



## RESEARCH ARTICLE

### COMPARATIVE STUDY OF ANKLE BRACHIAL INDEX IN CONTROLLED AND UNCONTROLLED DIABETICS

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#### ABSTRACT

**Background:** Diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action or both. Macro-vascular complications include cerebro-vascular disease, ischemic heart disease and Peripheral arterial disease. Peripheral arterial disease (PAD) is a disorder characterized by decreased blood flow to the limbs, due to an obstruction or narrowing of the vessels tributaries. The ankle brachial index (ABI) is the accepted non-invasive gold standard for both diagnosing PAD and the assessment of disease severity. **Objective:** To compare Ankle Brachial Index in controlled vs. uncontrolled diabetics. **Methods:** 23 patients (Age:  $55 \pm 5.4$  years) in controlled group and 30 patients (Age:  $56 \pm 4$  years) in uncontrolled group were chosen by nonrandomized convenient sampling and divided according to their HbA<sub>1c</sub>. Ankle-brachial index was measured using hand-held Doppler D580 and sphygmomanometer. **Results:** The mean ABI of controlled group and uncontrolled group is  $1.05 \pm 0.13$  and  $1.02 \pm 0.12$  respectively. There is no significant difference of ABI with  $t = 0.90$  with  $p = 0.19$ . **Conclusion:** There may not be any significant difference in ABI of controlled diabetics and uncontrolled diabetics.

**Key words:** Diabetes mellitus, Peripheral Arterial Disease, Ankle Brachial Index, Hand held Doppler.

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#### INTRODUCTION

According to International Diabetes federation there were 425 million people having diabetes in the world and there were over 72 million cases of diabetes in India in 2017 (<https://www.idf.org/our-network/regions-members/south-east-asia/members/94-india.html>). Diabetes mellitus is a group of metabolic diseases characterized by hyperglycaemia resulting from defects in insulin secretion, insulin action or both. Several pathogenic processes are involved in the development of diabetes. These range from autoimmune destruction of  $\beta$ -cells of the pancreas with consequent insulin deficiency to abnormalities that result in resistance to insulin action. The complications caused by diabetes can be divided into micro-vascular and macro-vascular complications. Micro-vascular complications include retinopathy, nephropathy and neuropathy and Macro-vascular complications include cerebro-vascular disease, ischemic heart disease and Peripheral arterial disease (Marshall and Flyvbjerg, 2006). Peripheral arterial disease (PAD) is a disorder characterized by decreased blood flow to the limbs, due to an obstruction or narrowing of the vessels tributaries (Stoekenbroek *et al.*, 2015).

Lower extremity PAD ranges in severity from asymptomatic to critical limb ischemia with the tissue loss (Natsuaki *et al.*, 2014). PAD has been widely accepted as the significant risk factor for death and lower limb amputation in diabetes (Xu *et al.*, 2010). PAD has a negative impact on quality of life for people with diabetes and is associated with an increased risk of lower-extremity amputation (Aerden *et al.*, 2011). Glycated hemoglobin (HbA<sub>1c</sub>) gives an indication of chronic glycaemia rather than being a test of glycaemia at a single point in time. It gives an integrated index of glycaemia over the entire 120 day lifespan of the red blood cell, but within this period of 120 days, recent glycaemia has the largest influence on the HbA<sub>1c</sub> value, with 50% of HbA<sub>1c</sub> formed in the month prior to sampling and 25% in the month before that. It therefore seems logical that such a test would be appropriate in diagnosing a disease characterized by chronic hyperglycemia and a gradual progression to complications. It is a relatively convenient test, not requiring the patient to fast and only using a single blood sample (Owora, 2018). HbA<sub>1c</sub> can be used for assessing the risk of complications of diabetes as well as for monitoring glycemic control. The WHO consultation has also concluded that HbA<sub>1c</sub> can be used to diagnose diabetes (Florkowski, 2013). The ankle brachial index (ABI) is the accepted non-invasive gold standard for both diagnosing PAD and the assessment of disease severity. The ABI is a reproducible and reasonably accurate, non-invasive measurement for the detection of PAD and the determination of disease severity

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(Aboyans *et al.*, 2008). The ABI is the most simple and inexpensive test, its reliability is excellent, and the validity in leg arteries is high (sensitivity ≈ 90% and specificity ≈ 98%) (Selvin *et al.*, 2004). The diagnostic criteria for PAD based on the ABI are interpreted as follows (Gerhard-Herman *et al.*, 2016). If the ABI values are known in controlled diabetics and uncontrolled diabetics, then we can aware the people of community and avoid the risk of amputation and secondary complications of PAD. So, the objective of the study was to find out ABI in controlled diabetics, uncontrolled diabetics and compare their values with each other.

**MATERIAL AND METHODS**

**Study Design:** Cross sectional study

**Study Setting:** Hospital & Community setting

**Study sampling method:** Nonrandom convenient sampling method

**Sample size:** n = 53 patients of Type II Diabetes Mellitus

Group: 1: 30 = uncontrolled diabetics

Group: 2: 23 = controlled diabetics

**Data collection tools**

- Handheld Doppler (Minidop)D580 8Mhz calibrated mercury (31 cm long×11 cm wide)
- Sphygmomanometer (Diamond)

**Inclusion Criteria**

- Both genders
- Age: 40-60 years
- Duration of Diabetes: 5 years or more
- Has done HbA<sub>1c</sub> test in recent past

**Exclusion Criteria**

- Foot ulcer
- Presence of any co-morbidities
- Uncooperative patients
- Open injury in hand or foot
- Recent fracture in hand or foot
- Smokers

**Procedure**

We performed ABI in a quiet, warm environment to prevent vasoconstriction of the arteries. The ABI results were obtained when the patient were relaxed, comfortable. The procedure was explained to the each of the participant and written informed consent was taken. Placement of pressure cuffs and access to pulse sites by Doppler was carried out. Participants were in a supine position. One small pillow was placed behind the patient’s head for comfort. Pressure cuffs was placed approximately 2-3 cm above the cubital fossa on the arms and medial malleolus at the ankle.

We have ensured that the patient had rest for a minimum of 10 minutes prior to the test to allow pressures to normalize. The arm was relaxed and was supported at heart level. The brachial pulse was palpated to determine location to obtain an audible pulse. The tip of the Doppler probe was placed at a 45° angle pointed towards the participant’s head until an audible

pulse signal was obtained. The pressure cuff was inflated 20-30 mmHg above the point where the pulse was no longer audible. The pressure cuff was deflated at a rate of 2-3 mmHg per second, reading at which the first pulse signal was heard and have recorded that systolic value. The cuff on the participant’s lower leg was placed approximately 2-3 cm above the medial malleolus. Measurement of both dorsalis pedis and posterior tibial pulses in each leg was done. The pressure cuff was inflated 20-30 mmHg above the point where the pulse was no longer audible. The pressure cuff was deflated at a rate of 2-3 mmHg per second, reading at which the first pulse signal was heard and have recorded that systolic value.

$$\text{Right ABI} = \frac{\text{Higher of the right ankle pressure (Dorsalis Pedis / Posterior Tibial)}}{\text{Higher arm Pressure (right or left arm)}}$$

$$\text{Left ABI} = \frac{\text{Higher of the right ankle pressure (Dorsalis Pedis / Posterior Tibial)}}{\text{Higher arm Pressure (right or left arm)}}$$

The lower of these numbers is the participant’s overall ABI.

**Data analysis**

Data analysis was done using Microsoft Excel 2007. Demographics were compiled for mean, standard deviation and frequency distribution. Unpaired t test was applied for comparing the ABI results of controlled diabetics with uncontrolled diabetics with level of significance p = 0.05.

**RESULTS**

**Table 1. Diagnostic criteria for pad based on ABI**

ABI Values	Interpretation
0.91–1.30	Normal
0.70–0.90	Mild obstruction
0.40–0.69	Moderate obstruction
<0.40	Severe obstruction
>1.30	Poorly compressible

**Table 2. AGE Group wise distribution**

Age Group (in years)	Uncontrolled Diabetics [n (%)]	Controlled Diabetics [n (%)]
40-45	2(6.67%)	2(8.69%)
46-50	2(6.67%)	2(8.69%)
51-55	6(20.01%)	7(30.43%)
56-60	20(66.67%)	12(52.17%)
Total [n (%)]	30 (100%)	23 (100%)
Mean ± S.D.	56 ± 4 years	55 ± 5.4 years

**Table 3. Gender wise distribution**

Gender	Uncontrolled Diabetics	Controlled Diabetics
Male	17	14
Female	13	9
Total	30	23

**Table 4. Mean ABI of controlled and uncontrolled diabetics**

Type of Diabetics	Controlled	Uncontrolled
ABI: Mean ± SD	1.05 ± 0.13	1.02 ± 0.12

**Table 5. HbA<sub>1c</sub> Group wise distributions in controlled diabetics**

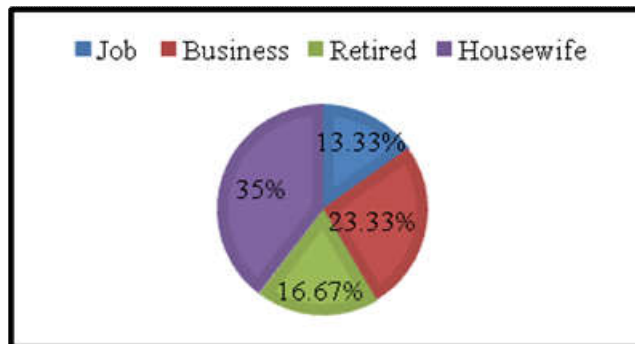
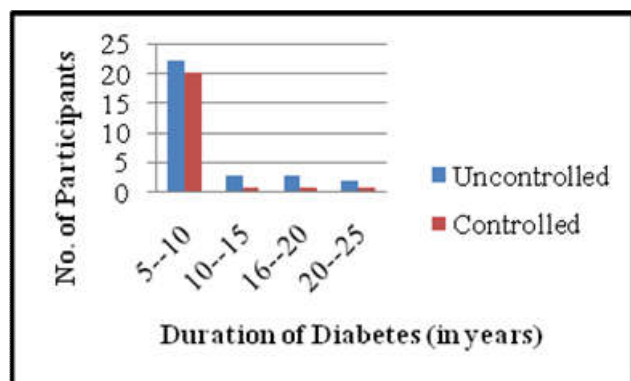
HbA <sub>1c</sub> Test Value	No. of Controlled Diabetics
6.5-7	12
7.1-7.5	8
7.6-7.9	3
Total	23
Mean ± S.D.	7.08 ± 0.44

**Table 6. HbA<sub>1c</sub> Group wise distributions in uncontrolled diabetics**

HbA <sub>1c</sub> Test Value	No. of Uncontrolled Diabetics
8-9.9	20
10-11.9	7
12-14	3
Total	30
Mean ± S.D.	9.69 ± 1.54

**Table 7. Unpaired t-test results comparing controlled vs. uncontrolled diabetics**

Degree of freedom	46
t Statistical value	0.90
P(T<=t) one-tail	0.19
t Critical one-tail	1.68

**Graph 1. Occupation wise distribution****Graph 2. Duration of diabetes (in years) for controlled vs. uncontrolled diabetics**

## DISCUSSION

The findings of our study focus on the comparison of ankle brachial index in controlled and uncontrolled diabetic patients. We found the mean of ABI in uncontrolled diabetics patients (n=30) is 1.02 and in controlled diabetics patient (n=23) is 1.05. We compared ABI of controlled diabetics vs. uncontrolled diabetics and found no statistical significance with t value 0.90 with significance level  $p = 0.19$ . The probable reason for the not significant difference between controlled and uncontrolled diabetics may be related to lifestyle habits,

dietary patterns, exercise habits etc... those we have not asked during our study to each of our participants but confounders for the ABI. The other reason for not significant results would be ABI of all the participants in the range of  $1.05 \pm 0.13$  for controlled diabetics and  $1.02 \pm 0.12$  for uncontrolled diabetics which are in the normal ABI levels. 2016 AHA/ACC guideline on the management of patients with lower extremity peripheral artery diseases have recommended the use of resting ABI by using Doppler probe and sphygmomanometer and have found that individuals with diabetes and high ABI levels were at higher risk for CVD death than those with normal ABI levels (0.9-1.30) (Aboyans *et al.*, 2008). The study by Owara AH *et al* shows that pulse ABI had a sensitivity of 62% and a specificity of 90% in diagnosing PAD. Even though the Doppler method cannot be replaced by pulse palpation method, there was a significant positive correlation between the two methods. However, there is limitation of Doppler devices in most of the resource poor settings. In contrast, the pulse palpation method requires only a blood pressure apparatus with a suitable cuff and is a cheaper and readily available alternative. Hence pulse ABI can be utilized to predict the ABI in resource poor setting (Owora, 2018). The patterns of the daily living like eating habits, walking etc... were not asked, to the participants, which might have affected the study. We recommend to have similar study with larger population with consideration of drug dosage, exercise habits and other confounding factors should be taken in future.

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## Declaration

**Funding:** NIL

**Conflict of Interest:** NIL

**Conclusion:** There may not be significant difference in ABI values in controlled and uncontrolled diabetics.

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