REVIEW ARTICLE

SONOGRAPHIC ASSESSMENT OF INTIMA-MEDIA THICKNESS OF CAROTID ARTERIES - A REVIEW OF LITERATURE

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We conducted a systematic review of the literature that has examined carotid arteries using ultrasonography in order to better explain the association between diabetes, hypertension, and intima-media thickness (IMT). The goal of this study was also to get a precise evaluation of increasing intima-media thickness predictive value for clinical cardiovascular outcomes. From 2000 through 2021, we searched the Google Scholar, NCBI, PubMed, and Medscape databases. The following essential keywords were looked up: ultrasound of carotid arteries, ultrasound of common carotid arteries intima-media thickness, and carotid IMT in diabetes and hypertension. Of the 135 retained studies the percentage of detection was used to calculate the diseases that affect intima–media thickness. As a result following were the causes that alter intima–media thickness: diabetes and hypertension at 81.4 % and 80 % respectively. Coronary artery disease at 21.4%, dyslipidemia and stroke at 14.8% and 5.2% respectively. Microalbuminuria at 3%. However, non-alcoholic fatty liver disease, peripheral arterial disease (PAD) and chronic kidney disease (CKD) at an equal effect of 2.2%, MI at 1.5%. Breast arterial calcification, polycystic kidneys and glomerulonephritis at an equal effect of 0.7%. In conclusion, patients with hypertension and diabetes are most at risk of developing coronary artery disease.

Keywords: ultrasound of carotid arteries, ultrasound of common carotid arteries intima-media thickness, and carotid IMT in diabetes and hypertension

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INTRODUCTION

Millions of people worldwide are affected by the cardiovascular disease due to high blood pressure and diabetes.[1] The prevalence of hypertension in Pakistan is 19.1%.[2] A major risk factor for developing hypertension is increasing age.[3] Higher prevalence was noted in non-Hispanic black adults make up 40.3 percent of the population, compared to non-Hispanic white adults who make up 27.8%, Hispanic adults who make up 27.8%, and non-Hispanic Asian adults who make up 25.0 percent.[4] Renal parenchymal disease and aortic coarctation. are the most prevalent sources in children. In adults, hypertension has many risk factors like renal causes (renal parenchymal disease, obstructive uropathy, renal artery abnormalities, renal failure), endocrine causes (congenital adrenal hyperplasia, hyperthyroidism), vascular system causes (polycythemia, anemia, arteriovenous fistula, leukemia), metabolic causes, neurologic and drug-related causes.[5]

The prevalence of diabetes in Pakistan is 14.62%.[6] Major risk factors for diabetes are overweight or obesity, family history, hypertension, high cholesterol levels, smoking, alcohol drinking. Nervous and endocrine systems disorders, inactivity, genetic factorsagingng) can increase the risk of diabetes.[7] Diabetic problems and the consequences of hypertension have a lot in common. There are two types of complications: macrovascular and microvascular. CAD (Coronary artery disease), MI (myocardial infarction), congestive heart failure, stroke, and (PVD) peripheral vascular disease are examples of macrovascular problems. Retinopathy, nephropathy, and neuropathy are microvascular consequences of diabetes.[8]

The intima-media thickness is a noninvasive ultrasonographic variable used to detect endothelial dysfunction and preclinical atherosclerosis. Increased intima-media thickness in the common carotid arteries is linked to cardiovascular risk factors and is a proven early marker of the initial phases of vascular disease. It is also linked to the development of cardiovascular disease.[9] Intima-media thickness readings in the common carotid arteries are found to be greater in males than in women. Furthermore, African–Americans have greater values than Caucasians. The absolute limit of normal for mean intima-media thickness in the carotid arteries in men was 0.59-0.95 mm, while in women it was 0.52-0.93 mm. Intima-media thickness values are affected by age, gender, the prevalence of risk factors, echogenicity, segmentation, measuring technique, and ultrasound technology.[10]

B-mode with high-resolution ultrasound is a non-invasive, low-cost, accurate, and repeatable tool for evaluating and quantifying adaptive vascular changes including artery wall thickening and atherosclerotic development. Ultrasound allows quantitative assessment of the intima-media thickness (IMT), which is a assessment or measurement of the thickness of the artery walls.[11] To present an overview of the relevant studies, we conducted a systematic review of the literature that have examined carotid arteries using ultrasonography in order to better explain the association between diabetes, hypertension and intima-media thickness. The goal of such study was also to get more precise assessment or evaluation of increasing intima-media thickness predictive value for clinical cardiovascular outcomes.

METHODOLOGY

From 2000 through 2021, we searched the Google Scholar, NCBI, PubMed, and Medscape databases. The following essential keywords were looked up: Ultrasound of Carotid arteries, Ultrasound of Common Carotid arteries intima-media thickness and Carotid IMT in diabetes and hypertension. All references were carefully reviewed after duplicates were removed. The relevant papers' titles and abstracts, as well as the entire articles, were screened.

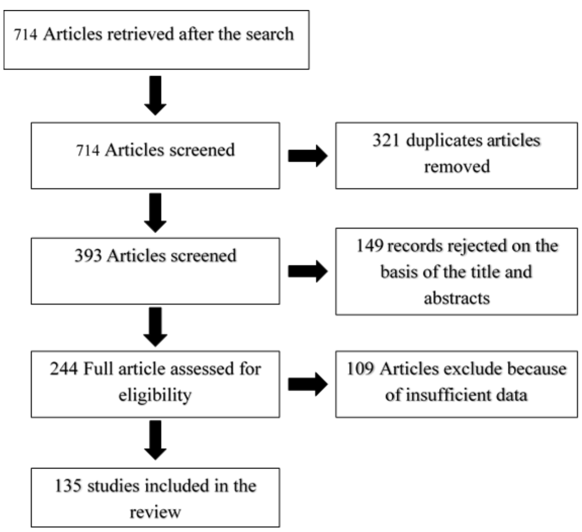

Figure 1: A flowchart illustrating the process of searching and selecting articles

Following the search, 714 studies were discovered. 321 were rejected because of duplication, 149 because they lacked adequate data for our study, and 109 because of the titles and abstracts. Through examination, the flow chart highlights the flow records. In the end, 135 papers were considered for the evaluation (Figure 1). Prospective and observational studies were considered. Isolated abstracts, review papers, randomized controlled trials, case reports, and case series were all omitted. Based on the above requirements, two independent reviewers examined articles for eligibility.

A table was created for preset subgroups of article kinds, author names, publication years, sample size, research design, age, gender, diabetic patients, hypertensive patients and normal and increased IMT. Microsoft Excel 2017 was used to do the data analysis and Statistical Package for the Social Sciences version 24 (SPSS 24).

RESULTS

Only 135 of the 714 published papers found and retrieved for this study. Of the 135 studies, the mean sample size was 742.36±1549.25 with a minimum sample size of 25 and maximum sample size of 12885. According to 126 studies the mean male sample was 330.61±579.35 with a minimum sample of 11 and maximum of 4804 males. In 128 studies the mean female sample was 338.64±598.33 with minimum sample of 9 and maximum sample of 3767. The mean age of patients was 54.70±9.03 with a minimum of 16 years old and a maximum of 74 years old. In 110 studies the mean diabetic sample was 293.65±924.21 patients with a minimum and maximum of 7 and 8571 patients respectively. The mean sample of hypertensive patients was 241.69±388.49 with a minimum of 7 and maximum of 2649 patients. The mean Carotid intima-media thickness (normal) was 0.71±0.16mm with a minimum and maximum Carotid intima-media thickness of 0.5 and 1.3mm respectively. Of the 131 studies the mean Carotid intima-media thickness (abnormal) was 0.91±0.267mm with a minimum of 0.5mm and maximum of 2mm (Table 1).

Table 1: Descriptive Statistics of the data from 135 studies

	N	Min	Max	Mean	Std. Deviation
Sample Size	135	25	12885	742.36	1549.25
Male	126	11	4804	330.61	579.35
Female	128	9	3767	338.64	598.33
Mean Age	135	16	74	54.70	9.03
Diabetes	110	7	8571	293.65	924.21
Hypertension	108	7	2649	241.69	388.49
Normal C-IMT	135	0.05	1.3	0.71	0.16
Increased C-IMT	131	0.50	2.0	0.91	0.26

C-IMT=carotid arteries intima-media thickness

Of the 135 retained studies the percentage of detection was used to calculate the diseases that affect intima–media thickness. As a result, 110 of the 135 articles revealed the most common reasons that alter intima–media thickness were diabetes and hypertension at 81.4 % and 80 % respectively. This review shows that Coronary artery disease increases IMT at 21.4%.

Dyslipidemia and Stroke could also alter IMT at 14.8% and 5.2% respectively. In this review we found that the Microalbuminuria could effect at 3%. However, Non-alcoholic fatty liver disease, PAD and CKD were found to associate with increased IMT at an equal effect of 2.2. MI could alter IMT at 1.5%. Breast arterial calcification, polycystic kidneys and Glomerulonephritis were determined to alter IMT at an equal effect of 0.7% (Table 2).

Table 2: Frequency and Percentage of Pathologic Conditions that alter IMT

	Frequency	Percent
Diabetes	110	81.4
Hypertension	108	80
Coronary artery diseases	29	21.4
Dyslipidemia	20	14.8
Stroke	7	5.2
Microalbuminuria	4	3.0
Non-alcoholic fatty liver disease	3	2.2
Peripheral arterial disease	3	2.2
Chronic kidney diseases	3	2.2
Myocardial infarction	2	1.5
Breast arterial calcification	1	0.7
Polycystic kidneys, Glomerulonephritis	1	0.7

DISCUSSION

Diabetes incidence is globally increasing thus considered as an epidemic. When comparing patients with diabetes to those who do not have the condition, hypertension is about twice as common. Hypertension and diabetes mellitus are amongst the most common causes of arteriosclerotic diseases. The results of this current literature current review shows that the most frequent causes that alter intima–media thickness were diabetes and hypertension. Bulut, Atilla et al stated that C-IMT is a simple, inexpensive, noninvasive, and accurate assessment method for the diagnosis and monitoring of arteriosclerotic diseases. Diabetes is a familiar risk factor for CVD (cardiovascular disease). Carotid IMT levels were elevated in persons with type 2 diabetes. C-IMT elevation is an indication of subclinical atherosclerosis and which can utilized to predict the occurrence of early atherosclerosis in people with type 2 diabetesand those who have prediabetes.[12] Bernd Kowall et al stated that after being matched for age, sex, and other factors, there was no correlation between blood glucose (HbA1c) and CIMT.[13] C. Snehalatha et al also determined that despite the fact that insulin resistance was greater in IGT (impaired glucose tolerance), It has nothing to do with an increase in IMT.[14] Ghodratollah Naseh et al stated that carotid arteries IMT in hypertensive patients is greater than that of healthy adults, it could be an indication of subclinical atherosclerosis and according to the study, which also found no link between the length of HTN and IMT.[15] Massimo Puato et al determined in their study that when compared to normotensive control participants, subjects with hypertension grade I (who did not require antihypertensive medication) showed an accumulated carotid IMT rise that was 3.4-fold higher for mean IMT and 3.2-fold higher for maximal IMT. Their study also indicated that Carotid IMT is greaterr and increases faster in young grade I hypertension participants whose blood pressure stayed below the treatment threshold.[16]

Although diabetics have increased carotid IMT, hypertensive individuals have a higher yearly rise in thickness. Yu, J.-S., et al stated that hypertension clearly affected IMT thickness and major adverse cerebrovascular events was significantly associated with age. They also stated that in young adults, IMT is significantly linked to cardiovascular risk factors and the early phases of vascular atherosclerosis. Even though they had only been exposed to hypertension for a short period and had few cardiovascular risk factors, younger hypertensive participants exhibited considerably thicker carotid IMT.[17] Ramachandran Meenakshi sundaram et al stated that the presence of diabetes, hypertension, and smoking did not affect IMT.[18]

In current review CAD is one of the most common cause that alter IMT of carotid arteries. Similar to this G. Geroulakos et al stated that elevated carotid IMT is a non-invasive sign of coronary vascular disease that could be employed as a biological marker of CAD in observational studies and clinical trials. Furthermore, a higher IMT could be useful as a screening tool for coronary atheroma.[19] A Kablak-Ziembicka et al also determine in their study, that IMT increases with progressive CAD; and patients with a mean IMT exceeding 1.15 mm have a high risk (94%) of CAD.[20] IMT is a well-known cardiovascular disease marker, and increased IMT has been connected with the development of CAD and stroke. In males, IMT larger than 1 mm is associated with a twofold increase in the risk of CAD. and a fivefold increase in the risk of CAD in women.[21] In contrast to this Paul L. Allan et al found in their study that the relationship between coronary heart disease and CCA IMT was not statistically significant.[22]

The lipid profile has one of the major influences on CVD. In this study we also find an association between CVD and hyperlipidemia and IMT. Shinichi Wada also stated that Age, hypertension, smoking, HDL cholesterol, and diabetes mellitus were associated with mean IMT.[23] Michael Leutner et al showed in their study that there was no significant difference in carotid IMT measurements between Hyperlipidemic men and Hyperlipidemic women.[24]

In current study we found that stroke is associated with increased IMT. Similar to this study Peiyang Zhou et al stated that there is a link between IMT and the risk of stroke in young people. The mean IMT in the AIS (acute ischemic stroke) population was found to be significantly higher in this study.[25] In contrast to current study Joseph F. Polak stated that the change in the common carotid artery IMT is linked to stroke. In our baseline analysis, we discovered that IMT is related with incident stroke. but this sassociation became non-significant after adjustment for risk factors.[26]

In current review we found that microalbuminuria have a significant impact on IMT progression. G Leoncini et al also stated that microalbuminuria was significantly correlated IMT and several metabolic and non-metabolic risk factors (blood pressure, body mass index, serum lipids). In patients with primary hypertension, microalbuminuria is an integrated sign of subclinical organ damage.[27] Marc M H Hermans et al determined that in general population after adjusting for traditional cardiovascular disease risk factors microalbuminuria was not significantly correlated with carotid IMT.[28] Leena Mykkänen et al stated that microalbuminuria was associated with increased IMT of the CCA but not of the ICA.[29] Stefan Agewall et al found that in clinically healthy men urinary albumin excretion was significantly associated with IMT of the common carotid artery.[30]

Non-alcoholic fatty liver disease (NAFLD is linked to an elevated risk of incident CVD events in both individuals with diabetes as well as those without type 2 diabetes.[31] In present study we found that NAFLD is associated with increased IMT. Similar to this Ali Mohammadzadeh et al determined that an increased carotid IMT is strongly linked to NAFLD, even when other cardiovascular risk factors are controlled for, and should be evaluated in these individuals.[32] In contrast to this Anders Gummesson et al stated that NAFLD was not significantly linked with carotid plaques and IMT.[33] Although NAFLD is frequent in those with type 2 diabetes, it is not linked to a higher risk of carotid atherosclerosis. Having both NAFLD and insulin resistance, on the other hand, appeared to be an independent predictor of higher C-IMT.[34]

In this review we determined that chronic kidney disease (CKD) is associated with increased IMT. Andrea Gaspar Marcos et al stated that IMT in early-stage CKD patients was related to coronary artery calcification.[35] Alan Hinderliter et al stated that the Patients with advanced CKD had a high prevalence of coronary risk factors and clinical CVD. IMT was strongly associated with traditional cardiovascular risk factors, (age, diabetes, dyslipidemia, systolic blood pressure, and tobacco use), than nontraditional risk factors.[36]

In this review study we found that peripheral artery disease (PAD) is associated with increased IMT. Similarly Akimichi Iwamoto et al and Rajendra Pradeepa et al stated that MT was significantly larger in the atherosclerotic peripheral artery disease (PAD) group.[37]

Breast arterial calcification is linked with carotid intima medial thickness. In this review we found that there is a link between breast arterial calcification and carotid intima medial thickness. Similar to this some studies showed that Breast arterial calcification was attributed to greater carotid artery intima media thickness. Women with Breast arterial calcification are more likely to have thicker IMT.[38] In contrast to this N. Sarrafzadegann et al stated that no statistically significant differences were seen between those with and without Breast arterial calcification.[39]

In our study we found that IMT may be greater in patients with polycystic kidneys and Glomerulonephritis. We found a study in which author stated that patients with Autosomal-dominant polycystic kidney disease who have normal blood pressure and good renal function have considerably higher carotid IMT.[40]

CONCLUSION

Patients with hypertension and diabetes are most at risk of developing coronary artery disease.

AUTHORS' CONTRIBUTION

HIK, MS, and RB: Concept and design, data acquisition, interpretation, drafting, final approval, and agree to be accountable for all aspects of the work.

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