

## Vascular Study in Diabetic Foot using Doppler Ultrasound

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**Abstract:** Diabetes mellitus is a widespread pathological disorder present in developing countries with high prevalence rates. Doppler ultrasound offers the framework for non-invasive and accurate measurement of the range and rate of flow in arteries that can be tracked on a systematic basis. The aim of the study is to correlate the severity of diabetic foot lesions by Wagner grading with Ankle Brachial index and Doppler findings. Vascular study in a diabetic foot using Doppler ultrasound. The 50 cases of ‘Diabetic Foot’ were studied from May, 2011-2013 admitted in Krishna Institute of Medical Sciences, Karad. In Doppler study 22 patients showed atherosclerosis with the normal flow. The 19 patients showed atherosclerosis with the reduced flow. Most number of patients 14 had moderate stenosis and complete Occlusion was seen in 4 patients.

## INTRODUCTION

Diabetes mellitus is a widespread pathological disorder present (Nisar *et al.*, 2007) in developing countries with high prevalence rates (Hashim *et al.*, 2004). In the progression of the disease’s natural history, diabetes mellitus has a significant effect on the quality of life attributable to the severe and long-term complications related to the interaction of micro and macro vessel (Martinez-Castelao, 2008). Peripheral Arterial Disease (PAD) is a process characterized by characteristic changes in the arteries of the lower extremities. PAD is clearly frequent in people with diabetes. In diabetic individuals with PAD, peripheral ischemic event rates are higher than in non-diabetic and even atherosclerotic populations (Marso and Hiatt, 2006; Hittel and Donnelly, 2002).

Doppler ultrasound offers the framework for non-invasive and accurate measurement of the range and rate of flow in arteries that can be tracked on a systematic basis. Doppler scanning was not assessed by local trials as a way of evaluating artery risks in diabetics. The purpose

of this analysis was to establish on a Doppler-based assessment the incidence, extent and trends of lower limb arterial insufficiency in diabetic patients.

**Aim and objectives:** Vascular study in a diabetic foot using Doppler ultrasound. To correlate the severity of diabetic foot lesions by Wagner grading with Ankle Brachial index and Doppler findings. To determine the frequency level and pattern of lower limb arterial insufficiency in diabetic patients on a Doppler based evaluation.

**Literature review:** Mechanical marvel is the human foot; it consists of 42 muscles, 29 joints, 26 bones and a multitude of tendons and ligaments. Over the dorsum of foot, skin is about 2 mm thick. In the dorsum few fibrous septa penetrate to deeper fascial structures except in areas of wrinkle in the dorsal skin, overlying metatarsophalangeal joints and interphalangeal joints where the fibrous septa attach the dermis to the deep fascia. The skin in these sites is relatively more fixed than

at any other dorsal sites. The dermis of the sole is attached to plantar fascia by fibrous septa that encloses the fat lobules. The lateral and medial portions of plantar fascia are thinner and covers medially abductor hallucis and laterally abductor digiti quinti muscles.

Three plantar metatarsal arteries run forward opposite lateral three spaces. Each gives of an anterior perforator artery and bifurcates into plantar digital arteries that supply the contiguous sides of lateral toes. The lateral plantar digital artery of the little toe springs independently from the lateral extremity of arch. Dorsalis pedis artery is the continuation of anterior tibial, it lies lateral to the extensor hallucis longus in the space between first and second metatarsal, it generally divides into deep plantar and a dorsal metatarsal branch. Medial plantar artery gives cutaneous branches and superficial digital branch which divides and anastomosis with plantar digital arteries. Diabetes affects vascular tree at all levels. The major difference in a diabetic and a non-diabetic is extensive involvement of small vessels and microangiopathy. Large arteries show various stages of evolution of atherosclerosis. Smaller arteries suffer secondary lesions like thrombosis and vascular occlusion. Medium sized vessels are affected by a peculiar calcific lesion of media which is benign and inconsequential. Arteriosclerosis is more related to prevailing high blood pressure than to diabetes. Capillaries exhibit unique microangiopathy. Venous system is less frequently affected in diabetes. Williamson and Kilo (1976) believed that basement membrane thickening is a direct or indirect consequence of hyperglycemia. Alpert *et al.* (1972) have demonstrated that increased permeability of capillaries to intravenously administered iodinated albumin resulting in increased interstitial fluid in diabetics. There is some evidence that thickened capillary basement membrane may inhibit aggressive of leucocyte in the interstitial space which explains difficulty in fighting with infection of diabetic foot. However, exact pathophysiology is still unknown. Crisband *et al.* (1980) supported the response to injury hypothesis. Following vessel injury, fibrous flake evolves as a result of proliferation of arterial smooth muscle cells which is accomplished by accumulation of cellular and extra-cellular lipid, collagen and proteoglycans. Disruption of endothelial barrier may follow any form of injury be it mechanical or immunological. According to Johnson *et al.* (1981) diabetics have thickened perineural basement membrane as compared to non-diabetics. This may be secondary to leakage of proteolytic enzyme inhibitors as macroglobulin (Jali, 1985). This alteration in blood barrier would allow access to endoneurium for substances that might be detrimental to nerve conduction.

Evolution of atherosclerosis in diabetes has recently attracted much attention. It is shown in animal studies that induction of hyper-cholesterolemia lead to endothelial transport and subendothelial deposition of plasma lipoproteins (Ross, 1997). Very high levels and abnormal

forms of LDL and VLDL favours such transport (Goldstein *et al.*, 1979). There are beta-VLDL receptors on macrophages which can trigger exactly similar mechanism (Kissebah *et al.*, 1982). Chylomicrons though not atherogenic, their metabolic products, the remnant particles rich in cholesterol are atherogenic and may play role in atherosclerosis (Kissebah *et al.*, 1982). The circulating T lymphocytes and monocytes develop increased adherence to endothelial cells and late migrate subendothelially. These cells take up lipid and lipoproteins and become foam cells rich in cholesterol and cholesterol esters. Collection of large number of foam cells give rise to fatty streak that projects into lumen of vessels. Platelets in diabetics show greater adhesiveness and aggregability in response to imbalance between arachidonic acid derivatives PGI<sub>2</sub> and thromboxane A<sub>2</sub>, later being aggregatory and vasoconstrictive (Hersch and Bodey, 1997; Majerus, 1983). As the foot collapses, the arch of foot flatten and the patient may develop a racket bottom deformity. With spontaneous mid-foot dislocations, the foot may assume banana shape. With time the process ceases but the patient is left with a deformed, insensitive foot that is prone to ulceration at the points of bony deformity and prominence.

Although, various classifications have been suggested, there is as yet, no universally acceptable classification. The diabetic foot is classified, as per the underlying etiology, into Neuropathic foot (Neuropathy is dominant) and Neuroischemic foot (Occlusive vascular disease is dominant).

## MATERIALS AND METHODS

The present study of carried out in our hospital during the period of May, 2011-2013, 2.50 cases of diabetic foot lesions admitted in Krishna Hospital, Karad were examined prospectively with patients referred from both medical and surgical units. Adult diabetic patients (aged 18 years or above) irrespective of type of diabetes and gender with suspected peripheral vascular insufficiency or complaints of numbness, discoloration of periphery or ulceration. Patients who had undergone arterial graft procedures. Blisters, Cellulitis, Abscess, Gangrene lesions occurring other than diabetes. Gestational diabetic patients. All patients were evaluated by taking detailed history, clinical examination and necessary investigation were taken along with Doppler study according to case proforma. Categorization and tabulation of the data was done according to the observation section.

## RESULTS AND DISCUSSION

A number of 50 patients were studied in this series between age groups of 21-90 years maximum incidence was seen in age group of 51-60 years. Youngest patient was 27 and oldest was 82 (Table 1).

Table 1: Age wise distribution

Age (Years)	No. of cases	Percentage
21-30	1	2
31-40	2	4
41-50	9	18
51-60	17	34
61-70	14	28
71-80	6	12
81-90	1	2

Table 2: Sex wise distribution

Sex	No. of cases	Percentage
Male	35	70
Female	15	30

Table 3: Showing duration of diabetes

Diabetic duration (Years)	No. of cases
1-5	21
6-10	20
11-15	6
16-20	1
21-25	2

Table 4: Side affected

Side affected	No. of patients
Right	20
Left	23
Bilateral	7

As showing on Table 2, of the 50 cases study in the present study 35 were male and 15 female. There was marked male preponderance in this study.

According to Table 3, most of patients had diabetes duration between 1-5 years. Table 4 indicated that the most common affected limb was found in left side with 23 patients and 20 patients on right side. Bilateral lower limb was affected in 7 patients.

Prevalence of diabetes is greater in persons over age of 50 years. In our study of 50 patients ranging from 21-90 years, it was found that age group 51-60 years had the highest number of patients 17 (34%) (Baddeley and Fulford, 1965; Oakley *et al.*, 1956). Like, Mayfield *et al.* (1996), the present study had more number of male patients (70%) suffering from diabetic foot lesions than females (30%). But the proportion between the two was far greater in this study. The present study had ratio of M:F as 2.33:1 Whereas by Mayfield *et al.* (1996) the M:F ratio was almost equal. Higher incidence in males may be due to associated habits of smoking, alcoholism, type of work, etc. According to Mayfield *et al.* (1996) study about 3/4th of total patients with diabetic foot lesion had duration of diabetes for >16 years which did not correlate with present study where patients with diabetic foot lesions had diabetes duration of <10 years in about 82% of the cases.

In present study patients with diabetic duration >5 years were more prone for complications. The severity of the disease depends upon not the age of patient but on the diabetic age. Among 50 patients studied with peripheral vascular insufficiency 37 (74%) patients had

atherosclerotic plaque suggesting that significant number of patients had peripheral arterial disease. Out of 37 plaque patients 7 patients had significant stenosis, i.e., 50-99% occlusion 26 patients had 1-49% stenosis. Out of 50 patients studied, 4 (8%) patients had complete occlusion.

## CONCLUSION

Doppler sonography can accurately locate the site and extent of stenosis/occlusion. Duplex Doppler imaging is safe, cost effective, repeatable, noninvasive procedure for investigating lower limb arteries. Hence, it is the primary investigation of choice in all cases of lower extremity arterial disease and helps to decide the need for further evaluation by angiography. Duplex sonography allows the evaluation and quantification of arterial disease. Color Doppler study also helps in the follow-up of the arterial diseases. This study indicates that these patients have PVD risk factors. Doppler can enable early detection of vital limbs at risk of failure and enable avoid and reduce the high incidence of limb impairment in our patients. This study indicates that these patients have PVD risk factors. Doppler can enable early detection of vital limbs at risk of failure and enable avoid and reduce the high incidence of limb impairment in our patients.

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