Side Preference for Wrist Fractures Caused by Falls from a Standing Height in Old Age

Ariel Zohar , David Maman * , Eyal Behrbalk

Posted Date: 23 February 2023

doi: 10.20944/preprints202302.0392.v1

Keywords: Distal radius fracture; fall; elderly; older adults

Article

Side Preference for Wrist Fractures Caused by Falls from a Standing Height in Old Age

Ariel Zohar [1,2], David Maman [1,2,*] and Eyal Behrbalk [1,2,3]

[1] Technion–Israel Institute of Technology, Haifa, Israel
[2] Hillel Yaffe medical center, Department of Orthopaedics, Hadera
[3] Director of Spine Unit, Director of Orthopedic Department Senior Lecturer Affiliated to Technion University Hillel Yaffe Medical Center
* Correspondence: maman.dvid.maman@gmail.com

Abstract: Introduction: Fractures in older individuals are often caused by falls, with approximately 90% of hip fractures resulting from falls. The risk of falling increases with age, and while a significant portion of individuals over 65 fall at least once per year, only a small percentage of these falls result in hip fractures. Factors that influence the likelihood of a fracture occurring include the intensity of the fall and the quality of the bone, with lower bone mineral content increasing the risk of fracture. Older women, particularly those in their 70s, are significantly more prone to hip fractures and any type of fracture. Efforts to reduce the likelihood of falls or mitigate the associated trauma are more complex than treating osteoporosis, due in part to a lack of understanding of the causes and contributing factors of falls in older age. Methods: This study analyzed data from patients admitted to Carmel medical center with upper or lower limb fractures between 2017 and 2019 to determine the side of wrist fractures and compare it to patient age in order to examine whether there was a difference in the distribution of sides in distal radius fractures based on age and test the hypothesis that falls are more likely to occur on the left side due to the assumption that dominant hand gross motor skills are better preserved. The study received approval from the Institutional Helsinki Committee and used statistical analysis with a significance level of 0.05. Potential sources of bias include limited availability of reliable data for many patients and the risk of errors in fracture registration or diagnosis, although the small sample size is expected to minimize these biases. Results: In this analysis of patient data from 2019 to 2017, a binomial test found that the probability of breaking the left wrist is significantly greater than the probability of breaking the right wrist ($p < 0.05$), while a t-test found no difference in the distribution of fractures between the right and left wrists of the distal radius based on age ($p = 0.2774$). Discussion: The findings of the study are consistent with previous research, and indicate that there is no change in side preference for fractures with age. Conclusion: The probability of breaking the left wrist is approximately 1.5 times greater than the probability of breaking the right wrist.

Keywords: distal radius fracture; fall; elderly; older adults

1. Introduction

Fractures in older individuals often occur due to decreased bone strength and the occurrence of a fall. In fact, approximately 90% of hip fractures are caused by falls [1]. As people age, the risk of falling increases [2,3], and while a significant portion of individuals over 65 fall at least once per year, only a small percentage of these falls result in hip fractures [2,3]. The likelihood of a fracture occurring is influenced by both the intensity of the fall and the quality of the bone. The mineral content of the bone can impact its quality, with lower mineral content increasing the risk of fracture following a fall [4].

Older women, particularly those in their 70s, are significantly more prone to hip fractures and any type of fracture [5]. In fact, they are five times more likely to experience a hip fracture and three times more likely to suffer from any kind of fracture [5]. It is important to note that some elderly

individuals may be at an even higher risk of fractures, highlighting the need for effective prevention efforts in this population [5].

The primary interventions for reducing the incidence of fractures in older individuals focus on preventing bone weakness associated with osteoporosis. There is increasing awareness of this issue among primary care physicians, and it is common to initially treat osteoporosis with a specialist endocrinologist or family doctor [6]. However, efforts to reduce the likelihood of falls or mitigate the associated trauma are more complex than treating osteoporosis. This is due, in part, to a lack of understanding of the causes and contributing factors of falls in older age. As the global population ages and the proportion of individuals over 65 grows, finding ways to prevent fractures in this age group is of paramount importance for public health. It is projected that within the next two decades, more than a quarter of the world's population will be over the age of 65.

Frequent falls in older age are a significant source of morbidity and increased mortality. It is currently believed that dementia or degeneration of the central nervous system may lead to impaired motor abilities [7]. This can result in an increased risk of falls due to developing instability and psychomotor slowing, leading to fractures of the limbs and head injuries [8]. Prevention of falls in this population can be challenging, and there is currently no effective treatment for instability due to the complexity of the underlying mechanisms. Further research into the mechanisms related to motor stability and function may help to improve our understanding of this issue.

Falls due to instability are not a common occurrence throughout a person's lifespan [9]. Children are able to avoid falling from a standing height within a few weeks of learning to walk on two legs. When falls do occur, children are able to instinctively prevent significant injury. The low energy involved in falls at this age is due to the child's small size relative to their weight. While children may experience more falls during childhood, the ability to avoid falls typically matures in early adolescence [10].

In healthy adults, falls that result in significant injury are typically triggered by a provocative factor or an event that amplifies the energy transferred during the fall. A fall is an unplanned transition from a standing to a lying position. The first stage of a fall is the INITIATION stage, in which the center of gravity deviates from its support base. This deviation can be caused by environmental factors, such as unstable objects or slippery surfaces, or internal factors such as muscle weakness or impaired reflexes. The second stage is the RECOVERY stage, in which the body's system for maintaining an upright position is activated. This system should detect and correct the deviation of the center of gravity and prevent the fall in time. In a healthy individual, this stage allows for the prevention of a fall or the distribution of energy to prevent significant injury. Failure at this stage is often associated with the individual themselves. The final, negative stage is the IMPACT phase, in which the body makes contact with the ground and experiences a transfer of forces that can result in injury. The probability of injury is determined by the strength, direction, and physical properties of the affected tissue [11].

Lockhart et al. studied the differences between young and old individuals in terms of the biomechanics of falls. They found that the RECOVERY phase, or the ability to recover from a loss of equilibrium event, is much faster in young people, allowing them to effectively prevent falls. This is not the case for older individuals, who may have weaker muscles, less agility, and poorer balance, making it difficult for them to recover from falls [12]. Older individuals tend to maintain a wider base while walking and have shorter walking lengths, resulting in a longer stance time on two legs. They also have weaker push-off forces and land with a flatter foot position. There is also a decline in the Index of dynamic balance, a measure of stability in a standing position. These changes in gait pattern are thought to be adaptive changes in response to the development of stability disorders over time, and the Index of dynamic balance indicates the severity of this stability [13].

According to Sheldon et al., recurrent falls are common in 24% of men and 44% of women over the age of 65. These falls were categorized as "accidental" falls, falls due to imbalance, lightheadedness, syncope events, pre-syncope, and leg weakness. Among adult falls, 34% were classified as "accidental" falls, which were considered preventable. Adults who reported these falls

 doi:10.20944/preprints202302.0392.v1

often expressed frustration about their inability to maintain balance as they could in their younger years. This suggests a physiological difficulty in preventing falls.

Possible mechanisms contributing to this phenomenon include loss of sensation in the legs, which was observed in 25-35% of patients who fell. Planetary returns with extensor dominance were found to be four times more common in the population of patients who fell compared to the population of the same age. In addition, more than half of the adults tested in the Romberg test demonstrated instability. These findings suggest that neurological factors may play a major role in causing instability and falls in older adults.

2. Methods

The study analysed data from patients admitted to Carmel medical center with a diagnosis of upper or lower limb fractures between 2017 and 2019. The records of these patients were reviewed to determine the side of the wrist fracture and compare it to the patient's age.

The inclusion criteria for the study included all patients admitted to the hospital with a wrist fracture during the study period, while the exclusion criteria included patients younger than age 50 and those with incomplete records lacking relevant data such as age or fracture side.

The aim of the study was to examine whether there was a difference in the distribution of sides in distal radius fractures based on patient age, with the hypothesis that falls are more likely to occur on the left side due to the assumption that the gross motor skills of the dominant hand are better preserved. The study received approval from the Institutional Helsinki Committee.

All statistical analyses were conducted with a significance level of 0.05. Statistical analysis was conducted using SPSS software version 28. Descriptive statistics were calculated for all parameters, including the mean, standard deviation, median, percentiles, and ranges. The normal distribution of continuous parameters was tested using the Shapiro-Wilk test, and parametric or non-parametric tests were performed accordingly.

There are several potential sources of bias that may impact the results of this study. One potential bias is the limited availability of reliable data for many patients, as some may not be included in the hospital's databases or may not reside in the study area. There may also be a risk of errors in the registration or diagnosis of fractures, although the small sample size of a few thousand cases is expected to minimize this potential bias. Despite these limitations, it is anticipated that the study will be able to provide a statistical representation of the data.

3. Results

In our analysis of patient data from 2019 to 2017, we identified a total of 219 individuals who were diagnosed with a fracture of the distal radius and treated in the emergency room. Of these patients, 89 had fractured their right wrist, while 130 had fractured their left wrist.

To further investigate this finding, we conducted a binomial test (see Table 1). The results of this test indicated that the probability of observing 130 left wrist fractures out of a sample of 219, assuming a probability of 0.5 for fracturing either the right or left wrist, is p = .00115423. The probability of observing exactly, or fewer than, 130 fractures is p = .99778511, while the probability of observing exactly, or more than, 130 fractures is p = .00336912. The one-tailed probability of observing exactly, or more than, 130 fractures is p = .003436.

Table 1. BINOMIAL Analysis Table.

n	k	p	q
213	130	0.5	0.5

Based on these results, we conclude that the probability of breaking the left wrist is significantly greater than the probability of breaking the right wrist ($p < 0.05$). It should be noted that our analysis may have been impacted by disruptions in the patient registration process due to the implementation

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 23 February 2023 doi:10.20944/preprints202302.0392.v1

of a new information system called "Chameleon." Some patient records may not have been retrieved electronically as a result.

We conducted a second analysis to examine the hypothesis that there is no difference in the distribution of fractures between the right and left wrists, according to age. To test this hypothesis, we conducted a t-test. The data for the corresponding wrists is presented in the attached table (Table 2):

P-value	Maximum	Median	Minimum	Std Dev	Mean	N Obs	Side
0.4822	98	70	50	10.98	69.98	89	Right
	96	68	52	12.14	68.85	130	Left

We conducted this test again, this time dividing the study group into two age categories. In this test, we treated age as an ordinal variable with categories increasing in increments of 10 years. To test this hypothesis, we conducted a t-test. The data for the corresponding wrists, according to age, is presented in the attached table (Table 2)

Left hand	Right hand	Age
33 (64.71%)	18 (35.29%)	50-59
43 (63.24%)	25 (36.76%)	60-69
24 (46.15%)	28 (53.85%)	70-79
22 (61.11%)	14 (38.89%)	80-89
8 (66.67%)	4 (33.33%)	90+

We found that there is no difference in the distribution of fractures between the right and left wrists of the distal radius, according to age ($p = 0.2774$) among the patients who fractured their wrist. Our analysis indicates that there is no significant difference in the distribution of fractures based on age.

4. Discussion

There was a slight increase in the probability of breaking the left wrist, with approximately 50% greater likelihood compared to the right wrist. It is important to note that the data used in this study may not accurately reflect the overall incidence of distal radius fractures at our institution due to issues with data extraction from hospital systems. Despite this limitation, the findings of this study are consistent with previous research by Pesola et al., who observed a statistically significant preference for breaking the left wrist in their sample of 127 patients. Pesola et al. did not find a relationship between gender and fracture side but did find an increasing probability of left wrist fractures with advancing age, up to a ratio of 2.3:1.

Our study was unable to disprove the hypothesis that there is no change in the side of fracture over time. Our data showed a consistent ratio of approximately 1.5:1 for the distribution for breaking the left wrist versus the right wrist across all age groups, with the exception of the seventh decade. If we had access to a larger number of files spanning multiple years, we would expect to see this consistent pattern maintained over time. These findings suggest that the degeneration of the nervous system, which increases the probability of falls and fractures, does not affect the likelihood of a fracture occurring on a specific side once a fall has occurred.

Dementia is a neurological disorder characterized by widespread degeneration of the brain, rather than excess degeneration on one side of the brain (with the exception of certain syndromes such as Parkinson's or Benson's). This is consistent with the findings of our study, which showed no change in side preference with aging. The fact that individuals tend to use their opposite hand to try to stop a fall, coupled with our findings, supports the hypothesis that there is no change in side preference over time.

As part of this work, there was an attempt to find a difference between hand dominance and the side of the fracture from which the patient suffers, but considering the lack of registration in the absolute majority of the cases found, it was decided that it was not possible to make this comparison.

We still assume that the preference for right dominance over left dominance was preserved among the research population for which the work was carried out. A work carried out by Porac found that the chance of injury to the palm is equally common in patients with right-hand dominance as it is common in those with left-hand dominance. The danger of this work was that the chance of injury does not depend on dominance, it depends on activity [33]. This work demonstrates that right or left dominance do not constitute a risk factor in itself for these fractures only on the side of the injury. The fact that specific dominance does not increase the risk of a fall or fracture in one group or another demonstrates that the left dominance of the fractures is not because those with left dominance tend to break more and those with right dominance are not skilled in stopping a fall on the hand left and vice versa.

This work shows that it makes sense to guide both elderly and young patients, who are at risk of falling, to increase the use of the non-dominant hand when moving around or when holding objects, in order to free the dominant hand to allow it to effectively stop a fall when it occurs.

5. Conclusion

In conclusion, our study found that the probability of breaking the left wrist is approximately 1.5 times greater than the probability of breaking the right wrist. Additionally, we found no differences in the distribution of fracture sides in the distal radius as a function of age.

Funding: This research received no external funding.

Informed Consent Statement: Informed consent was obtained from the patients.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. A. L. Boskey, L. Imbert, Bone quality changes associated with aging and disease: a review, Annals of the New York Academy of Sciences 1410 (1) (2017) 93–106. doi:10.1111/nyas.13572. URL https://dx.doi.org/10.1111/nyas.13572
2. A. J. BLAKE, K. MORGAN, M. J. BENDALL, H. DALLOSSO, S. B. J. EBRAHIM, T. H. D. ARIE, P. H. FENTEM, E. J. BASSEY, FALLS BY ELDERLY PEOPLE AT HOME: PREVALENCE AND ASSOCIATED FACTORS, Age and Ageing 17 (6) (1988) 365–372. doi:10.1093/ageing/17.6.365. URL https://dx.doi.org/10.1093/ageing/17.6.365
3. S. R. Cummings, M. C. Nevitt (2010). [link]. URLhttp://dx.doi.org/10.1056/NEJM199409293311310. https://www.nejm.org/doi/pdf/10.1056/NEJM199409293311310
4. D. Marshall, O. Johnell, H. Wedel, Meta-analysis of how well measures of bone mineral density predict occurrence of osteoporotic fractures, BMJ 312 (7041) (1996) 1254–1259. doi:10.1136/bmj.312.7041.1254. URL https://dx.doi.org/10.1136/bmj.312.7041.1254 [5] (2020). [link]. URL https://pubmed-ncbi-nlm-nih-gov.carmel-ez.medlcp.tau.ac.il/10525710/. Accessed9

6. K. N. Tu, J. D. Lie, C. Wan, Osteoporosis: A Review of Treatment Options, P T 43 (2018) 92–104.
7. J. Lee, B. Lee, Y. Park, Y. Kim, Effects of combined fine motor skill and cognitive therapy to cognition, degree of dementia, depression, and activities of daily living in the elderly with Alzheimer's disease, J Phys Ther Sci 27 (2015) 3151–3154.
8. Y. Liu, J. S. Y. Chan, J. H. Yan, Neuropsychological mechanisms of falls in older adults, Frontiers in Aging Neuroscience 6 (2014). doi:10.3389/fnagi.2014.00064. URL https://dx.doi.org/10.3389/fnagi.2014.00064
9. T. Al-Aama, Falls in the elderly, Can Fam Physician 57 (2011) 771–776. [10] (2019). [link]. URLhttps://www-ncbi-nlm-nih-gov.carmel-ez.medlcp.tau.ac.il/pmc/articles/PMC2895260/.Accessed3

11. M. P. I. Of, D. Us, R. L. Berg, J. S. Cassells, Falls in Older Persons: Risk Factors and Prevention, National Academies Press, US, 1992.
12. T. E. Lockhart, J. L. Smith, J. C. Woldstad, Effects of Aging on the Biomechanics of Slips and Falls, Human Factors: The Journal of the Human Factors and Ergonomics Society 47 (4) (2005) 708–729. doi:10.1518/001872005775571014. URL https://dx.doi.org/10.1518/001872005775571014
13. D. A. Winter, A. E. Patla, J. S. Frank, S. E. Walt, Biomechanical Walking Pattern Changes in the Fit and Healthy Elderly, Physical Therapy 70 (6) (1990) 340–347. doi:10.1093/ptj/70.6.340. URL https://dx.doi.org/10.1093/ptj/70.6.340

 doi:10.20944/preprints202302.0392.v1