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Original Research

Evaluate the role of resistive index in the diagnosis of reduced blood flow in diabetes and hypertension patients with age

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ABSTRACT:

Aim: The aim of the present study to evaluate the role of resistive index in the diagnosis of reduced blood flow in diabetes and hypertension patients with age

Methods: 40 patients with hypertension and type 2 diabetes Mellitus (26 females and 14 males, their age range between 30 to 72 year old with mean age of 56.92± 9.79 years), they have been divided into two groups at the age of 50 year old the younger group 20 patients, age range was 30-50 year old mean was 47.56 ± 6.87 and the older group 20 patients age range 50-72 with mean of 60.87 ±5.26, to investigate the effect of IMT and RI change on blood PSV and volume flow rate.

Results: There was insignificant change in lumen diameter between the two age groups (3.51%), p value > 0.05, While the change in (IMT) between both age groups was (34.15%) with significant p-value. The change in (PSV) was (-20.01%) with p value >0.05. On the other hand, the (EDV) change for younger and old group (-32.12%) with significant p-value. The change in (RI) between the two age groups was (12%), and in (PI) was (21%), both were significant, p value < 0.05.The change in the pressure gradient between both age groups were (-30.95%) and in the flow rate, was (-21.11%), both were insignificant, p value > 0.05

Conclusion: We concluded that the resistive index can be an indicator for atherosclerosis role in the impairment of blood vessels function via blood flow deterioration detected by RI and not by the increase in IMT only in other words it can show the extent IMT effect to materialize in blood flow.

Keywords: Blood flow, diabetes, hypertension, resistive index.

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INTRODUCTION

Doppler ultrasonography (US) provides morphologic and vascular information noninvasively in various diseases.[1] The diagnostic validity of Doppler US in renal parenchymal disease is still under debate; however, recent studies have shown that the resistive index (RI) correlates with tubulointerstitial and vascular lesions.[2] Doppler US may also be used to evaluate orbital vascular flow velocities and characteristics.[3] The RI is a parameter for characterizing the arterial waveform with Doppler US. In vitro and in vivo studies have shown that RI is related to vascular resistance.[4] Intima-media thickness (IMT) is associated with PWV and AASI in untreated hypertensive patients The studies made in type 2 diabetic patients conclude that PWV is associated to microalbuminuria and renal function estimated by the glomerular filtration rate.[5] However, there are no data on the relationship between IMT and arterial stiffness at central level. A recent study in a Japanese population with type 2 diabetes found CCA-IMT, but not PWV, to be independently associated to silent cerebral infarction.[6] Carotid intima-media thickness (IMT) is related to cardiovascular risk factors and diseases, and its measurement by means of ultrasound makes it possible to detect thickening in the initial phases of atherosclerosis.[7] For every 0.1-mm increase in carotid IMT, the relative risk of ischemic heart disease increases by 15% and that of cerebrovascular disease by 18%.[8] In type 2 diabetes mellitus (DM2)

patients, the carotid IMT is 0.13mm greater than in the controls. This implies an increase in age of 10 years, a circumstance that is related to a 40% higher cardiovascular risk. Hypertensive patients, even those in a state of prehypertension, have a greater carotid IMT than controls.[9] In Spain, carotid IMT values in patients with no cardiovascular risk factors are available,[10] but we have no data on the carotid IMT in DM2 and hypertensive patients. Previous studies have documented the strong association between intrarenal RI values and extrarenal markers of vascular stiffness, such as intima-media thickness of the femoral and carotid arteries.[11]

MATERIAL AND METHODS

This Prospective observational study included 40 patients with hypertension and type 2 diabetes Mellitus (26 females and 14 males, their age range between 30 to 72 year old with mean age of 56.92± 9.79 years), they have been divided into two groups at the age of 50 year old the younger group 20 patients, age range was 30-50 year old mean was 47.56 ± 6.87 and the older group 20 patients age range 50-72 with mean of 60.87 ±5.26, to investigate the effect of IMT and RI change on blood PSV and volume flow rate.

The Ultrasound and Doppler machine used in this study was Fukuda Denshi (UF-750XT) with a linear probe (FUT-LD 386-9A) at 6–9MHz. All patients examined by performing chest X ray, ECG examination and tests for liver and kidney functions, patients selected free from any diseases except from diabetes and hypertension. The selection for diabetic patients was carried out on the bases of Fasting Blood Sugar (FBS), so that the Fasting Glucose value ≥110 mg/dl, and /or HbA1c ≥ 7.6%, and for hypertensive patients of blood pressure more than 90/140 mm Hg were included in the study (Table 1).

METHOD

Patients were advised to lie down on the couch of examination in supine position and extended his/ her neck, putting pillow under the neck, to extend full-length of the common and internal carotid artery. The transducer was placed at the lateral side of the neck where the maximum lumen diameter appeared and the typical double lines of the artery could be seen.

The (IMT) was identified on ultrasound by the presence of the double lines pattern consisting of two parallel echogenic interfaces in the far wall of the common carotid arteries with the first one between the blood and the tunica intima and the other between the tunica media and the tunica adventitia.

The peak systolic velocity (PSV) and end diastolic velocities (EDV) were measured in both the distal internal carotid artery (ICA) at the location where the highest PSV is seen, as the PSV may vary along the length of CCA artery

The IMT measurement of the CCA should be made 2 cm before the bifurcation at a point where the vessel still has a uniform diameter, before its widening towards the bifurcation.[12]

Pulsatility index (PI) and resistive index (RI) were measured and recorded.

The average volume flow rate was calculated as (Lumen cross section area) *x* (The average velocity).

The average velocity was obtained from the pulsating index as, Average velocity = (PSV-EDV) / PI

Statistical analysis

Results were analyzed using Microsoft Office Excel 2009, and were expressed as mean ± standard deviation and percentages. Test for significance was carried out using unpaired t-test and p value <0.05 was considered significant.

RESULTS

Table 2 shows the change between parameters for the two age groups 50-72 year for old and young age group 30-50 year old for left common carotid and internal carotid arteries.

There was insignificant change in lumen diameter between the two age groups (3.51%), p value > 0.05, While the change in (IMT) between both age groups was (34.15%) with significant p-value. The change in (PSV) was (-20.01%) with p value >0.05. On the other hand, the (EDV) change for younger and old group (-32.12%) with significant p-value. The change in (RI) between the two age groups was (12%), and in (PI) was (21%), both were significant, p value < 0.05.

The change in the pressure gradient between both age groups were (-30.95%) and in the flow rate, was (-21.11%), both were insignificant, p value > 0.05

Table 1: Clinical characteristics of patients

Mean ±SD **The age range** (30-50) years		Mean ±SD **The age range (**50-72) years
Age, years	47.56 ± 6.87	60.87 ±5.26
Duration of disease	DM 10.2 ± 6.87	DM 13.09 ± 7.69
(years)	HT 4.5 ± 2.55	HT 12.98 ± 6.87
BMI (kg/m2)	27.02 ± 2.36	28.89 ± 2.98
FBS (mg/dl)	206.74 ± 119.78	174.52 ± 81.66
HbA1c (%)	9.18 ± 3.02	8.77 ± 1.48
S. Cholesterol (mg/dl)	208.9 ± 51.55	139.36 ± 28.96
S. Triglycerides (mg/dl)	173.69 ± 77.69	97.68 ±34.55

Table 2: The measured parameters for the left common & internal carotid arteries for two age groups using Doppler and B-mode

Parameter	**(**DM+**HT**) Patients (LCCA) Mean ±SD		Change % = (old-young / young) x 100	**p-value**
	Age range (30-50) years	Age range (50-72) years		
IMT (mm)	0.71 ± 0.36	0.95 ± 0.237	34.15%	<0.05
lumen D(mm)	5.47 ± 0.89	5.74 ± 0.95	3.51%	>0.05
		LICA		
PSV (cm/s)	50.02 ± 20.11	40.88 ±6.39	-20.01%	>0.05
EDV (cm/s)	19.36 ± 8.37	13.22 ± 3.54	-32.12%	<0.05
RI	0.7± 0.059	0.61±0.062	12%	<0.05
PI	1.05 ± 0.23	1.31±0.34	21%	<0.05
Pressure gradient (mmHg)	0.8±0.63	0.58±0.24	-30.96%	>0.05
Volume Flow rate (cm3/sec)	7.13±4.55	5.67±3.19	-21.11%	>0.05

DISCUSSION

Ultrasound and Doppler imaging has also traditionally been used in the assessment of chronic renal disease. Not only does Doppler ultrasonography detect renal macroscopic vascular abnormalities but it also identifies changes in blood flow at the microvascular level. Evaluation of vascular impedance at different sites of the renal parenchyma may suggest functional or structural changes within the kidneys and could provide useful diagnostic and prognostic information. The intima media is significantly thicker in the old age group for LCCA by (34.15%), but the increase in the thickness of intima media did not reduce the lumen diameter significantly, but increased slightly no more than (3.51%) in spite of the large significant change in the IMT thickness, and this is caused by the increase in the artery wall.[13] The very small change in the lumen can be originated from the lack of compliance and elasticity[14], caused by aging and by the effect diseases such as diabetes and/or hypertension[15,16], in addition to other important factors including possible endothelial dysfunction[17], and a decrease in muscle tone with age, which can include the arteries muscles consequently contributes to the reduction of compliance.[18]

The very small insignificant change in the lumen diameter in LCCA between the two age groups with a large change in the PSV indicates that the slower velocity may not relate only to the change in the LCCA intima media thickness (as it did not reduce the lumen diameter) but also to the increased artery stiffness influencing PI consequently the flow, and RI which can be more effective as it is linked with the increase in the flow resistance originated from the capillary bed. The increase in the IMT thickness can be an indicator for the smaller vessels plaque buildup with a consequent increase in the resistive index.

Results show that there is an interplay between IMT and the resistive index, as it is higher in the old age group than younger group by 12% this index is an indicator of an increased resistance in the distal vessels i.e. capillary bed.[19]

As the lumen diameter is still almost the same with large increase in IMT thickness and the resistive index is significantly increased then the later may be an indicator for blood flow deterioration which may cause brain ischemia or stroke.[20] One benefit of the resistive index is to give an indication of how far the effect of the IMT thickening affecting the blood flow as reflected on the capillary bed resistance.

The pulsating blood velocity appears on the pulsatility index which is higher in the older group by 21%. The increased pulsatility index may also be attributed to the less arteries compliance or less distensiblity in the older group leading to blood flow with less change in the lumen size during peak systole while for better compliance arteries as in the younger group can absorb part of the systolic pressure impact (windkessel effect)[21] leading to less variation in the velocity of the blood flow pulses.

Because the blood is impeded through the capillary bed (as seen on the increase in the resistive index) the PSV reduced consequently the volume flow rate is also reduced.

Factors influencing the CA such as by aging the arteries become stiffer or less compliant leading to less distensibility this in addition to the increase of atherosclerosis with age.[22] Hypertension also increases atherosclerosis and stiffness.[23] Diabetes also increases atherosclerosis and stiffness.[24] The concomitant effect of these three factors can induce cardiac overloa[d25] 24 as well as increasing not only the risk of ischemia but also increasing the risk of brain strok[e26] and heart attack.[27] These effects can be seen in our results the reduction of blood volume flow rate from 7.13 cm3/s for the younger group down to 5.67cm3/s for the elderly group. Although results for (flow rate, PSV, pressure gradient) are insignificant but the percentage change was close to significance, this is due to the large variation between patients measured parameters giving large standard deviation which needs higher number of patients to show clear significance.

CONCLUSION

We concluded that the resistive index can be an indicator for atherosclerosis role in the impairment of blood vessels function via blood flow deterioration detected by RI and not by the increase in IMT only in other words it can show the extent IMT effect to materialize in blood flow. The intima media is significantly thicker for the old age group patients than in the younger group, but the lumen diameter did not change significantly, for this reason the reduction in the volume flow rate and PSV in the elderly group is primarily related to the increase in the resistance of capillary bed as appeared on RI.

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