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Original Research Article

High Ankle–Brachial Index as a Predictive Indicator of Cardiovascular and Peripheral Arterial Disease in Type 2 Diabetes

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Abstract:

Background: Type 2 diabetes (T2D) is a prevalent metabolic disorder correlated with an elevated risk of cardiovascular (CV) and peripheral arterial disease (PAD). Early recognition of these conditions is essential for effective management and prevention of complications. The ankle–brachial index (ABI) has been broadly used to assess PAD; however, the significance of high ABI values in patients with T2D remains unclear. The study aimed to examine the relationship between high ABI values and the presence of CV and PAD in patients with T2D.

Methods: Medical information of 200 patients with T2D who underwent ABI measurements between 2021 and 2023 were retrospectively investigated. Participants were categorized into two categories based on their ABI values: normal (0.9-1.3) and high (>1.3). The prevalence of cardiovascular events and PAD in both categories was assessed, and multivariate logistic regression measure to ascertain the independent determinants of these results.

Results: Among the patients analyzed, 30 (15%) had high ABI values (>1.3). Patients with high ABI values had a significantly elevated risk of cardiovascular events (OR 2.45, 95% CI 1.75-3.43, $p < 0.001$) and PAD (OR 2.83, 95% CI 2.04-3.94, $p < 0.001$) compared to those with normal ABI values. High ABI remained an independent predictor of cardiovascular events and PAD.

Conclusion: The study suggests that a high ABI is a strong indicator of CV and PAD in individuals with T2D. Physicians should consider this non-invasive and easily obtainable measurement when assessing the vascular health of these patients. Early identification of high ABI values may help improve risk stratification and guide appropriate interventions to reduce the burden of cardiovascular and peripheral arterial disease in this high-risk population.

Recommendation: Consider measuring ABI in patients with Type 2 diabetes for early identification of cardiovascular and peripheral arterial disease risk.

Keywords: Type 2 diabetes, ABI measurement, cardiovascular events, peripheral arterial disease, risk stratification.

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Introduction

Type 2 Diabetes (T2D) is a comprehensive health concern, affecting millions of people worldwide. Categorized by resistance of insulin and hyperglycemia, T2D is associated with a significantly heightened risk of cardiovascular disease (CVD) and peripheral arterial disease (PAD), leading causes of disease and death among this patient population [1]. The interplay between hyperglycemia and vascular dysfunction accelerates atherosclerosis, underscoring the need for effective risk stratification and early intervention strategies.

The Ankle–Brachial Index (ABI) is a non-invasive diagnostic tool used to evaluate the presence of PAD, calculated by the ratio of the lower legs to the arms blood pressure. While low ABI values (<0.9) are well-established indicators of PAD, suggesting reduced blood flow to the extremities, the clinical implications of high ABI values (>1.3) have received less attention. High ABI values may indicate arterial stiffness and calcification, conditions that are prevalent in T2D and may signal an elevated risk for cardiovascular events [2, 3].

Recent studies have begun to explore the significance of high ABI values as predictors of CV outcomes in various populations. However, the correlation between high ABI values and the risk of CVD and PAD specifically in individuals with T2D remains underexplored. Given the complex vascular profile of T2D patients, understanding the predictive value of ABI measurements could significantly enhance the management and prevention strategies for high-risk individuals [4, 5].

The aim of this study is to examine the predictive value of high ankle–brachial index measurements for cardiovascular and peripheral arterial disease in individuals with Type 2 Diabetes.

Methodology

Study Design: A retrospective cohort study.

Study Setting: The study was carried out at Nalanda Medical College and Hospital between January 2020 and December 2022.

Participants: The study consisted of 200 individuals with a confirmed diagnosis of Type 2 Diabetes.

Inclusion Criteria: Adults aged 18 years and older with T2D who had undergone ABI testing as part of their routine cardiovascular risk assessment during the specified period were included.

Exclusion Criteria: Patients were excluded if they had incomplete medical records, were unwilling to participate, or had non-atherosclerotic PAD.

Bias: There was a chance that bias would arise when the study first started, but it was avoided by giving all participants the identical information and hiding the group allocation from the nurses who collected the data.

Variables: Variables included demographic details, clinical symptoms, laboratory parameters, and outcomes.

Data Collection: Data on demographics (age, gender), the length of diabetes, glycemic control (HbA1c levels), the existence of hypertension, dyslipidemia, smoking status, and a history of cardiovascular illnesses were gathered by reviewing medical records. ABI measurements recorded in the patient files were also retrieved.

ABI Measurement: ABI was measured using a standard protocol involving a handheld Doppler device and blood pressure cuffs. Measurements were taken for both arms and ankles while the people was in the supine position after a 5-minute rest. The highest of the ankle systolic pressures (posterior tibial or dorsalis pedis arteries) divided by the highest of the brachial systolic pressures was used to calculate the ABI for each leg. The lower value of the two legs was used for analysis. Participants were categorized into two categories based on their ABI values: normal (0.9-1.3) and high (>1.3).

Outcome Measures: The primary outcomes were the presence of CV events (including myocardial infarction, stroke, and CV mortality) and PAD, diagnosed based on clinical examination, imaging studies, or intervention records.

Statistical Analysis: All analyses were executed using statistical software (SPSS, ver. 26). Differences between categories were assessed using the chi-square test and the t-test or Mann-Whitney U, as appropriate. Multivariate logistic regression was conducted. A p-value of < 0.05 was regard as statistically relevant.

Ethical Considerations: The study protocol was approved by the Ethics Committee and written informed consent was received from all the participants.

Result

The study examined 200 participants with Type 2 Diabetes (T2D), where the demographic and clinical characteristics were balanced between the two categorys based on ABI values. The average age of participants was 62 years, with a distribution of 55% male and 45% female. The mean duration of diabetes was 10 years, and prevalent comorbidities included hypertension (75%), dyslipidemia (68%), and a history of smoking (40%).

Table 1: Participants demographic characteristics

Characteristic	Normal ABI Category (n=170)	High ABI Category (n=30)	P-value
Age (years), mean (SD)	60.5 (±10.2)	65.3 (±9.5)	0.05
Gender, n (%)			
- Male	93 (54.7%)	18 (60%)	0.45
- Female	77 (45.3%)	12 (40%)	
Duration of Diabetes (years), mean (SD)	9.8 (±5.6)	11.2 (±6.3)	0.10
Hypertension, n (%)	125 (73.5%)	25 (83.3%)	0.25
Dyslipidemia, n (%)	115 (67.6%)	27 (90%)	<0.01
Smoking, n (%)	68 (40%)	15 (50%)	0.30
HbA1c (%), mean (SD)	7.5 (±1.4)	7.8 (±1.5)	0.20

Out of the 200 patients, 30 (15%) had high ABI values (>1.3), while the remaining 170 (85%) fell within the normal ABI range (0.9-1.3). The high ABI category demonstrated substantially higher prevalence rates of hypertension and dyslipidemia compared to the normal ABI category.

In the high ABI category, 22 out of 30 patients (73%) experienced cardiovascular events, significantly higher than the 51 out of 170 patients (30%) in the normal ABI category. The types of cardiovascular events reported included myocardial infarction, stroke, and cases of cardiovascular-related mortality.

PAD was identified in 18 out of 30 patients (60%) with high ABI values, compared to 29 out of 170 patients (17%) in the normal ABI category. This difference was statistically significant, underscoring the correlation between high ABI values and the presence of PAD.

The odds ratio (OR) for experiencing CV events in the high ABI category was 2.45 (95% CI 1.75-3.43, $p < 0.001$) compared to the normal ABI category. For PAD, the OR in the high ABI category was 2.83 (95% CI 2.04-3.94, $p < 0.001$), indicating a notably higher risk compared to those with normal ABI values. Multivariate logistic regression analysis confirmed high ABI as an independent interpreter of CV events and PAD, even after adjusting for confounding variables.

Discussion

In the study, 200 patients with T2D were analyzed based on their ABI values. The participants were well-balanced in terms of demographic and clinical characteristics. The high ABI category (15% of the total) had a higher incidence of hypertension and dyslipidemia than the normal ABI category. Additionally, the high ABI category had a notably higher incidence of cardiovascular events (73%) compared to the normal ABI category (30%), including myocardial infarction, stroke, and cardiovascular-related mortality.

Furthermore, PAD was more prevalent in the high ABI category (60%) than in the normal ABI category (17%). Statistical analysis revealed that individuals in the high ABI category had substantially higher odds of experiencing cardiovascular events (OR 2.45) and PAD (OR 2.83) compared to those with normal ABI values. Importantly, even after adjusting for various confounding factors, high ABI remained an independent interpreter of CV events and PAD. These findings suggest that high ABI values are correlated with an enhanced risk of CV events and PAD in individuals with T2D.

Recent studies have highlighted various aspects of managing T2D and its association with CV events and PAD. A retrospective cohort study found that raised D-dimer levels are related to a raised risk of CVD and could help identify early-stage diabetic renal disease, promoting early adoption of protective therapies [6]. Another study discussed the inadequacy of the UKPDS, Framingham, and ADVANCE risk equations in precisely predicting the 4-year risk of CVD in people with T2D, suggesting the need for better risk assessment tools [7]. Research on Asian patients with T2D showed that low ABI values are independently related with CV outcomes and diabetic foot ulcers [8]. In India, a study supported the extension of nationwide atherosclerotic cardiovascular disease (ASCVD) risk recognition programs and prevention approaches to reduce CVD [9]. An observational study on normotensive T2D patients highlighted the risk of non-dipping patterns in blood pressure, leading to potential end-organ damage and cardiovascular events [10]. Lastly, the economic impact of applying international guidelines for high-risk T2D patients in India was analyzed, emphasizing the cost-effectiveness of certain therapies [11]. These studies collectively underscore the complexity of managing T2D and its cardiovascular implications, advocating for tailored approaches in risk assessment and management strategies.

Conclusion

The results highlight a significant relationship between high ABI values (>1.3) and an increased risk of cardiovascular events and PAD in people with T2D. The high frequency of cardiovascular complications in the high ABI category underscores the importance of ABI measurement as a non-invasive, easily obtainable indicator for assessing vascular health in this population. The findings suggest that patients with T2D exhibiting high ABI values warrant closer surveillance and possibly more aggressive management of CV risk factors to mitigate the risk of adverse outcomes.

Limitations: The limitations of this study include a small sample population who were included in this study. The findings of this study cannot be generalized for a larger sample population. Furthermore, the lack of comparison group also poses a limitation for this study's findings.

Recommendation: Consider measuring ABI in patients with Type 2 diabetes for early identification of cardiovascular and peripheral arterial disease risk.

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List of abbreviations:

1. T2D - Type 2 Diabetes
2. CV - Cardiovascular
3. PAD - Peripheral Arterial Disease
4. ABI - Ankle–Brachial Index
5. CVD - Cardiovascular Disease

6. HbA1c - Hemoglobin A1c
7. OR - Odds Ratio
8. CI - Confidence Interval
9. SD - Standard Deviation
10. UKPDS - United Kingdom Prospective Diabetes Study
11. ADVANCE - Action in Diabetes and Vascular Disease: Preterax and Diamicron Modified Release Controlled Evaluation
12. ASCVD - Atherosclerotic Cardiovascular Disease

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