PERIPHERAL ARTERIAL DISEASE
(PAD) IN TYPE 2 DIABETIC PATIENTS

DR. ATIF SITWAT HAYAT
MBBS, M.D (Medicine)
Consultant Physician,
Assistant Professor of Medicine
Northern Institute of Medical
Sciences (NIMS) Abbottabad,
NWFP, Pakistan.

DR. MOHAMMAD ADNAN BAWANY
MBBS, FCPS (Medicine)
Consultant Physician
Isra University Hospital Hala Road
Hyderabad, Sindh, Pakistan.

DR. GHULAM HUSSAIN BALOCH
MBBS, M.D (Medicine), DIP-Card
Assistant Professor of Medicine
Liaquat University of Medical and
Health Sciences Jamshoro, Sind, Pakistan.

Dr. Naila Shaikh
MBBS, DCP
Senior Lecturer Pathology
Liaquat University of Medical and
Health Sciences Jamshoro, Sind, Pakistan.

ABSTRACT... Background: The increase in prevalence of type 2 diabetes and its complications is alarming. The incidence of diabetic foot ulcers due to peripheral arterial disease, which leads to foot amputations far too often, is unacceptably high especially in developing countries. This study has been conducted to find out frequency and degree of peripheral arterial disease in type 2 diabetics having foot ulcers at tertiary care settings in Abbottabad. **Methods:** This was a prospective descriptive study-being conducted at Northern Institue of Medical Sciences (NIMS) and Ayub teaching hospital Abbottabad from August 2009 to June 2010. Type 2 diabetics with non-healing foot ulcers lasting longer than ten days, were selected for this study by non-probability purposive sampling method. All study subjects have undergone for palpation of peripheral arterial pulses in the lower limbs. Ankle-brachial index (ABI) is the ratio of the systolic blood pressure at the ankle to that in the arm. Peripheral arterial disease (PAD) was considered to be present if ABI was less than 0.90. It was further graded as mild, moderate and severe according to ABI values between 0.70-0.90, 0.50-0.69 and less than 0.49 respectively, as per recommendations of American Diabetes Association. **Results:** A total of 83 type 2 diabetics with foot ulcers were enrolled during eleven months period of this study. The mean age of study subjects was 53.68±9.51 years. There were 33 (39.75%) males and 50 (60.24%) females with M to F ratio of 1:1.51. Mean duration of diabetes was 13.67±5.80 years (ranging from 9-23 years). Majority 57 (68.67%) of our patients were obese having poor glycemic control. Peripheral arterial disease has been found in 35(42.16%) patients, out of them 18(51.42%) had mild PAD as their ABI values remained between 0.70-0.90, 15(42.85%) had moderate PAD due to their ABI values between 0.50-0.69 and 2 (5.71%) had severe PAD as their ABI values lie below 0.49. **Conclusions:** Ankle-brachial index is a non-invasive, inexpensive and office-based diagnostic tool for peripheral arterial disease in type 2 diabetics having foot ulcers, Healthcare professionals must be trained about early referral and regular feet care of these patients.

INTRODUCTION

Diabetes mellitus is a growing global health concern. Worldwide prevalence of type 2 diabetes mellitus has been estimated to rise from 150 million to 225 million by the end of 2010 and to as many as 300 million by 2025[1,2]. According to International Diabetes Federation (IDF), Pakistan is at the 7th rank on diabetes prevalence list. In Pakistan, 6.9 million people are affected by diabetes mellitus with IDF estimating that it will grow to 11.5 million by 2025 unless preventive measures are taken to control the disease[3].

Peripheral arterial disease (PAD) is one of the major complications of diabetes mellitus, which may result in diabetic foot ulcer-being four times more prevalent in diabetics than non-diabetics and hence can lead to limb amputations[4]. Diabetic foot ulcers are a common and much feared complication of diabetes, with recent studies suggesting that the lifetime risk of developing a foot ulcer in diabetic patients may be as high as 25%[5]. In Pakistan, 15% of diabetics suffer from foot problems[6]. Foot ulceration requires long and intensive treatment, has adverse effects on quality of life of both patients and care-givers[7] and is associated with major healthcare costs[8-11]. The development of a foot ulcer in diabetics, is traditionally considered to result from a combination of peripheral arterial disease, peripheral neuropathy, infections and co-morbidities. Peripheral arterial disease is present in approximately one-half of all patients with diabetic foot ulcers[12], and is considered an important

predictor of outcome[13,14].

Unfortunately, at present there is no integrated foot care strategy exist at most healthcare facilities in our country especially Abbottabad, hence we conducted this study in order to explore frequency and degree of peripheral arterial disease in type 2 diabetic patients having foot ulcers at tertiary care settings. Therefore, purpose of this study is early diagnosis of peripheral arterial disease and prevention of diabetic foot ulcers via ankle-brachial index (ABI) measurement.

PATIENTS AND METHODS

This prospective descriptive study has been conducted at Northern Institute of Medical Sciences (NIMS) and Ayub Teaching Hospital Abbottabad from August 2009 to June 2010. The study group comprised of 83 consecutive type 2 diabetic patients with foot ulcers – being non-healing and lasting longer than ten days by non-probability purposive sampling method. They were kept in medical wards of the above tertiary care hospitals for specific duration and underwent relevant investigations and their glycemic index was tightly controlled until cured. The protocol for this study has been approved by Ethical Committee of the institutes and an informed and written consent taken from all study participants.

The inclusion criteria was all type 2 diabetic patients with foot ulceration and with or without symptoms of limb ischemia (peripheral arterial disease). Type 1 diabetics, cigarette smokers and elderly patients with severe medical co-morbidities were excluded from this study.

A complete medical history has been taken; including parameters like age, sex, duration of diabetes, history of foot injury, ill-fitting shoes or in growing toe-nails, type of treatment received previously and status of glycemic control. In addition, patients were also inquired about history of rest pain in calf and intermittent claudication (PAD). All study subjects have undergone for detailed general physical and systemic examinations with special emphasis on palpation of peripheral arterial pulses in the lower limbs i.e. femoral, popliteal, posterior tibial and dorsalis pedis arteries. A local examination include inspection of the feet and legs noting the shape, any deformity, site and extent of foot ulcers and evidence of

gangrene. Meggitt and Wagner[15] assessed diabetic foot ulcers severity through following grades as shown in table-I.

Table-I. Meggitt and Wagners's criteria for grading of diabetic foot ulcers.	
Grades	Severity of diabetic foot ulcers
0	Intact skin
I	Superficial ulcer
II	Deep ulcer to tendon, bone, or joint
III	Deep ulcer with abscess or osteomyelitis
IV	Localized (Forefoot) gangrene
V	Whole foot gangrene

The laboratory evaluation include complete blood count (CBC), fasting and post-prandial plasma glucose estimations, HbA1c, urine examination for proteinuria, ECG, serum lipid profile, serum creatinine, X-ray chest (PA view) and x-ray of affected foot (AP and lateral views).

Ankle-brachial index (ABI) also sometimes called the ankle-brachial pressure index (ABPI)[16] or the ankle-arm index (AAI)[17] is the ratio of the systolic blood pressure at the ankle to that in the arm. It is a non-invasive, inexpensive and office-based diagnostic tool for peripheral arterial disease in type 2 diabetics having foot ulcers.

Ankle-brachial index (ABI) was measured by handheld Doppler Ultrasound device plus pneumatic cuff arm {sphygmomanometer} and mid-level of the corresponding calf. Reading of ankle pressure was the nominator while that of brachial pressure as denominator. Both observations were divided and index has been obtained and interpreted as per recommendations of American Diabetes Association[18]. Peripheral arterial disease was considered to be present if ankle-brachial index was less than 0.90. It was further graded as mild, moderate and severe according to ABI values between 0.70-0.90, 0.50-0.69 and less than 0.50 respectively.

The data of type 2 diabetics with foot ulcers was collected on a pre-designed proforma and analysed by SPSS version 10.0. Means with standard deviations (SD ±) were calculated for age and duration of diabetes, while frequencies and proportions for gender, ABI grades (mild, moderate and severe) and Meggitt and Wagner's classification. Pearson co-efficient had been used to determine any correlation between ABI and Meggitt and Wagner's criteria for diabetic foot ulcers.

RESULTS

A total 83 patients having diabetic foot ulcers were enrolled during eleven months period of this study. Their age ranged between 37-71 years and mean age of study subjects was 53.68±9.51 years. There were 33 (39.75%) males and 50 (60.24%) females with M to F ratio of 1:1.51 showing preponderance of the females during this study. Mean duration of diabetes was 13.67±5.80 years (ranging from 9-23). Majority 57 (68.67%) of our patients were obese having poor glycemic control. In this study, 57 (68.67%) of patients were taking oral anti-hyperglycemic drugs and 18 (21.68%) on insulin therapy, while 8(9.63%) were not taking any medication at all. Among 83 study participants 35(42.16%) had been suffering from peripheral arterial disease (PAD). Out of these 35 patients, 18(51.42%) had mild PAD as their ABI values remained between 0.70-0.90, 15(42.85%) had moderate PAD due to their ABI values between 0.50-0.69 and 2 (5.71%) had severe PAD as their ABI values lie below 0.49. It has been shown in table II.

Table-II. Different pattern of peripheral arterial disease in type 2 diabetic patients (n=83)

Pattern of PAD	ABI range	No. of patients	%age
Normal	0.91-1.0	48	57.83%
Mild	0.70-0.90	18	51.42%
Moderate	0.50-0.69	15	42.85%
Severe	<0.49	02	5.71%

Out of 50 female patients 24 (48%) were the victims of PAD and rest of them 26 (52%) have no PAD. On contrary, out of 33 male patients 11 (33.3%) were suffering from PAD while 22 (66.6%) have no PAD. Out of 35 patients having PAD, only 15(42.85%) had a history of

intermittent claudication, 3(8.57%) had suffered from rest pain before development of diabetic foot, while 17(48.57%) remained asymptomatic.

We have graded the study subjects according to Meggitt - Wagner's Criteria and found that no patient was in grade 0 and only 2(5%) in grade V, while majority 33 (79.4%) in grade I and 32 (76.3%) in grade II. Only 13 (31.1%) were in grade III and 3 (8%) in grade IV. The details were shown in table no III.

Table-III. Severity of Diabetic Foot Ulcers according to Meggitt-Wagner's criteria (n=83)

Grades	Gender	
	Males (n=33)	Females (n=50)
0	0	0
I	13 (39.4%)	20 (40%)
II	12 (36.3%)	20 (40%)
III	5 (15.1%)	8 (16%)
IV	2 (6%)	1 (2%)
V	1 (3%)	1 (2%)

Meggitt-Wagner's foot ulcer grades were correlated with ABI levels by using Pearson co-efficient (r). There was an inverse relation suggesting that more the peripheral arterial occlusion, severe will be foot ulcer grade. This correlation was significant at the level of 0.01 (2 tailed) as shown in following graph.

Fig. Showing co-relation foot ulcer grades and Ankle Brachial Index (ABI); significant at 0.01 level (2 tailed)
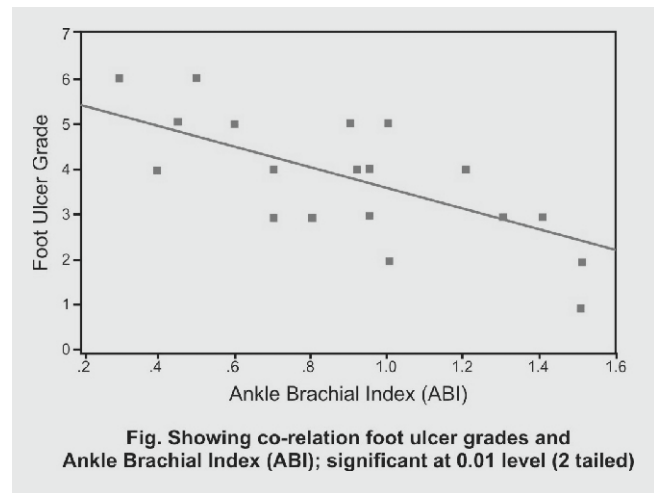
DISCUSSION

Peripheral arterial disease (PAD) affects between 5 and 10 million Americans and is a significant cause of morbidity and mortality[19,20]. Although a majority of patients are asymptomatic at the time of diagnosis, a percentage of patients with PAD will present with intermittent claudication, characterized by cramping pain in the legs with exertion that is relieved by rest. The most common cause for PAD in the lower extremity is atherosclerosis. Type 2 diabetes mellitus increases the risk for development of lower extremity arterial disease and hence limb ischemia. Furthermore, PAD now-a-days became a major public health concern in both developed as well as developing countries of the world.

Patients with longstanding diabetes mellitus are more likely to have more severe PAD of lower limbs[21, 22] and suffer from claudication symptoms[23]. Thus, the risk of a type 2 diabetic patient to develop lower extremity peripheral arterial disease and possibly chronic limb ischemia is correlated to the severity and duration of the diabetes[24,25]. Furthermore, moderate-to-severe PAD in diabetic patients may be asymptomatic due to peripheral neuropathy[26]. Therefore, PAD and or peripheral neuropathy might lead to foot ulcers, even after a minor trauma with superadded bacterial infections completing the clinical picture of a diabetic foot.

In addition to negative impact on quality of life caused by symptomatic PAD, patients with PAD also have a five-to six-fold increase in risk of morbidity and death from other atherosclerotic vascular diseases such as coronary artery disease (CAD) and stroke[27]. Since various etiological factors contribute to the development of foot ulcers in type 2 diabetics, PAD is the most important one that can be detected at an early stage by measuring ankle-brachial index (ABI). The ABI is an accurate measure (ABI<0.9 has a sensitivity of 95% and specificity of 100% in detecting PAD) that is non-invasive, inexpensive, office-based and can be reliably performed by primary-care providers and other healthcare professionals[28,29].

In this study, we are mainly concerned with frequency of PAD in type 2 diabetics having foot ulcers, and found that 42.16% of our patients have suffered from PAD which is quite similar to the study by Ince[30], who discovered PAD in 42.7% of their patients. This study has been conducted at UK in 2007 and dominant factors affecting healing process in diabetic foot ulcers were cross-sectional area at presentation and degree of PAD. In addition, results of our study closely match to a recent study conducted by Ansari[31] in 2009, which showed PAD in 44.7% of their patients. Majority of our patients have mild-to-moderate PAD, which is quite similar to the results of studies by Ansari[31] and Ali J[32]. Khammash MR[33], conducted a study on 60 patients with diabetic foot ulcers and he observed ischemia due to PAD in 35 (58.4%) patients. Among them 27 (45%) had moderate PAD (as their ABI lies between 0.5-0.9) and 8(13.3%) had severe PAD (as their ABI was below 0.49). This is contrary to our study in which 18(51.42%) had mild PAD, 15(42.85%) had moderate PAD and 2 (5.71%) had severe PAD. This variation may probably be caused by late presentation to vascular surgeons because majority of patients present to surgeons at an advanced stage of disease due to fear of operation. A local study by Ali SM[34] showed 58% of their diabetic foot ulcer patients have PAD; amongst them 65% were males and 35% females showing male dominancy. This is in contrast to results of our study, in which 39.75% were males and 60.24% females showing female preponderance. The female gender was also dominant in a study by Ali J[32] at Abbottabad. This may be because majority were illiterate, sedentary and obese having poor glycemic control hence predispose them to have PAD.

RECOMMENDATIONS

The following recommendations can be helpful at primary healthcare level for type 2 diabetics having foot ulcers.

Avoid illiteracy, different cultural beliefs, bare-foot walking and organization of regular interactive workshops (Continued Medical Education programs) for regular feet care in type 2 diabetics at primary healthcare centers in order to improve awareness among health care professionals.

Educate patients about the importance of optimizing

glycemic control, using appropriate foot-wear at all times, avoiding foot trauma, performing daily self-examination of the feet, and reporting any changes to primary care physicians.

Ankle-brachial index (ABI) is a sensitive and specific marker for type 2 diabetics having foot ulcers. Therefore, it should be performed by primary care providers as screening test for early detection of peripheral arterial disease.

Type 2 diabetic patients having peripheral arterial disease or critical limb ischemia should be referred to appropriate specialists to deal with these problems.

CONCLUSIONS
On conclusion, we discovered peripheral arterial disease in majority of our type 2 patients having diabetic foot ulcers, which have adverse effects on quality of life and imposing a heavy economic burden on the patient as well as healthcare budgets especially in developing countries. Hence early detection about the cause of diabetic foot ulcers via ankle-brachial index measurement should be done because it is a non-invasive, inexpensive and office-based diagnostic tool having 95% sensitivity but 100% specificity. Therefore, healthcare professionals must be trained about early referral and regular feet care of these patients.

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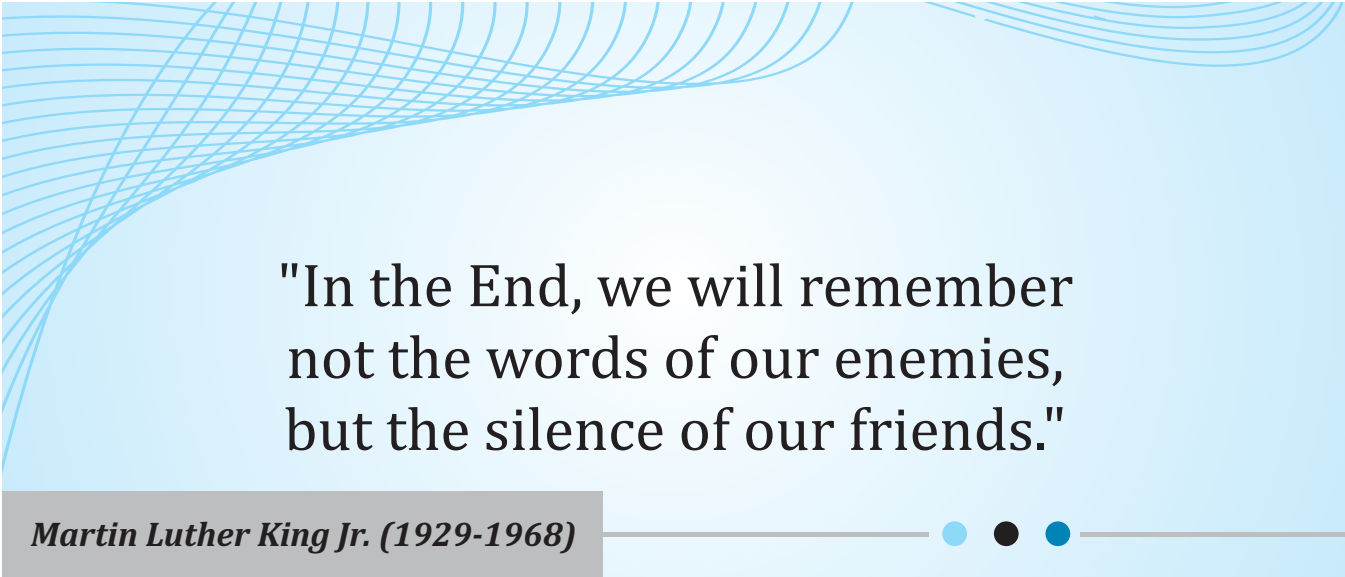
Correspondence Address:
Dr. Atif Sitwat Hayat
Consultant Physician,
Assistant Professor of Medicine
Northern Institute of Medical Sciences (NIMS),
Abbottabad
NWFP, Pakistan.
ashayat@hotmail.com

"In the End, we will remember not the words of our enemies, but the silence of our friends."

Martin Luther King Jr. (1929-1968)