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Incidence of Peripheral Arterial Disease in Diabetic Foot Infection Patients: A Prospective Study

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Abstract

A prospective study was conducted on 30 patients with Diabetes. Patients were evaluated on the basis of history, clinical examination, laboratory investigations, conventional radiological investigations and Arterial Doppler lower limb and Ankle Brachial Index assessment of the affected foot. The incidence and prevalence of peripheral vascular disease (PAD) increases with age in both diabetic and non-diabetic subjects and, in those with diabetes, increases with duration of diabetes[1] Given the inconsistencies of clinical findings in the diagnosis of PAD in diabetic patient, measurement of ankle brachial pressure index (ABPI) has emerged as the relative simple, non-invasive and inexpensive diagnostic tool of choice. An ABPI < 0.9 is not only diagnostic of PAD even in asymptomatic patients, but is also an independent marker of increased morbidity and mortality from cardiovascular disease. In our study all thirty (100%) patients presented with ulcer. Twenty-two (73%) presented with single ulcer while eight (27%) patients presented with multiple ulcers. 86% patients had inadequate blood sugar control. 40% of patients presented with Grade II ulcers (according to Wagner's Classification) followed by Grade III (37.5%) and Grade I (16%). Radiological examination of the foot showed changes in 17 (56%) patients. Commonest finding was osteomyelitis 7(23%) patients. 18(60%) patients were found to have peripheral arterial disease diagnosed on the basis of decreased ABPI (ankle brachial pressure index). One patient (3%) had ABPI abnormally high (value >1.4) due to calcification of wall and 11 (36%) had normal ABPI. Lower values of ABPI were observed with worsening of ulcer grade on Wagner Classification. We conclude that ABPI is very important non invasive adjunct for diagnosis of peripheral artery disease in diabetic patients.
Key words: *ABPI- Ankle Brachial Pressure Index : PAD- Peripheral Arterial Disease.*

Introduction

Peripheral arterial disease (PAD) has long been recognized as a risk factor in the development of non-healing foot ulcers and lower extremity amputations in people with diabetes[1]. The American Diabetes Association in a consensus

statement (ADA, 2003), has called for Peripheral arterial disease screening in all people over the age of 50 years who have diabetes and in people under the age of 50 years with diabetes, who have other associated risk factors such as hypertension, hypercholesterolemia, a smoking habit, or diabetes duration of 10 years or more[2,3]. Peripheral vascular disease in diabetes is compounded by the presence of peripheral neuropathy and by susceptibility to infection. These confounding factors in diabetic patients contribute to progression of peripheral vascular disease to foot ulcerations, gangrene, and ultimately to amputation of part of the affected extremity. Diabetes accounts for ~50% of all non-traumatic amputations in the United States. Globally, diabetic foot infections are the most common skeletal and soft-tissue infections in patients with diabetes. Foot ulcers occur in 5-10% of all diabetic patients and up to 3% will have lower limb amputations during their life time. The overall risk of amputation is increased by 15 folds in diabetics than non-diabetic population. Authorities now accept that a reduced arterial pressure, neuropathy, abnormal pressure loading, and susceptibility to infection constitute major factors in pathogenesis of diabetic foot[4]. The mortality risk is higher in patients with chronic osteomyelitis and in those with acute necrotizing soft-tissue infections. Among the factors predisposing the diabetic patients to foot infections are poorly understood host defenses and immunological disturbances. The anatomy of the foot may lead to proximal spread of infection, and favor ischemic necrosis of confined tissues[5,6]. The ABPI is a useful tool to measure prevalence as well as severity of peripheral arterial disease. ABPI value is the ratio between Doppler-measured systolic blood pressure in the lower and upper limb extremities. An ABPI value of < 0.9 diagnoses peripheral vascular disease[7].Arterial Doppler studies are useful in determining the presence of peripheral arterial occlusive disease, the level of occlusion or stenosis, the extent and also the presence of collaterals. There is a need for

systemic evaluation of peripheral arterial disease in all patients with diabetes and especially in 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, mortality and social costs associated with this disease.

Material and Methods

This study was conducted in IGMC Shimla in the department of Surgery in collaboration with the department of Radiodiagnosis on 30 patients having diabetic foot infection presenting to OPD as well as from indoor ward during July 2013 to June 2014 after obtaining necessary permission from ethical committee. Written consent was obtained from every patient for inclusion in present study. Patients included were those with diabetic foot infection and more than 18 years of age, willing for Ankle brachial pressure study, willing for Arterial Doppler study and all grades ulcers of Wagner's classification. Patients with previous history of surgeries for arterial occlusive disease, suffering from co-existent conditions which could lead to ulceration in lower limb i.e. connective tissue disorder, varicose veins, immune system disorder, and malignancy and with severe sepsis or amputation were excluded from this study. In every case detailed history was taken, and thorough clinical examination was done including, Peripheral pulses, Signs of ischemia, Types and Grading of ulceration on the basis of Wagner's classification. Required investigations including Fasting and post prandial blood sugar, HBA1C, Lipid profile, Pus culture sensitivity and X-ray foot, Doppler study to measure Ankle Brachial Pressure index and Arterial Doppler study for level of occlusion or stenosis were done in every case.

Method of Measuring ABPI

The systolic blood pressure in both arms is measured using Doppler ultrasound and a sphygmomanometer. The sphygnomanometer cuff is inflated proximal to the artery in question till pulsations cease. Now cuff is deflated slowly till

pulsations reappear and detected by ultrasound. This is systolic blood pressure for the arm (Parm) . The higher systolic reading of the left and right arm brachial artery is generally used in the assessment. The pressures in each foot's posterior tibial artery and dorsalis pedis artery are measured with the higher of the two values used as the pressure for leg (Pleg). ABPI is the ratio of Parm to Pleg for that leg.(8

Arterial Doppler Patients were kept fasting for at least 6 hours to improve visualization of the aorto-iliac region, the access to which is hindered by the overlying bowel gases. Triplex scanning was performed on GE LOGIQ P6 scanner having band width frequency transducer with a range of 6-12 MHz and 2-6 MHz. The examination was commenced from the abdomen to scan the infrarenal aorta, followed by iliac arteries, common femoral, superficial femoral (supine position) and finally popliteal arteries (prone position). Collaterals were evaluated simultan-eously. Colour flow assisted B-mode was used to rapidly map the vessel of interest and locate the lesion followed by use of gray scale sonography to identify morphology features like plaques calcification and thrombus. Pulse Doppler was then used to analyze spectral waveform and to measure Peak systolic velocity (PSV). Arterial lesions were located by changes in colour flow pattern, changes in vessel diameter and broadening of spectrum, whereas stenosis was quantified by change in PSV and PSV ratio with respect to a point with normal flow pattern in the lumen at least 4cm proximally. Data was recorded on proforma summarizing the location of normal / insignificant stenosis (0-49%), significant stenosis (50-99%) and occlusion (100%) and the length of occlusion / stenosis were measured in millimeters. Patency of the vessel was determined by the normal triphasic pattern and colour saturation demonstrated throughout the lumen of the artery. Occlusion was diagnosed when no colour saturation and no Doppler waveform was seen in the artery. A hemodynamically significant stenosis was inferred when waveform changes

from triphasic to monophasic waveforms, with appearance of spectral broadening and increase in Peak systolic velocity.

Observations

Age and sex distribution of patients is depicted in table-1 and duration of diabetes in table-2.

Table – 1 Age and Sex Distribution

Age (in years)	Sex	
	Male	Female
< 30	00	00
30 – 40	03	00
41 – 50	07	01
51 – 60	08	01
61 – 70	06	00
71 – 80	03	01
Total	27	03

Out of 30 patients, 27(90%) were males and 3(10%) were females. Male to female ratio was 9:1.

Table –2 Duration of Diabetes Mellitus

Duration of diabetes (in years)	No. of Patients
Diagnosed for 1st time	7
≤ 5	3
6 – 8	8
9 – 15	9
16 – 20	2
> 20	1
Total	**30**

23(76%) patients were known diabetics while 7 (23%) patients were diagnosed to have diabetes for first time. 20(67%) patients had diabetes duration of more than 6 years.

12(40%) patients presented with intermittent claudication. Brachial and radial arteries were palpable on both right and the left upper limbs in all (100%) patients. In the lower limbs, femoral artery was palpable in both right and the left limbs in all (100%) patients.

Anterior tibial artery was palpable in 18(60%) patients in right lower limb and was palpable in 20(66%) patients in left lower limb. Posterior tibial artery was palpable in 16(53%) patients in the right lower limb. It was palpable in 14(46%) patients in the left lower limb. Dorsalis pedis artery was palpable in 9(30%) patients on the right

side and it was palpable in 7(23%) patients on the left side.

All patients presented with ulcers. 22 (73%) patients had single while 8(27%) had multiple ulcers. According to Wagner's classification 12 (40%) were grade II, 7(23%) ulcers were grade – III, 5 (16%) ulcers were grade I, 4 (14%) were grade IV and 2(7%) were grade V.

Ten (33%) patients presented with fasting blood sugar levels between 151 – 250 mg%. Eight patients presented with post prandial blood sugar levels <200 mg%. Ketone bodies were absent in the urine of all patients. 8(27%) patients had

HbA1c levels below 7.0 and Mean value was 8.32.

Total cholesterol level was within normal limits in 6(20%) patients. High Density Lipoprotein (HDL) and Low Density Lipoprotein (LDL) were within normal limits in 18(60%) patients each. Very Low Density Lipoproteins (VLDL) were within normal limits in 9(30%) patients and increased in 21(70%) patients. Triglycerides level was within normal limits in 4(13%) patients and increased in 26 (87%) patients. 26(87%) patients had hypertriglyceridemia as shown in table-3

Table-3   Lipid Profile

	(Normal level(mg%)	No. of Patients	Increased	Decreased
Total cholesterol	< 200	06	244	00
HDL	> 35	18	00	12
LDL	< 130	18	12	00
VLDL	< 40	09	21	00
Triglycerides	65 -165	04	26	00

Clinically cellulitis was seen in 2(6%) and abscesses in 6 (20%) patients, neuropathic ulcer in 5(16%) and and ischemic in 9(30%) patients. Eight (27%) patients were diagnosed with neuro-ischemic ulcers.

X-ray foot showed changes in 17(56%) patients. Out of these, 7(23%) had osteomyelitis, 4(13%) patients had loss of foot arch, 4(13%) patients showed demineralization of bones. Pathological fracture was noted in 2(6%) patients. In our study 23(76.7%) patients were already on anti-diabetic medications prior to admission and 7(23.3%) were newly diagnosed. At the time of discharge 6(20%) patients were on insulin therapy while remaining 24 (80%) were on oral medication. 7(23.3%) patients required minor amputations and one (3.3%) had above knee amputation. E. coli were found in 13(43.3%), Streptococcus in 7(23.3%),

Proteus in6 (20%) and mixed bacterial cultures(aerobic and anaerobic) were found in4(13.3%) cases. ABPI observed is shown in Table-4

Table-4 Ankle Brachial Pressure Index

Range	Type	No. of patients
>1.4	Abnormally igh	1
>0.9	Normal.	11
0.9-0.6	Mild	8
0.6-0.3	Moderate	7
<0.3	Severe	3

Patients having ABPI <0.9 were considered of having PAD. 18 (60%) patients were diagnosed of having PAD while 11 (36%) had normal ABPI. Abnormally high reading was found in 1(3.3%) patient due to calcification of vessel wall.

Table- 5 Vasculopathy In Patients With Diabetic Foot Using Doppler Ultrasound

Vessels affected	No. of patients
Femoral	0
Popliteal	2
Anterior tibial artery	10
Posterior tibial artery	18
Dorsalis pedis artery	15

On Arterial Doppler most common vessel affected was Dorsalis pedis in 15 (50%) patients. Posterior

tibial in 18(60%), Anterior tibial in 10(33%) and Popliteal in 2(7%) patients.

Table-6 ABPI and Wagner Grading of ulcer

ABPI	Wagner Grade of ulcer				
	G I	G II	G III	G IV	G V
> 1.4	1	0	0	0	0
>0.9	4	7	0	0	0
0.9-0.6	0	3	5	0	0
0.6-0.3	0	2	2	3	0
<0.3	0	0	0	1	2

1 (3%) patient was having ABPI >1.4 and G I ulcer of foot. 11(36%) had normal ABPI.4 (36%) had Grade I ulcer while 7 (64%) had Grade II ulcer. 8 (27%) had ABPI in range of 0.9-0.6. Three (37%) had Grade II ulcer while Five (63%) had Grade III ulcer. 7 (23%) had ABPI in range of 0.6-0.3. Two (28.5%) had Grade II, two (28.5%) had Grade III and three (42%) had Grade IV ulcer. ABPI <0.3 was found in three(10%) patients . Two of them (66%) had Grade V ulcer while 1out of three had Grade IV ulcer.

Discussion

This study was conducted to know the incidence of peripheral vascular disease in diabetic patients using ABPI and assess the level of occlusion or stenosis in peripheral vessels using arterial Doppler. 76% patients were between the ages of 41-70 years. Male to female ratio was 9:1. 57% patients presented with known history of diabetes mellitus for last 6-15 years and is in accordance with other studies[6,10]. Twelve (40%) patients presented with intermittent claudication. Two patients (6%) presented with rest pain. All 30 (100%) patients presented with ulcer. Dorsalis pedis artery was the most frequent artery which was not palpable followed by posterior tibial artery and anterior tibial artery respectively and is in accordance with studies[9,12]. 86% patients had inadequate blood sugar control. In the present study lipid profile showed that hypertriglyceridemia was present in 87% patients and hypercholesterolemia was present in 80% patients

as found in study by Hankey et al al and Hiatt et[7,19]. *E-coli* was the most common organism isolated from pus culture of affected foot 36% followed by *streptococcus* and *proteus* and some patients had mixed culture and agrees with studies by Wheat et al(18) Radiological examination of the foot showed findings of osteomyelitis in 7(23%) patients followed by loss of foot arch. Most of patients presented with Grade II ulcers (according to Wagner's Classification of Diabetic foot ulcers) i.e. in 40%, followed by Grade III (37.5%) and Grade I (16%). Neurogenic ulcers were diagnosed in 5(16.6%), ischaemic in 9(30%) and neuroischaemic in 8(26.6%) cases. These findings are in accordance with studies by Cyrus et al, Boyko et al and Fagerberg et al[13,16,17]. All patients were treated conservatively initially and 7(23.3%) required minor amputatios of toes. One patient had to undergo above knee amputation. 18(60%) patients were found to have peripheral arterial disease diagnosed on the basis of decreased ABPI (ankle brachial pressure index). One patient (3%) had ABPI abnormally high (value >1.4) due to calcification of vessel wall. 11 (36%) had normal ABPI. Eight patients (26%) had mildly deranged ABPI while seven (23%) had moderately deranged ABPI. Three (10%) had severe derangement of ABPI[9,11,15]. Most common vessels affected were posterior tibial (60%) followed by dorsalis pedis artery in(50%) cases[21-23]. Lower values of ABPI were observed with worsening of ulcer grade on Wagner Classification[18-20]. Studies have shown the sensitivity of

ABPI is 90% with a corresponding 98% specificity for detecting hemodynamically significant stenosis >50% in major leg arteries, defined by angiogram[8,9]. An index of <0.9 is suggestive of occlusive peripheral vascular disease (reference value peripheral arterial disease in diabetics.

Conclusion

A significant number of diabetics presenting with foot infections have underlying peripheral arterial disease .The patients might not all be symptomatic or show obvious signs of PAD, but need to be investigated for the same. The incidence of PAD in the present study was 60%. The older the individual the more the chances of having peripheral vascular compromise. The treatment outcomes, the need for amputations, is more likely in individuals with diabetes and PAD. Thus the detection of peripheral vascular disease in patients presenting with diabetic foot infection, can be of great value in long term care of these individuals. Many studies have consistently proven the need and benefit of investigating diabetics for peripheral ischemia. The American Diabetes Association has called for Peripheral arterial disease screening in people over the age of 50 years who have diabetes and in people under the age of 50 years with diabetes, who have other associated risk factors such as hypertension, hypercholesterolemia, a smoking habit, or diabetes duration of 10 years or more. Given the inconsistencies of clinical findings alone in the diagnosis of PAD in diabetic patients, thorough screening which includes systematic examination and risk assessment aided by ABPI, patient education, and timely intervention may further reduce the unnecessarily high prevalence of lower-extremity morbidity and amputations in the diabetic population. ABPI levels < 0.8 indicate peripheral arterial disease regardless of symptoms. Hence measurement of ankle brachial pressure index (ABPI) which is <0.9 in our study, has emerged as the relative simple, non- invasive and inexpensive diagnostic tool for PAD in diabetics even in asymptomatic patients. particularly if symptoms or clinical findings such as bruits or absent pulses are present.

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