Video Capture of the Prevalence and Risk Factors for Impact to the Hip or Head During Falls in Older Adults

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Disclosures:

Introduction: Falls are the number one cause of injury among older adults over age 65, and account for 95% of hip fractures and 60% of head injuries in this population. Over 50% of hip fracture patients experience a major loss of independence, and 25% die within one year. Preventing falls in older adults is challenging, since falls result from complex interactions between intrinsic, situational, and environmental factors. Furthermore, we have little objective evidence on the mechanisms of falls (“how” and “why” they occur) to guide risk assessment and prevention strategies. Instead, our knowledge of fall mechanisms in older adults has been based on self-reports by the patient (or witnesses, if any), which rarely provide the depth and accuracy of information necessary for clinical decision making.

In the current study, we partnered with two long-term care (LTC) facilities to collect video footage of real-life falls in LTC. We then analyzed these data to determine the intrinsic and situational factors that associate with two primary determinants of fall severity - impact to the hip (which increases risk for hip fracture by over 30-fold [1]) and impact to the head.

Methods: Between April 2008 and September 2013, we captured 993 falls experienced by 342 older adults, through video cameras installed in hallways, dining rooms, and lounges of Delta View and New Vista LTC facilities. We analyzed each fall with a 24-item, validated questionnaire probing the initiation, descent, and impact phases of falls [2-4]. We used multivariate logistic regression to examine whether the odds of hip or head impact while falling associated with physiological factors (age, gender, and data on physical and cognitive status from computerized minimal data set (MDS) medical records). This analysis was based on 235 falls experienced by 85 individuals (of mean age 81 (SD 9); 62% female and 38% male) who also provided us with written consent to access their medical records. We also report results from logistic regression models (based on separate analysis of 237 falls in 130 individuals) that examined whether with odds for hip or head impact associated with biomechanical/situational characteristics of the fall (e.g., cause of imbalance, activity at time of fall, fall direction, upper limb protective responses).

Results: We found that hip impact occurred in 40% of falls. The odds for hip impact while falling increased with increasing dependency in daily activities, particularly self-transfer performance (OR=3.3, 95% CI 1.2-9.3), and with a dementia diagnoses (OR=1.8, 95% CI 1.1 - 3.0), but did not associate with age or gender (p > 0.05). The odds for hip impact were 5.3-fold higher in falls initially directed sideways than backwards (OR 5.3, 95% CI 2.6 - 10.8), and 3.2-fold higher in falls initially directed forward than backward (OR 3.2, 95% CI 1.7 - 6.1). However, there was no difference in the odds for hip impact during falls initially directed forward versus sideways (OR 1.7, 95% CI 0.78 - 3.6). This was due to a tendency for fallers to rotate backward during descent, so 33% of forward falls ended up in a sideways landing configuration, and 37% of sideways falls ended up in a backward landing configuration. Hip fracture occurred in six recorded falls, and always involved direct impact to the hip (Figure 1).

Head impact occurred in 29% of falls, usually onto a vinyl or linoleum floor (Figure 2). The odds of head impact increased with poor vision (OR=3.1, 95% CI 1.1-8.5) and hypertension (OR=1.9, 95% CI 1.0-3.8). Women were nearly three times more likely than men to experience head impact while falling (OR=2.7, 95% CI 1.3-5.4). Age did not associate with odds of head impact (p = 0.9). Impact to one or both hands occurred in 74% of falls, but had no significant effect on odds of head impact (p = 0.3). We also observed a higher odds of head impact associated with falls in the forward direction, when compared to backward falls (OR 2.7, 95% CI 1.3-5.9) or sideways falls (OR 2.8, 95% CI 1.2- 6.3). The tendency to rotate from sideways to backward reduced the odds for head impact (OR 0.20, 95% CI 0.04-0.80). In one-third of falls involved head impact, there was reported bruising, swelling, laceration or fracture of the head. However, no concussions were documented.

Discussion: Based on capture and analysis of video footage of real-life falls in older adults, our results provide insight on the prevalence and factors that influence odds for head impact and hip impact during falls in LTC, and highlight several modifiable risk factors.

The odds for hip impact increased with impaired ability to self-transfer and with cognitive impairment. We also found no significant difference in the odds for hip impact during falls initially directed forward versus sideways (but lower odds in backward falls), due to a common tendency among fallers to rotate backward during descent. This questions the notion of a single fall direction (as employed in most clinical studies of falls) and indicates the need to focus on balance training in the anterior-posterior as well as the medial-lateral directions.

Poor vision was associated with increased odds for head impact, likely via its effect on the coordination of safe landing
responses. Hypertension also increased odds for head impact, perhaps by increasing the likelihood for syncope or dizziness following postural changes (secondary to medications). Females were nearly 3-fold more likely to impact their head. Forward falls created the greatest risk, and while 74% of falls involved hand impact (indicating persistence in the generation and execution of upper limb protective responses), this response was largely ineffectiveness in halting downward movement and preventing head impact, perhaps due to insufficient muscle strength. The tendency we observed for backward rotation during descent mimics the falling strategies trained in martial arts and supports the potential benefit of such programs for older adults [5]. The lack of concussion diagnoses may reflect the challenges in the frail long-term care of separating the cognitive effects of head injury from baseline dementia.

**Significance:** In this novel study of the mechanisms of falls in LTC, we found that the likelihood for impact to the hip or head while falling associates with self-transfer ability, cognitive impairment, visual impairment, hypertension, and fall direction.

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**References:**
Figure 1. Fall by a 85-year-old woman (due to incorrect weight shifting following a misstep during walking), which resulted in hip fracture. The initial fall direction was forward. Body rotation during descent led to a sideways landing and direct impact to the lateral aspect of the pubis. Images are used with written consent of the individual.
Figure 2. Fall of an 82 year old woman (due to foot collision with her wheelchair) which resulted in back impact, despite an attempt to arrest the fall with the upper limbs.

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