ORIGINAL ARTICLE

Screening of Renal Artery Stenosis in Egyptian Diabetic Patients

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Abstract

Background: ***Renal artery stenosis (RAS) is the narrowing of one or both of the renal arteries, is not a common disease in general population, but it is found at about 1-5% out of hypertensive persons. Atherosclerosis or fibromuscular dysplasia most often cause it, also it can be complicated by chronic kidney disease (CKD) and end-stage renal disease.***

Aim and objectives: ***To evaluate the role of color Doppler among Diabetic patients.***

Subjects and methods: ***This cross-sectional study was carried out on 100 subjects who were recruited from the outpatient clinics, inpatient ward, and nephrology unit at Al-Azhar University Hospitals from January 2024 to January 2025. Subjects were divided into two groups: Group A: eighty patients had DM. Group (B): twenty apparently normal persons as a control group.***

Results: ***According to the comparison of the prevalence of RAS between diabetic cases and controls, the result was significant (p-value<0.05). As the prevalence of RAS among diabetic cases was 15% compared to no one among controls, out of 12 cases with RAS, 7 cases had unilateral RAS and 5 cases had bilateral RAS.***

Conclusion: ***The means of resistive index (RI), peak systolic velocity (PSV), acceleration time (AT), Pulsatilty index (PI) and renal aortic ratio (RAR) were significantly higher among diabetic patients with RAS positive than negative cases. So, duplex ultrasonographic mainly RI can be used as early, sensitive marker for detection of RAS.***

Keywords: Renal artery stenosis; Egyptian diabetic patients

1. Introduction

Both insulin resistance and insulin shortage contribute to type 2 diabetes mellitus (T2DM), whereas antibody-mediated and cell-mediated death of pancreatic islets characterize type 1 diabetes, an autoimmune illness. Diabetes mellitus type 2 typically follows the metabolic syndrome, which consists of insulin resistance, visceral obesity, hypertension, hyperuricemia, and dyslipidemia. Historically, insulin resistance was mostly observed in older adults, but type 2 diabetes mellitus (T2DM) is now more commonly observed in younger adults, adolescents, and even children, as a result of a gradual decrease in pancreatic β-cell function that ultimately leads to hyperglycemia. Diabetes mellitus (DM) can also develop in pregnant women, in people with certain metabolic abnormalities, or as a side effect of immunomodulatory medications such as corticosteroids.[1]

The relation between diabetes and macrovascular complications is well known. Among many others, renal arteries could be affected frequently by an accelerated atherosclerotic process. This process increases with age, long-lasting history of hypertension, among smokers, diabetics and with the extent of presence extrarenal atherosclerotic changes.[2]

Noninvasive procedures like renal arterial duplex have increasing importance in detecting renal arterial stenosis (RAS) through measured parameters, which were discussed later.[3] The 2017 ESC, European Society of Cardiology Guidelines severely curtailed the use of angiography, the gold standard for endovascular treatment, and other peripheral arterial disorders (including renal arteries) when it came out.

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Consequently, the onus has fallen more squarely on the shoulders of ultrasonography physicians, who not only aid in the first RAS diagnosis but also share responsibility for the patient's potential imaging algorithm extension. Given this predicament, we will use renal duplex imaging to study the prevalence of renal artery stenosis in the Egyptian population of people with diabetes mellitus (DM) and the possible association between this condition and other microvascular diabetic sequelae.

The aim of this study was to evaluate the role of color Doppler among diabetic patients.

2. Patients and methods

This cross-sectional study was carried out on 100-subjects were recruited from the outpatient clinics, inpatient ward, and nephrology unit at Al-Azhar University Hospitals from January 2024 till January 2025. Subjects were divided into two groups: Group A: eighty patients had DM. Group (B): twenty apparently normal persons as a control group.

Inclusion criteria:

Subjects aged 16–65-year-old, and who had type 1 diabetes more than 5 years and T2DM since diagnosis.

Exclusion criteria:

People who are either under the age of 16 or above the age of 65, as well as those with malignant diseases, liver cell failure, respiratory failure, or infectious infections within the past month.

Patients underwent the following procedures when they enrolled: whole background, providing: information on the population: gender, age, habits, and health history: Details about diabetes mellitus (including when it first appeared, how long it has lasted, how well it has been managed, and any complications that have occurred, such as chronic kidney disease (CKD), retinopathy, or neuropathy), as well as any other chronic diseases that may be present, such as hypertension, liver disease, endocrine disease, cancer, COPD, mental disorders, and pharmaceutical use in the past.

Complete clinical examination:

General examination: vital signs were evaluated, including blood pressure, peripheral pulsations, and temperature. Local examination: examination of CVS. Peripheral pulsation, abdominal bruit, peripheral sensations, and foot examination. Basal laboratory work-up: (HbA1c, lipid profile, uric acid, serum creatinine, blood urea, CRP, ALT, CBC, Albumin, U ACR). Fundus examination for detecting retinopathy. Renal arterial duplex was done for all patients to detect RAS through fulfilling the resistive index, peak systolic velocity, acceleration time, acceleration index, pulsatility index, and RAR.

Statistical analysis:

Statistical Package for the Social Sciences, version 22 for Windows® (IBM SPSS Inc., Chicago, IL, USA) was used to code, process, and analyze the data that was collected.

Ethics and patient consent:

Patients' verbal and written agreement was obtained in accordance with all protocols that were approved by the Al-Azhar University ethical committee.

3. Results

Table 1. Comparison of demographic data between diabetic cases and control.

	DIABETIC CASES (A) (N=80)	CONTROL (B) (N=20)	P-VALUE
AGE			
MEAN±SD	54.9±8.1	52.6±6.6	0.25
RANGE	25-66	43-60	
GENDER			
MALE	49(61.3%)	15(75%)	0.25
FEMALE	31(38.8%)	5(25%)	
WEIGHT			
MEAN±SD	77.2±8.6	70.9±4.7	0.002*
RANGE	59-95	67-83	
HEIGHT			
MEAN±SD	164.7±4.9	166.8±4	0.09
RANGE	157-172	158-171	
BMI			
MEAN±SD	28.4±3.1	25.5±1.7	<0.001*
RANGE	23-34.08	23.8-28.7	
BMI CATEGORY			
NORMAL	10(12.5%)	9(45%)	0.001*
OVERWEIGHT	50(62.5%)	11(55%)	
OBESE	20(25%)	0(0%)	
WAIST CIRCUMFERENCE			
MEAN±SD	96.1±10.1	91.9±7.9	0.05*
RANGE	79-120	79-106	
FAMILY HISTORY OF DM	22(27.5%)	3(15%)	0.24
FAMILY HISTORY OF RAS	6(7.5%)	0(0%)	0.20
SMOKING	23(28.7%)	2(10%)	0.08
ASSOCIATED HTN	29(36.3%)	4(20%)	0.16

*:significant at p-value<0.05

There was significant difference regarding weight, BMI and waist circumference (p-value<0.05) as the means of weight, BMI and waist circumference were significantly higher among diabetic cases than control

On other hand, insignificant difference was found regarding age, gender, height, family history of DM, family history of RAS, smoking and hypertension (p-value>0.05),(table 1;figures 1&2).

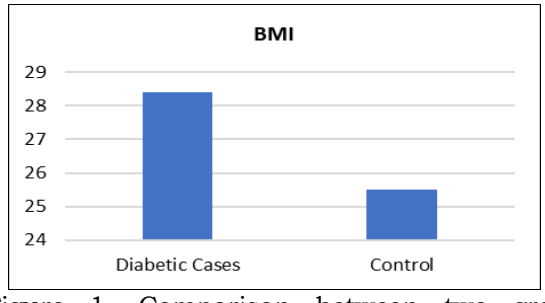

Figure 1. Comparison between two groups regarding BMI.

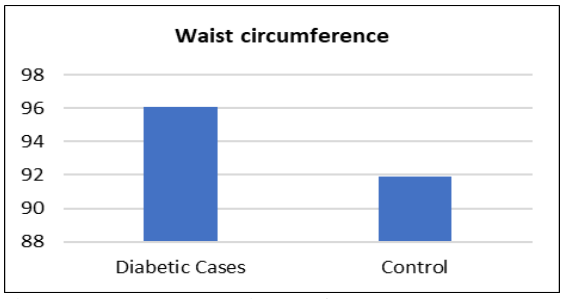

Figure 2. Comparison between two groups regarding waist circumference.

Table 2. Comparison between two groups regarding of prevalence of RAS.

	DIABETIC CASES (A) (N=80)	CONTROL (B) (N=20)	P-VALUE
RENAL ARTERY STENOSIS NO YES	68(85%) 12(15%)	20(100%) 0(0%)	0.05*
SIDE OF RENAL ARTERY STENOSIS (N=12) UNILATERAL BILATERAL	7(58.3%) 5(41.7%)	-----	-----

*:significant at p-value<0.05

According to the comparison of prevalence of renal artery stenosis between diabetic cases and control, the result was significant (p-value<0.05)

As the prevalence of renal artery stenosis among diabetic cases was 15% compared to no one among control, out off 12 cases with renal artery stenosis, 7 cases had unilateral RAS and 5 cases had bilateral RAS,(table 2; figure 3).

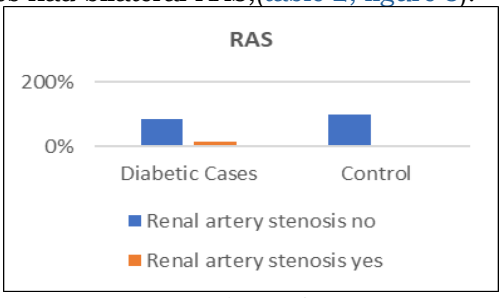

Figure 3. Comparison between two groups regarding of RAS.

Table 3. Comparison between two groups regarding duplex findings.

	DIABETIC CASES (A) (N=80)	CONTROL (B) (N=20)	P-VALUE
RESISTIVE INDEX (RI) MEAN±SD RANGE	0.64±0.08 0.52-0.89	0.57±0.06 0.47-0.79	<0.001*
PEAK SYSTOLIC VELOCITY (PSV) (CM/S) MEAN±SD RANGE	155.1±44.1 89-277	138.8±27 98-188	0.04*
ACCELERATION TIME (SEC) (AT) MEAN±SD RANGE	0.10±0.05 0.03-0.29	0.07±0.03 0.02-0.14	0.01*
ACCELERATION INDEX (AI) MEAN±SD RANGE	347.1±158 114-754	438.3±175.3 120-768	0.02*
PULSATILTY INDEX (PI) MEAN±SD RANGE	1.5±0.15 1.2-1.9	1.19±0.21 0.89-1.69	<0.001*
RENAL AORTIC RATIO (RAR) MEAN±SD RANGE	2.4±1.03 1.1-5.6	2.06±0.6 1.1-3.1	0.04*

*:significant at p-value<0.05

According to this table, results were significant (p-value<0.05) as followed:

As the means of RI, PSV (cm/s), AT, PI and RAR was significantly higher among diabetic cases than control, while the mean of AI was significantly lower among diabetic cases than control, (table 3).

Table 4. Clinical data among diabetic cases.

	DIABETIC CASES (N=80)
DURATION OF DIABETES (YEARS) MEAN±SD RANGE	 7.7±3.7 1-14
TREATMENT REGIMEN ORAL HYPOGLYCEMIC INSULIN BOTH	 36(45%) 28(35%) 12(20%)
ANY COMPLICATION NO YES	 40(50%) 40(50%)
CKD	27(33.8%)
RETINOPATHY	7(8.8%)
NEUROPATHY	24(30%)

The mean duration of illness among studied cases was 7.7 years, ranged from 1 to 14 year with 45% were on oral hypoglycemic treatment alone while 20% were on oral hypoglycemic and insulin.

Regarding presence of complication, one half of cases had complication either CKD, retinopathy, neuropathy alone or in combination with nearly one third had CKD, then 30% had neuropathy while retinopathy was found among 8.8% only, (table 4).

Table 5. ROC curve analysis for duplex finding for prediction of RAS among diabetic patients

	RI	PSV	AT	AI	PI	RAR
AUC	0.92	0.98	0.94	0.91	0.96	0.98
95% CI	0.87-0.98	0.97-0.99	0.89-0.99	0.84-0.98	0.91-0.99	0.96-1
P VALUE	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*
CUT OFF VALUE	>0.665	>193.5	>0.125	<195.5	>1.6	>3.35
SENSITIVITY	91.7%	91.7%	83.3%	91.7%	91.7%	91.7%
SPECIFICITY	82.4%	94%	85.3%	88.2%	86.8%	91.2%
PPV	57.8%	73.3%	50%	57.9%	55%	64.7%
NPV	98.2%	98.5%	96.7%	98.4%	98.3%	98.4%
TOTAL ACCURACY	87%	93.7%	85%	88.7%	87.5%	91.2%

*:significant at p-value<0.05

For RI, it had a sensitivity and specificity of 91.7% and 82.4% respectively for prediction of RAS among diabetic patients when cut of point more than 0.665 with significant p-value<0.001 and total accuracy of 87%.

For PSV, it had a sensitivity and specificity of 91.7% and 94% respectively for prediction of RAS among diabetic patients when cut of point more than 193.5 with significant p-value<0.001 and total accuracy of 93.7%.

For AT, it had a sensitivity and specificity of 83.3% and 85.3% respectively for prediction of RAS among diabetic patients when cut of point more than 0.125 with significant p-value<0.001 and total accuracy of 85%.

For AI, it had a sensitivity and specificity of 91.7% and 88.2% respectively for prediction of RAS among diabetic patients when cut of point less than 195.5 with significant p-value<0.001 and total accuracy of 88.7%.

For PI, it had a sensitivity and specificity of 91.7% and 86.8% respectively for prediction of RAS among diabetic patients when cut of point more than 1.6 with significant p-value<0.001 and total accuracy of 87.5%.

For RAR, it had a sensitivity and specificity of 91.7% and 91.2% respectively for prediction of RAS among diabetic patients when cut of point more than 3.35 with significant p-value<0.001 and total accuracy of 91.2%, (table 5; figure4& 5).

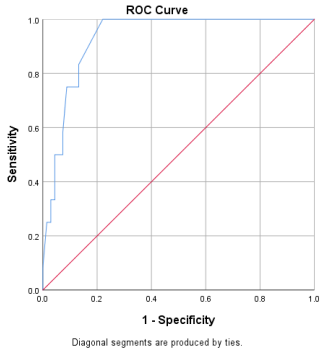

Figure 4. ROC curve analysis for RI for prediction of renal artery stenosis among diabetic patients.

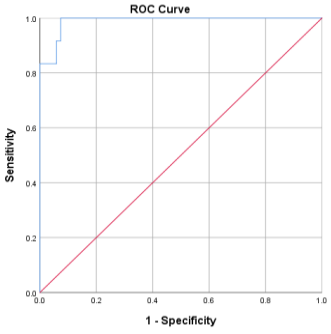

Figure 5. ROC curve analysis for PSV for prediction of renal artery stenosis among diabetic patients.

4. Discussion

DM is a significant global health issue that affects quality of life and economic costs.[4]

Large atherosclerotic lesions are a result of diabetes mellitus. Patients with both diabetes and hypertension are more likely to have atherosclerotic RAS, as DM is associated with an increased risk of both conditions. Hence, the frequency may be greater than in the overall hypertensive population.[5,6]

RAS is an umbrella term for any vascular lesion that narrows the renal artery and reduces blood flow to the kidneys. The pathophysiologies of this disease are diverse, with atherosclerotic renal artery disease and fibromuscular dysplasia (FMD) being the most prevalent.[7]

The present study revealed that according to demographic data in the studied groups, there was significant difference regarding weight, BMI and waist circumference (p-value<0.05) as the means of weight, BMI and waist circumference were significantly higher among diabetic cases than control. On other hand non-significant difference was found regarding age, gender, height, family history of DM, family history of renal artery stenosis, smoking and hypertension (p-value>0.05).

Our results in concordance with Ali et al.,[8] They set out to establish whether measuring renal RI was useful for diagnosing diabetic nephropathy (DN) in type 2 diabetics at an early stage. The participants in this cross-sectional study were 82 adults with type 2 diabetes and 18 healthy volunteers who were matched for age and sex. The control group consisted of persons who did not have diabetes and had normal kidney function. The researchers found a statistically significant difference in body mass index (BMI) between the type 2 diabetic and control groups. (P=0.048), But no difference was seen in terms of gender or age.

In the present study, our results showed that the mean duration of illness among studied cases was 7.7 years, ranging between 1 and 14 years, with 45% being on oral hypoglycemic treatment alone, while 20% were on oral hypoglycemic and insulin. Regarding presence of complication, one-half of cases had complication either CKD, retinopathy, neuropathy alone or in combination with nearly one third had CKD, then 30% had neuropathy while retinopathy was found among 8.8% only.

Our results were in line with those of Postma et al.,[9] We set out to find out how common RAS was among consecutive diabetic individuals with or without impaired kidney function. Out of the 54 patients studied, 8 had type 1 diabetes and 46 had type 2 diabetes; 26 of these patients received insulin treatment. Diabetic complications lasted an average of 14.6±8.9 years. With hypertension and impaired renal function, 39 patients met the inclusion criteria.

According to the comparison of prevalence of renal artery stenosis between diabetic cases and control, the result was significant (p-value<0.05) as the prevalence of renal artery stenosis among diabetic cases was 15% compared to no one among control, out of 12 cases with renal artery stenosis, 7 cases had unilateral RAS and 5 cases had bilateral RAS.

In concordance with the present study, Postma et al.,[9] revealed that an atherosclerotic RAS was found in 18 of 54 (33%) patients, of which 12

were over 50% of luminal diameter. Six had a RAS of less than 50%. Three patients had bilateral stenoses, of whom one had one of two right arteries occluded and a stenosis of the single left renal artery.

According to the comparison of duplex ultrasonographic finding for screening of renal artery stenosis between diabetic cases and control, the result was significant (p-value<0.05) as the means of RI, PSV (cm/s), AT, PI and RAR were significantly higher among diabetic cases than control, while the mean of AI was significantly lower among diabetic cases than control. Our results, in concordance with Mancini et al.,[10] found that compared to the non-diabetic controls, diabetes patients had noticeably higher values for renal area index, renal volume, and RI (P<0.001)

According to the comparison of baseline and clinical data between renal artery stenosis positive and negative cases among diabetic patients, it was found that there was significant difference regarding age, BMI, family history of RAS, smoking, associated hypertension, and duration of diabetes (p-value<0.05) as the means of age, BMI and duration of diabetes were significantly higher among RAS positive cases than RAS negative cases.

Also, percentage of cases with family history of RAS, smoker, and hypertensive were significantly higher among RAS positive cases than RAS negative cases. On other hand non-significant difference was found regarding gender, waist circumference and treatment regimen (p-value>0.05).

Our findings, in line with Postma et al.[9] discovered that individuals with and without RAS differed significantly with respect to age, DM type, disease duration, body mass index (BMI), and medication usage.

Regarding the comparison of lab data between RAS negative and positive cases among diabetic cases, it was found that there was significant difference regarding creatinine, serum urea, fasting blood glucose, HBA1C, triglyceride, cholesterol and LDL (p-value<0.05) as the means of creatinine, serum urea, fasting blood glucose, HBA1C, triglyceride, cholesterol and LDL were significantly higher among RAS positive cases than RAS negative cases. On other hand non-significant difference was found regarding HB, TLC, platelet, ALT, AST, total bilirubin, direct bilirubin, albumin and HDL (p-value>0.05).

Our results in concordance with Ali et al.,[8] determined that T2DM with DN had significantly higher HbA1c (8.2±0.5%) compared with T2DM without DN (6.9±0.2%) and normal (5.3±0.5%) (P<0.001).

According to the comparison of duplex ultrasonographic finding for screening of renal artery stenosis between RAS positive and negative cases among diabetic patients, the result was highly significant (p-value<0.05) as the means of RI, PSV (cm/s), AT, PI and RAR were significantly higher among RAS positive cases than negative cases, while the mean of AI was significantly lower among RAS positive cases than negative cases.

Our results in consistent with Ali et al.,[8] reported that T2DM patients with DN have significantly higher renal RI, therefore they have significantly higher values in the right kidney (0.71±0.015), left kidney (0.71±0.02), and both kidneys (0.71±0.015) when compared with T2DM without DN, right kidney (0.640±0.016), left kidney (0.637±0.019), and both kidneys (0.639±0.017), and when compared to control group right kidney (0.57±0.03), left kidney and both kidneys (0.56±0.02) (P<0.001).

Regarding the results of ROC curve analysis for duplex finding for prediction of renal artery stenosis among diabetic patients, it was found that:

For RI, it had a sensitivity and specificity of 91.7% and 82.4% respectively, for the prediction of RAS among diabetic patients when the cut-off point was more than 0.665 with a significant p-value<0.001 and a total accuracy of 87%.

For PSV, it had a sensitivity and specificity of 91.7% and 94% respectively, for the prediction of RAS among diabetic patients when the cut-off point was more than 193.5, with a significant p-value of <0.001 and a total accuracy of 93.7%.

For AT, it had a sensitivity and specificity of 83.3% and 85.3% respectively for prediction of RAS among diabetic patients when cut of point more than 0.125 with significant p-value<0.001 and total accuracy of 85%.

For AI, it had a sensitivity and specificity of 91.7% and 88.2% respectively, for the prediction of RAS among diabetic patients when the cut-off point was less than 195.5, with a significant p-value<0.001 and a total accuracy of 88.7%.

For PI, it had a sensitivity and specificity of 91.7% and 86.8% respectively for prediction of RAS among diabetic patients when cut of point more than 1.6 with significant p-value<0.001 and total accuracy of 87.5%.

For RAR, it had a sensitivity and specificity of 91.7% and 91.2% respectively, for the prediction of RAS among diabetic patients when the cut-off point was more than 3.35, with a significant p-value<0.001 and a total accuracy of 91.2%.

Our findings, in line with those of Ali et al., 8 reported that the RI at a cutoff level of >0.62 had an AUC of 0.92, which can discriminate T2DM without DN from normal with 85.2% sensitivity, 88.9% specificity, 88.5% PPV, and 85.7% NPV

(P<0.001). The RI at a cutoff level of >0.68 had an AUC of 1.0, which can discriminate T2DM with DN from that without DN with 100% in all sensitivity, specificity, PPV, and NPV (P<0.001).

4. Conclusion

The means of RI, PSV, AT, PI and RAR were significantly higher among diabetic patients with RAS positive than negative cases. So, duplex ultrasonographic mainly RI can be used as early, sensitive marker for detection of RAS.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article

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Conflicts of interest

There are no conflicts of interest.

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