

## A clinico-radiological study of Peripheral Arterial Disease in patients with type 2 Diabetes Mellitus using ankle-brachial index and peripheral arterial doppler

Vasudha V Sardesai<sup>1</sup>, Shubham More<sup>1</sup>, Rohidas T Borse<sup>1</sup>

<sup>1</sup>Department of Medicine, B. J. Government Medical College and Sassoon General Hospital, Pune, Maharashtra, India

### Corresponding Author

Vasudha V Sardesai

E-mail ID: drvasudhasardesai@gmail.com

Submission: 30.01.2023

Acceptance: 17.03.2023

Publication: 31.03.2023



[https://www.doi.org/10.56136/BVMJ/2023\\_00005](https://www.doi.org/10.56136/BVMJ/2023_00005)

### Abstract

**Background:** Peripheral Arterial Disease (PAD) is an important complication of Diabetes Mellitus (DM). PAD is a part of systemic illness caused by atherosclerosis, resulting in arterial narrowing. Hence PAD is a marker of atherosclerosis in other parts of the vascular system, especially in the arteries supplying the brain and heart. Over two - third of the patients with PAD are asymptomatic, resulting in inadequate treatment of their risk factors. There is a need to screen every DM patient for effective treatment of PAD and the risk factors. Ankle-brachial Index (ABI) is a useful test for the same. **Objective:** The objective of the study was to find out the incidence of PAD in DM and the factors affecting it. **Materials and Methods:** It was a hospital-based prospective observational study. In all, 200 diabetic patients from tertiary care hospital (outpatient and indoor) were screened for PAD using ABI, and those showing ABI < 0.9 were further confirmed using Duplex Ultrasonography (DUS). Smokers and patients with a previous history of lower limb surgery, vasculopathy, or trauma were excluded from the study. Factors affecting the incidence of PAD were also studied. **Results:** Overall incidence of PAD was 10% using ABI as a screening test, confirmed with DUS. Male gender, aging, obesity, duration of DM, poor control of DM, hypertension, coronary artery disease, cerebrovascular disease, hyperlipidemia, and presence of retinopathy were found to be adversely affecting risk factors for PAD. **Conclusion:** ABI is a bedside, simple, reliable, non-invasive, and cost-effective clinical test for diagnosing PAD, a marker of atherosclerosis in the body. There is a need to screen for PAD, even in asymptomatic patients, for its early detection and management of risk factors.

**Keywords:** Peripheral Arterial Disease (PAD), Ankle-brachial index (ABI), Diabetes Mellitus (DM)

### Introduction

Over 77 million Indians are reported to suffer from diabetes, a significant proportion of which are either undiagnosed or under-treated leading to poor glycemic control<sup>(1)</sup>. This leads to the accelerated development of micro and macrovascular complications, including Peripheral Arterial Disease (PAD). Diabetes Mellitus (DM) plays a fundamental role in the pathophysiology of PAD. It is part of a systemic illness caused by atherosclerosis which results in arterial narrowing, causing a mismatch between oxygen supply and demand. The PAD is a marker for atherosclerosis in other parts of the vascular system with possible concomitant atherosclerotic disease of the arteries in the brain and heart<sup>(2)</sup>. PAD may be asymptomatic or present with symptoms ranging from intermittent claudication to critical limb ischemia. Disease progression leads to critical limb ischemia and diabetic foot, leading to limb loss.

Early detection and treatment of PAD in patients can surely prevent this complication and limit its debilitating effects. Over two-thirds of the patients with PAD are asymptomatic and not diagnosed with a systemic cardiovascular disease, resulting in inadequate treatment of their risk factors<sup>(3)</sup>. The

importance of early detection and PAD diagnosis is usually overlooked in routine history and examination. This lack of awareness about the morbidity and mortality associated with PAD is a significant barrier to PAD diagnosis. It also impedes secondary prevention. Therefore, a need to increase physician awareness and knowledge about PAD and clear guidelines for detecting PAD are needed. The treatment of PAD and managing risk factors are both effective, which provides justification for screening for PAD in every diabetic patient.

Various methods are available for the diagnosis of PAD. Duplex Ultrasonography (DUS) is considered as diagnostic in a clinical setting. Among the non-invasive methods available for screening, Ankle-Brachial Index (ABI) is well established<sup>(3)</sup>. There is a good correlation between ABI with DUS<sup>(4)</sup>. ABI measurement is validated as the method of choice for early diagnosis of PAD in a point-of-care setting.

The objective of the study was to find out the incidence of PAD in type 2 DM using ABI and Peripheral Arterial Doppler/DUS. It was also aimed at studying the factors affecting PAD.

## Methods

It was a prospective, observational study done in tertiary care hospital. Ethical committee approval was obtained. A total of 200 type 2 diabetic patients with or without hypertension were selected. Smokers, patients with a history of PAD due to some other cause, and a history of trauma or surgery of lower limbs were excluded from the study. Written informed consent was taken from the participants. After a detailed history, general and systemic examination and examination of peripheral pulses and feet were done. Examination of arterial pulse of dorsalis pedis and posterior tibial arteries as well as radial and ulnar arteries at wrist was done. Affection of both lower limbs, different segments of the same artery and multiple arteries of same limb, also below knee involvement of vessels were seen in diabetic patients. ABI was measured by using a hand doppler and sphygmomanometer. The ABI was measured three times and the average was calculated. ABI was calculated by the formula,  $ABI = \text{systolic BP in ankle} / \text{systolic BP in arm}$ . ABI was classified as follows: Incompressible -  $> 1.4$ , Normal -  $1.0 - 1.39$ , Borderline-  $0.9 - 0.99$ , Abnormal-  $< 0.9$ , Claudication:  $0.4$  and  $0.9$ , Rest pain:  $0.2$  to  $0.4$ , Tissue loss (ulcer, gangrene):  $0$  to  $0.4$ <sup>(5)</sup>.

Patients with  $ABI < 0.9$  were subjected to the DUS study after taking informed consent. Hitachi Aloka F37 doppler machine was used. The absence of color and spectral doppler signals at the site of occlusion were seen. An abnormality was identified as the following features: intraluminal echoes, abnormal waveforms, and flow velocity changes.

In our study poor glycemic control was taken as  $HbA1c > 7.0\%$ <sup>(5)</sup>.

## Results

Among 200 patients with type 2 diabetes, the average age of the population was  $56.2 \pm 11.3$  years, and the mean duration of diabetes was  $5.6 \pm 4.6$  years. Males were 45%, and females were 55%. There were 80% male patients in the group of T2DM with PAD. The incidence of PAD, detected by reduced ABI ( $< 0.9$ ) and confirmed by peripheral arterial doppler was 10%. The most common symptom was claudication pain, which was seen in 70% of cases of PAD compared to 5.5% of cases in non-PAD ( $P < 0.05$ ). Nonhealing ulcers were seen in 10% of cases with PAD as compared to patients without PAD (1.1%) ( $p = 0.07$ ). Bilateral, multisegmental, and multivessel involvement with more severe involvement of below-knee vessels was seen in our study.

There was a slight female preponderance (55%) compared to males (45%) in the study group, but there were 80% of males in the group of diabetes with PAD. That shows a higher incidence of PAD in males than females ( $p \text{ value} < 0.001$ ) in our study.

The mean duration of diabetes in the study group was  $5.6 \pm 4.6$

years. In our study PAD was found among the cases with a duration of DM between 6 to 10 years and  $> 10$  years. There was no case of PAD in patients with a duration of less than six years ( $p < 0.001$ ). In our study, 60% of patients with PAD had  $BMI > 25$ .

The mean age of patients with PAD was 61 years as compared to the mean age of patients without PAD (54 years) ( $p < 0.001$ ).

In our study, 50% of the PAD cases were hypertensive compared to only 6.7% of cases of the non-PAD group. ( $p = 0.01$ ). Coronary Artery Disease was present in 10% of the population studied and 40% of the PAD cases compared to only 6.7% of non-PAD ( $p < 0.0001$ ). History of cerebrovascular accident was present in 20% of the PAD cases compared to only 2.2% of non-PAD cases ( $p < 0.0001$ ). Chronic Kidney Disease (CKD) detected by proteinuria and/or reduced with Glomerular Filtration Rate (GFR) was present in 15% of patients with PAD compared to 11% of patients without PAD. Dyslipidemia was observed in 50% of cases of PAD compared to non-PAD cases ( $p < 0.001$ ). Retinopathy was present in 60% of patients with PAD as compared to 8.8% of patients with non-PAD ( $P < 0.0001$ ) (Table 1).

**Table 1: Association of PAD with comorbidities**

Comorbidities	T2DM with PAD N=20 n (%)	T2DM without PAD N=180 n (%)	p value
Hypertension	10 (50)	14 (7.8)	0.01
Coronary Artery Disease	8 (40)	12 (6.7)	$< 0.0001$
Cerebrovascular Disease	4 (20.0)	4 (2.2)	$< 0.0001$
Chronic Kidney Disease	3 (15)	21 (11.7)	0.663
Dyslipidemia	10 (50)	48 (24)	$< 0.001$
Retinopathy	12 (60)	16 (8.89)	$< 0.0001$

It was found that PAD was significantly associated with poor glycemic control ( $p < 0.001$ ). In our study, 90% of patients with PAD had poor glycemic control compared to 36.6% of patients without PAD (Table 2).

**Table 2: Association of PAD with Glycemic Control**

Parameters	T2DM with PAD n (%)	T2DM without PAD n (%)	p value
Good Glycemic Control	2 (10)	114 (63.3)	$< 0.001$
Poor Glycemic Control	18 (90)	66 (36.6)	

ABI < 0.9 was present in all PAD cases. ABI between 0.7-0.9 was observed in 80% of the PAD cases and 10% of non-PAD cases. ABI > 0.9 was found in 88.9% of cases of non-PAD ( $p < 0.001$ ). ABI < 0.7 was significantly associated with PAD (Table 3).

**Table 3: Association of PAD with ABI**

ABI	T2DM with PAD n (%)	T2DM without PAD n (%)	p value
<0.7	4 (20)	2 (1.1)	< 0.001
0.7- 0.9	16 (80)	18 (10)	

Note: PAD confirmed by DUS

Advanced age, male gender, longer duration of diabetes, obesity, poor glycemic control, dyslipidemia, hypertension, other macrovascular complications like Ischemic Heart Disease (IHD) and stroke/Transient Ischemic Attack (TIA), microvascular complications like retinopathy, nephropathy were significantly associated with PAD in our study (Table 4).

**Table 4: Association of PAD with other risk factors**

Sr. No.	Condition	PAD	Non-PAD	p value
1.	Mean age in years	61.5±10.8	54.2 ±11.3	< 0.001
2.	Male Gender	80%	41.1%	0.001
3.	Mean duration of DM in years	13.1± 5.3	4.67±3.5	< 0.0001
4.	Poor glycemic control	90%	36.7%	< 0.0001
5.	Obesity (BMI>25)	60%	42.5%	0.009
6.	Retinopathy	60%	8.89%	<0.0001

Note: Chi-square test applied

## Discussion

The incidence of PAD is higher in the western population<sup>(6,7)</sup> compared to the Indian population. The incidence of PAD in the Indian studies is around 10-14%, including our study, whereas the epidemiological studies suggest a lower incidence [Chennai Urban Population Study (CUPS)<sup>(8)</sup> and Chennai Urban Rural Epidemiology Study (CURES 111)<sup>(9)</sup>]. CUPS and CURES 111 were community-based studies, unlike our study which was hospital-based, hence accounting for a low incidence of PAD compared to our study. However, the reason for the lower rates of PAD in the Indian type 2 diabetic population is probably related to the younger age of onset of type 2 diabetes in our population.

As per Anjana et al.<sup>(10)</sup>, the male gender has a higher predisposition for T2DM. PAD has traditionally been identified as a male-dominant disease; however, recent population trends and studies in PAD suggest that women are affected at least as often as men<sup>(11)</sup>. Other Indian studies like CUPS<sup>(8)</sup>, study conducted by Agrawal et al.<sup>(11)</sup>, however, did not show any difference in the incidence of PAD between males and females.

The mean age difference in the occurrence of PAD from non PAD is around seven years, except in CURES 111 and study by Tavintharan et al.<sup>(12)</sup>. Hence elderly diabetics are more prone to PAD than younger diabetics. Other studies<sup>(8,9,13,14)</sup> also showed advanced age as an independent risk factor for PAD in diabetics similar to our study. Since aging and diabetes are two conditions that markedly increase the risk of PAD, it is expected that the concomitance of both these risk factors will dramatically raise the percentage of incidence of PAD, which translates into a worse cardiovascular prognosis.

People who were obese were 1.5 times more likely to develop peripheral artery disease with critical limb ischemia than those with normal weight<sup>(15)</sup>.

There was a significant difference in the prevalence of Hypertension between the PAD and the non-PAD subgroups. This indicates that hypertension accelerated the atherosclerotic process. Fremantle diabetes study<sup>(13)</sup> and The Kyushu Prevention Study for Atherosclerosis<sup>(16)</sup> showed a higher prevalence of hypertension in the PAD group compared to the non-PAD group. A similar result was seen in our study also. Cerebrovascular disease was present in 20% of patients with PAD in our study. In a study by Tavintharan et al.<sup>(12)</sup> stroke is present in 12.1% of patients with PAD and is significantly associated with PAD.

Higher HbA1c levels were seen in many studies in subjects with PAD than subjects without PAD, and it was statistically significant also in other studies<sup>(9,17,18)</sup>. But Tavintharan et al. study did not find any correlation between HbA1c with PAD<sup>(12)</sup>.

In our study, the average triglycerides and total Cholesterol were significantly higher in the PAD group than in the non-PAD group ( $p < 0.05$ ). Walters et al.<sup>(19)</sup> and Mohan et al.<sup>(20)</sup> found serum total cholesterol levels to be one of the predictive factors for PAD.

The present study showed an association between PAD and retinopathy, similar to another study done by Riccardi et al.<sup>(21)</sup>.

## Conclusion

Peripheral arterial disease is an important complication of diabetes mellitus, and its early detection is essential for treating and managing its risk factors. The ankle-brachial index is a bedside, reliable, non-invasive, and cost-effective test to detect PAD in diabetic patients.

**Conflict of Interest:** Nil

**Source of Support:** Nil

**Copyright** © 2023 Bharati Vidyapeeth Medical Journal (BVMJ). This is an open access article, it is free for all to read, download, copy, distribute, adapt and permitted to reuse under Creative Commons Attribution Non Commercial-ShareAlike: CC BY-NC-SABY 4.0 license.

#### ORCiD

Vasudha V Sardesai  0009-0003-4043-9392

#### References

- International Diabetes Federation. IDF Diabetes Atlas. 9<sup>th</sup> edition. Brussels, Belgium: International Diabetes Federation; 2019.
- Thiruvoipati T, Kielhorn CE, Armstrong EJ. Peripheral artery disease in patients with diabetes: Epidemiology, mechanisms, and outcomes. *World J Diabetes*. 2015 Jul 7;6(7):961-9.
- Olin JW, Sealove BA. Peripheral artery disease: current insight into the disease and its diagnosis and management. *Mayo Clin Proc*. 2010 Jul 1;85(7):678-92. Elsevier.
- Premalatha G, Ravikumar R, Sanjay R, Deepa R, Mohan V. Comparison of colour duplex ultrasound and ankle-brachial pressure index measurements in peripheral vascular disease in type 2 diabetic patients with foot infections. *J Assoc Physicians India*. 2002 Oct 1;50:1240-4.
- Braunwald E, Fauci AS, Kasper DL, Hauser SL, Longo DL, Jameson JL. Harrison's principles of internal medicine. In: Harrison's principles of internal medicine. 2018. McGraw Hill.
- Beach KW, Bedford GR, Bergelin RO, et al. Progression of lower-extremity arterial occlusive disease in type II diabetes mellitus. *Diabetes Care*. 1998 Jun 1;11(6):464-72.
- Fowkes FG, Housley E, Cawood EH, Macintyre CC, Ruckley CV, Prescott RJ. Edinburgh Artery Study prevalence of asymptomatic and symptomatic peripheral arterial disease in the general population. *Int J Epidemiol*. 1991 Jun 1;20(2):384-92.
- Premalatha G, Shanthirani S, Deepa R, et al. Prevalence and risk factors of peripheral vascular disease in a selected South Indian population: the Chennai Urban Population Study. *Diabetes Care* 2000 Sep 1;23(9):1295-300.
- Pradeepa R, Chella S, Surendar J, Indulekha K, Anjana RM, Mohan V. Prevalence of peripheral vascular disease and its association with carotid intima-media thickness and arterial stiffness in type 2 diabetes: The Chennai Urban Rural Epidemiology Study (CURES 111). *Diabetes and Vascular Disease Research*. 2014 May;11(3):190-200.
- Anjana RM, Deepa M, Pradeepa R, et al. Prevalence of diabetes and prediabetes in 15 states of India: results from the ICMR-INDIAB population-based cross-sectional study. *Lancet Diabetes Endocrinol*. 2017 Aug 1;5(8):585-96.
- Agrawal RP, Ranka M, Beniwal R, et al. Prevalence of micro and macro vascular complications in type 2 diabetes and their risk factors. *Int J Diabetes Dev Ctries*. 2004;24:11-16.
- Tavintharan S, Cheung N, Lim SC, et al. Prevalence and risk factors for peripheral artery disease in an Asian population with diabetes mellitus. *Diabetes and Vascular Disease Research*. 2009 Apr;6(2):80-6.
- Norman PE, Davis WA, Bruce DG, Davis TM. Peripheral arterial disease and risk of cardiac death in type 2 diabetes: the Fremantle Diabetes Study. *Diabetes care*. 2006 Mar 1;29(3):575-80.
- Li J, Hasimu B, Yu J, Wang J, Hu D. Prevalence of peripheral arterial disease and risk factors for the low and high ankle-brachial index in Chinese patients with type 2 diabetes. *Journal of health science*. 2006;52(2):97-102.
- Hicks CW, Yang C, Ndumele CE, et al. Associations of Obesity with Incident Hospitalization Related to Peripheral Artery Disease and Critical Limb Ischemia in the ARIC Study. *J Am Heart Assoc*. 2018 Aug 21;7(16):e008644.
- Maeda Y, Inoguchi T, Tsubouchi H, et al. High prevalence of peripheral arterial disease diagnosed by low ankle-brachial index in Japanese patients with diabetes: The Kyushu Prevention Study for Atherosclerosis. *Diabetes research and clinical practice*. 2008 Dec 1;82(3):378-82.
- Agarwal AK, Singh M, Arya V, Garg U, Singh VP, Jain V. Prevalence of peripheral arterial disease in type 2 diabetes mellitus and its correlation with coronary artery disease and its risk factors. *J Assoc Physicians India*. 2012 Jul 1;60(7):28-32.
- Adler AI, Stevens RJ, Neil A, Stratton IM, Boulton AJ, Holman RR, UK Prospective Diabetes Study Group. UKPDS 59: hyperglycemia and other potentially modifiable risk factors for peripheral vascular disease in type 2 diabetes. *Diabetes care*. 2002 May 1;25(5):894-9.
- Walters DP, Gatling W, Mullee MA, Hill RD. The prevalence, detection, and epidemiological correlates of peripheral vascular disease: a comparison of diabetic and

non-diabetic subjects in an English community. *Diabet Med.* 1992 Oct;9(8):710–15.