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Assessment of the Effect of Duration of Diabetes Mellitus on Dominant and Non -Dominant Hand Dexterity

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ABSTRACT

Background: Diabetes is a deadly disease, which is known to affect the multiple organs, and its long-term effects extend beyond the commonly recognized complications. Changes involving peripheral nerves, sensation and eventually motor control may interfere with hand movements, making everyday tasks more difficult. Whether these changes become more evident with increasing duration of diabetes remains an area of interest. The present study examines differences in dominant and non-dominant hand dexterity across varying durations of diabetes and determines the relationship between disease duration and hand performance.
Material and Methods: The data of 240 adult patients with DM were collected and analysed retrospectively from January 2024 to December 2025. The Nine-Hole Peg Test was used to assess dexterity and the time taken to complete the task was recorded in seconds for each hand. Based on disease duration, patients were grouped into <5 years (n=72), 5–10 years (n=68), 11–15 years (n=54), and >15 years (n=46). One way ANOVA and Tukey's post hoc were used to determine differences between groups. To investigate the relationship between diabetes duration and dexterity time, the Pearson's correlation coefficient analysis was used.
Results: We observed that completion times increased significantly and steadily as the disease duration increased. For the dominant hand, the mean dexterity time rose from 18.9 ± 2.8 seconds in patients with diabetes duration below 5 years to 25.4 ± 4.1 seconds among those with duration above15 years ($F=41.62$, $p<0.001$). Non-dominant hand performance followed a similar pattern, increasing from 20.1 ± 3.0 seconds to 28.2 ± 4.5 seconds ($F=53.84$, $p<0.001$). All pair-wise comparisons for disease duration revealed a significant. Diabetes duration correlated positively with dexterity time for both the dominant ($r=0.584$, $p<0.001$) and non-dominant hands ($r=0.669$, $p<0.001$).
Conclusion: Hand dexterity worsened with increasing duration of diabetes and the association was stronger for the non-dominant hand, indicating greater impairment with longstanding disease.

Keywords: Diabetes mellitus, disease duration, hand dexterity, Nine-Hole Peg Test, dominant hand, non-dominant hand

INTRODUCTION

Diabetes mellitus is one of the most common chronic metabolic diseases in the world and is still an important public health problem due to its long-term systemic complications.[1] While there has been some focus on diabetic retinopathy and nephropathy and lower-limb neuropathy, there has been relatively little attention on functional involvement of the upper extremities. More recently, though, there have been signs that diabetes significantly can impact hand performance, causing weakness, impaired dexterity and coordination.[2-4] Hand dexterity is an ability that involves rapid, coordinated and precise finger movements needed for routine daily activities like writing, buttoning clothes, using small objects and using electronic devices. Any slight loss of dexterity can have a negative impact on occupational tasks and quality of life. One of the most widely used tests of manual dexterity, the Nine-Hole Peg Test (9HPT), has been shown that healthy adults typically complete the task within approximately 18–20 seconds using the dominant hand, whereas performance tends to decline with aging and neurological dysfunction.[5] There are several possible mechanisms that lead to problems with hand function in diabetes. Polyneuropathy, microvascular dysfunction, connective tissue glycation and musculoskeletal abnormalities of the hand are possible consequences of chronic hyperglycemia. These changes can interfere with sensory feedback, proprioception and fine motor control, which consequently results in a decrease in manual performance.[2] It has been documented that diabetic individuals have high prevalence of carpal tunnel syndrome, flexor tenosynovitis and limited joint mobility, with the frequency of these abnormalities increasing as the duration of diabetes increases.[6,7] Studies assessing hand dexterity among diabetics have consistently shown an impairment in hand dexterity among diabetic patients compared with healthy controls/patients. The authors like Lima et al., found that patients with DPN took significantly longer to complete dexterity-based tasks and had impaired ability to regulate the grip force despite having relatively preserved maximal grip strength.[2] The results indicated that sensory dysfunction is strongly associated with the decrease of fine motor control in diabetic patients. Similarly, Pfützner et al., found a decline in manual proficiency and dexterity in both type 1 and type 2 diabetes, especially in those with longer duration of the disease and advanced age.[8]In addition to the role of chronic diabetes, the role of neuropathic involvement on hand functioning was evident as older diabetics had significantly lower scores in hand-function tests than healthy controls. Recent studies had focused more on the role of diabetic neuropathy in the hand dysfunction. It was shown that diabetic patients with DPN and CTS had a significantly lower Purdue Pegboard Test score than diabetic patients without DPN.[9] Although there has been increasing awareness of the diabetic hand difficulties, few studies have studied the dexterity of the dominant and non-dominant hands separately in relation to the duration of diabetes. The majority of the available investigations are largely related to neuropathy, and data on dexterity of various disease-duration groups is still limited. Also, it is not clear if the non-dominant hand is impaired more than the dominant hand. Hence, the present study was conducted to evaluate the influence of diabetes duration on dexterity of the dominant and non-dominant hand and to find out the correlation between duration of the disease and manual performance of the subjects suffering from diabetes mellitus.

MATERIAL AND METHODS

We retrospectively reviewed the records of patients with diabetes mellitus who underwent routine hand dexterity assessment in the Department of Physiology, SKIMS Medical College, Bemina, Srinagar. The dataset covered the period from January 2024 to December

2025 and eventually a total of 240 eligible records were available for analysis. Since only previously documented and anonymized information was examined, no patient contact or intervention was involved.

Inclusion Criteria

- Patients who have been diagnosed with diabetes mellitus
- Age ≥18 years
- Complete records of duration of diabetes and assessment of hand dexterity in the dominant and non-dominant hand available

Exclusion Criteria

- Family history of stroke, Parkinsonism or other neurological disorders that affect hand function
- Any deformity, trauma or surgery of the upper limbs or both hands
- Incomplete clinical records.

The Nine-Hole Peg Test was adopted to assess hand dexterity as part of the routine clinical assessment. Time was measured for each hand separately, dominant and non-dominant. Dexterity was measured in seconds to complete the task; the longer the time taken, the worse the dexterity. Hand dexterity time for both the dominant and non-dominant hands were the primary outcome measures. The secondary outcome was the association between duration of diabetes and dexterity performance.

Statistical Analysis

Data was entered into the MS. EXCEL and analyzed with IBM SPSS Statistics (26), the data were presented as mean ± SD for continuous variables and as frequencies and percentages for categorical variables. The mean dexterity times in each of the four diabetes-duration groups were compared using a one-way analysis of variance (ANOVA). For significant differences as determined by ANOVA, Tukey's post hoc test was used to make pairwise comparisons. Pearson's correlation coefficient was used to assess the relationship between duration of diabetes and dexterity performance of both hands. A p-value of < 0.05 was deemed as statistically significant.

Ethical Considerations

This study was based on anonymous, retrospective data from routine clinical records as such during the study period, no patient identifiers were accessed and no direct patient interaction took place. The analysis was carried out per institutional policies and procedures for the use of de-identified data for academic studies.

RESULTS

Table 1: Distribution of patients with duration of diabetes

Duration of diabetes (years)	N	%age
<5	72	30.0
5-10	68	28.3
11-15	54	22.5
> 15	46	19.2
Total	240	100

We observed that of the 240 patients with diabetes, majority (30%) were having a duration of less than 5 years, followed by 30% with a duration of 5 to 10 years, 22.5% with a duration of 11-15 years and 19.2 had a duration of above 15 years.

Table 2: Comparison of dominant hand dexterity across duration groups

Duration of diabetes (years)	N	Mean dexterity time (sec)	SD
<5	72	18.9	2.8
5-10	68	20.5	3.1
11-15	54	22.8	3.6
>15	46	25.4	4.1
Test	**F-value**	**P-value**	
One way ANOVA	41.62	<0.001	

When we analyzed the data on dominant Hand Dexterity, using one way ANOVA, a significant difference emerged (p-value<0.001) in the mean dexterity times between the individuals having different duration of diabetes as reflected in table 2. Evidently, the mean dexterity time was greater (25.4 sec) among individuals with duration of diabetes above 15 years and the shortest dexterity time of 18.9 sec was found in individuals with duration of diabetes below 5 years as shown in table 2.

Table 3: Comparison of non-dominant hand dexterity across duration groups

Duration of diabetes (years)	N	Mean dexterity time (sec)	
<5	72	20.1	3
5-10	68	22.3	3.4
11-15	54	24.8	3.9
>15	46	28.2	4.5
Test	**F-value**	**P-value**	
One way ANOVA	53.84	<0.001	

Similarly, non-dominant hand dexterity also showed a more pronounced deterioration with increasing duration of diabetes (p-value<0.001). Evidently, the mean dexterity time was greater (28.2 sec) among individuals with duration of diabetes above 15 years while as the shortest dexterity time of 20.1 sec was observed in individuals with duration of diabetes below 5 years (see table 3).

Table 4: Post hoc analysis (Tukey test) for dominant hand dexterity

Pairwise comparisons	Differences	p-value
(<5) vs (5-10)	1.6	0.021
(<5) vs (11-15)	3.9	<0.001
(<5) vs (>15)	6.5	<0.001
(5-10) vs (11-15)	2.3	0.003
(5-10) vs (>15)	4.9	<0.001
(11-15) vs (> 15)	2.6	0.004

As shown in table 4, the post hoc analysis of dominant hand dexterity revealed significant differences in all the possible pairwise comparisons across all diabetes duration groups

Table 5: Post hoc analysis (Tukey test) for non-dominant hand dexterity

Pairwise comparison	Differences	p-value
<5 vs (5-10)	2.2	0.009
(<5) vs (11-15)	4.7	<0.001
(<5) vs (>15)	8	<0.001
(5-10) vs (11-15)	2.5	0.005
(5-10) vs (>15)	5.8	<0.001
(11-15) vs (> 15)	3.3	<0.001

As shown in table 5, the post hoc analysis of non-dominant hand dexterity revealed significant differences in all the possible pairwise comparisons across all diabetes duration groups

Table 6: Correlation analysis of duration of diabetes with dexterity of both the hands

Variable	**Pearson's r**	**p-value**
Duration vs Dominant Hand Dexterity	0.584	<0.001
Duration vs Non-Dominant Hand Dexterity	0.669	<0.001

We analyzed the association of duration of diabetes with dexterity of both the hands wherein we found that dominant hand demonstrated a moderate-to-strong positive correlation with dexterity completion time. The relationship was stronger for the non-dominant hand, suggesting greater susceptibility to diabetes-related motor impairment (see table 6)

DISCUSSION

In the present study, the results demonstrated a significant decline in the dexterity of both dominant and non-dominant hands with increasing duration of diabetes mellitus. The mean dexterity time for the dominant hand increased progressively, patients who had lived with diabetes for less than five years completed the dominant hand dexterity task in a mean time of 18.9 ± 2.8 seconds whereas those with disease duration exceeding fifteen years required 25.4 ± 4.1 seconds. A similar observation was obtained for the non-dominant hand where the mean completion time increased from (20.1 ± 3.0) seconds to (28.2 ± 4.5) seconds across the similar diabetic duration categories. The highly significant ANOVA results for both dominant ($F = 41.62$, $p < 0.001$) and non-dominant hands ($F = 53.84$, $p < 0.001$) indicated that these differences are unlikely to be attributable to chance alone. What is particularly notable is that the increase was not abrupt but rather incremental, becoming progressively more pronounced as disease duration lengthened. These findings indicate that prolonged duration of diabetes is associated with progressive deterioration of fine motor performance, with the non-dominant hand showing relatively greater impairment. Our study results are in line with the work done by Chougule et al. who assessed the manual dexterity in 90 middle aged diabetic patients using Nine Hole Peg Test.[10] They reported the following times for dominant hand dexterity in patients with diabetes of less than 5 years duration (28.11 ± 1.33 seconds), 5–10 years duration (27.78 ± 1.25 seconds) and more than 10 years duration (29.80 ± 1.86 seconds).[10] Corresponding non-dominant hand values were 28.78 ± 1.30 seconds, 28.91 ± 1.34 seconds and 30.55 ± 1.96 seconds, respectively. They found significant difference between dominant and non-dominant hand performance in patients with shorter disease duration of diabetes ($p = 0.002$ and $p = 0.001$, respectively), but not after 10 years of diabetes ($p = 0.057$).[10] They also found, like in the present study, that manual dexterity decreased as a function of the disease duration and that the non-dominant hand was more affected. The present results are better understood when compared with normative data in healthy subjects reported by Wang et al., who examined Nine-Hole Peg Test performance in 4,319 healthy subjects of various ages.[5] They reported completion times of around 18-20 seconds for the dominant hand with healthy adults aged 16-39 years and a mean completion time of 23.3 seconds for the dominant hand and 25.4 seconds for the non-dominant hand. In this study patients with diabetes of less than 5 years duration had comparable performance of the dominant hand (18.9 seconds) to healthy controls. For the patients with a duration of diabetes > 15 years, the necessary time was significantly higher than the expected normative values: 25.4 seconds for the dominant hand and 28.2 seconds for the non-dominant hand. Koyama et al., reported a similar trend when they evaluated dexterity in healthy adults (23-40 years). They found the average completion time for the dominant hand to be 18.65 seconds and 20.11 seconds for the non-dominant hand.[11] These values are similar to the dexterity scores of the present study patients who had diabetes duration of less than 5 years (18.9 seconds and 20.1 seconds, respectively). With time, however, dexterity times also rose sharply in our study, to 25.4 seconds for the dominant hand and 28.2 seconds for the non-dominant hand. Evidently, it appears that prolonged diabetes could cause a more rapid decrease in manual dexterity than seen in healthy people. The

deterioration of dexterity noted throughout this study could be attributed to the progressive development of diabetic neuropathy, loss of tactile sensation, and impaired proprioception and musculoskeletal changes related to glycosylation. In a normative study conducted by Mathiowetz et al. (628 healthy adults), they found that the dexterity of the fingers decreased with age, and that it took older participants longer to complete the task.[12] Their study, however, did not focus on diabetic people specifically, but the results corroborate the notion that there are neurological and musculoskeletal changes which have a negative impact on fine motor function. These age-related changes can be exacerbated by chronic hyperglycemia and peripheral nerve dysfunction in diabetic individuals, such that the greater the duration of the diabetes, the greater the decrease in hand performance. One of the interesting findings of the present study was that dexterity time was always longer in the non-dominant hand than in the dominant hand for all the duration groups. In patients with diabetes duration of more than 15 years, the dominant hand took 25.4 seconds while the non-dominant hand took 28.2 seconds, a difference of almost 2.8 seconds, this result is consistent with that of Wang et al., who reported mean times of 23.3 seconds for the dominant hand and 25.4 seconds for the non-dominant hand in healthy subjects and that of Koyama et al., who found these times to be 18.65 seconds and 20.11 seconds respectively.[9,11] The consistent results indicate that the non-dominant hand has relatively lower motor efficiency, and might thus be more sensitive to the impact of diabetic neuropathy and sensorimotor dysfunction.

We performed the correlation analysis between the duration of diabetes and dexterity of both the hands, which revealed a significant positive association of dexterity with duration of diabetes. Dominant hand dexterity time was found to have a significant positive correlation with duration of diabetes ($r = 0.584$, $p < 0.001$), and a much greater correlation with non-dominant hand dexterity ($r = 0.669$, $p < 0.001$). The longer the duration of the disease, the worse the hand functioning, as reflected by the longer completion times found, and the higher correlation between disease duration and hand function of the non-dominant hand may suggest a higher susceptibility of this hand towards sensorimotor dysfunction due to diabetes. The results are consistent with several studies, with Zhang et al., showing moderate correlations with grip strength ($r = 0.467$ to $r = 0.530$, all $p < 0.001$).[9] Tactile sensory thresholds, on the other hand, were negatively correlated with dexterity scores ($r = -0.359$ to -0.447, $p < 0.001$), which means that the poorer the sensory function, the lower the dexterity scores. This correlation magnitudes observed are very similar to what we found in our study and indicate how neural and sensory abnormalities might be intermediaries between diabetes duration and reduction in dexterity. Similarly, Yang et al., found strong relationships between sensory nerve action potential amplitude of the median nerve and hand dexterity measures ($r = 0.28$ to $r = 0.43$, $p < 0.01$).[13] The results of their study revealed that as neural function deteriorated, so did manual performance, thus suggesting a physiological explanation for the progressive manual dexterity completion times as diabetes duration increased in the present study. Similarly, Lima et al. found that patients with DPN had significantly lower scores on the Nine-Hole Peg Test and the Jebsen-Taylor Hand Function Test than healthy controls, demonstrating the negative effect of having diabetic peripheral neuropathy on hand function.[2] In brief, the correlation analyses indicate that the association between diabetes duration and hand dexterity is not just there, but that the association keeps getting stronger over time.

CONCLUSION

In the present study, a definite decrease in dexterity of the hands with increasing

duration of diabetes mellitus was observed. Patients with longer disease duration needed significantly more time to accomplish dexterity tasks both with the dominant and non-dominant hands. The dexterity time was found to be significantly and positively correlated with duration of diabetes reflecting deterioration in fine motor performance with disease progression. This effect was stronger in the non-dominant hand. The results indicate that chronic diabetes may have an impact on hand function and highlights the importance of regular evaluations of manual dexterity in patients with diabetes.

Declaration by Authors

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