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Original Research Article

A study on diabetic foot and its association with peripheral artery disease

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ABSTRACT

Background: Diabetes mellitus is characterized by high blood sugar levels over a prolonged period due to alteration in either the insulin secretion, insulin action, or both. Worldwide, as of the recent 2016 data collected from the World Health Organization (WHO) around 422 million adults have diabetes mellitus which is estimated to almost double by 2030 which is composed of mainly type 2 diabetes (85-90% of all cases). The early detection of peripheral artery disease in asymptomatic patients goes a long way in reduction of major lower limb amputations and mortality. Hence, there is a need for evaluation of peripheral vascular disease in all diabetics, especially those with diabetic foot by formulating effective management protocols, thereby limiting the morbidity, mortality and social costs associated with the disease.
Methods: Patients admitted and seen in out-patient department for diabetic foot ulcers between January 2013 and October 2013 in Department of general surgery, vascular surgery and diabetology, Kilpauk Medical College Hospital, Chennai, India were taken for study.
Results: 150 cases satisfying the inclusion criteria were taken up for the study from January 2013 to October 2013. Out of 150 patients, 76 patients presented with ulcer in foot, 34 presented with gangrene of toe or foot. After clinical examination it was found that 52 patients had associated neuropathy, 17 patients had ABI less than 0.3 and 39 patients had ABI in between 0.4 and 0.9. Patients with ulcer and gangrene in foot and with ABI less than 0.9 were admitted and evaluated with doppler study of lower limbs. After getting consent, appropriate procedure was done for each patient. Wound debridement was done in 21 cases, toe disarticulation in 12, fore foot amputations in 4, Below knee amputation in 9, above knee amputation in 3. 11 patients were referred to vascular surgery and underwent revascularization procedures (BYPASS).
Conclusions: The prevalence of peripheral artery disease in patients with diabetic foot is significantly high i.e. 38 % as per this study. Males have a higher predilection for developing peripheral vascular disease than females. The average age of presentation of PAD in diabetics is 40 -60 years. The most common level of arterial occlusion in PAD associated diabetic foot is femoro-popliteal segment followed by tibial segment.

Keywords: Diabetic foot, Peripheral arterial disease

INTRODUCTION

In the history of medicine, there are several evidences pointing out to diabetes related foot diseases and its treatment in the past. There is evidence from the mummies of Ramses II, that there existed calcific atherosclerosis in the leg vessels around 1200 BC. There is also evidence of treatment i.e. cutting away the mortified parts for gangrene foot in Hippocrates text. In the Book of Kings from Bible, there is reference to King

Asa who became diseased in his feet and slept with his fore fathers which is speculated by some as the first recorded case of diabetic gangrene of foot in poorly controlled Type II diabetes.[1] WHO describes that the foot of a diabetic has potential risk of pathologic consequences like infection, ulceration, destruction of deep tissues associated with or without peripheral neuropathy, and or various degrees of peripheral vascular disease with metabolic complications of diabetes.

PAD is manifestation of atherosclerosis characterized by atherosclerotic occlusive disease of the lower extremities. The prevalence of peripheral vascular disease has been difficult to estimate and is around 13-45% in various studies. Framingham heart study revealed that 20% of symptomatic patients with PAD had diabetes but this probably underestimates the prevalence as most people with PAD are asymptomatic.[2] Diabetes, smoking, hypertension, advanced age, hyperlipidemia, elevated C-reactive protein, apolipoprotein, lipoprotein (a), fibrinogen and plasma viscosity are the risk factors for PAD.[3]

The mechanisms by which diabetes induces atherosclerosis are multifactorial and include inflammatory processes, derangements of various cell types within the vascular wall, promotion of coagulation, and inhibition of fibrinolysis. These factors both increase the susceptibility of the vasculature to atherosclerosis, as well as the instability that makes plaque prone to rupture and thrombosis. Thus, it is important to use a multidisciplinary approach to improve the clinical outcomes in this patient population. Diabetes is most strongly associated with femoro-popliteal and tibial occlusion i.e., below the knee PAD whereas smoking and hypertension are associated with more proximal disease in the aorto-ilio-femoral vessels.

Diagnosing PAD early is very crucial, because it can reduce the functional disability and limb loss. Also, very importantly it can identify a patient who is at high risk of developing a myocardial infarction or stroke.[4] Though the most common symptom of PAD without sensory neuropathy is intermittent claudication, it can also present late with rest pain, ulcer in foot and gangrene of toe, foot or the entire leg.

Critical limb ischemia (CLI) is a collective term including chronic ischemic rest pain, ulcers or gangrene attributable to objectively proven arterial occlusive disease.[5] On the other hand, patients with peripheral neuropathy will elicit subtle symptoms of slow walking velocity and easy leg fatiguability which they usually attribute to getting older. Hence most of these diabetics experience worst kind of lower limb dysfunction at a later date as they are prone to develop suddden ischaemia of their lower limb due to arterial thrombosis.[5,6]

Clinical examination includes

- Palpation of peripheral pulses - absence of two or more pulses on both the feet is diagnostic of peripheral vascular disease[7]
- Measurement of ankle brachial index.

Aim of the study was to study the prevalence of peripheral arterial disease (PAD) in diabetic foot, to study the average age of presentation of PAD in diabetics, to study its prevalence in male and female, to study the level of arterial occlusions in PAD associated diabetic foot, to study the implications of socioeconomic status in PAD with diabetic foot, to study the outcome of diabetic foot patients with PAD, to study the prevalence of coronary artery disease and cerebrovascular accidents in diabetic patients with PAD.

METHODS

Patients admitted and seen in OP for Diabetic Foot ulcers between January 2013 and October 2013 in Department of General Surgery, Vascular surgery and Diabetology, Kilpauk Medical College Hospital, Chennai, India were taken for study

Inclusion criteria

- All Diabetic patients with foot ulceration and gangrene toe
- Diabetics with previous foot ulceration and amputations
- Diabetics with callus over foot
- Diabetics with foot deformities
- Diabetics with burning sensation/pins and needles/ loss of sensation in foot
- Diabetics with intermittent claudication / rest pain in feet

Exclusion criteria

- Non-diabetic ulcers
- Diabetic ulcers with co-existing varicose veins /DVT
- Malignant ulcers
- Diabetics on corticosteroids/ immunosuppresants
- Diabetics with previous amputations for malignancy/acute trauma
- Diabetics with lymphoedema foot
- Diabetics with osteomyelitis foot.

Patient's data were collected using a proforma based on factors such as age, sex and socioeconomic status were noted. History such as foot ulcer with its duration, presence of pain and its duration, numbness, discolouration, joint mobility, trauma were recorded.

Duration and treatment of diabetes, family history of diabetes, previous history of surgery (amputations/disarticulations) were also recorded.

Physical examination was done to note site and size of ulcer, presence or absence of discharge; peripheral pulsation; sensation to touch, pain and temperature; vibration perception and joint mobility. X-ray foot, doppler and ankle brachial index (ABI) were taken. Follow up was done with physical examination, doppler and ABI once in every month for a minimum of 2 months.

RESULTS

The study conducted in our institution from January 2013 to October 2013 showed the following results.

The high prevalence of PAD is often under estimated. As some patients in the study were asymptomatic, subclinical PAD is often missed. But with the use of ankle brachial index and Doppler even the subclinical cases were picked up in our study. Our study demonstrated a prevalence of 38% i.e., 57 patients out of 150 patients had PAD associated with diabetic foot.

Table 1: Prevalance of PAD according to duration of diabetes.

Duration of diabetes (years)	Number of PAD patients	Percentage
<1	1	0.66
1-10	24	16
11-20	21	14
21-30	10	6.66
>30	1	0.66

Prevalence of PAD according to the duration of diabetes is maximum between 1-10 years with a prevalence of 16% (24 cases out of 150), closely followed with a 14 % prevalence (21 cases out of 150) in the duration of diabetes between 11-20 years.

Table 2: Sex distribution of PAD in diabetic foot patients.

Sex	Frequency	Incidence
Male	33	22%
Female	24	16%

Our study reported a higher prevalence of PAD in males with diabetic foot with an incidence of 22% compared to an incidence of 16% in females.

Our study reported that around 11 patients (37%) with PAD and diabetic foot had occlusion in the femoro-popliteal segment followed by tibial occlusion noted in 8 patients (27%). Amputations and disarticulations have higher frequency (49.12%) than revascularisations (12.28%) for PAD associated diabetic foot.

Around 12 patients (42.85%) underwent amputation at the level of the toe followed by 9 patients (32.14%) who underwent below knee amputation. Around 28 diabetic foot patients (49.12%) with PAD underwent amputation compared to 9 diabetic foot patients (9.6%) without PAD. Higher rate of amputation was noted in diabetic foot patients with PAD.

Table 3: Distribution of peripheral artery disease according to the site of arterial narrowing or occlusion.

Site	Frequency	Percentage
Aorto-iliac	2	6
Iliac	1	3
Femoral	2	6
Femoro-popliteal	11	37
Popliteal	5	17
Tibial	8	27

Table 4: Surgical procedures done.

Procedures	Frequency	Percentage
Debridement	21	36.84
Amputation/disarticulation	28	49.12
Revascularisation	7	12.28

Table 5: association of CAD/CVA in diabetic foot patients with and without PAD.

Diabetic foot patients	CAD/CVA	Percentage
With PAD (57)	11	19.29
Without PAD (93)	7	7.52

(CAD - coronary artery disease, CVA - cerebrovascular accident)

CAD and CVA are significantly increased in diabetic foot patients with PAD. In this study, associated CVA/CAD was noted in 11 patients out of 57 diabetic foot patients with PAD. The incidence of associated CVA/CAD was 19.29 % in diabetic foot patients with PAD compared to 7.52% in diabetic foot patients without PAD.

DISCUSSION

Diabetic foot related problems is increasing steadily in India owing to the high prevalence of diabetes mellitus in India. With a prevalence of 65.1 million, which is more than 7.1% of the adult population, India holds the second place in the world.

It is clear from the study that it has been difficult to estimate the prevalence of PAD in patients with diabetes, because the presentation is varied, from numbness due to neuropathy to claudicating pain, ulcer and gangrene. The prevalence of PAD increases with advancing age and is

3.2% below 50 years of age and rises to 55% in those above 80 years of age.[9] Similarly it also increases with increased duration of diabetes, 15% at 10 years and 45% after 20 years.[10]

Our study has given a prevalence of 38% when compared to Marinelli et al (33%) and Migdalis et al (44%) which have given a prevalence of 33% and 44% respectively. i.e., 57 patients out of 150 patients had PAD associated with diabetic foot.

Table 6: Comparison of prevalance of PAD according to duration of diabetes in various studies.

Prevalance	1 - 10 years	11 - 20 years
Our institution	16%	14%
Rochester	15%	45%
Kristianstad	16.4%	38.4%
Zagreb	18.5%	25%

PAD according to the duration of diabetes is maximum between 1 and 10 years with a prevalence of 16% (24 cases out of 150), closely followed by 11- 20 years duration with 14% prevalence (21 cases out of 150). But in comparison, various studies have shown steady and a significant rise in prevalence of PAD with duration of diabetes.[11] This can be attributed to the small study group of 150 cases and cases reported in 11- 20 years duration and 21 -30 years duration were only 19 and 17 respectively.

Table 7: Comparison of prevalance of PAD in both sexes in various studies.

Studies	Prevalence	
	Male	Female
Our institution	22	16
Rochester	21.3	17.6
Framingham	12.6	8.4

On analyzing the prevalence of PAD in diabetic foot patients according to sex, from my study it is higher in males (22%) than in females (16%). While comparing with other studies, the result of my study is comparable to rest with higher incidence in males than in females.[12] This also correlates with the existing data that male sex has a higher prevalence of PAD in diabetic foot.

Table 8: Comparison between two studies on amputations and revascularisations in diabetic foot with PAD.

Study	Amputation	Revascularisation
Our institution	49.12%	12.28%
Zagreb	30.57%	16%

On analyzing the data, amputations are higher (49.12 %) than revascularizations (12.28 %) in our institution which is similar to Zagreb study. When compared to the study by Zagreb et al, the percentages of amputations are higher.[12]

Many patients for whom amputations were done had stage 4 PVD (late presentation) and had superadded infection. Also since most of our patients are from low socio economic status (lower middle, upper lower and lower), their knowledge of the disease was low and hence presented late.

Table 9: Comparison between two studies on the type of amputations.

Study	Toe	Foot	Above knee	Below knee
Our institution	42.85%	14.28%	32.14%	10.71%
Zagreb	62.61%	7.47%	15.88%	14.01%

Most of the amputations are minor (toe and foot) which is similar to that of Zagreb study but with slight higher percentage (57.53 % versus 70.08 %) because the level of occlusion is highest at femoro-popliteal and tibial vessels according to our study. Above knee amputations are performed in much higher rate in our institution when compared to Zagreb study.

The prevalence of PAD according to socioeconomic status shows higher rate in lower socio economic groups. This finding could be substantiated by the fact that risk factors like smoking and diabetes is higher in lower socio economic groups. A population based study by Kroger K et al and Monica G et al study has also concluded that PAD is more prevalent in lower socio economic groups. Also, additional behavioral risk factors such as awareness to health or adherence to treatment can be attributed to increased prevalence of PAD in diabetic foot.

CONCLUSION

- The prevalence of peripheral artery disease in patients with diabetic foot is significantly high i.e. 38% as per this study. All patients may not be symptomatic or show obvious signs of PVD, but there is a need for properly investigating them.
- Males have a higher predilection for developing peripheral vascular disease than females.
- The older the individual, the higher are the chances of having peripheral vascular compromise. The average age of presentation of PAD in diabetics is 40-60 years.
- The most common level of arterial occlusion in PAD associated diabetic foot is femoro-popliteal segment followed by tibial segment.
- PAD influences the outcome of diabetic foot ulcers significantly with higher rate of amputations in PAD patients.
- CAD and CVA are significantly increased in diabetic foot patients with PAD and hence PAD is a marker of systemic vascular disease involving

coronary and cerebral vessels, like myocardial infarction (MI), stroke and death.

- The prevalence of PAD is higher in lower socioeconomic status group.
- This study and others in the past have consistently proved the benefits and need of investigating diabetics for peripheral vascular disease through clinical palpation for peripheral pulses and ankle brachial index. The use of Arterial Doppler along with clinical methods can be of great significance in the proper evaluation and appropriate management of these individuals.

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REFERENCES

1. World Health Organization, Global Report on Diabetes. Geneva; 2016.
2. Murabito JM, Agostino RB, Silbershatz H, Wilson WF. Intermittent claudication: a risk profile from the Framingham heart study. Circulation. 1997;96:44-9.
3. Kannel WB, Mcgee DL. Diabetes and glucose tolerance as risk factors for cardiovascular disease: the Framingham study. Diabetes Care. 1979;2:120-6.
4. Weitz JI, Byrne J, Clagett GP, Farkouh ME, Porter JM, Sackett DL, et al. Diagnosis and treatment of chronic arterial insufficiency of the lower extremities: a critical review. Circulation. 1996;94:3026-49.
5. Norgren L, Hiatt WR, Dormandy JA. Inter- society onsensus for the management of peripheral arterial disease (TASC II). Eur J Vasc Endovasc Surg. 2007;33(1):1-75.
6. Daniel M, Cronenwett JL. Basic data related to natural history of intermittent claudication. Ann Vasc Surg. 1989;3:273-7.
7. Marinelli MR, Beach KW, Glass MJ. Non-invasive testing vs clinical evaluation of arterial disease, a prospective study. JAMA. 1997;241:2031-4.
8. Diabetes can be controlled in 80 percent of cases in India. Available at news.biharprabha.com. Accessed on 6 February 2016.
9. Janka HU, Stand IE, Mehnert H. Peripheral vascular disease in diabetes mellitus and its relation to cardiovascular risk factor: screening with doppler ultrasonic technique. Diabetes Care. 1980;3:207.
10. Palumbo PJ, Melton LJ. Peripheral vascular disease and diabetes In Harris MI, Hamman RF. Diabetes in America, Washington: US Government Printing Office. 1985;1468.
11. Orchard TJ, Dorman JS, Maser RE. Prevalence of complications in IDMM by sex and duration. pittsburg epidemiology of diabetes complications. Diabetes. 1990;39:1116-24.
12. Singh S, Armstrong EJ, Sherif W, Alvandi B, Westin GG, Singh GD, Amsterdam EA, et al. Association of elevated fasting glucose with lower patency and increased major adverse limb events among patients with diabetes undergoing infrapopliteal balloon angioplasty. Vasc Med. 2014;19:307-14.

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