Triplex ultrasound findings of chronic leg ischemia with clinical correlation

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Summary:

Background: Chronic leg ischemia commonly affects the arteries supplying the leg and mostly caused by atherosclerosis. Triplex ultrasound scanning is useful for delineating the anatomic site of disease in the lower limb in addition to the grading of the stenosis and evaluation of post-stenotic flow.

Objectives: To determine the extent of vasculopathy in patients with chronic leg ischemia by using triplex ultrasound scanning and match the sonographic findings with the clinical signs and symptoms.

Patients and methods: A cross sectional study from October 2009 to September 2010 was performed on 56 patients with clinical suspicion of chronic leg ischemia referring to ultrasound unit for triplex ultrasound examination of lower limbs at Al-Shaheed Ghazi Al-Hariri Teaching Hospital in Baghdad. Patients selected randomly and consisted of 19 women and 37 men. The age ranged between 20 and 90 year.

Results: The highest proportion of patients was within 60-69 year age group. Dorsalis pedis artery was the most frequently involved artery. Most of study sample revealed multi-level stenosis. Atherosclerosis was highest causative factor in chronic leg ischemia. The commonest clinical presentation of leg ischemia was intermittent claudication. Most of the patients show high-grade stenosis. Bilateral involvement is more than the unilateral, right side affected more than the left side. Diabetes mellitus considered the leading risk factor.

Conclusions: Triplex ultrasound of the lower extremities is useful to diagnose anatomic location and degree of stenosis of peripheral arterial disease, which is available and low cost.

Key words: Triplex ultrasound, leg ischemia, stenosis.

Introduction:

Leg ischemia defined as an impairment of arterial blood flow to the lower limb, could be acute or chronic. (1) Synonyms are peripheral vascular disease, peripheral arterial occlusive disease or peripheral arterial disease, vaso-occlusive disease of the leg. (2) The clinical effect of peripheral arterial occlusive disease varies depending on the type, location and number of arterial lesions present. (3) Patients may be asymptomatic, suffer from pain on walking (intermittent claudication), pain while at rest, or tissue loss in the form of either ulceration or gangrene. (4) For evaluation of the vascular status in these patients different invasive and non-invasive methods are available like catheter arteriography, magnetic resonance angiography, computed tomographic angiography and triplex Doppler ultrasound scanning.(5) Triplex Doppler ultrasound scanning is widely preferred as it is simple, versatile and handy. The accurate diagnosis of the underlying cause is the first step towards a successful treatment plan. Triplex ultrasound grading of peripheral artery stenosis depends on the morphological and hemodynamic quantificati on of stenosis. The grade is the percentage of reduction in cross-sectional area, and classified as:

Low-grade stenosis, which is less than 50 % reduction in cross sectional area of affected artery.

Intermediate-grade stenosis, which is 51-75 % reduction in cross sectional area of affected artery.

High-grade stenosis, which is 76-95% reduction in cross sectional area of affected artery.

Subtotal occlusion state, which is more than 95 % reduction in cross sectional area of affected artery.

Complete occlusion state, which is 100% reduction in cross sectional area of affected artery. (6)

This study planned to determine the extent of vasculopathy in patients with chronic leg ischemia by using triplex Doppler scanning and match the sonographic findings with the clinical signs and symptoms.

Patients and Methods:

This cross sectional study done on 56 patients referred for Doppler ultrasound of lower limbs in Al-Shaheed Ghazi Al-Hariri Teaching Hospital - Medical City – Baghdad-Iraq, from October 2009 to September 2010 with patients clinically suspected as chronic leg ischemia.

The sample of this study consisted of 37 men and 19 women. The age of patients ranged between 20-90 years. Our patients randomly selected and no specific exclusion criteria were applied. These patients were presented with unilateral or

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bilateral symptoms and/or signs of chronic leg ischemia including intermittent claudication, rest pain, numbness, cold extremities, weakness, hair loss, ulceration, abscess formation, cellulitis and gangrene.

There is usually no special patient preparation required before Doppler scan. A peripheral arterial scanning option selected in the ultrasound machine before starting the examination, but adjustment of the control settings will often be required in the presence of significant disease. Detailed history was taking from patient including past surgical and medical diseases with careful clinical examination. The presence of vasculopathy assessed with triplex Doppler scanning by using a high-resolution real time ultrasound unit (Siemens Sonoline Elegra®) with 7.5-10 MHz linear array transducer depending upon the need and build of the patients. For evaluation of flow pattern, measurement of stenosis, we select high pulse repetition frequency, small color box, Doppler angle (60°), intermediate wall filter and intermediate color gain. While for measurement of slow flow, we select low pulse repetition frequency, low filter and high color gain. A combination of B-mode imaging, color flow imaging and spectral Doppler recordings used throughout the examination.

The common femoral, superficial femoral and deep femoral arteries examination begins with the patient lying supine with the limb externally rotated. The popliteal and crural arteries examination begin with turn the patient prone or on the side with the knee slightly flexed to view the popliteal artery, tibioperoneal trunk or peroneal artery. Scan for the anterior tibial artery through an anterolateral window with the patient supine and toes inverted.

The diagnostic workup of evaluation of chronic leg ischemia is consisting of: localization of flow obstruction, identification of type of flow obstacle (stenosis, occlusion), multiplicity of diseased segments, length of flow obstacle, grading of stenosis , identify the cause of stenosis or occlusion (atherosclerosis, trauma, ... etc), evaluation of post-stenotic or occlusive outflow tract.

The following points assessed by the triplex ultrasound scanning: Vascular calcification, thickening of arteries, and presence of plaques, color saturation, Spectral waveforms, peak systolic velocity, end diastolic velocity, peak systolic velocity ratio, Presence of collaterals, and any other findings. Then the data collected on a proforma that especially designed for this study hence the SPSS software version 10.0 used for descriptive data analysis.

During this study, we encountered a number of technical problems like severe calcification of the femoropopliteal arteries producing color image dropout and we try to solve it by making different transducer positions to work around the calcification. Also we face difficulty in examination of distal half of superficial femoral artery in obese patient with large thigh and we try to solve it by lowering the color and spectral Doppler transmit frequencies for better penetration; consider switching to a 3.5 MHz curved linear array transducer in very difficult situations. Finally, there is difficulty in examination of tibial arteries in patients with marked calf edema so we start the scan at the ankle and work proximally; a low frequency probe used to image these vessels proximally.

All patients in this study have no angiographic study so the comparison of our result with comparative angiographic results is not applied. Our patients in this study have no ankle-brachial index measurement prior to the Doppler examination. The aorta and iliac arteries assessment was not involved in this study. Since this is a descriptive study, therefore no patients follow up done.

The time allocated for the examination depends on the number of segments that need assessing and patient healthy status.

Results:

Over a period of one year, fifty-six patients with symptoms and/or signs of chronic leg ischemia were included in the study; five patients had negative Doppler ultrasound examination in spite of high clinical suspicion. The age at presentation ranged from 20 to 90 years. The mean age was 60.6 years and the maximum numbers of patients affected belong to the age group of 60 to 69 year. There were 37 males and 19 females in the patients included in the study. Males comprised 66% of the group while the females comprised 34%.

Table 1: Distribution of study sample by clinical presentations of chronic leg ischemia

Clinical presentations	Number (56)	%
Intermittent claudication	56	100
Coldness	33	58.9
Numbness	33	58.9
Loss of distal pulses	31	55.3
Rest pain	30	53.5
Weakness	22	39.3
Ulcer	12	21.4
Gangrene	9	16.07

Table (1) reveals that the commonest clinical presentation of leg ischemia was intermittent claudication (100%).

Diabetes mellitus is the leading risk factor for chronic leg ischemia in our study (57.1%), followed by smoking, hyperlipidemia and hypertension (33.9%, 32.1% and 30.3% respectively); however, the most of our patients in this study revealed multiple risk factors (60.7%).

Atherosclerosis was highest causative factor in chronic leg ischemia (91%), followed by previous arterial injuries, whether it is traumatic or surgical (5.4%) and burger's disease (3.6%).

Table 2: The incidence of individual arterial involvement in cases of chronic leg ischemia

Individual artery	Unilateral		Bilateral	Total (n=51)	%
	Right	Left			
Common femoral artery	4	5	8	17	33.33
Superficial femoral artery	7	4	8	19	37.25
Deep femoral artery	5	4	6	15	29.41
Popliteal artery	6	5	6	17	33.33
Anterior tibial artery	7	6	9	22	43.13
Peroneal artery	5	3	6	14	27.45
Posterior tibial artery	5	5	9	19	37.25
Dorsalis pedis artery	9	6	10	25	49.01

Table (2) shows that the dorsalis pedis and anterior tibial arteries are the most common arteries, which are involving by stenosis (49.01% and 43.13% respectively). Bilateral involvement is more than the unilateral, the right side affected more than the left side.

Table 3: Distribution of the study sample according grade of stenosis and side of involvement.

Degree of stenosis	Unilateral		bilateral	Total (56)	%
	Right	Left			
No stenosis	-	-	-	5	8.9
Low grade <50%	3	1	6	10	17.8
Intermediate grade 50-75%	5	4	1	10	17.8
High grade 75-95%	6	9	8	23	41.07
Subtotal occlusion >95%	2	2	3	7	12.5
Occlusion	1	-	-	1	1.7

Table (3) reveals that the high-grade stenosis is the highest percentage of study population (41.07%).

Table 4: The frequency of clinical presentations of chronic leg ischemia by level of stenosis

Clinical presentation	Level of stenosis			
	Single (N=16)	%	Multiple (N=35)	%
Intermittent claudication	16	100	35	100
Rest pain	9	56.25	19	54.28
Coldness	7	43.75	26	74.2
Numbness	8	50	24	68.5
Weakness	6	37.5	16	45.7
Ulcer	4	25	8	22.8
Gangrene	2	12.5	7	20
Pulse less	7	43.75	23	65.7

Table (4) shows that most of study sample reveals multi-level stenosis (n=35) more than single level involvement (n=16). The severity of most clinical presentation is increasing with increasing the numbers of stenotic sites.

Table 5: The frequency of clinical presentations of chronic leg ischemia by degree of stenosis

Clinical Presentations	DEGREE OF STENOSIS					
	Low grade (%) N(10)	Intermediate grade(%) N(10)	High grade (%) N(23)	Subtotal occlusion (%) N (7)	Occlusion (%) N (1)	No stenosis (%) N(5)
Intermittent claudication	10 (100%)	10 (100%)	23 (100%)	7 (100%)	1 (100%)	5 (100%)
Rest pain	4 (40%)	5 (50%)	12 (52.1%)	6 (85.7%)	1 (100%)	2 (40%)
Coldness	6 (60%)	7 (70%)	13 (56.2%)	5 (71.4%)	1 (100%)	2 (40%)
Numbness	5 (50%)	9 (90%)	14 (60.8%)	5 (71.4%)		1 (20%)
Weakness	3 (30%)	3 (30%)	11 (47.8%)	5 (71.4%)		
Ulcer		3 (30%)	6 (26.08%)	3 (42.8%)		
Gangrene		1 (10%)	4 (17.4%)	3 (42.8%)		
Pulse less		6 (60%)	16 (69.5%)	16 (83.7%)		

Discussion:

The total number of patients examined in our study was fifty six , in fifty one patients, the triplex ultrasound scanning was positive, giving vital information like degree of stenosis, abnormal waveform, luminal narrowing, plaques, and collaterals supporting the provisional diagnosis, while five patients had negative Doppler ultrasound examination in spite of high clinical suspicion. These patients may need ultrasound examination after exercise to reveal their symptoms, which not routinely applied in this study. This study was performed on fifty six patients with clinical findings of chronic leg ischemia, of whom were 37 male and 19 females (male/ female ratio equal to 1.9/1), which is in disagreement with Goldman, however claimed that in contrast to coronary heart disease, women and men have a similar risk for development of peripheral artery disease. (4) While it is in agreement with Abdul-Rahman et al, where the male/female ratio was 2.7/1. (7) This male predominance may be due to smoking, which is commoner among men, or associated diseases where the male gender is a known risk factor as hypertension, ischemic heart disease and Burger's disease. In this study, patients' age ranged between 20 and 90 year with an average 60.6 year. The highest proportion of patients was within 60-69 year age group (41.07%). This is because there appears to be a clear association between age and chronic leg ischemia. The incidence increasing with age as in different studies suggest that the prevalence of leg ischemia progressively increases with increasing age as shown in D.J. Margolis et al study. (8) The prevalence of all manifestations of arteriosclerotic disease related to increasing age. A decrease in the elastic properties, this is a natural physiological phenomenon, but it accelerated when risk factors such as smoking are present. The arterial distensibility also influenced by sex hormones. However, the femoral artery not influenced to the same extent as the aorta and carotid artery. Another factor influenced by sex hormones and age is disturbances in the microcirculation. In men, the increase in arterial stiffness is found earlier than in women, but after menopause, the process develops in similar ways in women and men. Women suffering from arteriosclerotic disease are generally older than men (3-10 years). The reasons for this difference are still not completely understood. (9) Endogenous changes in lipid levels also occur at the onset of menopause. Increased low-density lipoprotein and triglyceride levels and decreasing high-density lipoprotein levels could be major contributing factors for the rapid progression of arteriosclerotic disease after menopause. (10) In this study, the most frequently involved artery was dorsalis pedis artery (44.6%). This result is not consistent with results obtained in Abigail and Kenneth Myer studies on chronic leg ischemia, where the superficial femoral artery is mostly involved site (65%). (6, 11) This result may be due to the significant number of our patients in this study were suffering from diabetes mellitus, which predominantly affect the distal extremities.

The second most commonly involved artery is anterior tibial artery (49.01%). The least frequently involved artery was peroneal artery (27.45%), which is consistent with Jensen et al study. (12) The unilateral involvement more than bilateral involvement, the unilateral/bilateral ratio was 1.4-1.5/1. Most patients (68.6%) of the sample of study showed multi-level stenosis while only (31.4%) of sample of study shows single level stenosis. This indicates that chronic leg ischemia is generalized disease affecting the majority of the lower limb arteries. The number of levels affected was increasing with age of the patient that is consistent with most studies of chronic leg ischemia. (6,9,10) All signs and symptoms of chronic leg ischemia are commoner in the multiple level stenosis than in single level stenosis aside from intermittent claudication are same incidence in both (100%). Regarding the degree of stenosis, most of the patients (41.07%) show high-grade stenosis, while the low and intermediate grade stenosis are seen in (17.8%) of patients. The subtotal occlusion is seen in about (12.5 %) of patients. Only (1.7%) of sample of study reveals arterial occlusion. Only 8.9 % of patients show no stenosis. The incidence of calcification was more common with high-grade stenosis than other grades of stenosis (26.7%). The causes of chronic leg ischemia in our study were atherosclerosis (91.07%), previous arterial injuries (5.4%) and Burger's disease (3.6%). These results are consistent with most studies on peripheral artery disease. (10,11,12) Burger's disease was found prevail in younger age groups , which is in agreement with Fowkes FG et al. (13) Intermittent claudication was the most frequent symptom. It was present in 56 patients (100%), This finding goes with Jensen et al study. (12) The feeling of cold feet was the second frequent symptom present in 33 patients (58.9%). In this study, both limbs were commonly affected (37.5%) and right limb more than the left one (33.9% and 28.5% respectively). Claudication may occur in one leg only (40% of the time) or affect both legs (60% of the time). (4) The patients in this study have variable risk factors, which may predispose to chronic leg ischemia like diabetes mellitus (57.1%) which is in agreement with Hiatt WR et al, where the incidence was (25-65%). (10) From 32 patients with diabetes mellitus , only one patient was type 1 diabetes mellitus while 31 patients was type 2 diabetes mellitus. The male/female ratio among diabetes mellitus patients was 2.2/1, which is disagreement with Hiatt WR et al; however, they claimed that female predominance in diabetes mellitus patients. (10) In early menopause, the presence of the metabolic changes, hypertension and a negative lipid profile are common in diabetic women and contribute to their increased risk of coronary artery disease and lower limb ischemia compared to non-diabetic women. (14) The incidence of other risk factors are: smoking (33.9%) , where the male/female ratio equal to 18/1 , which is consistent with Sonesson B. et al. (15) Hyperlipidemia (32.1%), hypertension (30.3%), family history (21.4%), ischemic heart disease

(19.6%), cerebrovascular disease (3.5%), heart failure (3.5%), trauma (3.5%) and   multiple risk factors (60.7), the results are slightly different to the figures reported by Hooi J.D. et al, who noticed multiple risk factors in (66%) of total patients. (16)   Arterial wall calcification is seen in (n=22; 39.2%); majority (n=15; 68.1%) of them occur in diabetic patients, which is in agreement with Y. Leskinen et al. which found that both peripheral vascular disease and arterial calcification were common in patients with a sequelae of diabetes. (17) This study reveals the gangrene and loss of distal pulses of lower limbs were commonly present with high-grade stenosis and increased with increasing the degree of stenosis while the intermittent claudication is a manifestation of chronic leg ischemia nevertheless the degree of stenosis. In addition, the severity of stenosis augmented with increasing the numbers of arterial levels that involved.

Conclusion:
Triplex ultrasound considered noninvasive initial imaging modality in the assessment of the chronic leg ischemia, which is available and cheap. There is close correlation between severity of clinical manifestation and degree of stenosis as well as the multiplicity of level of stenosis. Diabetes mellitus is the leading risk factor in developing chronic leg ischemia in our country and exaggerate the severity of clinical manifestation.

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