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Original Research Article

# ASSOCIATION BETWEEN SIGNIFICANT INTER-ARM BLOOD PRESSURE DIFFERENCE AND THE PREVALENCE OF END-ORGAN DAMAGE IN DIABETES MELLITUS

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## ABSTRACT

**Background:** The incidence of diabetes complications is higher in diabetic patients exhibiting a substantial inter-arm blood pressure difference (IAD). Objective: To assess the prevalence of IAD in patients with diabetes mellitus (DM) and to examine the correlation between IAD and the severity of DM, as indicated by HbA1c levels, peripheral arterial disease, target organ damage such as diabetic nephropathy and retinopathy, and cardiovascular morbidities.
**Materials and Methods:** To determine the prevalence of substantial IAD among diabetic patients, a cohort of 314 individuals from the medical wards and outpatient department of Victoria and Bowring & Lady Curzon Hospital was assessed for IAD. A descriptive study was conducted involving 200 patients, categorized into two groups based on the presence or absence of a significant IAD, with 100 patients in each group. A comparison was made between the groups regarding the incidence of microvascular and macrovascular complications associated with DM. The assessment comprised urine albumin measurement and renal function tests for nephropathy, indirect ophthalmoscopy for retinopathy, arterial Doppler for peripheral vascular disease, and transthoracic echocardiography for patients exhibiting ECG alterations. Peripheral neuropathy was evaluated clinically.
**Results:** The average age of patients in the group exhibiting a significant IAD was 49.22 ± 9.13 years, while the average age of patients in the group without a significant IAD was 50.54 ± 9.51 years. The male-to-female distribution of cases was 58% and 42%, while that of controls was 55% and 45%, respectively. The two groups were matched for age and sex. The occurrence of substantial IAD was determined to be 31.8%. A positive link exists between a considerable IAD and inadequate blood sugar control, as indicated by HbA1c values (p=0.05). Nephropathy (p=0.05), retinopathy (p=0.03), and peripheral vascular disease (p=0.001) were considerably more prevalent in patients exhibiting a substantial IAD. Neuropathy was seen to be more prevalent in the case group, with a p-value of 0.063, indicating potential significance. No substantial link was identified between the existence of a significant IAD and the incidence of cardiovascular problems (p=0.329).
**Conclusion:** The prevalence of diabetic retinopathy, nephropathy, neuropathy, and peripheral vascular disease is elevated in diabetes individuals exhibiting a large IAD; however, no correlation was identified between cardiovascular problems and significant IAD.
**Keywords:** Diabetes Mellitus, Inter-Arm Blood Pressure Difference, Retinopathy, Nephropathy, Neuropathy, Peripheral Vascular Disease.

## INTRODUCTION

Given that India is recognized as the diabetes capital of the globe, the necessity for a study on Diabetes Mellitus (DM) is underscored.[1] The International Diabetic Federation forecasts that 552 million individuals would be diagnosed with diabetes by 2030, according to prevailing trends.[2] The significance of inter-arm blood pressure differences (IAD) in forecasting diabetes mellitus (DM) problems has recently attracted researchers' interest.

Factors elucidating the inter-arm disparity in systolic blood pressure measurements between the two arms encompass both anatomical and hemodynamic explanations.[3] Pathological etiologies of IAD encompass atherosclerosis, vasculitis, fibromuscular hyperplasia, connective tissue disorders, radiation arteritis, thoracic outlet syndrome, dissecting aortic aneurysm, and congenital anomalies.[4] In the absence of anatomical blockage, it has been hypothesized that the IAD in systolic blood pressure are associated with an inherent characteristic of the cardiovascular system.[5] Variations in arterial stiffness can account for the IAD in systolic blood pressure. When arterial flow is predominantly regulated by resistance arteries, an increase in resistance results in a corresponding rise in mean pressure, accompanied by equal incremental increases in systolic and diastolic blood pressure.[6]

Nonetheless, the pulse waveform experiences amplification as it propagates from the heart to the periphery, which explains the elevation in systolic pressure in the arms and legs relative to the aorta.[7] Increased arterial stiffness, characterized by less compliance, leads to heightened pressure oscillations, causing a significant rise in systolic blood pressure while minimally affecting diastolic blood pressure.[8] The elastic characteristics of conduit arteries varies across the arterial tree, which explains the variation in pressure oscillations between the arms, leading to differing recorded systolic blood pressure.[9] This study's significance is rooted in the potential relationship between a substantial blood pressure difference and the severity of diabetes, which could facilitate early problem detection and inform appropriate lifestyle changes.

**Aims and Objectives**

To measure the prevalence of IAD in patients with DM and to study the relation between IAD and severity of DM in terms of HbA1c values, peripheral arterial disease, target organ damage like diabetic nephropathy, retinopathy and cardiovascular morbidities.

## MATERIALS AND METHODS

**Source of data:** The study was conducted in the Department of Medicine, Victoria hospital and Bowring and
Lady Curzon hospital of Bangalore Medical College and Research Institute, Bangalore.

Patients aged more than 18 years who were diagnosed to have DM and willing to
participate in the study were included and those with Connective tissue disorders, Thoracic outlet
obstruction and Atherosclerosis features such as xanthelasma were excluded

**Data Collection**

Patients diagnosed with DM who consented to participate in the study were assessed and compared according to the proforma created for this purpose. In accordance with the study's objective to determine the prevalence of significant IAD among diabetic patients, blood pressure measurements were taken from both arms of the patients until the requisite sample size was achieved. A comparison of diabetes complications was conducted between two groups, each comprising 100 individuals. The categorization of the groups was determined by the existence or non-existence of a significant inter-arm blood pressure disparity.

Patients underwent non-invasive procedures such as fundoscopy to evaluate retinopathy status. Urine microalbumin, spot albumin, and renal function tests were conducted to assess nephropathy. An arterial Doppler examination was conducted on patients exhibiting characteristics of peripheral vascular disease. An echocardiogram was performed on patients with ECG alterations indicative of heart pathology. The patients were assessed for retinopathy, nephropathy, and peripheral vascular disorders. Patients were assessed clinically for peripheral neuropathy.

**Data Analysis:** Statistical analysis was conducted with SPSS 16 program. Given the parametric distribution of data, the Chi-square test and Fisher's Exact test were employed to analyze the differences across categorical data. The Student's t-test was employed to evaluate the connection between numerical variables.

## RESULTS

Two hundred individuals with DM were categorized into two groups of 100: one group exhibiting a significant IAD and the other group without such a difference. These instances were chosen from 314 diabetic patients whose blood pressure in both arms was assessed. The subjects of this study were outpatients or inpatients from either Victoria Hospital or Bowring and Lady Curzon Hospital, affiliated with Bangalore Medical College and Research Institute, and the research was done over an 18-month period. The minimum age of patients in the cohort exhibiting a significant IAD was 33 years, while the maximum age was 78 years, yielding a mean age of 49.22 years and a standard deviation of 9.1. The minimum age of patients in the group without a significant IAD was 28 years, while the maximum age was 71 years, yielding a mean age of 50.54 years and a standard deviation of 9.51 years. The average age of the cases and controls was equivalent. The male and female

distribution among patients in the case group was 58% and 42%, respectively, while in the control group it was 55% and 45%, respectively.

**Table 1: Inter-arm blood pressure difference**

| Inter Arm BP Difference | Cases | | Control | |
|---|---|---|---|---|
| | No | % | No | % |
| 0 | 0 | 0.0 | 16 | 16.0 |
| 1-2 | 0 | 0.0 | 33 | 33.0 |
| 3-5 | 0 | 0.0 | 37 | 37.0 |
| 6-10 | 0 | 0.0 | 14 | 14.0 |
| >10 | 100 | 100.0 | 0 | 0.0 |
| Total | 100 | 100.0 | 100 | 100.0 |
| Mean ± SD | 12.82±1.10 | | 2.99±1.86 | |

***P<0.001**, Significant, Student t test***

The mean IAD among cases was 12.82 with standard deviation 1.10 and among controls was 2.99 with standard deviation 1.86. The maximum IAD was found to be 16. [Table 1]

**Table 2: Estimation of Glycosylated Haemoglobin, Urine albumin, Serum Creatinine and Blood Urea**

| HbA1c % | Cases | | Control | |
|---|---|---|---|---|
| | No | % | No | % |
| <6.5 | 1 | 1 | 7 | 7 |
| 6.5-9 | 78 | 78 | 85 | 85 |
| >9 | 21 | 21 | 8 | 8 |
| Total | 100 | 100 | 100 | 100 |
| **Albumin** | | | | |
| Absent | 75 | 75 | 86 | 86 |
| Present | 25 | 25 | 14 | 14 |
| Total | 100 | 100 | 100 | 100 |
| **Serum Creatinine (mg/dl)** | | | | |
| <1.5 | 74 | 74 | 84 | 84 |
| >1.5 | 26 | 26 | 16 | 16 |
| Total | 100 | 100 | 100 | 100 |
| **Blood Urea (mg/dl)** | | | | |
| <40 | 74 | 74 | 84 | 84 |
| >40 | 26 | 26 | 16 | 16 |
| Total | 100 | 100 | 100 | 100 |

In the case group, 21% of patients exhibited elevated glycosylated hemoglobin levels, whereas only 8% of patients in the control group did. Albuminuria was observed in 25% of patients in the case group, whereas only 14% of patients in the control group exhibited albuminuria. Elevated creatinine levels were observed in 26% of patients in the case group, whereas only 16% of patients in the control group exhibited similar levels. Elevated blood urea levels were observed in 26% of patients in the case group, whereas only 16% of patients in the control group exhibited this condition. [Table 2]

**Table 3: Diabetic Complication Profile for the Current Study**

| Clinical features | Cases (n=100) | | Control (n=100) | | P value |
|---|---|---|---|---|---|
| | No | % | No | % | |
| Nephropathy | 25 | 25.0 | 14 | 14.0 | 0.05 |
| Retinopathy | 30 | 30.0 | 17 | 17.0 | 0.030* |
| Peripheral Neuropathy | 18 | 18.0 | 9 | 9.0 | 0.063+ |
| Cardio vascular complication | 18 | 18.0 | 13 | 13.0 | 0.329 |
| Peripheral vascular disease | 19 | 19.0 | 4 | 4.0 | 0.001** |

The percentage of nephropathy, retinopathy, peripheral neuropathy, cardiovascular complication and peripheral vascular disease were 25%,30%,18%,18%,19% respectively among the patients under study. [Table 2]

## DISCUSSION

A descriptive study was conducted including 200 patients with diagnosed DM who attended the Medicine outpatient department or were hospitalized in the medical wards at Victoria Hospital or Bowring and Lady Curzon Hospitals, affiliated with Bangalore Medical College and Research Institute. The patients

were categorized into two groups according to the existence or lack of a significant IAD, with 100 patients in each group. A comparison was conducted between the groups regarding the incidence of microvascular and macrovascular complications of DM.

Blood pressure measurements were conducted on both arms of 314 diabetic patients, revealing that 100 exhibited a significant IAD, so qualifying them as cases for the study.

A difference of ten or more in systolic blood pressure between both arms is deemed noteworthy. Patients exhibiting a substantial IAD were categorized into one group, while those lacking a significant IAD were placed in another group.

Fasting Blood Sugar, Postprandial Blood Sugar, and HbA1c were conducted for all patients.

All patients were assessed for both microvascular and macrovascular consequences of diabetes. The ophthalmologist conducted a retinopathy evaluation using indirect ophthalmoscopy. Urine microalbumin, spot albumin, and renal function tests were conducted for nephropathy assessment. An arterial Doppler examination was conducted on patients exhibiting clinical manifestations of peripheral vascular disease. An echocardiogram and ECG were conducted to assess cardiovascular disease. Patients were clinically assessed for peripheral neuropathy. Patients exhibiting connective tissue disorders, thoracic outlet obstruction, and atherosclerotic characteristics such as xanthelasma were removed from the study to eliminate confounding variables.

**Age and sex distribution**

The ages of patients in the cohort exhibiting a significant IAD ranged from 33 to 78 years, with a mean age of 49.22 ± 9.13 years. The age of patients in the group lacking substantial inter-arm differences. The blood pressure difference varied from 28 to 71 years, with a mean age of 50.54 ± 9.51 years. The male and female distribution in the former group was 58% and 42%, respectively, whereas in the latter group it was 55% and 45%, respectively. The disparity in mean age and sex was not statistically significant, with p-values of 0.318 and 0.669, respectively. In a comparable study by Clark et al., the mean age of the case group was 63 years, whereas the mean age of the control group was 56.9 years.[10]

**Prevalence**

314 diabetic patients from the medical wards and OPD was checked for inter-arm BP difference. 100 of them had a systolic BP difference of more than or equal to 10 which satisfied the criteria of significant inter-arm BP difference. The prevalence thus was found to be 31.8%. A cross-sectional study including 200 DM patients, conducted by Uday Subhash and Anish Anthony at KIMS Hubli, revealed a significant inter-arm variation in systolic blood pressure in 35.7% of the participants.[11]

**Glycated Hemoglobin**

In the case group, 21% of patients exhibited elevated glycosylated hemoglobin levels, whereas only 8% of patients in the control group did. The correlation was deemed significant (p-value of 0.05). A study by Kimura et al. indicated that patients with elevated HbA1c levels exhibited an increased risk of an absolute SBP difference above 10 mmHg.[12]

**Diabetic Nephropathy**

Albuminuria was observed in 25% of patients in the case group, whereas only 14% of patients in the control group exhibited albuminuria. The correlation was deemed significant (p-value of 0.05). Elevated creatinine levels were observed in 26% of patients in the case group, whereas only 16% of patients in the control group exhibited similar levels. The correlation was indicative of significance (p-value of 0.08). Elevated blood urea levels were observed in 26% of patients in the case group, whereas only 16% of patients in the control group exhibited this condition. The connection was deemed suggestive of significance with a p-value of 0.08. We assessed diabetic nephropathy by identifying albuminuria and abnormal renal function tests, having ruled out other potential causes. Nephropathy was observed to be more prevalent among patients exhibiting a substantial IAD, with a significant p-value of 0.05. A cross-sectional study by Uday Subhash and Anish Anthony at KIMS Hubli found that a systolic blood pressure difference exceeding 10 mmHg between arms is connected with microalbuminuria, with a p-value of <0.001.[11]

**Retinopathy**

The prevalence of retinopathy in the case group was 30%, while in the control group it was 17%. The outcome was determined to be significant (p value 0.03). A study by Yoshimitsu Tanaka et al. identified a robust link between retinopathy and a large inter-arm blood pressure differential in diabetes patients.[13]

**Neuropathy**

The prevalence of peripheral neuropathy in the case group was 18%, while in the control group it was 9%. The outcome was statistically indicative of significance (p value 0.063).

**Cardiovascular complications and peripheral vascular disease**

The prevalence of cardiovascular problems in the case group was 18%, while in the control group it was 13%. Nonetheless, the outcome was deemed unimportant (p value 0.329). The prevalence of peripheral vascular disease was 19% in the case group and 4% in the control group. The outcome was determined to be significant (p value 0.001). A study by Christopher E. Clark et al. found that notable systolic IAD in diabetes correlate with heightened cardiovascular mortality (Odds Ratio: 3.5), which is statistically significant.[14] The study revealed that notable IAD were linked to peripheral vascular disease (Odds Ratio: 3.4).

**Summary**

DM is a significant metabolic disorder that results in considerable morbidity from both the disease and its sequelae. Descriptive research was conducted with 200 patients diagnosed with DM. The patients were

categorized into two groups according to the presence or absence of a significant inter-arm blood pressure differential, with 100 patients in each group. A comparative analysis of the incidence of microvascular and macrovascular consequences of DM between the two groups was conducted. Both groups were matched for age and sex. A substantial positive link was identified between IAD and inadequate blood sugar control, as indicated by HbA1c values (p value: 0.05).

Nephropathy was observed to be substantially more prevalent among patients exhibiting a substantial inter-arm blood pressure differential, with a p-value of 0.05 indicating statistical significance. Retinopathy was observed to be substantially more prevalent among patients exhibiting a substantial inter-arm blood pressure difference, with a p-value of 0.03 indicating statistical significance. The incidence of cardiovascular problems in the case group did not demonstrate a significant difference (p value 0.329). Neuropathy was observed to be more prevalent among patients exhibiting a substantial inter-arm blood pressure differential, with a p-value of 0.063. This indicates statistical significance. Peripheral vascular disease was more prevalent among patients exhibiting a substantial inter-arm blood pressure differential, with a p-value of 0.001 indicating statistical significance. The subsequent profile of problems was observed among the patients examined. The majority of patients had retinopathy (30%) and nephropathy (25%), followed by peripheral vascular disease (19%), peripheral neuropathy (18%), and cardiovascular problems (18%), respectively.

## CONCLUSION

In this study, 31.8% of diabetes individuals had substantial inter-arm BP differences. A positive connection was discovered between large inter-arm BP differences and poor HbA1c management. Patients with large inter-arm BP differences had higher rates of nephropathy, retinopathy, and peripheral vascular disease. A significant p-value indicated that the case group had more neuropathy. No significant connection was detected between major inter-arm BP differences and cardiovascular problems.

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