PROFILE OF PERIPHERAL ARTERIAL DISEASE IN TYPE 2 DIABETES MELLITUS – A HOSPITAL-BASED OBSERVATIONAL STUDY IN COASTAL KARNATAKA

© E. Arora[1], H. Korada[1], T. Devasia[2], Rama Bhat[2], G. Kamath[2], A. Maiya[1]*

[1]Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, Karnataka, India
[2]Kasturba Medical College, Manipal Academy of Higher Education, Manipal, Karnataka, India

INTRODUCTION: Ankle Brachial Index (ABI) is one of the common non-invasive diagnostic tools available for diagnosing Peripheral Arterial Disease (PAD). However, it has been observed that for an individual diagnosed with both PAD and Type 2 Diabetes Mellitus (T2DM), ABI tends to give false diagnostic value because of the calcification of the major lower limb arteries. Therefore, the health care professionals are at times misled for the diagnosis of PAD. To overcome this another diagnostic tool Toe Brachial Index (TBI) was suggested to perform. However, there is limited literature on performing both ABI and TBI in the given population in a single study.

AIM: The main focus of this study is to report the profile of ABI and TBI along with classical symptoms like claudication pain, palpation of pulse and history of T2DM for the screening and diagnosis of PAD in T2DM.

MATERIALS AND METHODS: In this cross-sectional observational study, a total of 121 participants diagnosed with T2DM were recruited for the study as per the inclusion criteria. Detailed demographic details of the participants were noted. Diagnostic tool including both ABI and TBI were performed for all the participants and the data was analysed.

RESULTS: Among 121 participants, only 3 participants had both ABI and TBI positive indicating positive diagnostic test for PAD and 106 participants had both ABI and TBI negative. However, in the remaining 12 participants, 10 showed TBI positive but ABI negative and 2 had ABI positive but TBI negative.

CONCLUSIONS: Based on our study we have reported the profile of PAD in T2DM individuals, which is found to be 10.75.%. Therefore, it can be concluded that ABI and TBI both should be performed to rule out any complication. This will be beneficial in early screening and detection of neuro ischemic changes in foot and subsequently to prevent amputation.

KEYWORDS: peripheral arterial disease; type 2 diabetes mellitus; toe brachial index; observational study

ПРОФИЛЬ ЗАБОЛЕВАНИЯ ПЕРИФЕРИЧЕСКИХ АРТЕРИЙ ПРИ САХАРНОМ ДИАБЕТЕ 2 ТИПА – СТАЦИОНАРНОЕ ОБСЕРВАЦИОННОЕ ОБСЛЕДОВАНИЕ, ПРОВЕДЕННОЕ В ПРИБРЕЖНОЙ КАРНАТАКЕ

© Esha Arora[1], Hrishikesh Korada[1], Tom Devasia[2], Rama Bhat[2], Ganesh Kamath[2], Arun Maiya[1]*

[1]Manipal College of Health Professions, Manipal Academy of Higher Education, Манипал, Карнатака, Индия
[2]Kasturba Medical College, Manipal Academy of Higher Education, Манипал, Карнатака, Индия

ОБОСНОВАНИЕ. Лодыжечно-плечевой индекс (ЛПИ) – достаточно распространенный неинвазивный метод, применяемый для диагностики заболеваний периферических артерий (ЗПА). Однако было отмечено, что у пациентов с диагнозом ЗПА и сахарным диабетом 2 типа (СД2) ЛПИ не имеет диагностической ценности в связи с кальцификацией крупных артерий нижних конечностей. Таким образом, врачи могут быть введены в заблуждение относительно диагностики ЗПА. Для этого был разработан другой метод диагностики – пальце-плечевой индекс (ППИ). Однако объем литературы, содержащей сведения о применении ЛПИ и ППИ в одной группе в рамках одного исследования, ограничен.

ЦЕЛЬ. Целью данного исследования является описание профилей ЛПИ и ППИ наряду с такими классическими симптомами, как боль при хромоте, пальпация пульса и анамнез СД2 для проведения скрининга и диагностирования ЗПА при СД2.

МЕТОДЫ. Для участия в данном поперечном обсервационном обследовании в соответствии с критериями включения была набрана группа в количестве 121 участника с установленным диагнозом СД2. Были собраны детальные демографические данные участников. Всем участникам был проведена диагностика с помощью диагностических методов ЛПИ и ППИ, а полученные данные были проанализированы.

РЕЗУЛЬТАТЫ. Из 121 участника только 3 участника имели положительный результат по обоим методам ЛПИ и ППИ, что означает положительный результат диагностики ЗПА, у 106 участников оба метода ЛПИ и ППИ

Received: 02.01.2020. Accepted: 06.07.2020.

показали отрицательный результат. Однако среди оставшихся 12 участников были выявлены следующие результаты: у 10 участников ППИ положительный, а ЛПИ отрицательный, у 2 участников ЛПИ положительный, а ППИ отрицательный.

ЗАКЛЮЧЕНИЕ. В результате проведенного исследования мы установили ЗПА при СД2 в 10,75% случаев. Таким образом, считаем, что для выявления осложнений должны быть использованы оба метода – ЛПИ и ППИ. Это сыграет определенную положительную роль при ранней диагностике и установлении нейроишемических изменений в стопе и, соответственно, позволит избежать ампутации.

КЛЮЧЕВЫЕ СЛОВА: заболевание периферических артерий; сахарный диабет 2 типа; пальце-плечевой индекс; обсервационное обследование

Ankle brachial index (ABI) is one of the most common diagnostic tools available to diagnose Peripheral Arterial Disease (PAD) [1]. However, when PAD is accompanied with Type 2 Diabetes Mellitus (T2DM), ABI tends to give false value due to calcification of major lower limb arteries. It is important to have another diagnostic tool to diagnose PAD in T2DM. Therefore, another diagnostic tool Toe Brachial Index (TBI) was preferred to diagnose PAD in T2DM [2]. The global prevalence of PAD is around 27.2% and 23.3% in South Asia [1]. In Southern India, it's between 8.5-14.1% in diabetic population [3,4]. It has known to have significant effect on the functional activities and quality of life on the individual [5].

PAD is developed by the fatty depositions or plaque on the inner walls of arteries which is otherwise known as atherosclerosis which leads to either narrowing or obstruction of the major arteries of the lower limb [5]. Literature suggests that only one-third of the affected individuals had typical symptom and remaining were asymptomatic leading to the condition being underdiagnosed [3]. The most common symptom of PAD is cramping pain or discomfort at the calf region while walking which in other terms is defined as intermittent claudication [5]. But the major concern over here lies in diagnosing the type and cause of pain responsible for PAD. Majority of the individuals do not complain of any symptoms making it difficult for early detection of PAD. One of the possible reasons could be, reporting of claudication pain at times is misinterpreted by the individuals for some muscular pain and may not be reported at the early stage [6]. So, it is very crucial to have a specific screening measurement for the diagnosis of PAD which is both feasible and cost-effective for patients as well as health care centres [7].

There have been various school of thoughts for the diagnosis of PAD. Different diagnostic methods include invasive and non-invasive methods, which have been studied to diagnose PAD in the diabetic population. Non-invasive methods are ABI, TBI and ultrasound doppler. ABI is defined as the fraction of systolic pressure of ankle to a systolic pressure of the arm. The normal value ranges from 0.91 to 1.3. Any reading below this is categorised as PAD. The non-invasive methods are easy to perform, inexpensive, less time consuming, and carry a lower risk of complication and are readily available in a primary setup [7].

Despite having an established relationship between PAD and T2DM, PAD is still undermanaged and underdiagnosed within a tertiary health care setup. Even though ABI is considered to be sensitive in the general population but when considered in T2DM population it may be inconclusive. This may be due to the calcification of arteries in the T2DM population. The resistance to the compression of arteries in T2DM is questionable and thus is suspected to give falsely elevated ABI values [1, 5]. Falsely elevated ABI is also highly prevalent in autonomic neuropathy and chronic renal insufficiency conditions [5, 6].

Because of the limited data on ABI for individuals with T2DM and PAD, new diagnostic criteria Toe Brachial Index (TBI) came into notability. TBI is defined as the systolic pressure of toe to systolic pressure of upper arm [7]. Few studies in a systematic review have tried to examine the normal values of TBI but are said to be unsatisfying [8, 9]. Studies report that values of above 0.7 in TBI should be considered as normal values [7]. It is assumed that TBI eliminates the errors caused due to calcification of the arteries as the pressure is taken at the toes involving the end capillaries [1, 9]. Still, there is limited evidence to rule out whether ABI and TBI individually or together have a higher diagnostic chance for the diagnosis of PAD [9, 10]. Usually because of the asymptomatic nature of PAD, at times it leads to negligence for the diagnosis. PAD is a known complication of T2DM, so it is necessary that this is examined on the routine basis in the health care centres which can lead to gangrene and amputation of the lower limb. Therefore, the objective of this study is to report the characteristic profile of ABI and TBI along with classical symptoms and signs like claudication pain, palpation of pulse and history of T2DM, which could highlight the early screening and diagnosis of PAD in T2DM.

MATERIALS AND METHODS

Study Design and Setting

This cross-sectional observational study design was conducted between the duration of January 2019 to July 2019. All the participants were recruited from a tertiary health care centre of Karnataka, India, using a convenience sampling method. A total of 121 participants were screened for the study utilising a comprehensive diabetic foot evaluation sheet which includes neurological, vascular, and musculoskeletal components. Basic demographic details from all the participants were recorded and eligible participants were explained about the procedure.

Inclusion and Exclusion Criteria

Inclusion criteria were, participants above the age of 30 years- both male and female, patients of T2DM; on medication or insulin as current mode of treatment with more than 5 year and directly coming to the hospital on OPD basis. Exclusion criteria were individuals with any musculoskeletal, neurological or respiratory disorders. These exclusion criteria were identified based on difficulty in performing ABI and TBI and to have a differential diagnosis for PAD.

Procedure

The detailed demographic recording, clinical and biochemical assessment was performed upon all the participants.

Blood Pressure Measurement: The participants were made to rest for 15 min on a couch and the procedure was explained to them. The dominant side of the participant was taken for the examination. A blood pressure cuff was tied to the participants lower limb and the pressures was recorded from the posterior tibialis artery with the help of a Doppler (Hadeco smartdop 30EX, year 2017). After this the cuff was tied to the upper limb and systolic pressure was recorded from the brachial artery and ABI was obtained. Followed by this, a smaller blood pressure cuff for the great toe was tied and a plethysmograph (PPG) sensor was connected to the great toe to measure the pressure from the toe. The toe pressure was divided by the brachial pressure and TBI was obtained and the data was analysed.

Ethics Approval

After the approval from the institutional ethics committee (IEC 846/2017), the study was initiated. Detailed information about the study was given and informed consent was obtained from all the participants who were willing to take part in the study.

Statistical analysis

The study used convenient sampling method for the study for a span of 7 months duration. EZR was used as a statistical software for measuring the descriptive statistics of the variables. 2X2 table was used for demonstrating the proportions of variables.

RESULTS

A total of 121 participants were screened for the study. Among them, 13 (10.75%) participants fulfilled the inclusion criteria. The mean age of the individuals was 66.3±7.91 in years. The basic demographic details are given in Table 1.

Table 1. Demographic characteristics of the participants

Variable	Value
Total participants, n	121
Gender (m:f), n	82:39
Age, years	66.75±7.28
Weight, kg	66.58±10.15
Height, cm	161.5±11.1

Out of 121 participants, 13 participants (10.75%) were found to have reported claudication pain during walking and had a feeble pulse on palpation. Within these 5 were found to have an ABI value of less than 0.9 and all 13 had TBI values less than 0.7 which shows that though ABI and TBI can be used to investigate PAD, TBI has shown to be a stronger indicator than ABI. Table 2 shows the distribution of characteristics of the participants. Table 3 shows characteristics features of PAD in T2DM and table 4 shows profile of ABI and TBI in PAD with T2DM.

DISCUSSION

T2DM is related to inflammation, oxidative stress and advanced glycated end product and so is PAD by down regulation of vasodilators, up regulation of vasoconstrictors and apoptosis of endothelial cell which leads to atherosclerosis of the artery [11]. As only one-third of the individuals with Peripheral Arterial Disease (PAD) exhibit typical symptoms; majority being asymptomatic, it is difficult to diagnose them at a primary health centre [3]. Although PAD can be diagnosed by invasive methods like computed

Table 2. Clinical and Biochemical distribution of characteristics of participants

	T2DM (n=108) mean±SD	T2DM with PAD (n= 13) mean±SD
Duration of diabetes, years	14.12±4.47	21.36±5.28
HbA_{1c}, %	6.1±0.7	7.4±0.9
Brachial blood pressure Systole, mmHg	128.6±8.4	126±9.1
Pedal Blood pressure Systole, mmHg	121.4±7.1	103.3±7.9
Great toe pressure	108.8±6.7	79.3±5.75
ABI	0.95±0.04	0.83±0.02
TBI	0.84±0.03	0.62±0.03
Medication history for diabetes		
OHA, n	94	4
Insulin, n	14	9
Medication history for PAD	-	13
Smoking history		
Present, n	19	7
Absent, n	89	6

Notes: ABI - Ankle Brachial Index; TBI - Toe Brachial Index; OHA – oral hypoglycemic agents; PAD - Peripheral Arterial Disease.

Table 3. Profile of Peripheral Arterial Disease in type 2 diabetes mellitus

Variables	Number of participants, n (%)
Claudication pain during walking	
Present	13 (10.75)
Absent	108 (89.3)
Palpation of posterior tibial pulse	
Palpable	108 (89.3)
Feeble	13 (10.75)

Table 4. (2x2 table) Ankle Brachial Index / Toe Brachial Index profile of type 2 diabetes mellitus

ABI positive TBI positive	ABI positive TBI negative	TOTAL
3	2	**5 (4.14%)**
ABI negative TBI positive	**ABI negative TBI negative**	
10	106	**116 (95.86%)**
13 (10.75%)	**108 (89.25%)**	**121 (100%)**

Notes: ABI - Ankle Brachial Index; TBI - Toe Brachial Index.

tomography angiograms which are accurate and precise, they are quite expensive, time-consuming, unavailable to general practitioners and difficult to perform at a primary health care centre, alternatively simple, non-invasive approaches like ABI or TBI can be incorporated in diagnosing PAD [6, 8]. There is a need for early detection for ischemic changes of the foot, of small blood vessels as it is an early warning of signs of an ulcer.

In the present study, we have presented the profile of PAD in T2DM individuals with the available data. Based on the demographic and biochemical profiles of our population we found PAD features were also seen along with T2DM. Among 13 participants, all 13 participants had duration of T2DM more than 5 years along with claudication pain. Smoking history was present in 7 participants and 9 participants had glycated haemoglobin more than 7%. With the available data we could conclude that as the duration of T2DM, HbA_{1c} and smoking history increases the risk factor of PAD also increases. This conclusion correlate with the study conducted in India in 2014 which stated the higher incidence of PAD with T2DM with above-mentioned factors [12].

In this study, we have also examined the trend of T2DM with PAD. Individual diagnosed with T2DM were screened for ABI and TBI. We have found that 10.75% (n=13) participants had claudication pain during walking and a feeble pulse was noticed, additionally, TBI values were less than 0.7. Among these 13 participants when stratification was done based on ABI it was seen that 10 participants had normal ABI values and 3 participants presented with abnormal ABI value, that is less than 0.9. This shows that TBI is more specific in diagnosing PAD than ABI. This could be justified by the fact that individuals with T2DM could develop calcification of the major artery supplying the foot, thereby altering/limiting the blood flow [1, 5]. Another possibility being that T2DM is an end-organ disease, capillaries supplying distal toe region develop vascular insufficiency due to autonomic neuropathic changes far before large arterial involvement giving a false value of ABI at times [13].

Interestingly, 1.6 % (n=2) in the asymptomatic individuals had ABI positive but TBI was negative i.e. more than 0.7. One possible reason for this could be the anatomical variation seen in the vascular supply of the foot. In this study, we have reported the ABI value of posterior tibial artery but when we look into the blood supply to great toe it is the combination of both first dorsal metatarsal artery and first plantar metatarsal artery which is the continuation of dorsalis pedis and posterior tibial artery respectively. The possibility is that there may be compensation of blood supply to the great toe which lead to TBI values being on the normal side [14].

American Diabetic Society recommends that the individuals diagnosed with T2DM should undergo comprehensive evaluation for PAD at least once in 5 years even if they fall under normal ABI [15]. As per world health organization statistics, every 30 second, people are losing their part of the lower limb (amputation) [16]. However, in Indian community and clinical level practice, assessment of diabetic foot is not routinely incorporated leading to the negligence of the common complications of T2DM like neuropathy and peripheral artery disease. The main reason for amputation is neuro-ischemic changes in the diabetic foot.

The major factors responsible for individual being at risk of PAD are age and duration of T2DM. In our study, it was observed that the individuals having ABI and TBI positive had T2DM for a prolonged duration and were above the age of 50 years which suggests that these factors can be an alarming characteristic to screen/diagnose PAD in T2DM and should be evaluated on a routine basis.

The limitations of the study are smaller sample size and invasive methods not being used as they are the gold standards to diagnose PAD.

CONCLUSION

Based on our study we have reported a profile of peripheral arterial disease (PAD) in individuals with type 2 diabetes mellitus (T2DM); which are found to be 10.75%. We strongly recommend the detailed diabetic foot evaluation in people living with T2DM. The early screening for diabetic foot like neuropathy, vascular and footwear assessment will reduce the burden of amputation. Also, we conclude that vascular evaluation which includes TBI and ABI (posterior tibialis and dorsalis pedis) both should be routinely performed in individuals with T2DM. Thus, it can be concluded that if ABI and TBI both are performed, it may help in early detection of neuro-ischemic changes thereby appropriate and timely measure can be taken to prevent ulcer gangrene and subsequent amputation.

ADDITIONAL INFORMATION

Conflict of interest: There is no potential conflict of interest among authors.

Acknowledgement: We thank Kody Medical Electronics Pvt Ltd., Chennai, India for their interest and for providing the Hadeco Smartdop 30 EX doppler.

We thank the World Diabetes Foundation WDF 15-941 and Centre for Diabetic Foot Care and Research for supporting the study and Manipal Academy of Higher Education for their Approval.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

СПИСОК ЛИТЕРАТУРЫ | REFERENCES

1. Litwak L, Goh SY, Hussein Z, et al. Prevalence of diabetes complications in people with type 2 diabetes mellitus and its association with baseline characteristics in the multinational A 1 chieve study. *Diabetol Metab Syndr*. 2013;5(1):57. doi: https://doi.org/10.1186/1758-5996-5-57.
2. Hernando S, Francisco J, Conejero AM. [Peripheral artery disease: pathophysiology, diagnosis and treatment. (In Spanish)]. *Rev Esp Cardiol*. 2007;60(9):969–982. doi: https://doi.org/10.1157/13109651.
3. Agarwal AK, Singh M, Arya V, et al. 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;60(7):28–32.
4. Arora E, Maiya AG, Devasia T, et al. Prevalence of peripheral arterial disease among type 2 diabetes mellitus in coastal Karnataka. *Diabetes Metab Syndr*. 2019;13(2):1251–1253. doi: https://doi.org/10.1016/j.dsx.2019.02.003.

5. Jude EB, Eleftheriadou I, Tentolouris N. Peripheral arterial disease in diabetes – a review. *Diabet Med*. 2010;27(1):4–14. doi: https://doi.org/10.1111/j.1464-5491.2009.02866.x.
6. Andras A, Ferket B. Screening for peripheral arterial disease. *Cochrane Database Syst Rev*. 2014;(4):CD010835. doi: https://doi.org/10.1002/14651858.CD010835.pub2.
7. Romanos MT, Raspovic A, Perrin BM. The reliability of toe systolic pressure and the toe brachial index in patients with diabetes. *J Foot Ankle Res*. 2010;3(1):31. doi: https://doi.org/10.1186/1757-1146-3-31.
8. Collins R, Burch J, Cranny G, et al. Duplex ultrasonography, magnetic resonance angiography, and computed tomography angiography for diagnosis and assessment of symptomatic, lower limb peripheral arterial disease: a systematic review. *BMJ*. 2007;334(7606):1257. doi: https://doi.org/10.1136/bmj.39217.473275.55.
9. Tehan PE, Santos D, Chuter VH. A systematic review of the sensitivity and specificity of the toe–brachial index for detecting peripheral artery disease. *Vasc Med*. 2016;21(4):382–389. doi: https://doi.org/10.1177/1358863X16645854.
10. Park SC, Choi CY, Ha YI, Yang HE. Utility of toe-brachial index for diagnosis of peripheral artery disease. *Arch Plast Surg*. 2012;39(3):227–231. doi: https://doi.org/10.5999/aps.2012.39.3.227.
11. Cade WT. Diabetes-related microvascular and macrovascular diseases in the physical therapy setting. *Phys Ther*. 2008;88(11):1322–1335. doi: https://doi.org/10.2522/ptj.20080008.
12. Eshcol J, Jebarani S, Anjana RM, et al. Prevalence, incidence and progression of peripheral arterial disease in Asian Indian type 2 diabetic patients. *J Diabetes Complications*. 2014;28(5):627–631. doi: https://doi.org/10.1016/j.jdiacomp.2014.04.013.
13. Bowling FL, Rashid ST, Boulton AJ. Preventing and treating foot complications associated with diabetes mellitus. *Nat Rev Endocrinol*. 2015;11(10):606–616. doi: https://doi.org/10.1038/nrendo.2015.130.
14. Brooks B, Dean R, Patel S, et al. TBI or not TBI: that is the question. Is it better to measure toe pressure than ankle pressure in diabetic patients? *Diabet Med*. 2001;18(7):528–532. doi: https://doi.org/10.1046/j.1464-5491.2001.00493.x.
15. American Diabetes Association. Microvascular complications and foot care. *Diabetes care*. 2015;38(Suppl 1):S58–66. doi: https://doi.org/10.2337/dc15-S012.
16. Armstrong DG, Fisher TK, Lepow B, et al. 26. Pathophysiology and principles of management of the diabetic foot. In: Fitridge R, Thompson M. Mechanisms of vascular disease: a reference book for vascular specialists [Internet]. Adelaide (AU): University of Adelaide Press; 2011.

AUTHORS INFO

***Arun G Maiya**, Dean, Professor; address: Manipal, Udupi, Karnataka, India-576104;
ORCID: https://orcid.org/0000-0002-3811-1350; e-mail: arun.maiya.g@gmail.com

Esha Arora; ORCID: https://orcid.org/0000-0003-3406-6799; e-mail: eshampt@gmail.com
Hrishikesh Yadav Korada; ORCID: https://orcid.org/0000-0002-1507-2862; e-mail: hrishi.yadav99@gmail.com
Tom Devasia; ORCID: https://orcid.org/0000-0002-7569-0670; e-mail: tomdevasia@hotmail.com
Ram Bhat; ORCID: https://orcid.org/0000-0002-3242-0881; e-mail: ram.bhat@manipal.edu
Ganesh Kamath; ORCID: https://orcid.org/0000-0003-1020-2717; e-mail: kamath.ganesh@manipal.edu

TO CITE THIS ARTICLE:

Arora E, Yadav H, Maiya A, Devasia T, Bhat R, Kamath G. Profile of Peripheral Arterial Disease in Type 2 Diabetes Mellitus – A Hospital-based observational study in Coastal Karnataka. *Diabetes Mellitus*. 2020;23(4):324–328. doi: https://doi.org/10.14341/DM12260

ЦИТИРОВАТЬ:

Arora E., Yadav H., Maiya A., Devasia T., Bhat R., Kamath G. Профиль заболевания периферических артерий при сахарном диабете 2 типа - стационарное обсервационное обследование, проведенное в Прибрежной Карнатаке // *Сахарный диабет*. — 2020. — Т. 23. — №4. — С. 324–328. doi: https://doi.org/10.14341/DM12260