Renal Artery Doppler as Screening Imaging Modality Required for theEvaluation of Hypertension in Cardiac Patients Experience at Tertiary Cardiac Care Centre

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ABSTRACT

Objective: To evaluate the efficiency of renal artery Doppler in diagnosis of secondary hypertension among cardiac patients.

Study Design: Analytical Cross-sectional study.

Place and Duration of Study: The present study was performed at Tertiary Care Center, Rawalpindi from Jan 2019 to July 2019.

Methodology: The study comprised of 50 patients with age range of 12-75 years with 90% confidence interval and 10% margin of error with prevalence of hypertension in Pakistan as 26.34%[12]. The study population included hypertensive patients referred for Doppler assessment of renal artery stenosis (RAS), in order to assess secondary cause of hypertension. The patients underwent angiography of kidneys within 14 days following Doppler assessment of RAS. The positive and negative outcome was presented as frequencies and percentages. The mean age was depicted as means ± standard deviation. The diagnostic features of specificity, sensitivity, negative predictive value and positive predictive values were calculated through a 2x2 table with angiographic findings considered as gold standard.

Results: In only 4(8%) patients bilaterally raised resistive index (RI) were evident. The diagnostic attributes of Doppler showed sensitivity of 48%, positive predictive value of 100% and diagnostic accuracy of 48%.

Conclusion: The role of renal artery Doppler in evaluating secondary hypertension has been over estimated. Thus, its application needs to be restricted for elderly patients to minimize time and cost expenses.

Keywords: Angiography, Hypertension, Renal artery doppler.

INTRODUCTION

Hypertension is an important health issue, which affects about one third of the adult population all over the world. It is a vital risk factor for ischemic heart disease and cerebrovascular disease. Both are considered as significant reasons of causing cardiovascular mortality.[1] Evidence shows that a rise in systolic blood pressure by 20mmHg doubles the mortality risk for heart disease. On the other hand, a drop of 10mmHg in systolic blood pressure reduces the chances of heart disease and stroke by 41%.[2]

Renal artery stenosis (RAS) is recognized as an important secondary cause of arterial hypertension. The diagnosis of this particular aspect of hypertension is highly therapy dependent, despite the previously documented trials illustrating analogous results for revascularization and conservative treatment.[3] The significance of RAS is upheld in case of flash pulmonary edema, acute oliguric renal failure with global kidney ischemia and congestive heart failure with preserved left ventricular function. This is highly true for patients with severe bilateral RAS and fibromuscular dysplasia.[4] The occurrence of RAS is helpful in devising adequate antihypertensive medical treatment. These factors make assessment of RAS a mandatory feature for evaluation of secondary hypertension.[5]

Presently, Doppler is highly applied in screening of RAS. The non-invasive nature, high diagnostic power and cost-effectiveness associated with this imaging modality makes it highly usable. However, the Doppler diagnosis of RAS is based on few criteria, which are limited in terms of assessment.[6] This includes the direct criteria of evaluating flow profiles in stenotic area of renal artery, whereas, the indirect criteria include assessment of flow profiles particles in intra parenchymal areas of vascular supply of the stenotic vessel. The direct criteria of evaluation is restricted by issues related to detection of stenotic section due to impaired examination conditions.[7] On the other hand, indirect criteria is easier to detect. The absolute and relative changes of renal intra-

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parenchymatous resistive index (RI) are considered as significant indirect Doppler criteria for RAS.[8]

Previous research works have extensively advocated the use of renal artery Doppler for assessment of secondary hypertension in individuals. The previous research,[9] encouraged the use of renal artery Doppler among the patients of atherosclerotic renal artery stenosis. Another research,[4] elaborated that increased renal resistive index is indicative of impaired renal hemodynamics. This value is depictive of cardiovascular morbidity, mortality and renal outcomes in hypertensive patients as it is independent of traditional risk factors. Research has also indicated that renal resistive index has high association with renal and cardiovascular outcomes, even after follow-up of years.[10] High renal resistive index have been affiliated with older age, female gender and multiple co-morbidities. However, renal artery Doppler have been overused among cardiac patients in order to diagnose hypertension, which can have negative overall diagnostic outcomes.[11] Thus, the present study aims to evaluate the efficiency of renal artery Doppler in diagnosis of hypertension among cardiac patients.

METHODOLOGY

The present cross-sectional study was performed at tertiary care center from January to July 2019 through random sampling technique. The data was collected after the official approval from ethical board of research AFIC-NIHD(IERB# 9/2/R&D/2022/206).

Sample Size: The sample was calculated by Raosoft, Inc by taking 90% confidence interval and 10% margin of error, with prevalence of hypertension in Pakistan as 26.34%[12] The study comprised study sample size of 50 patients.

Inclusion Criteria: The study population included hypertensive patients with any gender and age range 12-75 years, referred for Doppler assessment of RAS, in order to assess secondary reasons for hypertension.

Exclusion Criteria: The patients who did not fulfill clinical diagnostic criteria for RAS were excluded from the study. Moreover, patients reported with any other co-morbidity were also not made part of the study. The patients with history of chronic renal disease and absence of sinus rhythm were also excluded from the study.

The Doppler USG were performed by expert radiologists. Consent forms from the patients willing to participate in the study were collected. The patients underwent angiography of kidney within 14 days following Doppler assessment of RAS.

The categorical variables of gender and age were presented as frequencies and percentages. The positive and negative outcomes were depicted as frequencies and percentages. The mean age was shown as Mean ±SD deviation. The diagnostic features of specificity, sensitivity, negative predictive value and positive predictive values were calculated through a 2x2 table with angiographic findings considered as standard.

The entries were considered as positive or negative on the basis of renal resistive index value of Doppler. The renal resistive index of 0.70 was considered as cut of value for presence of RAS. On the other hand, the positive and negative values were also deduced through angiography of same patients. The entries showing positive for both Doppler and angiography were considered as true positive (TP). The ones showing negative for both the modalities were considered as true negative (TN). However, the entries showing negative for Doppler and positive value for angiography were marked as false negative (FN). The ones showing positive for Doppler and negative for angiography were marked as false positive (FP). Sensitivity of Doppler was calculated by formula TP/ TP+FN x 100, specificity by TN/ FP+TN x 100, positive predictive value by TP/ TP+FP x 100, negative predictive value by TN/ FN+TN x 100 and diagnostic accuracy by TP+TN/ TP+FP+FN+TN x 100.

RESULTS

The study comprised of 35(70%) male participants and 15(30%) female participants. Thus, the male population was in majority, indicating that hyperten-sion is more prevalent among male individuals. The age distribution of patients, shown in the Table-I, depicts that 9(18%) patients were 16-25 years old, 10(20%) were 26-35 years old, 3(6%) were 36-45 years old, 5(10%) were 46-55 years, 13(26%) were 56-65 years old and 10(20%) were 66-75 years old. The mean age of patients was estimated to be 37.6±2.5 years.

In only 24(48%) patients, bilaterally raised resistive index (RI) were evident. One of the patients was suffering from Takayasu's arteritis. In this patient narrowing was noted in aorta along with bilateral renal arteries narrowing depictive of secondary hypertension. The other 3 young hypertensive patients were positive for coarctation of aorta and they showed low acceleration time.

Table-I: Demographic Distribution

Variables	Frequency (n) Percentage (%)
Gender	
Male	35(70%)
Female	15 (30%)
Age (Years)	
16-25	9(18%)
26-35	10(20%)
36-45	3(6%)
46-55	5(10%)
56-65	13(26%)
66-75	10(20%)

In 5 patients, cause of hypertension was renal hypertensive nephropathy. Out of which, 3 were below 40 and 2 were older than 50 years. Majority of cases (n=23; 46%) were of older age group and their raised blood pressure was due to either primary hypertension, diabetes, non-compliance or poor combination of antihypertensive drug.

The Table-II shows comparative results for Doppler and angiography of hypertensive patients. It is evident that 24(48%) cases were observed as true positive because it was positive for both the modalities. However, 26(52%) cases were marked as false negative because they were positive for angiography and negative for Doppler. The categories for false positive and true negative were found to be nil.

Table-II: Comparative Doppler and Angiographic Results

Doppler Results	Angiographic results		Total n (%)
	Positive	Negative	
Positive	24 (True positive; TP)	0 (False positive; FP)	24 (48)
Negative	26 (False negative; FN)	0 (True negative; TN)	26 (52)
Total n (%)	50 (100)	0 (0)	50

Table-III shows Calculation For Diagnostic Attributes Of Doppler. The Sensitivity Of 48%, Positive Predictive Value of 100% and Diagnostic Accuracy Of 48% Were Observed. However, the specificity and negative predictive values were 0% for each.

Table-III: Calculation for Diagnostic Attributes of Doppler

Factors	Calculations	Results (%)
Sensitivity	24/24+26 x 100	48
Specificity	0/0+0 x 100	0
Positive Predictive Value (PPV)	24/24+0 x 100	100
Negative Predictive Value (NPV)	0/26+0 x 100	0
Diagnostic Accuracy	24+0/24+0+26+0 x 100	48

DISCUSSION

The pulse contour has previously been postulated as a means of detection of renal artery stenosis. The supporters of this modality claim that changings in waveform can be highly predictive of occurrence and severity of stenosis. However, in case of cardiac patients the reliability and applicability of renal artery Doppler is still questionable.[13] The Doppler predicts renal artery stenosis through RI values. However, in case of cardiac patients the accuracy of RI values might be doubtful because of the underlying reasons of hypertension. In such cases, the use of other better modalities may be suggestive.[14] The present study is an effort towards understanding the applicability of Doppler in assessing hypertension in cardiac patients.

The sensitivity of Doppler in depicting hypertension in cardiac patients was found to be 48%. On the other hand, specificity was 0%. The positive predictive value was 100% but negative predictive value was 0%. The diagnostic accuracy was found to be 48%. The data also shows that negative values of Doppler were found for elderly patients. The reason for such deliberately values may be due to the fact that in elderly patients the cause of hypertension was either diabetes, non-compliance with drugs or poor combination of drugs. Thus, in such patients, the diagnostic potential of renal artery Doppler has constrictions and should not be overly recommended for management of elderly patients. Previous research has indicated that high renal resistive index values are associated with factors such as old age, female gender and multiple comorbid conditions.[15] Same has been justified in the present study. The patients showing higher values of renal resistive index mostly belonged to age more than 55. Though, male population was in majority, but higher renal resistive index values were observed for female individuals. The individuals with higher values of renal resistive index are thought to have higher mortality rates[16] The renal resistive index values are actually prognostic values that are beyond the limitation of pulse pressure. This value is actually representative of arterial stiffness. The underlying pathophysiology includes arteriosclerosis, reduced capillary surface area, tubulointerstitial disease, enhanced renal vascular resistance and decreased vascular compliance. All these factors lead towards increased vascular resistance and constriction in the vascular bed.[17]

LIMITATIONS OF STUDY

Despite the merits of renal artery Doppler, it has limitation when it comes to cardiac patients. It has

been noted that Doppler does not enhance risk prediction for hypertension. It is actually influenced by many extrarenal factors including systemic arterial compliance, pulse pressure and cardiac function.[18] Its prognostic value is usually related to vascular disease that is systemic in nature. Thus, its application in diagnosing hypertension among cardiac patients need to be revised and constricted according to requirement.[19]

CONCLUSION

Renal artery Doppler is a very useful imaging tool for evaluation of secondary hypertension by measuring RI in younger patients presented to cardiac center. However, its role in assessing hypertension in elderly patients is limited because in most cases the cause is diabetic hypertensive nephropathy leading to raised blood pressure. Thus, by selective referral for renal artery Doppler burden of imaging in busy cardiac centers of an underdeveloped countries is expected to be minimized both in term of cost and time.

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Conflict of Interest: None.

Author's Contribution

Following authors have made substantial contributions to the manuscript as under:

AI: Manuscript writing, concept and editing

ND: Manuscript writing, Principle investigator,proof reading

SA: Data collection, data analysis and review of article

SK: Formatting, critical review and data collection/entry

FN: Review of article, formatting and critical review

SSK: Drafting the manuscript, proof reading & critical review

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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