



ORIGINAL RESEARCH PAPER

Medical Science

VASCULAR STUDY IN DIABETIC FOOT USING DOPPLER ULTRASOUND

KEY WORDS: Ankle brachial index, Wagner grading, Duplex ultrasound.

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ABSTRACT

INTRODUCTION: Diabetes mellitus is a common pathological condition at present times with a higher prevalence rate in developing countries. Diabetes mellitus has a marked impact on the quality of life due to the acute and long-term complications secondary to the involvement of micro & macro vasculature with the progression of natural history of disease. Peripheral arterial disease (PAD) is a condition characterized by occlusive changes in the lower extremities arteries. PAD is markedly frequent among individuals with diabetes.

OBJECTIVE: 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.

MATERIAL AND METHODS: The Present study was carried out in our hospital during the period of June 2017 to June 2019. 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 and above) irrespective of type of diabetes and gender with suspected peripheral vascular insufficiency or complaints of numbness, discoloration of periphery or ulceration.

RESULTS AND CONCLUSIONS: Maximum incidence was seen in age group of 51-60 yrs. Youngest patient was 27 and oldest was 82. In the present study, 35 were male and 15 female. There was marked male preponderance in this study .2.33:1 MALE TO FEMALE. Maximum number cases 14 were seen in Wagner Grade III followed by 12 cases in grade II. Maximum number of patients 13 had normal ABI. 14 patients showed moderate Ankle Brachial Index. Most common absent pulsation was found in Dorsalispedis artery in 20 patients and least common with popliteal artery in 4 patients. In Doppler study, 22 patients showed atherosclerosis with the normal flow. 19 patients showed atherosclerosis with the reduced flow.

INTRODUCTION :

Diabetes mellitus is a common pathological condition at present times with a higher prevalence rate in developing countries.

Diabetes mellitus has a marked impact on the quality of life due to the acute and long-term complications secondary to the involvement of micro & macro vasculature with the progression of natural history of disease.

Peripheral arterial disease (PAD) is a condition characterized by occlusive changes in the lower extremities arteries. PAD is markedly frequent among individuals with diabetes. Peripheral ischemic event rates are higher in diabetic individuals with PAD than in non-diabetic and even atherosclerotic populations. PAD is an important contributory factor to diabetic foot ulceration and gangrene leading to lower-extremity amputation in diabetes mellitus. Spectral Doppler (Duplex) sonography is well accepted as a noninvasive imaging modality to be used as a diagnostic test for detecting and grading the presence and severity of arterial disease.

Diagnosis of PAD in diabetic patients is of great clinical significance in order to determine the subset of patients that may be at a high risk of subsequent myocardial infarction or stroke regardless of the presence or absence of symptoms of PAD and to treat the symptoms PAD, which can lead to limb loss and functional disability. Thus, regular screening is essential as a part of aggressive management to reduce the impact of comorbidities on the affected person.

The evaluation of the state of peripheral arteries of lower limb in terms of stenosis (percentage) if any, and its association with patient symptomatology is important. This can act as basis of regular follow up of the cases at the risk of arterial disease and early intervention to salvage the limb if vascular insufficiency is detected at an early stage. Doppler ultrasound provides the basis for non-invasive and objective

measurements of the spectrum and velocity of flow in arteries that can be serially monitored. Local studies have not evaluated Doppler scanning as a means of evaluating vascular complications in diabetes. the objective of this study was to determine the frequency, level and patterns of lower limb arterial insufficiency in diabetic patients on a Doppler-based evaluation.

AIMS AND OBJECTIVES:

1. Vascular study in a diabetic foot using Doppler Ultrasound
2. To correlate the severity of diabetic foot lesions by Wagner grading with Ankle Brachial Index and Doppler findings.
3. To determine the frequency level and pattern of lower limb arterial insufficiency in diabetic patients on a Doppler Based Evaluation.

WAGNER CLASSIFICATION SYSTEM:

| GRADE | DESCRIPTION |
|-------|---|
| 0 | No open ulceration present. |
| 1 | Full thickness ulceration, but depth does not go beyond loss of skin. |
| 2 | Deeper , tendon or joint capsule involvement may be present |
| 3 | Open to bone, osteomyelitis may be present |
| 4 | Wet or dry gangrene plus or minus cellulitis |
| 5 | Extensive gangrene indicating higher amputation |

DUPLEX ULTRASOUND TECHNIQUES:

Similar to other arterial applications of duplex scanning, the lower extremity assessment on high quality 13-mode imaging to identify the artery of interest and facilitate precise placement of the pulsed doppler sample volume for spectral waveform analysis. both colour flow and power Doppler imaging provide important flow information to guide spectral Doppler interrogation. these imaging modalities are also valuable for recognizing anatomic variations and for identifying arterial disease by showing plaque or

calcification. However, it should be emphasized that color flow Doppler and power Doppler imaging are not replacements for spectral waveform analysis, the primary method for classifying the severity of arterial disease.

When examining an arterial segment, it is essential that the ultrasound probe be sequentially displaced in small intervals along the artery in order to evaluate blood flow patterns in an overlapping pattern. This is necessary because the flow disturbances produced by arterial lesions are propagated along the vessel for a relatively short distance. Experimental work has shown that the high-velocity jets and turbulence associated with arterial stenosis are damped out over a distance of only a few vessel diameters. Consequently, failure to identify localized flow abnormalities could lead to under estimation of disease severity. Because local flow samples may be obtained at more widely spaced intervals when color flow Doppler is used. Nonetheless, it is advisable to assess flow characteristics with spectral waveform analysis at frequent intervals, especially in patients with diffuse arterial disease. Lengths of occluded arterial segments can be measured with a combination of B-mode, color flow, and power Doppler imaging by visualizing the point of occlusion proximally and the distal site where flow reconstitutes through collateral vessels. Because flow velocities distal to an occluded segment may be low, it is important to adjust the Doppler imaging parameters of the instrument to detect low flow rates.

For ultrasound examination of aorta and iliac arteries, patients should be fasting for about 12 hours to reduce interference by bowel gas. Satisfactory aortoiliac Doppler signals can be obtained from approximately 90% of individuals that are prepared in this way. It is usually convenient to examine patients early in the morning after an overnight fast. The patient is initially positioned supine with the hips rotated externally. A left lateral decubitus position may also be advantageous for the abdominal portion of the examination. An electric blanket placed over the patient prevents vasoconstriction caused by low room temperatures.

For a complete lower extremity arterial evaluation, scanning begins with the upper portion of abdominal aorta. An anterior midline approach to the aorta is used, with the transducer placed just below the xyphoid process. Both ultrasound images and Doppler signals are best obtained in the longitudinal plane of aorta, but transverse views are useful to define anatomic relationships, assess branch vessels, and determine the cross sectional lumen. If specifically indicated, the mesenteric and renal vessels can be examined at this time, although these do not need to be examined routinely when evaluating the lower extremity arteries. The aorta is followed distally to its bifurcation, which is visualized by placing the transducer at the level of the umbilicus and using an oblique approach. The iliac arteries are then examined separately to the level of the groin with the transducer placed at the level of iliac crest to evaluate the middle to distal common iliac and proximal external iliac arteries. This may require applying considerable pressure with the transducer to displace overlying bowel loops. The origin of the internal iliac artery is used as a landmark to separate the common iliac from external iliac artery.

Each lower extremity is examined in turn, beginning with the common femoral artery and working distally. After common femoral and proximal deep femoral arteries are studied, the superficial femoral artery is followed as it courses down the thigh. At the distal thigh, it is often helpful to turn the patient in prone position to examine the popliteal artery. However, some examiners prefer to examine to popliteal segment with the patient supine and the leg externally rotated and flexed at the knee. As the popliteal artery is scanned in longitudinal view, the first branch encountered below the knee joint is usually the anterior tibial artery. The tibial and peroneal

arteries distal to tibioperoneal trunk can be difficult to examine completely, but they can usually be imaged with color flow or power Doppler. Identification of these vessels is facilitated by visualization of adjacent paired veins. These vessels are best evaluated by identifying their origins from the distal popliteal artery and scanning distally or by finding the arteries at the ankle and working proximally. Several large branches can often be seen originating from the distal superficial femoral and popliteal segments. These are rapidly visualized with color flow or power Doppler imaging and represent the geniculate and sural arteries.

Pulsed Doppler spectral waveforms are recorded from any areas in which increased velocities or other flow disturbances are noted. Recording should also be made at the following standard locations:

1. Proximal and distal abdominal aorta
2. The common, internal & external iliac arteries
3. The common femoral & proximal deep femoral arteries
4. The proximal, middle and distal superficial femoral artery
5. The popliteal artery
6. The tibial/ peroneal arteries at their origins and at the level of the ankle.

As with other applications of arterial duplex scanning, Doppler angle correction is required for accurate velocity measurements. Although an angle of 60 degrees is usually obtainable, angles below 60 degrees can be utilized to provide clinically useful information.

A complete examination of the aortoiliac system and the arteries in both lower extremities may require 1-2 hours, but a single leg can usually be evaluated in less than 1 hour.

MATERIAL AND METHODS:

Ethical Statement: The Study made the standards outlining the declaration of Helsinki and Good Epidemiological practices. This study did not change or modify the laboratory of clinical practices of each centre and differences of practices were kept as they are. The data collection was anonymous and identifiable patient information was not submitted.

Individual researchers were responsible for complying with local ethical standards and hospital registration of study.

1. The Present study was carried out in our hospital during the period of June 2017 to June 2019.
2. 50 cases of diabetic foot lesions admitted in Krishna Hospital, Karad were examined prospectively with patients referred from both medical and surgical units.
3. **Inclusion Criteria:** Adult diabetic patients (aged 18 years and above) irrespective of type of diabetes and gender with suspected peripheral vascular insufficiency or complaints of numbness, discoloration of periphery or ulceration.
4. **Exclusion Criteria:** Patients who had undergone arterial graft procedures. Blisters, Cellulitis, Abscess, Gangrene lesions occurring other than diabetes. Gestational diabetic patients.
5. All patients were evaluated by taking detailed history, clinical examination and necessary investigation were taken along with Doppler study according to Case proforma.
6. Categorization and tabulation of the data was done according to the observation section.

OBSERVATION AND RESULTS:

Table no 1: Age wise distribution

| Age in 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 no 2: Sex Wise distribution

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

Table no 3: Number of patients having history of trauma

| History of trauma | No. of patients |
|-------------------|-----------------|
| Yes | 31 |
| No | 19 |

Table no 4: Showing duration of Diabetes

| Diabetic Duration(in Years) | No. of Cases |
|-----------------------------|--------------|
| 1-5 | 21 |
| 6-10 | 20 |
| 11-15 | 6 |
| 16-20 | 1 |
| 21-25 | 2 |

Table no 5: Side Affected

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

Table no 6: Mode of Clinical Presentation

| Type of Lesion | No. of Cases |
|----------------|--------------|
| Cellulitis | 12 |
| Abscess | 10 |
| Ulcer | 17 |
| Gangrene | 11 |

Table no 7: Co-Morbidities:

| Co-Morbidities | No. of patients |
|----------------|-----------------|
| COPD | 8 |
| HTN | 23 |
| IHD | 5 |

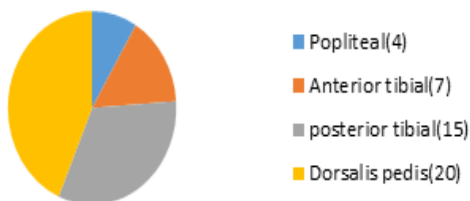
Table no 8: Wagner's Grading

| Wagner's Grading | No. of Cases |
|------------------|--------------|
| 0 | 4 |
| 1 | 9 |
| 2 | 12 |
| 3 | 14 |
| 4 | 7 |
| 5 | 4 |

Table no 9: Ankle Brachial index

| Ankle Brachial index | No. of patients |
|----------------------|-----------------|
| Normal(0.9-1.3) | 13 |
| Mild(0.8-0.9) | 12 |
| Moderate(0.5-0.8) | 14 |
| Severe(<0.5) | 7 |
| Critical(<0.3) | 4 |

Pie no 1: Absent Pulses



Pie no 2: showing Doppler study in selected No. of Cases

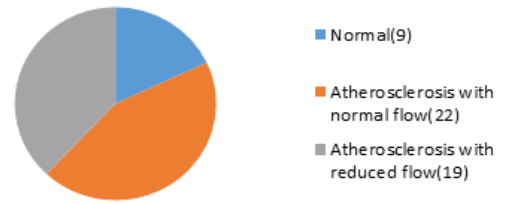


Table no 10: Correlation of wagner grading, Ankle brachial index and percentage of stenosis

| Wagner grading | Ankle Brachial index | % of stenosis | No. of patients |
|----------------|----------------------|---------------|-----------------|
| 0-1 | 0.9-1.3 | No stenosis | 13 |
| 2 | 0.8-0.9 | 1%-19% | 12 |
| 3 | 0.5-0.8 | 20%-49% | 14 |
| 4 | 0.3-0.5 | 50%-99% | 7 |
| 5 | <0.3 | Occlusion | 4 |

DISCUSSION AND SUMMARY:

50 cases of Diabetic foot were studied from June 2017 to June 2019 admitted in Krishna Institute of Medical Sciences, Karad. Here we summarize the findings:

- 1) Maximum incidence was seen in age group of 51-60 yrs. Youngest patient was 27 and oldest was 82.
- 2) In the present study, 35 were male and 15 female. There was marked male preponderance in this study .2.33:1 MALE TO FEMALE.
- 3) Most of patients had diabetes duration between 1-5yrs were 21 patients.
- 4) Majority of patients gave history of trauma as predisposing factor while in remaining patients there was no history of trauma. Here 31(62%) patients were having history of trauma.
- 5) Most common mode of presentation was ulcer in 17 cases followed by 12 cases of cellulitis.
- 6) In the present study, 23 patients had hypertension followed by 8 cases of COPD and 5 cases of IHD.
- 7) Maximum number cases 14 were seen in Wagner Grade III followed by 12 cases in grade II.
- 8) Maximum number of patients 13 had normal ABI. 14 patients showed moderate Ankle Brachial Index.
- 9) Most common absent pulsation was found in Dorsalispedis artery in 20 patients and least common with popliteal artery in 4 patients.
- 10) In Doppler study, 22 patients showed atherosclerosis with the normal flow. 19 patients showed atherosclerosis with the reduced flow.
- 11) Most number of patients 14 had moderate stenosis and complete Occlusion was seen in 4 patients.

CONCLUSION:

The findings of this study suggested vascular insufficiency was seen in 62% of the patients with Dorsalispedis being the commonest site of involvement. The insufficiency was moderate and the flow was biphasic in a majority of the cases. The mean duration of disease was almost a decade in patients exhibiting Doppler-documented vasculopathy.

Colour 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. Colour Doppler study also helps in the follow-up of the arterial diseases.

This study shows that these patients had risks factors for PVD. The use of Doppler will aid early diagnosis of critical limb at risk of loss and help prevent and reduce high rate of limb loss in our patients.

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