard tables. J Orthop Res. 1988;6:215-22.
25. Fritz S, Lusardi M. White paper: "Walking speed: The sixth vital sign". J Geri Phys Ther. 2009;32:2-5.
26. Bohannon R. Comfortable Walking Speed: Norms for Adults Derived Using Meta-Analysis. NIH Toolbox Conference: Bethesda, MD. 2008.
27. Solway S, Brooks D, Lacasse Y, Thomas SG. A qualitative systematic review of the measurement properties of functional walk tests used in the cardiorespiratory domain. Chest 2001;119:256-70.
28. Salbach NM, Mayo NE, Higgins J, Ahmed S, et al. Responsiveness and predictability of gait speed and other disability measures in acute stroke. Arch of PM & R 2001;82:1204-12.
29. Whitney SL, Marchetti GF, Morris LO, Sparto PJ. The reliability and validity of the Four Square Step Test for people with balance deficits secondary to a vestibular disorder. Arch Phys Med Rehabil 2007;88:99-104.
30. Blennerhassett JM, Jayalath VM. The Four Square Step Test is a feasible and valid clinical test of dynamic standing balance for use in ambulant people post stroke. Arch Phys Med Rehabil 2008; 89:2156-61.
31. Dite W, Connor HJ, Curtis HC. Clinical identification of multiple fall risk early after unilateral transtibial amputation. Arch Phys Med Rehabil 2007;88:109-14.
32. Nashner LM. Adapting reflexes controlling the human posture. Exp Brain Res 1976;26:59-72.
33. Wade MG, Jones G. The role of vision and spatial orientation in the maintenance of posture. Phys Ther 1997;77:619-28.
34. Horak FB. Postural compensation for vestibular loss. Restor Neurol Neurosci 2010;28:57-68.
35. Goebel JA, Sataloff RT, Hanson JM, Nashner LM, et al. Posturographic evidence of nonorganic sway patterns in normal subjects, patients, and suspected malingerers. Otolaryngol Head Neck Surg 1997;117:293-302.
36. Slattery EL, Sinks BC, Goebel JA. Vestibular tests for rehabilitation: Applications and interpretation. NeuroRehabilitation 2011;29:143-51.
37. Powell LE, Myers AM. The Activities-specific Balance Confidence (ABC) Scale. J Gerontol Med Sci 1995;50:M28-34.
38. Meyers AM, Fletcher PC, Myers AH, Sherk W. Discriminative and evaluative properties of the Activities-specific Balance Confidence (ABC) scale. J Gerontol A Biol Sci Med Sci 1998;53:M287-94.
39. Borah D, Wadhwa S, Singh U, Yadav SL, et al. Age related changes in postural stability. Indian J Physiol Pharmacol 2007; 51:395-404.

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