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Original article

Association between Hand Dominance and Side of Disc Prolapse in Patients with Lower Back Pain: A Retrospective Observational Study

Quratulain Haroon [1], Sadaf Nasir [1], Manzar Hussain [2], Uzair Siddiqui [*2], Bushra Shamim [1], Yussra Khattri [1]

[1]Department of Radiology, Liaquat National Hospital, National Stadium Road, Karachi, 74800, Pakistan.
[2]Department of Neurosurgery, Liaquat National Hospital, National Stadium Road, Karachi, 74800, Pakistan.

*Corresponding author: Uzair Siddiqui; *uas3490@gmail.com*

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Abstract

Background: Lower back pain, often with leg radiation, is a common complaint affecting both the general population and athletes. Lumbar disc prolapse is a significant cause of this pain, with potential biomechanical factors such as hand dominance hypothesized to play a role in its etiology. This retrospective observational study aimed to investigate the potential association between hand dominance and the laterality of disc prolapse in patients with lower back pain. ***Methods:*** A total of 112 outpatient patients aged 20-50 years of age, undergoing an MRI spine for lower back pain were included. Data on disc prolapse side and hand dominance were collected and analyzed using SPSS version 25. Associations were assessed using chi-square tests. ***Results:*** Among the patients, 92.9% were right-handed and 7.1% were left-handed. The majority (75%) had multi-level disk involvement and diffuse disc bulges (87.5%). Right-sided disc prolapse was observed in 31.3% of cases. No significant association was found between hand dominance and multi-level disk or diffuse disc bulge. However, a significant association was observed between disc prolapse side and multi-level disk (p=0.025), with a predominance of right-sided disc prolapse (88.6%). ***Conclusion:*** This study did not find a significant association between hand dominance and the laterality of disc prolapse. However, there was a notable correlation between disc prolapse side and multi-level disk involvement, suggesting potential biomechanical implications in lumbar disc herniation.

Keywords: ***Lumbar Disc prolapse, lumbar disc herniation, lower back pain, Laterality of disc prolapse, degenerative spine.***

Introduction

Lower back pain (LBP) ranks among the most prevalent reasons for seeking medical care, and is a leading cause of activity limitations and work-related absenteeism [1,2]. The incidence of LBP, varies in different epidemiological studies but is significant, with a lifetime prevalence ranging from 60-90% [3-5]. LBP with or without radiculopathy is not only common in general population, but is also a major contributing factor affecting the performance of professional athletes, and results in breaks from their playing time [6,7].

Among the myriad of causes of lower back pain with radiculopathy, Lumbar disc herniation (LDH) and degenerative spine diseases are the most common culprits [6-9]. While individual susceptibilities and psychosocial factors can influence pain across various professions and sports [10], repetitive tasks and poorly designed workplaces are the primary culprits behind occupational low back pain [11,12]. Ergonomic risk factors, affecting the spinal column, like awkward lifting techniques, heavy loads, prolonged static postures (both sitting and standing), and whole-body vibration (common for drivers) pose a greater threat. These factors create excessive stress on muscles, disco-ligamentous complex and joints, ultimately leading to pain and potential disc degeneration [12]. A most commonly proposed cause of acute disc prolapse is the act of lifting and turning while the trunk is flexed. Seidler et al. proved a statistically significant positive association between extreme forward bending and lumbar disc herniation [11]. In sportsmen or in people performing heavy exercises, the combination of lumbar spine flexion and rotation under load can even result in unilateral fractures [13]. In considering degenerative disease, disc degeneration is considered to be the first step, and it is usually followed by intervertebral disc narrowing, osteophyte formation, and resultant spinal stenosis [13,14].

Although the majority of the population is right-handed, it was hypothesized that the incidence of lumbar disc prolapse may not be equal and could be higher on the side opposite the dominant hand. While the hypothesis suggested a potential correlation between lumbar disc prolapse incidence and hand dominance, previous studies have not supported this idea. Research has found no significant differences in the side incidence of lumbar disc prolapse, and there appears to be no direct correlation with hand dominance [15]. The prevailing view is that the occurrence of disc prolapse and the affected side is not solely attributable to unilateral actions associated with hand dominance. Instead, it is believed to be an outcome of pre-existing disc degeneration. While neurological

deficits are a rare complication following lumbar disc herniation, they can lead to lasting disabilities [16].

Hand dominance can lead to differences in daily activities and posture. Increased stress and strain on the dominant side can lead to discrepancies between the two sides, commonly known as directional asymmetry [17]. Most research on disc prolapse focuses on already established risk factors like lifting mechanics, posture, and degenerative changes in the spine. However, there might be some indirect connections between handedness and disc prolapse that warrant further investigation. An asymmetry in activities does exist where people tend to favor one side of their body for certain activities due to their handedness. As mechanical stress significantly contributes to the development of disc herniation and facet joint degeneration, consistent application of mechanical stress on one side can lead to unilateral symptoms and uneven degeneration of intervertebral joints and discs [18]. For instance, right-handed individuals may have tendency to use their right side more, for carrying and lifting weights and other activities. This can lead to variations in biomechanical stress planes on lumbar spine which could result in repetitive stress on one side of the spine only, potentially increasing the risk of development of LDH on that side [19]. Similarly certain sports, like golf, involve twisting and asymmetrical movements that could be influenced by handedness. Studying disc prolapse rates in athletes categorized by handedness and sport might reveal some connections. Existing literature reveals conflicting or limited evidence regarding the impact of hand dominance [19].

The objective of this study was to investigate the potential association between hand dominance and the laterality of disc prolapse in patients with lower back pain. The study aimed to determine if there is a significant correlation between the dominant hand and the side of disc prolapse. The results may provide insights into the etiology of disc prolapse and its relationship to biomechanical factors such as hand dominance. Understanding whether hand dominance is risk factor for lumbar disc prolapse can have clinical implications. If there is significant association the health care providers can use this information to tailor treatment plan and improve clinical outcome. Furthermore it could influence preventive measures, rehabilitation strategies and agronomics recommendations based on their hand dominance.

Methods

This retrospective observational study was conducted at the Department of Radiology, Liaquat National Hospital Karachi, over 6 months from January 2023 to June 2023. All hospitalized and outpatient patients with a total of 112 patients, aged 20-50 years of age, who had undergone an MRI spine at the hospital for lower back pain with or without leg radiation were included. Patients with a history of trauma, malignancy, or lumbar surgery were excluded. Radiology data were retrieved from the institution's PACS software (OSIRIX) and interpreted by a skilled radiologist to note the side of the disc prolapse. Hand dominance was ascertained, along with other demographic variables like age, weight, gender and height, as a part of already established hospital protocol for the initial visit of every patient. As this part of the study involved solely the collection of data, it was conducted under a waiver of consent. Data analysis was performed using Statistical Package for the Social Sciences Software (SPSS) version 25. Frequency and percentages were calculated for gender and disc prolapse side. Means were calculated for age and hand dominance. Effect modifiers were controlled through stratification of disc prolapse side and hand dominance. Post-stratification chi-square tests were applied, with a significance level set at $p \leq 0.05$.

Results

A total of 112 outpatient patients, aged between 20 - 50 years with a mean age of 39±6 years and who had an MRI spine for lower back pain with or without radiation to the legs were included in the study. The male-to-female ratio was 52:60 (Table 1). Among 112 patients, 92.9% were right-handed and 7.1% were left-handed. Out of 112 patients, 75% were found with Multi-Level Disk, 87.5% with diffuse disc bulge, and 31.3% with right-sided disc prolapse, as presented in Table 2.

Among right-handed patients, 75% were found with multi-level disk, 86.5% with diffuse disc bulge 31.7% with right-sided disc prolapse, and 68.3% with left-side disc prolapse. Among left-handed patients, 75% were found with multi-level disc, 100% with diffuse disc bulge 25% with right-sided disc prolapse, and 75% with left-sided disc prolapse as presented in Table 3.

Among disc prolapse sides, 94.3% were right with multi-level disks, and 5.7% were found with disc bulges as associations are presented in Table-3 and Table-4 respectively and presented in Table-4.

We found no significant association of the hand side with multi-level disk (p=1.000), diffuse disc bulge (p=0.593), and disc prolapse side (p=1.000). There was a significant association of disc prolapse side with multi-level disk (p=0.025, 5.7% were left-sided while 88.6% were right-sided found) while no significant association of side of disc prolapse with hand side (p=1.000). Detailed results of associations are presented in Table 3 and Table 4 respectively.

Table 1: Demographic data

Age in Years	**39±6 years (mean) SD**
Gender	
Male	52 (46.4%)
Female	60 (53.5%)

Table 2: Descriptive statistics of study population (n=112)

	n (%)
Hand Side	
Right Hand	104 (92.9)
Left Hand	8 (7.1)
Multi-Level Disk	
Yes	84 (75)
No	28 (25)
Diffuse Disc Bulge	
Yes	98 (87.5)
No	14 (12.5)
Disc Prolapse side	
Right	35 (31.3)
Left	77 (68.8)

Table 3: Association of hand side

	Hand Side n (%)		**p-value**
	Right Hand	**Left Hand**	
Multi-Level Disk			
Yes	78(75)	6(75)	1.000
No	26(25)	2(25)	
Diffuse Disc Buldge			
Yes	90(86.5)	8(100)	0.593
No	14(13.5)	0(0)	
Disc Prolapse Side			
right	33(31.7)	2(25)	1.000
left	71(68.3)	6(75)	

Chi-square/fisher exact test was applied. P<0.05 were considered as significant.

Table 4: Association of Disc Prolapse Side

	Disc Prolapse Side n (%)		p-value
	Yes	**No**	
Hand Side			
Right Hand	33(94.3)	71(92.2)	1.000
Left Hand	2(5.7)	6(7.8)	
Multi-Level Disk			
Yes	31(88.6)	53(68.8)	0.025*
No	4(11.4)	24(31.2)	

Chi-square/fisher exact test was applied. P<0.05 were considered as significant.

Discussion

Lower back pain (LBP) ranks among the most prevalent reasons for seeking medical care worldwide, with substantial societal and individual consequences, including high healthcare costs and reduced productivity in terms of mobility limitation and work absence [20,21]. Multiple factors including comorbid, psychological disorders, obesity, smoking, lack of exercise, increasing age, and lifestyle factors, are considered as risk factors for low back pain [22].

Lower back pain is commonly observed symptom in intervertebral disc degeneration with associated disruption of the complex anatomy of the nucleus pulposus, annulus fibrosus, and adjacent supporting structures of the spine. Change in the shape and intensity of nucleus pulposus, decreased disc height, disc herniation, vertebral endplate changes, presence of osteophyte, and posterior high intensity zones are considered as degenerative changes on imaging [15].

The Intervertebral disc (IVD) is the largest avascular organ in the human body, relying on diffusion for nutrition and elimination of cellular wastes. As a result of repeated trauma or stress, there is a slowing down of biological repair and regeneration process of the IVD and it is overtaken by degeneration [7,22]. LDH is a localized displacement of IVD tissue beyond the physiological margins of the intervertebral disc space. The prevalence of LDH is about 1-3% mostly among people aged between 30 and 50 years [14]. Asymmetric changes occur in inter-vertebral disc under asymmetric loading. The lumbar spine and its associated soft tissues work in a coordinated manner [17]. A study Kanat et al. showed asymmetric feature of LDH in human, high rate incidence of left-sided discectomy. It seems to be imperative to understand this asymmetric process to better target treatments.

The human body which seems symmetrical at first glance, aligning along the midline, in reality exhibits both morphological and physiological asymmetry. Most people have a strong preference for using the right hand in unimanual tasks, a minority prefers the left hand, and very few people do not exhibit a hand preference. This lack of symmetry is attributed to variations in mechanical stress [23]. Lateralization and asymmetry secondary to hand dominance may be important in lateralization of disc pathology.

Our study encompassed a total of 112 patients who underwent MRI spine scans due to lower back pain, with or without radiation to the legs. Notably, 92.9% of these patients were identified as right-handed, while 7.1% were left-handed. A study by Weatherly (15) stated, eighty-three patients (90.2%) were right-handed, eight (8.7%) were left-handed and one patient (1. 1%) was ambidextrous. In our study, within the cohort, 75% exhibited a Multi-Level Disk, 87.5% had a diffuse disc bulge, and 31.3% presented with disc prolapse.

Further analysis within the right-handed subgroup revealed that 75% had multi-level disk issues, 86.5% exhibited a diffuse disc bulge, and 31.7% experienced disc prolapse, with a prevalence of right-sided disc prolapse. A previous study by Weatherly et al, of the eighty-three right-handed patients, forty (48.2%) had a left-sided disc prolapse and forty-three (51.8%) had a right-sided disc prolapse.

Conversely, in our study, among left-handed patients, 75% displayed multi-level disk problems, 100% showed a diffuse disc bulge, 31% experienced right-sided disc prolapse, and 71% had left-sided disc prolapse. The observed variations between right and left-handed individuals raise questions about the influence of handedness on the manifestation and localization of spinal conditions, providing a basis for further exploration and understanding in this area of research [15].

In consideration of lumbar disc prolapse, our study has illuminated a striking revelation that no discernible variance exists in the prevalence of this condition between different sides of the spine. Remarkably, hand dominance, a factor often scrutinized for potential correlations, appears insignificant in influencing the occurrence of lumbar disc prolapse. Instead, the emergence of a disc prolapse appears to be interrelated with the gradual progression of disc degeneration [16,19,24].

While lumbar disc herniation is, in most instances, a manageable condition, the presence of neurological deficit is revealed as its most dreaded complication [7,22]. Though rarely, instances, where neurological complications ensue, can lead to enduring disabilities, underscoring the need for vigilant monitoring and timely intervention in cases of lumbar disc herniation. Understanding the intricacies of this condition is paramount in ensuring effective preventive measures and treatment strategies for those at risk or currently grappling with lumbar disc issues [22].

These findings prompt a discussion on the potential correlation between handedness and the distribution of spinal issues, particularly in the context of multi-level disk problems, diffuse disc bulges, and the sidedness of disc prolapse. The observed variations between right and left-handed individuals raise questions about the influence of handedness on the manifestation and localization of spinal conditions, providing a basis for further exploration and understanding in this area of research [5].

It should also be noted that in the current population of older people, the majority declare their right hand as dominant. Without thorough research, we cannot say whether similar processes occur in left-handed people, and if these changes are the same or greater than in the case of right-handed people [25].

A study by Sung et al. highlighted this potential methodological flaw, emphasizing the importance of assessing hand dominance as an explanatory factor when comparing dominant and non-dominant side back muscle response time [25,26].

It's important to emphasize that the manifestation of lumbar disc herniation is not the outcome of a singular unilateral action; rather, it materializes as the culmination of pre-existing disc degeneration [27]. This multifaceted process involves intricate interplays of factors that contribute to the eventual protrusion of the disc, dispelling the notion of a unilateral causative agent [28,29].

Finally, it must be realized that failing to explicitly consider hand dominance when examining differential lumbar muscle responses, in conjunction with the side assessed, can lead to confounding effects [30].

Our study had well-defined objectives aiming to investigate the potential association between hand dominance and the laterality of disc prolapse in patients with lower back pain, providing a clear focus for the research. Radiology data retrieval and interpretation were conducted by a skilled radiologist using standardized protocols, ensuring consistency and reliability in the assessment of disc prolapse. Robust statistical methods were employed, including

stratification to control for potential effect modifiers and post-stratification chi-square tests to assess associations, enhancing the validity of the findings. The study included patients with lower back pain undergoing MRI spine, ensuring relevance to the research question and enhancing the clinical applicability of the findings. Patients with a history of trauma, malignancy, or lumbar surgery were excluded, reducing confounding factors that could influence the study. To our knowledge, this is the largest study carried out for Asian population in the last 5 years, addressing a potential gap in the literature. The findings of the study have potential clinical implications for tailoring treatment plans and preventive measures based on hand dominance, highlighting the practical relevance of the research.

Few limitations of the study are its retrospective design, conducted at a single hospital and limited sample size. The study focused solely on MRI findings of disc prolapse and did not assess other potential contributing factors such as spinal alignment or muscle strength, which could provide a more comprehensive understanding of lumbar spine pathology.

Conclusion

No differences have been found in the side incidence of lumbar disc prolapse, and there was no correlation with hand dominance. The presence of disc prolapse and its side is not entirely because of any unilateral action but rather an outcome of pre-existing disc degeneration. Despite potential limitations, the study contributes valuable insights into the relationship between hand dominance and disc prolapse, adding to the existing body of literature in the field of lumbar spine pathology. Further research is warranted to elucidate the complex interplay between hand dominance, biomechanics, and lumbar disc pathology.

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Conflict of Interest

None declared

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