

Evaluation of Dorsalis Pedis Artery Calcification in Relation to Duration of Diabetes

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Diabetes often associated with peripheral vascular disease, commonly affecting the older age group of population having longer duration of diabetes. This cross sectional study was carried out on 110 consecutively selected diabetic patients referred to the Department of Radiology and Imaging of Bangabandhu Sheikh Mujib Medical University and BIRDEM hospital for X-ray of foot. In 92 patients analyzed the mean age of the patients was 54.7±6.4 years and the lowest and highest ages were 45 and 63 years respectively. Sixty four percent of the patients were male giving a male to female ratio of roughly of 2:1. Slightly less than half (43.5%) of the patients were retired from service, about 16.3% were involved in household work, 9.8% in service, another 9.8% in business and remaining 6.5% in farming and one-third (33.7%) of the patients were overweight and obese. The proportion of patients with intermittent claudication (pain on walking and relieved by rest) and ulceration on foot were much higher in patients suffering from diabetes for a longer duration (≥10 years) compared to those who were suffering from the disease for a shorter duration (<10 years). Presence of arteria dorsalis pedis pulse was significantly less in patients with longer duration of diabetes (22.1%) than that in those with shorter duration (75%). About 13.2% of patients with longer duration of diabetes presented with gangrene on foot and 39.7% with peripheral neuropathy as opposed to none in those with shorter duration of diabetes. In terms of presence of potential risk factors of PVD, over 87% of shorter duration had hypertension, 25% had history of IBD of past MI and another 25% past history of stroke which in old diabetics were 91.9% and 51.5% respectively. Smoker and ex-smoker were almost equally distributed between the groups (p=0.761). Patients with longer duration of diabetes on an average smoked 15 sticks per day, while the shorter duration diabetics smoked 10 sticks a day (p=0.010). The mean duration of smoking was, however, almost identical between groups (p=0.364). Half (50%) of the diabetes patients of shorter duration was in premenopausal and another half (50%) in menopausal state. In contrast, all of the patients in longer duration group were in menopausal state. The presence of calcification in arteria dorsalis pedis was more than two times higher in patients with longer duration of diabetes than diabetic patients with shorter duration (60.3% vs. 25%, p= 0.003). All the diabetic patients in the both groups had history of receiving oral diabetic agent. Investigation findings show that 38.3% of the 47 patients who developed calcification in the arteria dorsalis pedis had hyperglycemia, while none of the patients without calcification in the artery exhibited hyperglycemia.

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Introduction

Diabetes mellitus (DM) is a multisystem disorder often associated with peripheral vascular disease. The disease is a common cause of small vessel vasculopathy, hence accounting for atherosclerotic disease is often more diffuse

in diabetics, with severe involvement of the distal small vessels. Peripheral vascular disease in diabetics is severe and extensive. Despite advances in our understanding and treatment of diabetes mellitus, diabetic foot disease remains a formidable problem.

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Diabetes is recognized as the most common cause of non-traumatic lower limb amputation in the western world, individuals with diabetes over 20 times more likely to undergo an amputation compared to the population.¹ The St. Vincent Declaration in 1990 aimed at significantly reducing lower extremity amputation rates over five years which was not achieved.²

There are two types of vascular calcification (VC) on the plain radiograph, arterial medial calcification and arterial intimal calcification. The former outlines the distribution of the artery as typical liner tram-track form and the latter is irregular and patchy in distribution. The presence of medial artery calcifications on the radiograph which is more common in dialysis patients than in the general population, is a powerful and independent prognostic marker for all-cause and cardiovascular mortality in chronic haemodialysis patient.³ Typical linear railroad-track type (angiography like) calcifications on the plain radiograph that outline the vessel walls are considered as medial artery calcification which is differentiated from intimal calcifications.³ Medial artery calcification of dorsalis pedis artery on the plain radiography of feet is also important peripheral artery vascular calcifications.

The lower extremity amputation prevention (LEAP) is a comprehensive program aimed at reducing lower extremity amputations in individuals with peripheral vascular disease. The aims of lower extremity amputation prevention are to detect and treat early chronic ischaemic lesions, offer alternatives to amputations in surgically untreatable patients, preserve the remaining limb after major amputation and reduce the global risk for cardiovascular disease. Critical limb ischaemia may be treated conservatively. However, if conservative therapy does not

lead to improvement, intervention in the form of percutaneous transluminal angioplasty (PTA) or bypass surgery should be considered.

Peripheral vascular disease in diabetics differs from that in non-diabetics in many aspects. In non-diabetics the sites of occlusion are usually the infrarenal aorta, iliac and superficial femoral arteries, with sparing of distal vessels. Whereas, in diabetics occlusive lesions occur in crural arteries namely tibials and peroneals, with sparing of the arteries of the foot.⁴ This characteristic vascular involvement in diabetics had made it possible to carry out vascular reconstruction, where proximal vessel like popliteal is anastomosed to foot vessels like dorsalis pedis thus bypassing the obstructed tibial and peroneal vessels. This pedal artery bypass technique has led to a significant decline in the incidence of all levels of limb amputations in Western countries.⁵

Revascularization is necessary to save the limb and this can be performed surgically or percutaneously.⁶ When both treatments are possible, endovascular therapy is preferred because of similar clinical outcomes and lower costs.⁷ The present study was designed to find the pattern and severity of dorsalis pedis artery calcification and factors related with medial artery calcification on the plain radiography of feet in relation to the duration of diabetes.

Methods

This cross sectional study was carried out on 110 consecutively selected diabetic patients referred to the Department of Radiology and Imaging of Bangabandhu Sheikh Mujib Medical University and BIRDEM hospital for X-ray of foot. At first all the patients were evaluated by detail history and clinical examination. Of the 110 patients, 18 refused to participate in the study and hence were

excluded, leaving 92 for final analysis and evaluation. Data were collected in a structured questionnaire containing all the key variables. Diabetic patients referred to the Department of Radiology and Imaging of Bangabandhu Sheikh Mujib Medical University, Dhaka and BIRDEM Hospital, Dhaka were enrolled in this study.

Results

Table I shows the age distribution of the patients. About one-third (32.6%) of patients was below 50 years old, 28.3% between 50-60 years and rest 39.1% 60 years or more than 60 years. The mean age of the patients was 54.7 ± 6.4 years and the lowest and highest ages were 45 and 63 years respectively.

Table I: Distribution of patients by age (n = 92)

Age (years)	Frequency	Percentage
<50	30	32.6
50-60	26	28.3
≥ 60	36	39.1

Mean age = (54.7 ± 6.4) years; range = (45.63) years

Sex distribution of the patients is shown in figure 1. Sixty four percent of the patients were male giving a male to female ratio of roughly of 2:1. Nearly 45% of the patients were retired service-holder, 16.3% were involved in household work (housewife), 9.8% in business, 6.5% in farming and the remaining 14.1% in other diverse occupations (Table II).

Table II. Distribution of patients by occupation (n=92)

Occupation	Frequency	Percentage
Service	09	9.8
Business	09	9.8
Farming	06	6.5
Retired From Service	40	43.5
Housewife	15	16.3
Other	13	14.1

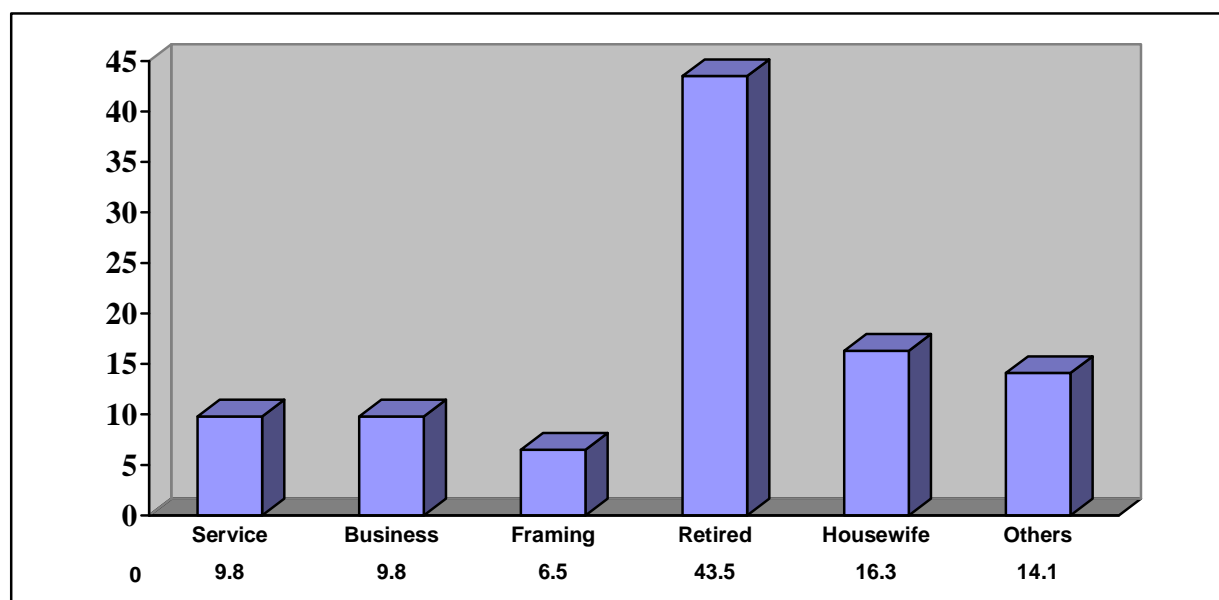


Figure 1. Sex distribution of the patients

The data of BMI shows that one-third (33.7%) of the patients was overweight and obese. The Mean BMI was 25.1 ± 2.9 kg/m² (table III)

Table III. Distribution of patients by BMI (n = 92)

BMI [#] (kg/m ²)	Frequency	Percentage
Normal (18.9-24.9kg/m ²)	61	66.3
Over weight & obese (>25kg/m ²)	31	33.7

Mean body mass index = (25.1 ± 2.9) kg/m².

The proportion of patients with intermittent claudication (pain on walking and relieved by rest) and ulceration on foot were much higher in patients suffering from diabetes for a longer duration (≥ 10 years) compared to those who were suffering from the disease for a shorter duration (< 10 years) ($p = 0.035$ and $p = 0.074$ respectively). Presence of dorsalis pedis artery pulse was significantly less in patients with longer duration of diabetes (22.1%) than that in those with shorter duration (75%) ($p < 0.001$). Gangrene and peripheral neuropathy were considerably higher among old diabetics than those among diabetics of shorter duration ($p = 0.481$ and $p = 0.325$ respectively) (Table IV)

Table IV. Comparison of clinical presentation between groups

Clinical presentation	Duration of DM		P-value
	Shorter duration (<10 yrs) (n = 24)	Longer duration (<10 yrs) (n = 68)	
Intermittent claudication	3(12.5)	24(35.3)	0.035
Dorsalis pedis artery pulse	18(75.0)	15(22.1)	<0.001
Ulceration on foot	5(20.8)	28(41.2)	0.074
Gangrene on foot	2(8.3)	9(13.2)	0.481
Pripheral neuropathy	7(29.1)	27.39.7)	0.325

Data were analysed using Chi-square (X^2) Test

Over 87% of patients of shorter duration had hypertension, 25% had history of IHD or past MI and another 25% past history of stroke which in old diabetics were 91.2%, 52.9% and 51.5% respectively. Smoker and ex-smoker were almost equally distributed between the groups ($p=0.761$). Patients with longer duration diabetes smoked 10 sticks a day ($p=0.010$). The mean pack-years of smoking was significantly higher in the former group than that in the latter group ($p=0.027$).

Table V. Comparison of presence of potential risk factors of PVD between groups.

Presence of potential risk factors of PVD	Duration of DM		P-value
	Shorter duration (<10yrs) (n=24)	Longer duration (≥ 10 yrs) (n=68)	
Hypertension [#]	21(87.5)	62(91.2)	0.602
H/O IHD of past MI [#]	6(25.0)	36(52.9)	0.018
Past H/O stroke [#]	6(25.0)	35(51.5)	0.025
Smoking Habit [#]	12(50.0)	32(47.1)	0.761
Smoker & Ex-smoker	12(50.0)	36(52.9)	
Non-smoker			
Number of sticks smoked Daily [#]	10 \pm 3	15 \pm 4	<0.001
Duration of smoking (pack-yrs) [*]	290 \pm 35	446 \pm 39	0.027

Data were analysed using χ^2 Test; data were analysed using Student's t-Test.

There were 33 female patients altogether. Of them 6 fell in shorter duration 27 in longer duration groups. Reproductive status illustrates that half (50%) of the diabetes patients of shorter duration was in premenopausal another half (50%) in menopausal state. In contrast, all of the patients in longer duration group were in menopausal state. The difference between the groups with respect to reproductive status was statistically significant ($p=0.004$) (Table VI).

Table VI. Comparison of reproductive status between groups

Reproductive status	Duration of DM		P
	Shorter duration (<10 yrs) (n=6)	Longer duration (\geq 10 yrs) (n=6)	
Premenopausal	3(50.0)	00	0.004
Menopausal	3(50.0)	27(100.0)	

Data were analyzed using Chi-square (X^2) Test.

Table VII shows that the presence of calcification in arteria dorsalis pedis was more than two times higher in patients with longer duration of diabetes than the diabetic patients with shorter duration (60.3% vs. 25%, $p=0.003$).

Table VII. Association between duration of DM & calcification of dorsalis pedis artery on X-ray

Calcification in dorsalis pedis artery	Duration of DM		p
	shorter duration (<10 yrs) (n = 24)	Longer duration (\geq 10 yrs) (n = 68)	
Present	6(25.0)	41(60.3)	0.003
Absent	18(75.0)	27(39.7)	

Data were analyzed using Chi-square (X^2) Test.

Investigation findings show that 38.3% of the 47 patient who developed calcification in the arteria dorsalis pedis had hyperglycemia, while none of the patients without calcification in the artery exhibited hyperglycemia ($p<0.001$) (Table VIII)

Table VIII. Association between calcification in arteria dorsalis pedis and RBS

RBS (mmol/L)	Calcification of artery		p
	Present (n = 47)	Absent (n = 45)	
Normal (\leq 11.1)	29(61.7)	45(100.0)	<0.001
Hyperglycemia (>11.1)	18(38.3)	00	

Discussion

The current study was conducted over ninety two patients to evaluate the calcification of dorsalis pedis artery in diabetic patients in relation to duration of diabetes. Some of the findings of the study presented in the earlier chapter need to be interpreted further compared and contrasted with the findings of other similar studies to arrive at a conclusion.

The mean age of the patient was 54.7 ± 6.4 years and the youngest and oldest diabetics were 45 and 63 years respectively. Male to female ratio was roughly of 2 : 1. Retired service holders were predominant in the series. The data of BMI shows that one-third of the patients was overweight and obese. Similar findings were reported by Murabito et al (1997)⁸ with mean age of the patients being 61.2 years and a male predominance (71%). Hiatt (2001)⁹ reported that mean age were 54.8 years and most of the patients was involved in household work. In another study conducted by Criqui (2001)¹⁰ a large proportion of the patients were overweight which is not consistent with the findings of the present study.

Previous studies have demonstrated a higher risk of intermittent claudicating, absence of dorsalis pedis arterial pulse and ulceration on foot in patients suffering from diabetes for longer duration.¹¹ This was also supported by the study of Mehrotra et al. (2004)¹² who stated that intermittent claudication, dorsalis pedis arterial pulse, gangrene on foot and peripheral neuropathy most common clinical presentation in patients suffering from longer duration compared to shorter duration. In this study, proportion of patients with intermittent claudication (pain on walking and relived by rest) and ulceration on foot were much higher in patients suffering from diabetes for a longer duration (\geq 10 years) compared to those who were suffering from the disease for a shorter duration (<10 years). Presence of

dorsalis pedis arterial pulse was significantly less in patients with longer duration of diabetes (22.1%) than that in those with shorter duration (75%). Gangrene and peripheral neuropathy were relatively high among diabetics with longer duration than those among diabetics of shorter duration ($p=0.481$ and $p=0.325$ respectively)

Diabetes mellitus is especially considered as an important risk factor for PAD.¹³ The number of people with diabetes is growing in Pakistan as a result of urbanization, physical inactivity and obesity.

Bangladesh is considered to be one of the countries with rapidly increasing diabetic population and presently ranked seventh globally by the International Diabetes Foundation (IDF Diabetes Atlas, 2009). As prevalence of diabetes is high in Bangladesh, it is important to diagnose diabetes early and offer treatment to avoid complications of the coronary and cerebral vasculature that are preventable.¹⁴ Patients with diabetes had higher CAC scores with more vessels affected, and in the presence of diabetes men and women had the same risk for CAC. In patients with diabetes, age, hypertension, smoking habit, past history of stroke were the explanatory variables for detecting the presence of CAC, while age, hypertension and smoking history predicted severity. This study revealed that over 87% of patients of shorter duration had hypertension, 25% had history of IHD or past MI and another 25% past history of stroke which in patients of longer duration were 91.2%, 52.9% and 51.5% respectively. Smoker and ex-smoker were almost equally distributed between the groups ($p=0.761$). Patients with longer duration of diabetes on an average smoked 15 sticks per day, while the shorter duration diabetics smoked 10 sticks a day ($p=0.010$). The mean pack-years of smoking was

significantly higher in the former group than that in the latter group ($p=0.027$).

Reproductive status illustrates that half (50%) of the women diabetics were in premenopausal and another half (50%) in menopausal state. In contrast, all of the patients in longer duration group were in menopausal state. This was supported by other previous study of Meijer et al. (1998)¹⁵ who found that 76% of diabetic patients of longer duration was in menopausal and 24% in premenopausal state. On the other hand, La Monte et al. (2005)¹⁶ in a recent study concluded that 65% of patients of shorter duration and 81% of longer duration was in menopausal state.

This study shows that presence of calcification in arteria dorsalis pedis was more than two times higher in patients with longer duration diabetes than the shorter duration diabetes. All the diabetic patients in the both groups had history of receiving oral diabetic agent. About 40% who developed calcification in the arteria dorsalis pedis had hyperglycemia. Basit et al. (2004)¹⁷ reported that there is a strong association between duration of DM & calcinosis of artery. A similar tendency was also observed by Selvin et al. (2004)¹⁸. The records of 104 patients with diabetes were reviewed and evaluated by Donnelly (1997)¹⁹ in his study which revealed that 31% of patients with hyperglycemia had calcification in his study which revealed that 31% of patients with hyperglycemia had calcification in the arteria dorsalis pedis.

Conclusion

The results of the present study showed that the calcification in arteria dorsalis pedis is common in patients with longer duration of diabetes. The clinical presentation, such as, intermittent claudication, ulceration on foot, gangrene on foot and peripheral neuropathy were frequently observed in patients suffering from longer duration of diabetes than those

suffering from shorter duration of diabetes. As diabetes is recognized as the most common cause of non-traumatic lower limb amputation, early detection of vascular calcification in diabetic patients can help in proper and prompt medical therapy of surgical intervention to save the limb and to minimize morbidity and mortality.

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