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Hand Dominance and Walking Aid Use – Pre-determinants for Hip Fracture in the Elderly?

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Abstract

AIM: Left handedness has previously been associated with an increased risk of fracture for a number of sites but to the best of our knowledge no association between handedness and hip fracture has previously been reported.

MATERIALS AND METHODS: Two separate 6-month prospective reviews of hip fracture patients aged over 65 years of age were conducted at two different hospitals, with the second review focusing on walking aid use. The patients with a neurological condition or contralateral hip prosthesis were excluded due to increased balance problems and falls risk.

RESULTS: Hand dominance was recorded for 339 patients; 304 right and 35 left. A total of 91 patients were excluded from the study. Of the remaining 248 patients, 2.06 times as many fractured their hip on the side of their non-dominant hand. For the left-handed individuals this increased to 4.6 times. Walking aid use was recorded for 102 patients. Equal numbers of the right and left hip fractures were sustained for patients using no walking aids, a Zimmer frame or two walking sticks; while 97.7% of patients using one walking stick did so in their dominant hand, sustaining 84% contralateral hip fractures.

CONCLUSION: The direction in which people fall and the causes of hip fractures is clearly multifactorial. However, we did find an association between hand dominance and hip fracture, especially when using a single walking aid. By being aware of this association, it may be possible to target both patient education and physiotherapy potentially reducing the number of patient falls and associated hip fractures.

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Introduction

Approximately 70,000–75,000 hip fractures are treated in the UK each year costing an estimated £2 billion [1], [2]. With increasing life expectancies and an ever growing elderly population, this is estimated to increase to 101,000 patients costing £2.2 billion per year by 2020 [1]. This places an ever increasing burden on health services and anything which could help identify and potentially prevent fractures could be of significant benefit.

A number of studies have demonstrated a higher incidence of the left-sided hip fractures compared to the right, but no specific causative factors have ever been identified [3], [4].

Hand dominance is one potential relationship revealed by Dane *et al.* [5], who found significant differences in bone mineral density (BMD) of the proximal femora between right- and left-handed men.

Interestingly, left handedness has previously been shown to be associated with an increased risk of dental trauma [6], wrist fracture [7], and fracture of the proximal humerus [8] although the reason for this remains unclear.

Impaired core muscle stability may be implicated; with Has *et al.* [4], attributing the higher number of the left hip fractures to pronounced weakness of pelvirochanteric muscles and walking instability. While Sung *et al.* [9], demonstrated delayed lumbar spinal muscle response time and increased fatigability on the contralateral side to hand dominance, more so in the left-handed individuals.

In the general population, the right hand dominance is significantly more prevalent, with the left handedness accounting for only approximately 8–10% of the population [6], [10], [11].

The aim of this paper is to review whether this predominance of the right handedness could be related to the higher incidence of the left-sided hip fractures and whether this information could be used to help guide falls prevention therapies thereby reducing the number of hip fractures. An extensive literature search of the MEDLINE and EMBASE databases including the terms hip fracture, neck of femur fracture, hand dominance, and handedness reveals no previously reported association between hand dominance and the laterality of hip fracture.

Materials and Methods

The patients aged over 65 years old, admitted with a neck of femur fracture were prospectively reviewed over two separate 6-month periods in two different local hospitals. The first review was conducted between December 2012 and May 2013 at insert Hospital 1 while the second review was conducted from April 2017 to September, 2017 at – insert Hospital 2.

Hand dominance was ascertained at the time of admission by the clerking doctor. Walking aid use was also recorded for the second review period. The medical notes were reviewed to see whether patients had suffered a previous cerebrovascular accident (CVA) or had any other neurological problems which may affect their balance. The patient's radiographs were also reviewed to see whether there were any prostheses on the opposite side which may have led to leg length discrepancies and potential balance problems.

The patients with a previous CVA, known balance or neurological problems, or a previous hip prosthesis were excluded in an attempt to minimize the effects of other contributory falls risks and to focus on any potential association with hand dominance. The patients aged under 65 years old were also excluded due to younger patients typically sustaining higher energy injuries.

The results were collated and compared using Microsoft Excel software.

Results

Hand dominance was recorded in 339 patients (245 females and 94 males) aged over 65 years old who were admitted with a neck of femur fracture over the specified time periods. One hundred and forty-seven of these were right-sided fractures while 192 occurred on the left hand side, in keeping with the reported higher incidence of the left-sided hip fractures.

A total of 304 patients were right handed and only 35 left handed (10.3%), in keeping with the figure of approximately 10% seen in the general population [6], [10], [11].

Forty-eight of these patients had been affected by a CVA and 40 had a hip prosthesis on the contralateral side, while one patient was affected by both. One patient suffered from vertigo and two were non-ambulatory; these 91 patients were therefore excluded from the study.

Of the remaining 248 patients; 81 patients fractured the same side hip as their dominant hand while 167 patients, more than twice as many (2.06 times) fractured their hip on the side of their non-dominant hand.

There was a greater difference in women where 54 patients fractured the same side and 121 (2.24 times) fractured the opposite side to their dominant hand. Conversely, there was less difference in men; with 27 fracturing the same side and 46 (1.7 times) fracturing the opposite side to their dominant hand (Table 1).

Table 1: Laterality of hip fracture per handedness and sex

Sex	Hand dominance	Laterality of fracture		Contralateral fracture	Phi coefficient
		Right	Left		
Male	Right	25	39	1.56 x	-0.25
	Left	7	2	3.50 x	
Female	Right	51	105	2.05 x	-0.33
	Left	16	3	5.33 x	

Looking at the right and left handedness separately (Table 2); left-sided hip fractures occurred 1.89 times more frequently than right-sided hip fractures, in right hand dominant individuals. While right-sided hip fractures occurred 4.6 times more frequently than left-sided hip fractures, in left-handed individuals. From this data, a phi coefficient of association was calculated at -0.34 confirming a moderate correlation between hand dominance and the laterality of hip fracture. With the negative correlation being consistent with an increased frequency of contralateral sided hip fractures when compared to hand dominance.

Table 2: Side of hip fracture per handedness

Hand dominance	Side fractured	
	Right	Left
Right	76	144
Left	23	5

Phi coefficient -0.34.

Further reviewing the laterality of hip fracture by hand dominance for male and female patients separately (Table 1), revealed that left-handed individuals whether male or female, experienced the highest number of contralateral hip fractures. With left-handed females have the highest frequency, with 5.33 times as many right hip fractures as on the left. While right-handed men experienced just 1.56 times more left-sided hip fractures than right-sided hip fractures. However, all groups experienced higher rates of contralateral sided hip fractures when compared to hand dominance.

In the second review period, walking aid use was recorded for 102 patients; 90 were righthanded while 12 were left handed (11.7%), slightly higher than in the first review period but again in keeping with the figure of approximately 10% seen in the general population [6], [10], [11]. Twenty-eight patients used no walking aids at all and 30 patients used either a walking frame or two walking sticks. Both of these groups of patients experienced an equal number of the right- and left-sided hip fractures, irrespective of hand dominance (Table 3).

Table 3: Laterality of hand dominance and hip fracture per walking aid use

Walking aid	Hand dominance	Hand used		Contralateral fracture	Ipsilateral fracture
		Dominant	Non-dominant		
No aid	-	-	-	14	14
Frame/2x stick	-	-	-	15	15
1x stick	Right	35	1	37	7
	Left	8	-		

Forty-four patients used one walking stick, with 97.7% of these patients doing so in their dominant hand.

Of the 43 patients using their stick in their dominant hand; 36 (83.7%) fractured their contralateral hip and just seven patients (16.3%) fractured their ipsilateral hip. Interestingly, the one patient who used their stick in their non-dominant hand still sustained a contralateral hip fracture to the side of hand dominance (Table 3).

Discussion

It is clear to see from these results that there is an association between hand dominance and laterality of hip fracture following a fall, particularly in left-handed individuals but it remains unclear what the underlying cause for this association may be.

Sahin *et al.* [12] found BMD of both femora to be greater in right-handed students than in left-handed students, concluding that this was consistent with the previous claims that left-handed individuals had a higher risk of trauma and injury. However, if left-handed individuals account for approximately 8–10% of the general population [6], [10], [11], surely if they were at increased risk of injury they should account for more than 10.3% of the hip fractures seen in this series.

Bilaterally, lower femoral BMD in left-handed individuals also fails to explain why left-handed individuals were found to experience 4.6 times more fractures of the right hip than the left, an occurrence which is opposite to that which is more commonly seen in the general population [3], [4].

Dane *et al.* [5] and later Gümüştekin *et al.* [13] found significant differences in BMD of the proximal femora between the right- and left-handed men. They demonstrated higher BMD of the femur on the opposite side to the dominant hand, which may suggest a degree of fracture protection; however, this was in fact the side most frequently fractured in this series. Interestingly, they found no significant differences between BMD of the femora in the right- and left-handed women.

One potential explanation why the BMD may be higher on the opposite side to the dominant hand is that hand dominance increases an individual's use of their musculature on their dominant side leading to better core stability and balance on that side, while causing a proportional weakness on the other side. This proportionally weaker side with poorer control therefore bears more load and increases in density over time in accordance with Wolff's law. However, while the BMD may inadvertently become higher on the weaker side due to increased compressive load and secondary remodeling, this would not necessarily convey any protection against the bending and rotational forces which would be encountered during a fall. This higher BMD may therefore not be as protective as it first appears.

Impaired core muscle stability and balance have previously been implicated as a factor in the lower extremity injury in athletes [14] and is very likely to play a role in the direction in which people fall. With studies demonstrating muscular weakness, delayed response time and fatigability on patients' non-dominant side, [4], [9] it may be that the significantly higher prevalence of right hand dominance in the general population, likely with comparatively reduced core stability on the left, partially accounts for the overall increased incidence of left-sided hip fractures.

A number of studies have found exercise programs and balance training safe, feasible, and effective in improving dynamic balance and isometric strength while reducing the fear of falling in the elderly [15], [16], [17]. This may therefore be a simple and effective way of potentially reducing the number of falls and associated hip fractures in the elderly in the future. The other key area to address is walking aid use and education. It has previously been shown that a large percentage of patients use walking aids incorrectly, frequently favoring their dominant hand [18], in-keeping with our findings. By effectively assessing patient's pathology and walking aid use it may be possible to reduce this trend. Furthermore, continued assessment and earlier progression to two walking sticks or a walking frame may have some protective benefit.

Conclusion

The direction in which people fall and the cause of hip fractures is clearly multifactorial. However, this study has shown that twice (2.06 times) as many patients experience hip fractures on the side of their non-dominant hand. A phi coefficient of association was calculated at 0.34 confirming a moderate correlation between hand dominance and the laterality of hip fracture.

This association was found to be the highest in left-handed females who sustained 5.33 times more right-sided hip fractures than left-sided hip fractures. However, all groups experienced higher rates of contralateral hip fractures when compared to hand dominance.

Left-sided hip fractures occurred more frequently than right-sided hip fractures (192 left and 147 right), and the majority of patients were right handed (89.7%) in keeping with numbers previously reported in the literature. The use of no walking aids, a walking frame or two walking sticks was associated with an equal number of the right- and left-sided hip fractures, irrespective of hand dominance. While 97.7% of patients using one walking stick did so in their dominant hand, in association with 83.7% contralateral hip fractures.

We proposed that the higher number of the left-sided hip fractures is due to a propensity for right hand dominance in the general population, in association with reduced non-dominant sided core stability and inappropriate walking aid use.

By being aware of the association between hand dominance and contralateral hip fracture it may be possible to target both patient physiotherapy in the elderly to increase core stability and balance, while improving patient education regarding walking aid use, potentially reducing the number of falls and associated contralateral hip fractures in the future.

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