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Sensitivity and Specificity of Ultrasonographic Compared with CT Angiography in Detecting Femoropopliteal and Infrapopliteal Arterial Lesions in Lower Extremity Arterial Disease in Dr. Mohammad Hoesin General Hospital Palembang

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Abstract

Background: Peripheral artery disease (PAD) is a chronic occlusive arterial disease of the extremities caused by atherosclerosis.[1] It is estimated that 20-30% of the population worldwide suffered PAD.[2] PAD is associated with a 1-year mortality and limb loss rate of 20%.[7] Critical limb ischemia (CLI) is a late stage clinical presentation of PAD. Imaging of the entire artery is possible using CT angiography. However, CT angiography has its drawbacks because the contrast used can be nephrotoxic, the risk of allergies, expensive, and not all health services have it. Ultrasonographic's (USG) sensitivity, specificity and accuracy were 96.55%, 61.53%, and 78.84% for detecting lower limb distal artery lesions.[11] Ultrasonographic does not require the use of contrast, radiation, low cost and almost all health services have them.[12] However, the Ultrasonographic examination has its limitations depending on the operator's capabilities. It is therefore necessary to conduct research that have never been previously studied in South Sumatra.

Methods: This study is a diagnostic test study that examines the sensitivity and specificity of ultrasound in detecting LEAD artery lesions. The samples were 29 patients.

SJS SRIWIJAYA JOURNAL OF SURGERY

Results: At the femoropopliteal level, the results obtained were 91% sensitivity and 86% specificity. At the infrapopliteal level, the results obtained were 95% sensitivity and 87% specificity.

Conclusion: Ultrasonographic has high sensitivity and specificity in detecting LEAD's lesions

Keywords: peripheral arterial disease, lower extremity arterial disease, chronic limb threatening ischemia, ct angiography, ultrasonographic

1. Introduction

Peripheral artery disease (PAD) is a chronic occlusive arterial disease of the extremities caused by atherosclerosis. PAD has become a global health problem, mainly due to the aging of the world's population and the growing prevalence of risk factors such as diabetes, smoking, hypertension and dyslipidemia.[1] It is estimated that 20-30% of the population worldwide suffers from PAD and there are more than 25% of individuals. aged over 75 years with PAD.[2] In primary health practice across the United States, 29% of patients over 70 years of age or over 50 years of age with a history of smoking or diabetes have reported having PAD.[3] PAD is often diagnosed late , untreated, is poorly understood by the public.[3] The amputation rate in PAD patients in the United States is very high. From 2000 to 2008 in the United States, 186.338 PAD sufferers were amputated during that time.[6] PAD was associated with a 1-year mortality rate of 20% and a 1-year limb loss rate of 20%.[7] Average annual expenditure per individual for patients with PAD is $11.553 to $42.613 in the United States.[8] However, there are no complete data on the number of PAD sufferers in Indonesia.

Chronic limb-threatening ischemia (CLTI) or Critical limb ischemia (CLI) is a late stage clinical presentation of PAD, CLI is associated with a high risk of limb loss if untreated, leading to amputation. Clinical manifestations of CLI are ischemic rest pain, ulcers or gangrene, and symptoms appear for more than 2 weeks. The objective diagnosis is ankle pressure less than 50mmHg, toe pressure less than 30mmHg, and ankle brachial index (ABI) value ≤ 0.41.

ABI examination has a sensitivity of 95% in diagnosing PAD[1], but ABI cannot determine the location of the lesion. After advancing the computed tomography (CT) angiography technique, we can assess the blood flow of the lower extremities in a few seconds. Optimization of intravenous contrast with blood flow

and CT angiography scanning provides higher spatial resolution and coverage over 120cm.[10] Imaging the entire artery is possible using CT angiography and has found excellent compatibility with digital subtraction angiography (DSA). However, CT angiography has its drawbacks because the contrast used can be nephrotoxic, the risk of allergies is expensive, and not all health services have it. Ultrasound (USG) is a good method for screening and follow-up, as well as for the definitive diagnosis of peripheral artery disease. The sensitivity, specificity and accuracy of ultrasound were 96.55%, 61.53%, and 78.84% for detecting lower limb distal artery lesions.[11] Ultrasound is a noninvasive technique that does not require the use of contrast, preparation of the patient before examination, or radiation exposure, low cost and nearly all services health has it.[12] However, ultrasound examination has limitations that is dependent on the ability of the operator.

Several studies on the comparison between ultrasound and CT angiography in detecting lower extremity arterial disease (LEAD) lesions, Ahmed I. Gamal El Dein et al.[62] stated that there was a significant and accurate relationship between ultrasound and CT angiography with the kappa technique. At the level of the common femoral artery, superficial femoral artery, popliteal artery, peroneal artery and anterior tibial artery, the kappa test values were 0.88, 0.82, 0.87, 0.88 and 0.88. In the study of Chidambaram et al.[11], it was obtained a sensitivity of 89%, specificity of 93%, and accuracy of 92%.

CT angiography has limitations on nephrotoxic contrast agents, cannot be performed on patients with renal dysfunction, is expensive, risks allergies, and not all health services have it. While USG is a sensitive, non-invasive, inexpensive, non-toxic examination to detect LEAD lesions, but ultrasonography is an operator dependent examination. Therefore, it is deemed necessary to conduct research on the sensitivity and specificity of ultrasonography compared to CT angiography in detecting lesions in LEAD which have not been previously studied in South Sumatra.

2. Methods

This study is a diagnostic test study that examines the sensitivity and specificity of ultrasound in detecting LEAD artery lesions compared to CT angiography.

The population was LEAD patients who came to the FK UNSRI / RSMH Vascular and Endovascular Surgery Division. The sample in this study was the entire population that met the inclusion criteria.

The inclusion criteria of this study were LEAD patients who were included in the indication for CT angiography examination and the exclusion criteria were patients who had major amputation[53] prior to CT angiography, patients with impaired kidney function, a history of allergy to contrast substances and pregnant women.

The sample size in this study was 25 people. The variables of this study included gender, age, history of diabetes mellitus, history of hypertension, hyperlipidemia, length of the lesion, location of the lesion, and type of lesion.

The sample data is presented in 2x2 table form and divided into 2 levels, namely femoropoplitea and infrapoplitea.

3. Results

Demographic characteristics

There were 29 PAD patients who came to RSMH who were willing to participate in the study. Distribution of samples based on gender, age, DM and hypertension were show in table 1.

Laboratory characteristics

The LDL test results was show in table 1.

CT angiography characteristics

In this study, distribution femoropopliteal and infrapopliteal lesions based on CT angiography and USG were show in table 1.

Distribution femoropopliteal and infrapopliteal lesions length based on CT angiography were show in table 1.

Distribution femoropopliteal and infrapopliteal lesions type based on CT angiography and USG were show in table 1.

Table 1. Demographic Characteristics of Research Subjects

Characteristics		N	%
Gender	Male	13	45
	Female	16	55
Age	≥ 70 years old	5	17
	60-69 years old	9	31
	50-59 years old	13	45
	40-49 years old	2	7
	< 40 years old	0	0
DM	Yes	22	76
	No	7	24
Hypertension	Yes	16	55
	No	13	45
DM and Hypertension		13	
LDL	<100mg/dl	19	73
	≥ 100mg/dl	10	27
Femoropopliteal lesion (CT Angiography)		22	76
Infrapopliteal lesion (CT Angiography)		21	72
Femoropopliteal lesion (USG)		21	72
Infrapopliteal lesion (USG)		21	72
Length of the femoropopliteal lesion (CT angiography)	< 5cm	15	
	5-10cm	6	
	> 10cm	1	
Length of the Infrapopliteal lesion (CT angiography)	< 5cm	13	
	5-10cm	7	
	> 10cm	1	
Type of femoropopliteal lesion (CT angiography)	Occlusions	9	
	Stenoses	14	
	Plaques	8	
Type of infrapopliteal lesion (CT angiography)	Occlusions	6	
	Stenoses	15	
	Plaques	11	
Type of femoropopliteal lesion (USG)	Occlusions	11	
	Stenoses	10	
	Plaques	4	
Type of infrapopliteal lesion (USG)	Occlusions	6	
	Stenoses	15	
	Plaques	10	

Ultrasound diagnostic test results compared with CT angiography

Distribution of the femoropopliteal lesion based on USG and CT angiography were show in table 2.

Distribution of the infrapopliteal lesion based on USG and CT angiography were show in table 3.

In this study, at the femoropopliteal level, sensitivity was 91%, specificity was 86%, positive predictive value was 95%, and negative predictive value was 75%, RK was positive 6.36, and RK was negative 0.1. At the infrapopliteal level, there was a sensitivity of 95%, specificity of 87%, a positive predictive value of 95%, and a negative predictive value of 87%, a positive RK of 7.61, and a negative RK of 0.054.

Table 2. Distribution of the femoropopliteal lesion (USG and CT angiography)

CT Angiography / USG	(+)	(-)
(+)	20	1
(-)	2	6

Table 3. Distribution of the infrapopliteal lesion (USG and CT angiography)

CT Angiography / USG	(+)	(-)
(+)	20	1
(-)	1	7

4. Discussion

According to data from Hiatt WR et al. (2001) there is no significant difference between gender in the prevalence of PAD.[1] The results of this study are slightly different from the study by Norgren et al, which states that more men suffer from peripheral arterial disease with a ratio of 2:1.[15]

In the United States, cases of PAD who are more than 60 years old have a greater percentage of those who are less than 60 years old. In line with the research results of Schroll et al, who reported that PAD sufferers were mostly found in respondents who were over 60 years of age.[54] According to Criqui et al. national health and nutrition examination study), aged over 65 years have a higher risk of PAD.[4]

The results of this study are consistent with research by Schroll which shows that diabetes mellitus is a risk factor for the occurrence.[54] This is in line with the results of the study by Ness et al which stated that diabetes mellitus is a predisposing factor.[55] The results of this study are in accordance with the Edinburgh Artery Study, where the prevalence of patients increases. in people with diabetes and poor blood sugar tolerance (20.6%) compared with people with good blood sugar tolerance (12.5%).[56]

The results of this study are in accordance with research by Schroll which shows that hypertension is a risk factor for this disease.[54] This is in line with the results of the research of Ness et al which stated that hypertension is a modifiable risk factors.[19] Approximately 50% -92% of sufferers also suffer from hypertension.[24] The risk of claudication increases 2.5-4 times in hypertension patients.[20]

The results of this study are inconsistent with the study by Schroll which showed that hyperlipidemia was a risk factor.[54] This is in line with the results of the study by Ness et al which stated that hyperlipidemia is a predisposing factor.[55] Hyperlipidemia increases the incidence of PAD by 10% for every 10 mg / dl increase of total cholesterol.[57]

Hyperlipidemia is one of the causes of endothelial dysfunction and increases the production of oxygen free radicals which deactivate nitric oxide, so that LDL-C will accumulate in the intima layer where endothelial permeability increases.

The accumulation of LDL-C in the vascular wall in the intima layer coupled with the chemical changes of fat triggered by free radicals in the artery wall will produce oxidized LDL-C which plays a role and accelerates the formation of atheromatous plaque.[58,59]

Growth factors and growth hormones stimulate the proliferation and migration of macrophages and vascular smooth muscle cells to form atherosclerotic plaques. Proliferation of smooth muscle cells and deposition of extra-cell matrix in the intima converts fatty patches to mature fibrofatty atheromas and plays a role in causing the growth of atherosclerotic lesions and forming atherosclerotic plaques.[59,60]

This causes a macroangiopathic process in the blood vessels so that the circulation of the tissue occurs.[60]

Based on the location of the lesions, a study conducted by Ahmed I. Gamal El Dein et al[62], on CT angiography of the common femoral artery level, 7 lesions were found, the superficial femoral artery level was 20 lesions, the popliteal artery was 10 lesions, the peroneal artery was 6 lesions, the posterior tibial artery was 16 lesions, the arteries tibialis anterior 14 lesions out of a total of 54 samples per level.

Based on the type of lesion, a study conducted by Ahmed I. Gamal El Dein et al[62], on CT angiography of the common femoral artery level, 3 stenoses and 4 total occlusions were obtained, 10 superficial femoral artery level stenoses and 10 occlusions, 8 popliteal artery stenoses and 2 occlusions, peroneal artery 2 stenoses and 4 occlusions, 10 posterior tibial artery stenoses and 6 occlusions, 12 stenoses anterior tibial artery and 2 occlusions out of a total of 54 samples.

Based on the type of lesion, a study conducted by Chidambaram et al[11], on CT angiography found 393 no stenoses or occlusions, 102 stenoses and 124 total occlusions. On USG, there were 339 no stenoses or occlusions, 123 stenoses and 157 total occlusions.

The results of this study are inconsistent with the study by Graziani et al, which stated that the longest lesions of 5-10 cm and the lesions at the infrapopliteal level were the most common morphological findings on CT angiography.

In a study conducted by Chidambaram et al.[11], it was found that the sensitivity was 89%, specificity was 93%, and accuracy was 92%. In accordance with the research conducted by Ahmed I. Gamal El Dein et al.[62], who stated that there was a significant and accurate relationship using CT angiography and ultrasound with the kappa technique. At the level of the common femoral artery, the kappa test value is 0.88. At the level of the superficial femoral artery, the kappa test value was 0.82. In the popliteal artery, the kappa test value was 0.87. The results of this study are in accordance with A. Ali et al.,[63] who stated that the sensitivity of Doppler ultrasound was 90.46%, the specificity was 92.05%, and the accuracy was 91.81% compared to CT angiography.

In a study conducted by Chidambaram et al.[11], it was found that the sensitivity was 96%, specificity was 62%, and accuracy was 79%. In accordance with the research conducted by Ahmed I. Gamal El Dein et al.[62], who stated that there was a significant and accurate relationship using CT angiography and Doppler ultrasound with the kappa technique. In the peroneal artery, the kappa test value is 0.88. In the anterior tibial artery, the kappa test value was 0.88. The results of this study are in accordance with A. Ali et al.,[63]

who stated that the sensitivity of Doppler ultrasound was 90.46%, specificity was 92.05%, and accuracy was 91.81% compared to CT angiography in evaluating PAD.

5. Conclusion

Ultrasonographic has high sensitivity and specificity in detecting LEAD's lesions.

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