Original Research Article

A clinical study of peripheral vascular disease due to atherosclerosis in diabetic foot infections

A. Tyagi*, S. Lavanya, G. Hari Prasad

Department General Surgery, ASRAM Hospital, Eluru-534005, West Godhavari District, Andhra Pradesh, India

*Correspondence:
Dr. A. Tyagi,
E-mail: tyagi.swarna20@gmail.com

ABSTRACT

Background: Foot infection is a common problem affecting diabetics. Ischemia is a major factor contributing to progress and morbidity of the disease. The prevalence of peripheral vascular disease is higher in diabetics, with faster progression. The prevalence differs among populations. This study aimed to clinical prevalence of peripheral vascular disease due to atherosclerosis in patients with diabetic foot infections presenting to this tertiary care centre.
Methods: This clinical study was conducted in ASRAM hospital, Eluru, Andhra Pradesh, India. All patients admitted with a diagnosis of diabetic foot infection to the department of general surgery during a period between October 2015 to October 2017, who fulfilled the inclusion and exclusion criteria, were enrolled for the study. After recording the pertinent information (as per performa), patients were subjected to a lower limb arterial Doppler and ABPI findings were tabulated.
Results: Peripheral vascular disease was found in 35% of patients studied. Majority had distal below the knee vessels stenosis or occlusion. There was significant correlation with age, history of tobacco use and various risk factors. The clinical presentations and outcomes were worse in individuals found to have peripheral vascular compromise on arterial Doppler study.
Conclusions: The care of diabetic patients should start with preventive measures which include proper foot care, glycaemic control and education about diabetic foot are key factors for better out come and quality of life.

Keywords: Ankle brachial presser index, Arterial Doppler, Diabetic foot, Peripheral vascular disease

INTRODUCTION

According to International Diabetes Federation (IDF), it was estimated that India has more diabetic patients 74 millions than any other country of the world after China 121 millions.[1] In India prevalence of diabetes range vary from 5-17%, with highest incidences was found in the southern part of the country like Trivandrum 9.2%, Chennai 6.4% and in all urban areas when compared with northern states like Delhi 6.0%, Ballabgarh 2.7%, eastern states like Dibrugargh 2.4% and west/central part of India like Nagpur 1.5%.[2] Diabetic foot is a severe chronic complication and this is the most common serious problems in persons with type 2 diabetes. The diabetic foot is defined as any foot pathology that results directly due to the diabetic state or its long term complications. It is described by the WHO as the foot of a diabetic patient that has the potential risk of pathologic consequences including infection, ulceration and or destruction of deep tissues associated with neurologic abnormalities, various degrees of peripheral vascular disease and/or metabolic complications of diabetes in the lower limb. Of these etiological factors in diabetic foot, peripheral artery disease (PAD) is more common in patients with diabetes and around half of patients with a diabetic foot ulcer have co-existing PAD.[3-5]

Atherosclerosis is the most common pathologic change associated with PAD. Atherosclerosis is a hardening of an artery specifically caused by an atheromatous plaque. The common mechanism is thought to be endothelial cell injury, smooth muscle cell proliferation, inflammatory reactivity, and plaque deposition. A number of causative factors have been identified for atherosclerosis not limited to hyperlipidemia, hypercholesterolemia, hypertension, diabetes mellitus, and exposure to infectious agents or toxins, such as from cigarette smoking, are all important and independent risk factors. Identifying PAD among patients with foot ulceration is important because its presence is associated with worse outcomes, such as a slower (or lack of) healing of foot ulcers, lower extremity amputations, subsequent cardiovascular events and premature mortality.[4,5] Diagnosing PAD is challenging in patients with diabetes, as they frequently lack typical symptoms, such as claudication or rest pain, even in the presence of severe tissue loss.[6-8] Arterial calcification, foot infection, oedema and peripheral neuropathy, each of which is often present with diabetic foot ulceration, may adversely affect the performance of diagnostic tests for PAD.[9-10] Foot disorders such as ulceration, infection, and gangrene are the leading causes of hospitalization in them for Diabetic patients.[9]

Diabetic foot infection is the commonest cause of hospital admission for diabetic patients. In addition to hospitalization, financial cost for the patients with diabetes is high, which include decreased independence, disability, recurrent infections and premature mortality.[10] According to source more than 50% of lower extremity amputations occur in diabetics.[11] The diagnostic test most used to check the asymptomatic population is the ankle-brachial index (ABI). In asymptomatic persons, an ABI <0.9 has a sensitivity >95% and a specificity approaching 100% as compared with arteriography.[12] It is thus important to examine for PAD, even in asymptomatic patients, in order to control the risk factors as soon as possible and reduce mortality.[12]

Arterial Doppler studies and ABPI are useful in determining the presence of peripheral arterial occlusive disease, the level of occlusion or stenosis, the extent as also the presence of collaterals. Doppler studies however need to be coupled with angiography for further vascular interventions. There is a need for systematic evaluation of peripheral vascular disease in all diabetic patients especially patients presenting with diabetic foot infections. The information can help in formulating protocols for effective management of diabetic patients with the aim of limiting the morbidity and social costs associated with the disease.

METHODS

The present study was approved by Institutional Ethics Committee and all patients were enrolled prior after giving their consent form.

Patient's selection

Patients admitted and seen in out patient department of general surgery, ASRAM Medical College, Eluru, Andhra Pradesh, India between October 2015 and October 2017. Patients on admission were evaluated with history taking with emphasis on duration of diabetes, duration of infection, previous history of peripheral vascular disease (PVD), interventions for the same also other co morbid conditions and history of tobacco use either chewing or smoking. Physical examination included besides routine evaluation, specific attention to presence or absence of peripheral pulses and their character and volume. diabetic infections where categorized as

- Cellulitis requiring conservative management.
- Foot abscess/infected ulcer requiring incision and drainage, minor debridement.
- Gangrene/necrosis requiring toe amputations or forefoot amputations/major debridement.

All patients were subjected to lower limb arterial Doppler and ABPI after obtaining consent.[13] The findings were tabulated along with patient data. Doppler findings were tabulated as presence of arterial stenosis or occlusion and level of disease.

Statistical methods

Clinico demographic data was analyzed for statistical significance by using MEDCALC® online software. For comparison of variables for the significances was carried out by using odds ratio and chi- square test, p value of <0.05 was considered of statistical significance.

RESULTS

During the period of study from October 2015 to October 2017, a total of 154 patients with diabetic foot infections were admitted to the department of General Surgery. Of them however 56 (36.36%) patients did not meet one or more inclusion/exclusion criteria. 23 (14.93%) patients who did not give consent for arterial Doppler study or were discharged prior to the fixed date for the study. Three (1.94%) patients had absent peripheral pulses on clinical examination and were thus excluded from the study. Thus 72 (46.75%) patients were included in the study. All patients were treated according to their diagnosis and 34 (47.22%) patients needed amputation or disarticulations with 6 (8.33%) patients needing second surgery 1(1.38%) patient had to undergo below knee amputation. Patients found to have PVD were referred to vascular surgeon for further management.

Table 1 shows clinico demographic factors of patients (n=72) enrolled in this present study. Of the patients it was found that 69% are males and 31% are females. Age distribution was shown in the table and here we found a youngest patient aged of 42-year old, male and oldest was a man aged 72 years. 21% patients fall in 40-50 years age

group and highest enrollment (51%) was in 51-60 years age group and 61 years and above (28%).

Table 1: Clinico demographic factors.

Variables	No. of patients	Percentage
Gender		
Males	50	69
Females	22	31
Age distribution		
40-50	15	21
54-60	37	51
61 and above	20	28
Clinical presentation		
Abscess	06	08
Cellulitis	14	20
Infected ulcers	18	25
Toe gangrene	21	29
Forefoot gangrene	13	18
Duration of diabetes		
<5 years	55	76
>5 years	17	24
Total number of PVD cases		
PVD	23	32
No PVD	49	68
PVD status in males		
PVD	19	38
No PVD	31	62
PVD status in females		
PVD	06	27
No PVD	6	73
Level of arterial stenosis		
Poplitel artery	03	13.04
Distal posterior tibial artery	04	17.39
Distal anterior tibial artery	04	17.39
Both tibial arteries distal	03	13.04
Both tibial artereis proximal	09	39.13

Regarding clinical presentation of the patients as shown in the Table 1, majority of patients presented with abscess, or infected ulcers, frank gangrene either of single or multiple toes or the forefoot and only 20% were cases of cellulitis managed with conservative management. Of 72 patients 76% of patients were diagnosed, with the disease was present for less than 5 years were found to be 76% and 24% of the patients were having disease for greater than 5 years. 32% of the patients showed presence of peripheral vascular disease (PVD) and majority of the patients (68%) did not have PVD.

Presence of peripheral vascular disease as diagnosed by arterial Doppler and ABPI of the 72 patients in the studied population 23 patients or 31.94% were found to have some

form of reduced arterial flow to the lower limb vessels, 49 patients or 68% patients were found to have a normal lower limb arterial Doppler study.

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Table 2: Duration of ailment.

Duration of ailment	<1 week	>1 week
Abscess	06	00
Cellulitis	12	02
Gangrene	00	13
Toe gangrene	01	20
Ulcers	00	18

As can be seen from the Table 2, most patients with cellulitis and foot abscess presented early and patients with infected ulcers, gangrene had delayed admission to hospital.
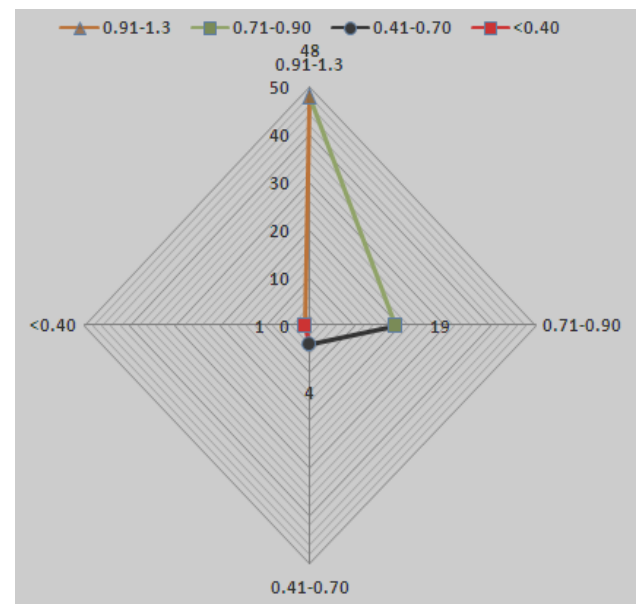

Figure 1: Clinical presentation of ankle brachial pressure index of the patients studied here, we found 67% of the patients were fall in acceptable group, 26% fall in arterial disease positive and 6% patients fall in moderate arterial disease group. Of 72 patients one patient was fell in severe arterial disease group according to ABPI.

From the Table 3, significance for PVD and tobacco usage with gender was found to negative where p showed >0.05.

Presence of peripheral vascular disease at different age intervals was presented in the Table 4 and it was found to be significance.

Table 3: Significance of gender in accordance to PVD risk and tobacco usage.

Variables	Males	Females	OR	95% CI	p-value
PVD	19 (38%)	06 (27%)	1.63	0.5449 to 4.9022	0.4
No PVD	31 (62%)	16 (73%)			
Tobacco users	17	03	3.2	0.8450 to 12.5975	0.08
Non tobacco users	33	19			

Table 4: PVD distribution according to age group and significance.

Age group (in years)	No. of patients (n=72)	PVD status		Chi-square	p-value
		PVD (n=23)	No PVD (n=49)		
40-50	15	02	13		
51-60	37	07	30	18.60	0.00*
61 and above	20	14	06		

*p= significance.

Table 5: Significance of Tobacco usage and PVD risk.

		PVD*		
		No	Yes	Total
Tobacco use*	No	44 (84.61%)	8 (15.38%)	52 (99.99%)
	Yes	5 (25.0%)	15 (75.0%)	20 (100%)
	Total	49 (68.05%)	23 (31.94%)	72 (99.99%)

*p≤0.05 (significance).

Table 6: Significance of duration of diabetes in PVD.

		PVD*		
		No	Yes	Total
Duration of DM	<5 years	39 (70.90%)	16 (29.09%)	55 (99.99%)
	>5years	10 (58.82%)	07 (41.17%)	17 (99.99%)
	Total	49 (68%)	23 (31.94%)	72 (99.99%)

Influence of tobacco usage with PVD risk was assessed here, it was found to be statistically significant where p showed <0.05 (Table 5).

Influence of duration of diabetes mellitus and PVD risk was assessed here, it was found to be statistically insignificant where p showed >0.05 (Table 6).

DISCUSSION

This study aimed to estimate prevalence of peripheral vascular disease due to atherosclerosis in patients with diabetic foot infections presenting to this tertiary care centre. It was reported and we found in this study that diabetic patients with evidence of systemic atherosclerosis were found to be at risk for peripheral arterial disease.[14] In this study, clinical prevalence of PVD was found to be 31.94% with 23 out of 72 patients showing vascular

compromise as diagnosed by arterial Doppler study and ankle brachial pressure index. The prevalence in males was found to be 34% while in females was 27.7%. This however was not found to be statistically significant showing lesser number of female subjects in this study. Also three (03) patients with impalpable peripheral pulses were not included in the study and had they been included then the rate can be assumed to have been higher. Also the patients in the study were asymptomatic and the rate represents more of subclinical peripheral vascular compromise. Prevalence of PAD in diabetic patients was found to be higher in males than females and the age of the patient was found to be above 50 years and more in present study. Although this seems equal, compared to existing studies it correlates with accepted data that progression with age is significant and indeed faster India betics. Age is the main marker of PAD risk. The estimated prevalence of intermittent claudication in persons aged 60-65 years is

35%. However, the prevalence in persons 10 years older (70-75 years) rises to 70% (Table 4).[15,16] Age showed statistical significance with PAD risk.

Greenland P et al discribed there is a need for systematic evaluation of peripheral vascular disease due to atherosclerosis in all diabetic patients specially patients presenting with diabetic foot infections.[17] The distal lower limb vessels were found to be more involved with 88% having lesions in the anterior tibial, posterior tibial or both (52%). The occlusion even among these subjects was found to be more distal (48%). This correlates with existing literature which shows that distal small arteries are more involved in diabetics.[17]

As also present data showed that most patients were diagnosed less than 5 years prior to admission to be diabetic, some were age more than 60 years. The problem of late diagnosis of diabetic status seen in our region could explain the very high prevalence of PVD in older age groups, as by the time the patients presented to a tertiary care centre with complications of diabetes the patho-physiological changes in the foot including vascular compromise were at an advanced level.

Arterial calcification identifying PAD among patients with foot ulceration is important because its presence is associated with worse outcomes, such as a slower healing of foot ulcers, lower extremity amputations, sub sequent cardiovascular events and premature mortality.[4,5,9,10] This study observed, Foot infection with oedema and peripheral neuropathy, ulceration, may adversely affected the performance of diagnostic tests for PAD. Arterial Doppler studies were useful in determining the presence of peripheral Arterial occlusive disease, the level of occlusion or stenosis, the extent as also the presence of collaterals (Table 1).

Atherosclerosis was the most common pathologic change associated with PAD which caused hardening of an artery specifically caused by an atheromatous plaque. However, number of causative factors has been identified for atherosclerosis. Hyperlipidemia hypercholesterolemia, hypertension, diabetes mellitus, and exposure to infectious agents of toxins, such as from cigarette smoking, were all important and independent risk factors studies have found a stronger association between tobacco abuse and PAD and the heavier smokers had a greater risk for PAD in ex-smokers it is 7 times greater than in non-smokers, and in active smokers it is 16 times greater.[9,18-20] The rates of amputations and mortality are also greater in smokers. In this study we found patients out of 23 were smokers' prevalence's 75%.[21] This shows higher prevalence when compared to existing studies (Table 5).

Diagnosing PAD is always tough in diabetic patients due to lack of usual symptoms, such as claudication rest pain, ulcer, gangrene and presence of severe tissue loss. The diagnostic test most used to check the asymptomatic population is the ankle-brachial index (ABI). In asymptomatic persons, an ABI <0.9 has a sensitivity >95% and a specificity approaching 100% as compared with arteriography.[22] It is thus important to examine for PAD, even in asymptomatic patients, in order to control the risk factors as soon as possible and reduce mortality.[12]

The prevalence of PAD, both symptomatic and asymptomatic, is greater in men than in women, especially in young persons in this study. Moreover, the prevalence in men is greater for the more severe degrees of involvement (critical ischemia). This study also proved this with previous studies. The presence of PVD was found in 6 of the 22 female patients with a prevalence rate of 27%. Patients with an ABI <0.5 had a 2-fold higher risk of requiring revascularization surgery or major amputation as compared with patients whose ABI was >0.5. In this study we found one person <0.5, had ABI, he underwent BKA.

Diabetes is not only a qualitative risk factor, it is also a quantitative risk factor as each 1% increase in glycosylated haemoglobin is associated with a 25% increase in the risk for PAD.[23] In this study we did not find statistical correlation for duration of diabetes and risk of PVD due to inadequate sample size and history of HbA1c from the study population (Table 6).

CONCLUSION

Identification of peripheral vascular disease in patients presenting with diabetic foot infection, using arterial Doppler studies and ABI along with routine clinical and laboratory assessment can be of great value in long term care of these individuals. The patients might not all be symptomatic or show obvious signs of PVD but need to be investigated for the same. The rate of prevalence in the present study was 34%. The older the individual the more the chances of having peripheral vascular compromise. Also a tobacco user and patient presenting with worse clinical findings is more likely to have PVD. This study and that of others before it has consistently proven the need and benefit of investigating diabetics for peripheral ischemia and the value of the same in giving better care to these patients. The care of diabetic patients should start with preventive measures, and it is important to avoid infections in patients with insensate feet because of neuropathy and educating about strict glycemic control will help to minimizing the foot complications.

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