

Comparison Study between Angio CT and USG Doppler for Early Detection of Arterial Stenosis of Lower Extremities in University Clinical Center of Kosovo

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Abstract

Peripheral artery disease (PAD), also known as atherosclerotic disease leading to peripheral artery obstruction, with a variety of symptoms and signs revealing extremity ischemia. The signs and symptoms of arterial insufficiency are due to low blood flow to the musculature. Low blood circulation leads to the changes in the metabolism. These changes are manifested with the pain in the precious muscle relating to the anatomical structure in which the obstruction occurs. Undoubtedly the peripheral arterial disease (PAD) is a common disease that can affect different groups of population with higher prevalence in different groups with risk factors such as: age (older age), hypertension, smoking, diabetes mellitus, obesity, inflammation, stress, live style, family history of cardio vascular (CV) disease, gender, heredity and dyslipidemia.

The main purpose of this study is to determine the role of USG Doppler and CT angiography examination in patient with PAD, furthermore to estimate the incidence rate of PAD in different group of population based on the age, profession and to identify the potential risk factors.

Material and method: This study was implemented at the University Clinical Center of Kosovo in the department of Radiology for patient with clinical signs of PAD in the lower extremities admitted from the emergency unit and patients who were referred by different unit over a period of one year. All patient were subjected to the duplex ultrasound examination and Angio-CT.

In this study included 150 patients from which 73.3 % were male and 26.7 female. Among the total number of patients 17.3% were urban residence and 82.7 % rural residence. 59.3% of patient were active smokers. During our study we found that most of the patient with peripheral disease were previously diagnosed with diabetes mellitus(DM). In our study we found that just 9.3 % of patient were without chronic disease.36.0% of patients were in the age-group from 60-70 years old. Our study showed that 39.4% of patients were with intensive claudication, 49.3% with moderate and 11.3% with mild claudication. The sensitivity of Duplex Doppler was 88.36%, specificity is 50.0 % and accuracy 87.33%.

Angio CT together with duplex ultrasound has higher predictive value that determines the level of occlusion. According to our results the accurate occlusion/sub occlusion is better defined if we use Angio CT and Duplex Doppler together to improve the diagnostic accuracy in PAD. More than half of patients participating in this study were heavy smoker.

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Introduction

Atherosclerosis is consequence from gathering of lipid and fibrosis in the layers of the

arterial wall. With time these changes lead to the narrowing of coronary, cerebral and peripheral arteries. Due to the atherosclerosis the narrowing of the peripheral vessel will cause disease known as lower extremity peripheral artery disease.

Results from recent research, report that prevalence of peripheral arterial disease in the lower extremity occurs approximately 10 percent of the population before the age of 55.¹ The data from the United States research suggest that this

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prevalence of peripheral arterial disease has higher rate among women than in men.² There are different risk factors that can contribute in the peripheral arterial disease such as smoking, older age, hypertension diabetes mellitus and dyslipidemia.^{3,4}

Occlusion due to atherosclerosis may be asymptomatic or with clinical manifestation with symptoms of peripheral disease. The clinical manifestation includes unilaterally or bilaterally claudication in one part of the extremities or in combination. The manifestation of this disease can be with acute or chronic symptoms. Vascular system includes each organ system in our body. The manifestations of vascular disease are different. The insufficient of blood supply to specific organs typically is followed with pain; such as calf pain with lower extremity claudication, postprandial abdominal pain from mesenteric ischemia, and arm pain with axillo-subclavian arterial occlusion.⁵ Symptoms of arterial disease typically are separated into acute and chronic types. The beginning of pain usually indicates whole occlusion of vessel clinically manifested with severe pain and ischemia in the specific part of the body. Low blood supply in the crucial artery finally causes limb gangrene or intestinal infarction. The diagnosis of peripheral arterial disease is proven by physical examination, measurement of ankle - brachial index, duplex ultrasonography, computed tomography, angiography and magnetic resonance angiography.⁶

The classification of peripheral artery disease (PAD) in the lower extremities are based on sorting out symptoms and anatomic lesions as follows:

Claudication is confirmed by initial and absolute walking distance (Rutherford scale graded from 1 to 3).

Classification based on the recommendation from Trans-Atlantic Inter-Society Consensus (TASC-II) for the atherosclerosis disease in the lower extremity.⁷

The Global Vascular Guidelines (GVG) recommends classification system based on the clinical manifestation (wound, Ischemia and foot infection- Wifl).⁸

Referring to the GLASS classification system peripheral arterial disease are distinguished based on the anatomical distribution such is femoropopliteal segment, infrapopliteal segment, infrainguinal stage (I to

III).⁸ Diagnosis of PAD in the initial phase of disease prevents further complication in different group of population. The examination using the color Doppler imagery are noninvasive procedure and inexpensive can help in early diagnosis and early treatment in comparison to Computed tomography angiography and magnetic resonance imagery that are expensive and difficult to reach in the developing countries. There is no data for PAD in our country regarding the incidence rate, risk factors and age of patient which are mostly affected.

Aim of the Study

The purpose of this study is to:

1. Determine the role of USG Doppler and CT angiography examination in patient with PAD
2. Estimating the incidence rate of PAD in different group of populations based on the age, profession and as well to identify the potential risk factors.

Materials and methods

Study Design

This study was conducted at the University Clinical Center of Prishtina in the Department of Radiology in patients admitted with clinical signs of the peripheral arterial disease (PAD) during the period of time from October 2018 up to October 2019.

Study samples

This study included 150 patients in each of them USG Doppler and Angio CT was performed in order to determine the level of occlusion, scale of occlusion comparing with patients ages, residency and co morbidities. Using duplex Doppler and CT angiography we performed examination in every patient to determine level and scale of occlusion in peripheral arterial system. This study has been approved by ethical committee at the University Clinical Center of Prishtina and informed consent was provided by all subjects participating in this study.

Inclusion criteria

All patients referred upon clinically suspicious for peripheral occlusion in the department of emergency.

Patients with chronic disease referred by other units (neurology, internal medicine, surgery)

1. Pregnant women were excluded from this study
2. Patient with high level of BUN

3. Allergic patient to iodinated contrast.
4. Patient who refused to be part of this protocol.

In all these cases with exclusion criteria we have performed only USG Doppler scan.

Duplex Doppler evaluation was performed by Philips ultrasound system. Patients were positioned in supine position while we performed examination of the iliac artery, tibial artery together with dorsalis pedis, while for popliteal artery the examination was done in prone position. The evaluation of patient suspicious for peripheral arterial disease was performed by using the linear probe (from 6 up to 12 MHz) together with color flow.

In all patients, except for patient with exclusion criteria after the Duplex Doppler in our unit we performed the CT Angiography. The evaluation was done using the Siemens 64 slice CT multidetector. All images obtained by examination, have been interpreted by radiologist of University Clinical Center of Pristina. Stenotic findings were classified according to scale of occlusion/sub occlusion that was identified in Duplex Doppler and CT angiography as follows:

- Normal or mild stenosis (0-19%)
- Moderate arterial stenosis (20-50 %)
- Significant stenosis (> 50-79%)
- Sever or "critical" stenosis (80-99%)
- occlusion (100%)

STATISTICAL ANALYSIS

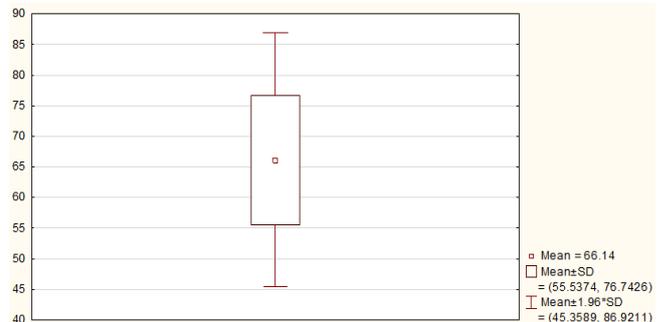
Statistical analyses are performed using statistical package SPSS 17.0 version software. All categorical variables are presented as proportion in percentages with their 95% confidence interval (95%CI). The mean values of all continuous variables will also present with their 95% CI. X2-analysis or Fisher exact test is performed to test the difference in proportions of qualitative variables between groups. The level $P < 0.05$ will be considered as the cut-off value for significance.

Results

A total of 150 cases that met inclusion criteria were included and analyzed in the current study using two diagnostic methods Duplex Doppler and CT Angiography. The mean age of the patients was 66.1 ± 10.6 years, with a range from 47 to 87 years (Table 1 and Graph 1).

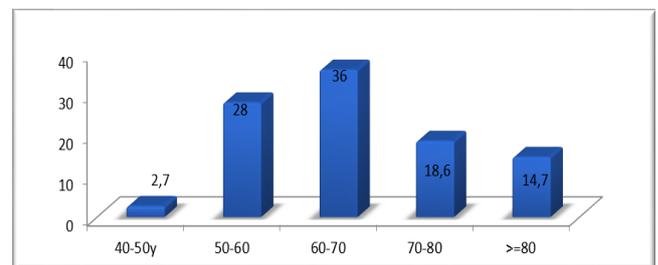
	Valid N	Mean	Minimum	Maximum	Std.Dev.
Age	150	66.14	47.0	87.0	10.62037

Table 1. Mean age of the patients.



Graph 1. Mean age of the patients.

More than half, 54 patients (36.0%) were the age-group 60-70 years (Graph 2). We discovered statistically significant association between the age-group equal to or above 60 years and claudication (11.648, $p = .000642$ using chi-square test). Age equal or above 60 years were associated with 2-fold increased risk of arterial stenosis of the lower extremities (OR=2.2609; 95%; 1.4101-3.6250)

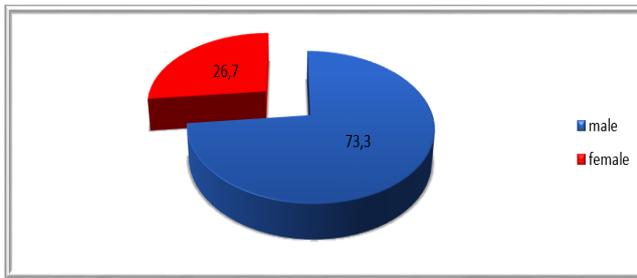


Graph 2. Distribution of the patients according to the age-groups.

Of the total number 150 patients (73.3%) were male and 40 patients (26.7%) were female (Table 2 and Graph 3). Statistically significant association was found between the arterial stenosis of the lower extremities and gender (31.74, $p = .0001$ using chi-square test). Male gender increases risk for arterial stenosis of lower extremities by nearly 3 times (OR=2.7500; 95%; 1.6964-4.4581)

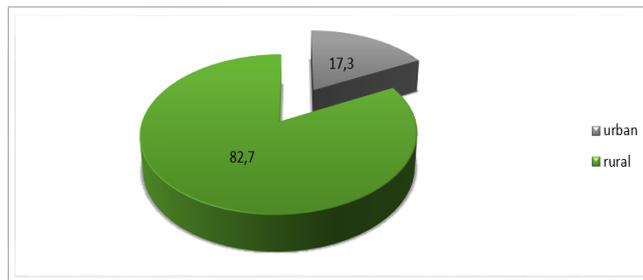
gender	Count	Percent
M	110	73.3
F	40	26.7
total	150	100.0

Table 2. Distribution of the patients according to the gender.



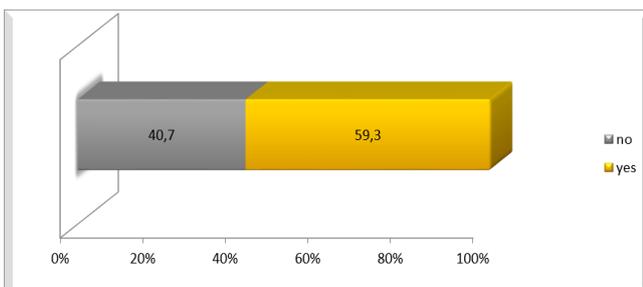
Graph 3. Distribution of the patients according to the gender.

124 patients (82.7%) are rural residence and only 26 patients (17.3%) are urban residence (Graph4). Association between the arterial stenosis of lower extremities and patient residence was considered statistically significant (35.837, $p=.0000$ using chi-square). Patients with rural residence were 4.7 times more likely to develop arterial stenosis of the lower extremities compared to those with urban residence (OR=4.7692; 95%; 2.8065-8.1047).



Graph 4. Distribution of the patients according to the residence.

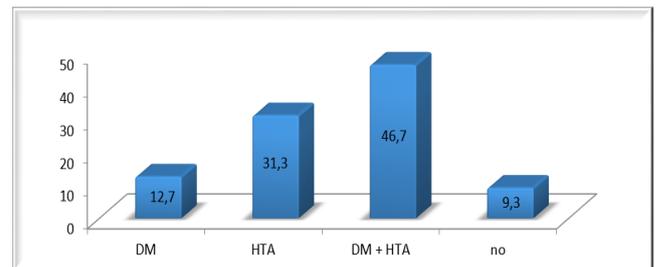
89 patients (59.3%) were active smokers and 61 patients (40.7 %) were nonsmokers (Graph 5). There was not statistically significant association between the smoking habit and arterial stenosis of the lower extremities (Pearson Chi-square 2.6363, $p=.104447$) in the current study.



Graph 5. Distribution of the patients according to the smoking habit.

Out of the total number of participants in this study, 70 patients (46.7%) had two comorbidities namely, diabetes mellitus and arterial hypertension, only hypertension 47 patients (31.3%), diabetes mellitus 19 patients (12.7%) and 14 patients (9.3 %) were without chronic diseases.

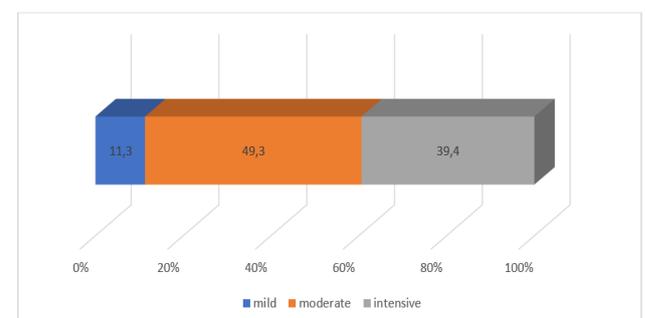
(Graph 6). Association between the arterial stenosis of the lower extremities and chronic hypertension was statistically significant (Pearson Chi- 21.7503, $p=.00001$).



Graph 6. Distribution of the patients with chronic disease/comorbidities.

Hypertension was associated with three-fold increased risk for arterial stenosis of the lower extremities (OR=3.1667; 95%;1.9346-5.1835). No significant association was found between the diabetes mellitus and arterial stenosis of the lower extremities (Pearson Chi-square 2.6363, $p=.104447$).

Severity of the claudication was categorized as mild, moderate and intensive. In our study 59 patients (39.4%) had intensive claudication, 74 patients (49.3%) moderate and 17 patients (11.3 %) mild claudication. Differences between intensive vs mild and moderate vs mild claudication were statistically significant ($p<0.05$) (Graph 7).

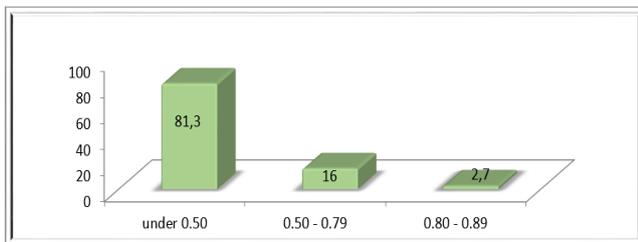


Graph 7. Distribution of the patients according to the severity of pain (claudication).

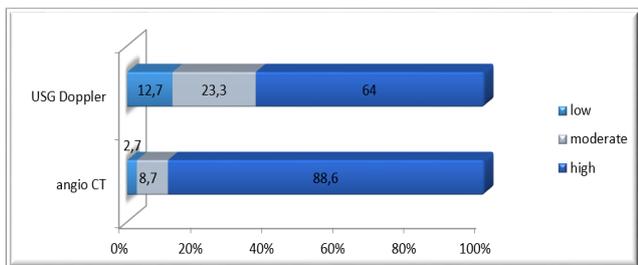
We found statistically significant association between the intensive claudication and age > 60 years, hypertension, diabetes mellitus and smoking (p=.0058, p=.0000, p=.0005 and p=.0433 respectively) (data not shown).

Ankle-brachial index (ABI) is highly reproducible and noninvasive test and normal range for the ABI is between 0.90 and 1.30. ABI lower than 0.9 indicates PAD with high sensitivity and specificity. ABI values from 0.50 to 0.89 indicate mild to moderate peripheral artery disease and values 0.50 or lower values indicate severe disease.

In the current study, 122 patients (81.3%) had severe arterial disease while 24 patients (16.0%) moderate arterial disease, according to the ankle-brachial index (Graph 8).



Graph 8. Distribution of the patients according to the ankle-brachial index (ABI).



Graph 9. CT Angiography and USG Doppler and the degree of stenosis.

In 150 subjects participating in the study Duplex Doppler and CT Angiography was performed to categorize the degree of the stenosis. Degree of stenosis is classified as low, moderate and high. Low degree stenosis was found in 19 patients(12.7%) with USG Doppler and in 4 patients (2.7%) with CT Angiography, therefore the difference was statistically significant for

Moderate occlusion was found in 35 patients (23.3 %) with USG Doppler and in 13 patients (8.7%) with CT Angiography. The

difference was statistically significant for p<0.05. CT Angiography revealed high occlusion in 133 patients (88.6%) while these findings were revealed in 96 patients (64.0%) with USG Doppler and the difference was statistically significant for p<0.05 (Difference test, p=.0000) (Graph 9).

In this study application of two methods, CT Angiography and USG Doppler detected the highest percentage of the arterial stenosis of the lower extremities for a.femoralis and a.infrapoplitea in 47 patients(31.3%). In 19 patients (12.7%) arterial stenosis was detected in a.infrapoplitea alone and the same percentage was found for the a.femoralis, poplitea and infrapoplitea together (Table 10).

The difference between the a.femoralis vs a.iliaca and a.poplitea as well as the difference between the a.infrapoplitea vs. a.poplitea and a.iliaca was statistically significant for p<0.05 (Difference test, p=.0000) (data not shown).

Angio CT and USG Doppler	Count	Percent
a.iliaca	4	2.7
a.femoralis	17	11.3
a.poplitea	1	0.7
a.infrapoplitea	19	12.7
a.femoralis ,a. infrapoplitea	47	31.3
a.poplitea, a.infrapoplitea	5	3.3
a.femoralis, a.poplitea, a.infrapoplitea	19	12.7
a.femoralis, a.poplitea	12	8.0
a.iliaca, a.femoralis	13	8.7
a.iliaca, a.femoralis, a.infrapoplitea	5	3.3
a.iliaca, a.femoralis,a.poplitea	3	2.0
a.iliaca, a.femoralis, a.poplitea,a.infrapoplitea	5	3.3
Total	150	100.0

Table 10. Distribution of the arterial stenosis of the lower extremities using CT Angiography and USG Doppler.

Discussion

The incidence of peripheral arterial disease is different, but according to the different studies occurrence is around 3 up to 12 percentage^{7,9}. Delay diagnosis and complication are important outcome measures during the clinical evaluation. Peripheral artery disease (PAD) of the upper extremities can be asymptomatic disease with years and also can be symptomatic, causing pains because of ischemic changes and finally leading to

gangrenous and ulcerative alterations. Dealing with patients which potentially are suffering from PAD is a clinical challenge and require multidisciplinary approach between clinicians and radiologist.

This cross-sectional study was conducted with intent to find the best diagnostic approach in patient related to PAD. During this study our intention was to determined the role of CT angiography and Doppler ultrasound in early detection of PAD. We accomplished to find the relation between the age of patient, gender, residency, smoking habits, chronic disease together with clinical appearance such is claudication and arterial stenosis in lower extremities. The data from our study were compared with corresponding studies.

In our study we analyzed 150 patients with symptoms of PAD in which after clinical examination, Duplex doppler and CT angiography were performed. From overall patients participated in this study 36.0% were in age group from 60 up to 70 years old.

According to this data the percentage difference was statistically significance with $p < 0.05$. Based on our study the age over 60-year-old and equal have increased risk for arterial stenosis for two-fold in comparison to other age groups. According to the recommendations from the American College of Cardiology (ACC/AHA) the occurrence of PAD are in group of age over 70 years^{10,12}.

Result in our study show that the percentage of patients with peripheral arterial disease are raising in the group of age from 60 up to 80-year-old which is roughly with recommendations from ACC and AHA. In the present study of 150 patients, 73.3% were male and 26.7% were female. There is a statistically significance comparing this two groups with $p < 0.05$. All though the prevalence of PAD between male and female are not well evaluated. The study from Hiramoto JS and al, found that women were considerably more probable to suffer from peripheral arterial disease comparing to the male gender.¹³

A recent study found that peripheral arterial disease has equal prevalence in male gender vs female in high-income countries, but this incidence is higher in women than men in low-income countries.^{14,16}

In this study we have analyzed the difference between the place of residence for all

patient participating in this study. Almost all of patient were from rural residence (82.7%) while just 17.3% were from urban residence. This proportion are statistically significant for $p < 0.05$. Recently several studies have investigated ethnic-associated differences in preponderance rates of peripheral arterial disease and found that PAD is more frequently in the African Americans than non-Hispanic.^{15,16} While we surf in the different database for peripheral arterial disease we did not find any paper related to comparison the prevalence of this disease between rural and urban population.

During this study we also analyzed the relation between the smoking habitis and PAD. From the total number of patient 59.3 were heavy smokers while 40.7 were non smokers. Based on different studies smoking is related with cardiovascular disease.¹⁷ The evidence from different studies suggest that vascular disease are more frequent in smokers patient in comparison with non-smokers in the sense of having symptomatic disease earlier in patient with smoking habits.¹⁸

In the present study we found that chronic disease can increase the incidence of PAD. Based on the result of our study the patient with diabetes mellitus and arterial hypertension are more likely to have peripheral arterial disease than patient without DM and HTA. Related to the different studies from USA and Rotterdam there is a strong relation between the arterial hypertension and risk for symptomatic PAD.^{19,21}

We have analyzed the strength of claudication and we found that out the total number 11.3.% of patient that were in the group with mild claudication, 49.3% moderate and 39.4 intensive claudication's this percent difference were statistically significant($p < 0.05$). Analyzing the Ankle-brachial index in our patients we revealed that 81.3% of patient were with severe arterial disease while 16.0% with moderate arterial disease. Referring to the earlier studies the sensitivity of ankle-brachial index in patient with PAD is around 80% while the specificity is more than 95 %.²⁵

In this cross-sectional study we manged to categorize the degree of stenosis in lower extremities using two methods CT angiography and USG Doppler. Low degree stenosis was found in 12.7% of patient while using the USG Doppler and 2.7% of patinet with CT angiography. Moderate stenosis was found in 23.3.% of patient

with Doppler and 8.7% with CT angiography, while high occlusion was identified in 88.6% with CT angiography and 64.0% using USG Doppler. These results are statistically significant with $p < 0.05$. The results from our study are more or less in line with other previous studies.^{20,24}

Conclusions

Duplex ultrasound and Ango-CT examination are both effective to accomplish the diagnosis of peripheral arterial disease. The result from our study show that combining of these two methods will raise the accuracy of diagnosis and can contribute in higher diagnostic accuracy and better outcomes.

Ethics Approval and Consent to Participate

The study protocol was approved by the ethical Review Committee, University Clinical Center of Kosovo- Prishtine

Availability of data and material

Data sharing not applicable to this article as no datasets were generated or analyzed during the current study.

Declaration of Interest

The authors report no conflict of interest.

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