Arteriosclerosis, Thrombosis, and Vascular Biology

CLINICAL AND POPULATION STUDIES

Carotid Atherosclerosis in Predicting Coronary Artery Disease

A Systematic Review and Meta-Analysis

Ibadete Bytyçi,* Rafik Shenouda,* Per Wester, Michael Y. Henein

OBJECTIVE: This meta-analysis aims to compare the relationship between phenotypic manifestation of coronary and carotid atherosclerosis using available imaging techniques.

APPROACH AND RESULTS: We searched all electronic databases until October 2020 for studies which reported relationship between carotid and coronary atherosclerosis. The primary end point was correlation between carotid intima-media thickness (CIMT) and carotid plaque features (calcification and lipid-rich necrotic core) with coronary artery disease (CAD). Secondary end points included carotid pathology that predicts CAD. Eighty-nine papers with 22 683 patients comparing carotid and coronary atherosclerosis were included in the analysis. CIMT was increased linearly with severity of CAD irrespective of its significance ($P<0.001$), mono versus 2 vessel disease ($P=0.003$), and 2 versus multivessel disease ($P<0.001$). Carotid plaque presence and calcification were less, and lipid-rich necrotic core was highly prevalent in nonsignificant versus significant CAD ($P<0.001$, $P=0.03$, $P<0.001$, respectively). Moderate correlation was found between CIMT and severity of CAD ($r=0.60$, $P<0.001$) and the number of diseased vessels ($r=0.49$, $P<0.001$). There was a moderate correlation between carotid and coronary stenosis ($r=0.53$, $P<0.001$) and between carotid and coronary calcification ($r=0.61$, $P<0.001$). CIMT ≥1.0 mm with a summary sensitivity of 77% and summary specificity of 72% and respective values of 80% and 67% for carotid plaque were the best predictors of CAD, irrespective of the technique used for its diagnosis.

CONCLUSIONS: These results support the concept that atherosclerosis affects both carotid and coronary systems, although not always in identical phenotypic manner. These findings highlight the beneficial examination of carotid arteries whenever CAD is suspected.

GRAPHIC ABSTRACT: A graphic abstract is available for this article.

Key Words: atherosclerosis ■ coronary artery disease ■ diagnosis ■ tomography ■ ultrasonography

Coronary artery disease (CAD) remains the most prevalent cause of death in the Western countries with atherosclerosis the main underlying pathology for CAD and cerebrovascular disease.[1] Over many decades, detection of luminal stenosis and its clinical consequences have been the main purpose for studying arterial disease,[2] but more recently, the management strategy changed. For carotid arteries, the degree of luminal stenosis, assessed by noninvasive imaging, such as ultrasound, computed tomography angiography (CTA), or magnetic resonance (MR) angiography, is now used for preoperative assessment,[3] compared with conventional angiography in CAD. This is justified by the superficial location of the carotid arteries which makes their imaging less challenging compared with the coronary circulation.[4] Based on the shared underlying atherosclerosis pathology in the 2 arterial systems, carotid examination in CAD and vice versa has become of clinical importance in order to accurately

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Nonstandard Abbreviations and Acronyms

CAD	coronary artery disease
CIMT	carotid intima-media thickness
CP	carotid plaque
CTA	computed tomography angiography
LRNC	lipid rich necrotic core
MRI	magnetic resonance imaging
ROC	receiver operating characteristic
WMD	weighted mean differences

identify patients who could benefit from aggressive preventive therapies as well as timely treatment.[5,6] The highly accurate recently developed imaging techniques made invasive imaging of the carotid arteries less attractive, for routine imaging and surveillance, hence reserved for interventional management.[7] Carotid plaque (CP) burden and composition features, particularly lipid necrotic core, are significantly associated with severity of CAD stenosis.[8] This systematic review and meta-analysis aims to explore the relationship between various phenotypic patterns of carotid atherosclerosis with the prevalence, phenotype, and severity of coronary atherosclerosis.

Highlights

- This systematic review and meta-analysis assessed the results of all studies using different imaging techniques to investigate the relationship between carotid and coronary atherosclerosis, the 2 most commonly affected systems by atherosclerosis. Eighty-nine papers with 22 683 patients comparing carotid and coronary atherosclerosis were included in the analysis.
- The moderate relationship we found between carotid intima-media thickness and severity of coronary artery disease and stenosis are important and not only serve in predicting the presence of severe disease, as our analysis has shown, but also help in identifying patients demonstrating established arterial disease who need optimum risk factors control and follow-up management.
- The large data set analyzed provided many comparisons and relationships that strengthened the relevance of the finding about pathological similarities of the 2 arterial systems.
- These results support the concept that atherosclerosis affects both carotid and coronary systems, although not always in identical phenotypic manner. These findings highlight the beneficial examination of carotid arteries whenever coronary artery disease is suspected.

METHODS

The research methodology used in this study followed the Meta-Analysis of Observational Studies in Epidemiology statement for reporting systematic reviews and meta-analyses of observational studies.[9] Due to the study design (meta-analysis), neither institutional review board approval nor informed consent was needed.[10]

Search Strategy

We systematically searched PubMed–Medline, EMBASE, Scopus, Google Scholar, the Cochrane Central Registry of Controlled Trials, and ClinicalTrial.gov, up to September 2020, with the following key words: "Coronary artery disease" OR "CAD" OR "Ischemic heart disease" OR "IHD" OR "Carotid atherosclerosis" OR "Carotid stenosis" AND "Carotid imaging" OR "Carotid ultrasonography " OR "computed tomography" OR ("magnetic resonance imaging") AND "Correlation" OR "Carotid intima-media thickness" OR "Carotid IMT" OR "Carotid and coronary plaque" OR "Carotid and coronary stenosis" AND "prediction". Additional searches for potential trials included the references of review articles on the subject and the abstracts presented at the scientific sessions of the European Society of Cardiology, European Atherosclerosis Society, the American Heart Association, American College of Cardiology, and European Association of Cardiovascular Imaging. The wildcard term "*" was used to enhance the sensitivity of the search strategy. The literature search was limited to articles published in English and to human studies.

Two investigators (I. Bytyçi and R. Shenouda) independently evaluated the abstracts of each article. No filters were applied. The remaining articles were obtained in full-text and assessed, again by the same 2 researchers who separately evaluated each article and performed data extraction and quality assessment.

Study Selection

The criteria for inclusion in the meta-analysis were studies: (1) investigating coronary and carotid atherosclerosis; (2) reporting carotid intima-media thickness (CIMT), carotid and coronary plaque presence, and plaque morphology; (3) reporting relationship between carotid and coronary atherosclerosis and predictive value; (4) that enrolled human population; and (5) that enrolled adults aged ≥18 years.

Exclusion criteria were as follows: (1) insufficient statistical data to compare the 2 groups; (2) only one study arm, that is, reporting only carotid or only coronary atherosclerosis; (3) nonhuman subjects; and (4) articles not published in English.

Outcome Variables

The key clinical end point was the relationship between mean CIMT and CAD, CP features (calcification, lipid-rich necrotic core [LRNC], and intraplaque hemorrhage) with CAD and with coronary plaque. Secondary end point included carotid phenotypic pathology that predicts CAD.

Significance CAD was defined as stenosis ≥50% and severe CAD stenosis as a coronary artery stenosis ≥70%.

Data Extraction

Eligible studies were reviewed, and the following data were abstracted: (1) first author's name; (2) year of publication; (3) study design; (4) data on 2 arms: carotid and coronary atherosclerosis; (5) carotid predictive value of CAD; (6) patients with CAD or suspected CAD disease; (7) carotid ultrasound, MR imaging (MRI), or CTA measurements; and (8) age and sex of study participants. Discrepancies in extractions were resolved by discussion with a third investigator (M.Y. Henein).

Risk of Bias Assessment

Assessment of risk of bias of RCTs was evaluated by the same investigators for each study and was performed independently using the Cochrane risk of bias tool.[9] The risk of bias was judged to be low, high, or unclear. For the assessment of risk of bias in cohort/observational studies, we used the Newcastle-Ottawa Scale. Three domains were evaluated with the following items: (1) Selection: (i) representativeness of the exposed cohort, (ii) selection of the nonexposed cohort, (iii) ascertainment of exposure, and (iv) demonstration that outcome of interest was not present at the start of the study; (2) Comparability of exposed and nonexposed; and (3) Exposure: (i) assessment of outcome, (ii) enough follow-up duration for outcomes to occur, and (iii) adequacy of follow-up of cohorts. The risk of bias in each study was judged to be good, fair, or poor.[11]

Statistical Analysis

The meta-analysis was conducted with statistical analysis performed using the RevMan software (Review Manager Version 5.1, The Cochrane Collaboration, Copenhagen, Denmark), with 2-tailed $P<0.05$ considered as significant. Weighted mean differences (WMD) and a 95% CI were calculated for each study. The baseline characteristics are reported as mean and SD values, which were estimated using the method described by Hozo et al.[12]

To test potential associations between carotid and coronary, we used the MedCalc program (Version 19.0, Medcalc Software, Ostend, Belgium) applying the Hedges–Olkin (1985) method for calculating the weighted summary correlation coefficient under the fixed/random-effects model and using the Fisher Z transformation of the correlation coefficients. The heterogeneity statistics were incorporated to calculate the summary correlation coefficient under the random-effects model.[13]

To evaluate different cutoffs of CIMT and CP presence in predicting CAD, we performed hierarchical summary receiver operating characteristic (ROC) analysis using the Rutter and Gatsonis model.[13] Summary sensitivity, summary specificity, and accuracy with 95% CI for individual studies based on true positive, true negative, false positive, and false negative were computed using the diagnostic random-effects model.[19] The summary point from the hierarchical ROC analysis was then used to calculate the positive likelihood ratio, negative likelihood ratio, positive predictive value, and negative predictive value. In studies that did not provide optimal cutoffs, we created the ROC curve and identified the optimal cutoff as the point on the ROC curve closest to 0.1 in *x-y* coordinates. Open Meta Analyst software version 12 for Windows (64-bit version; Microsoft) was used for statistical analysis including graphic presentations of forest plots of sensitivity and specificity and hierarchical summary ROC curves. The meta-analysis is presented in the form of forest plots and was performed with a random model.

The heterogeneity between studies was assessed using the Cochran *Q* test and the I^2 index. As a guide, $I^2<25\%$ indicated a low heterogeneity, 25% to 50% moderate heterogeneity, and >50% high heterogeneity.[13] Publication bias was assessed via visual inspections of funnel plots and Egger test.

RESULTS

Search Results and Trial Flow

Of 2845 articles identified in the initial searches, 162 studies were considered as potentially relevant. After a stringent selection process, 89 articles met the inclusion criteria[14–102] (Figure I in the Data Supplement). Seventy-seven studies reported carotid ultrasound,[14–90] 5 of them reported carotid CTA[91–95] and 7 reported carotid MRI.[92–102] Coronary atherosclerosis in 73 studies was evaluated by coronary angiography, and in the remaining 16 papers with coronary CTA.[23,24,39,49,54,63,67,94–102] Four[18,24,78,99] of the 89 studies were clinical trials and the rest were observational or cohort studies (Table I in the Data Supplement).

Characteristics of Included Studies

Eighty-nine studies with 22 683 patients comparing carotid and coronary atherosclerosis met all the inclusion and none of the exclusion criteria. Twenty-five studies reported also a control group[14,16,19,22,23,25,27,28,31,37,40,46,48,50–52,57,58,62,66,68,77,87,88,91] with a total of 1527 participants (Table I in the Data Supplement). The mean age of patients was 60.6±9.4 years and 31.5% were females irrespective of the biological sex.

Carotid (Ultrasound) and Coronary (Angiography) Atherosclerosis in CAD Cases and Controls

CIMT was higher in patients with CAD compared with controls, WMD=0.18 (95% CI, 0.16–0.21, $P<0.001$). CIMT was linearly higher proportional to severity of CAD, nonsignificant versus significant CAD, WMD=−0.12 (95% CI, −0.14 to −0.10, $P<0.001$), mono vessel disease versus 2 vessel disease CAD, WMD=−0.04 (95% CI, −0.07 to −0.02, $P=0.003$), and 2 vessel disease versus multivessel coronary CAD, WMD=−0.08 (95% CI, −0.11 to −0.05, $P<0.001$; Figure 1A, Figures II and III in the Data Supplement). In addition, CP presence was less prevalent in nonsignificant CAD compared with significant CAD, 35.9% versus 65.1% (relative risk=0.62, 95% CI, 0.50–0.75, $P<0.001$, Figure IV in the Data Supplement). Carotid calcification and LRNC measured by MRI in patients with CAD were higher than controls ($P<0.05$ for all

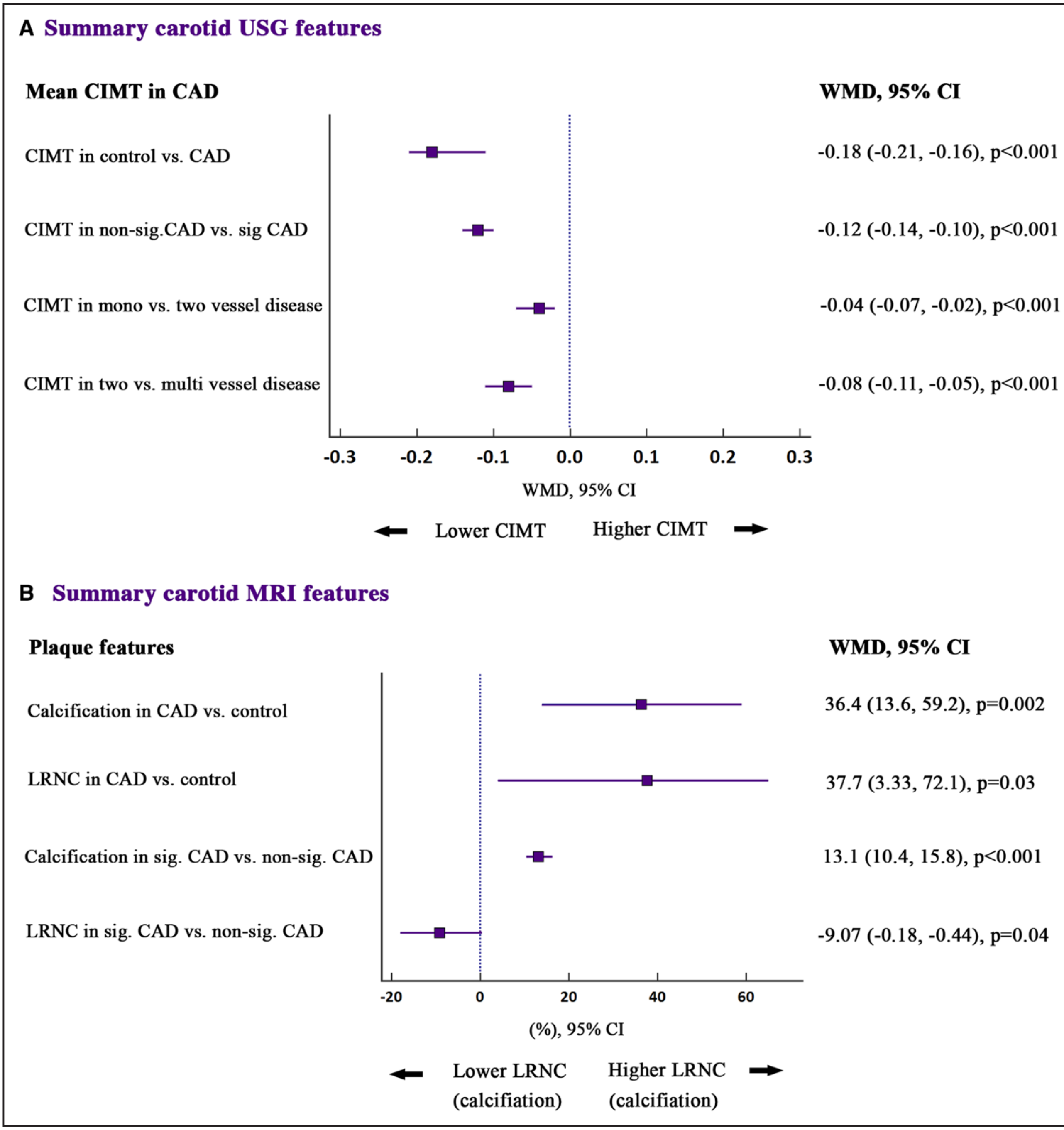

Figure 1. Summary carotid features in patients with coronary artery disease (CAD): (A) ultrasonography (USG) features; (B) magnetic resonance imaging (MRI) features.
CIMT indicates carotid intima-media thickness; LRNC, lipid-rich necrotic core; and WMD, weighted mean differences.

Figure VA and VB in the Data Supplement). Significant CAD had a higher degree of carotid calcification with WMD=13.7 (95% CI, 10.7–15.8, P<0.001) lower LRNC with WMD=−10.2 (95% CI, −18.1 to −1.84, P=0.02) but no difference in intraplaque hemorrhage WMD=1.80 (95% CI, −4.65 to 8.26, P=0.58) compared with nonsignificant CAD (Figure 1B, Figure VC through VE in the Data Supplement).

The Relationship Between Carotid and Coronary Atherosclerosis

A moderate positive correlation was found between CIMT and severity of CAD, r=0.60 (95% CI, 0.47–0.70, P<0.001) as well as a moderate correlation between CIMT and both the number of coronary vessel disease, r=0.49 (95% CI, 0.36–0.59, P<0.001)

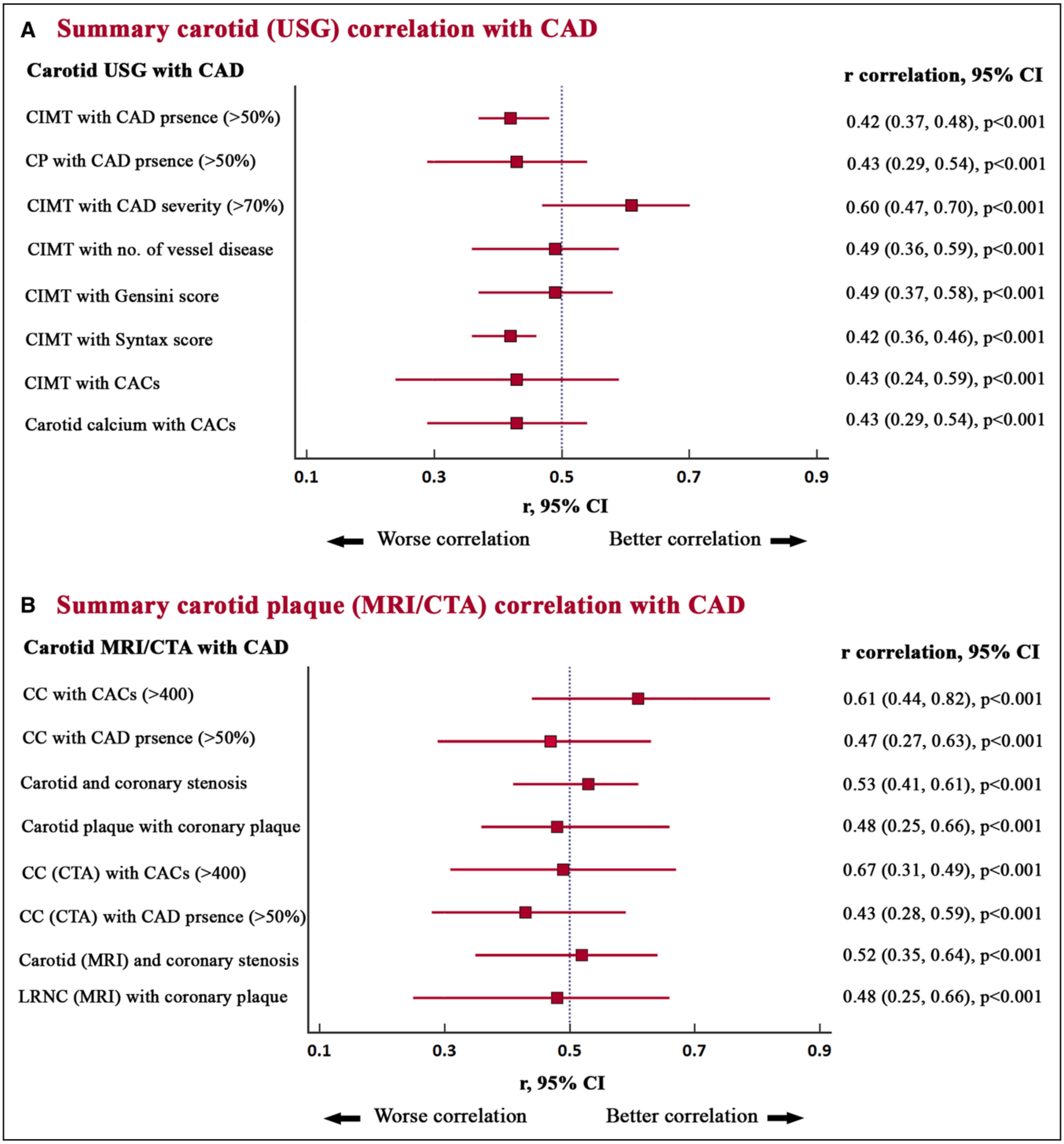

Figure 2. Summary carotid correlation with coronary artery disease (CAD): (A) ultrasonography (USG) correlation; (B) magnetic resonance imaging (MRI)/computed tomography angiography (CTA) correlation.
CACs indicates coronary artery calcium score; CC, carotid calcification; CIMT, carotid intima-media thickness; CP, carotid plaque; and LRNC, lipid-rich necrotic core.

and Gensini score, r=0.49 (0.37–0.58, P<0.001, Figures 3C and 3D and 4A). The relationship between CIMT and syntax score (r=0.42, P<0.001) as well as CIMT and significant CAD (r=0.42, P<0.001) was only modest (Figures 3A and 4B). Similarly, the relationship between CP presence and significant CAD (r=0.42, P<0.001) as well as between carotid calcification measured by ultrasonography and coronary calcification (r=0.43, P<0.001) was modest (Figures 2A, 3B, and 4).

In the same way, the relationship between carotid and coronary atherosclerosis measured by MRI and CTA was significant (P<0.001). Moderate correlation was found between carotid calcification (CTA/MRI) and

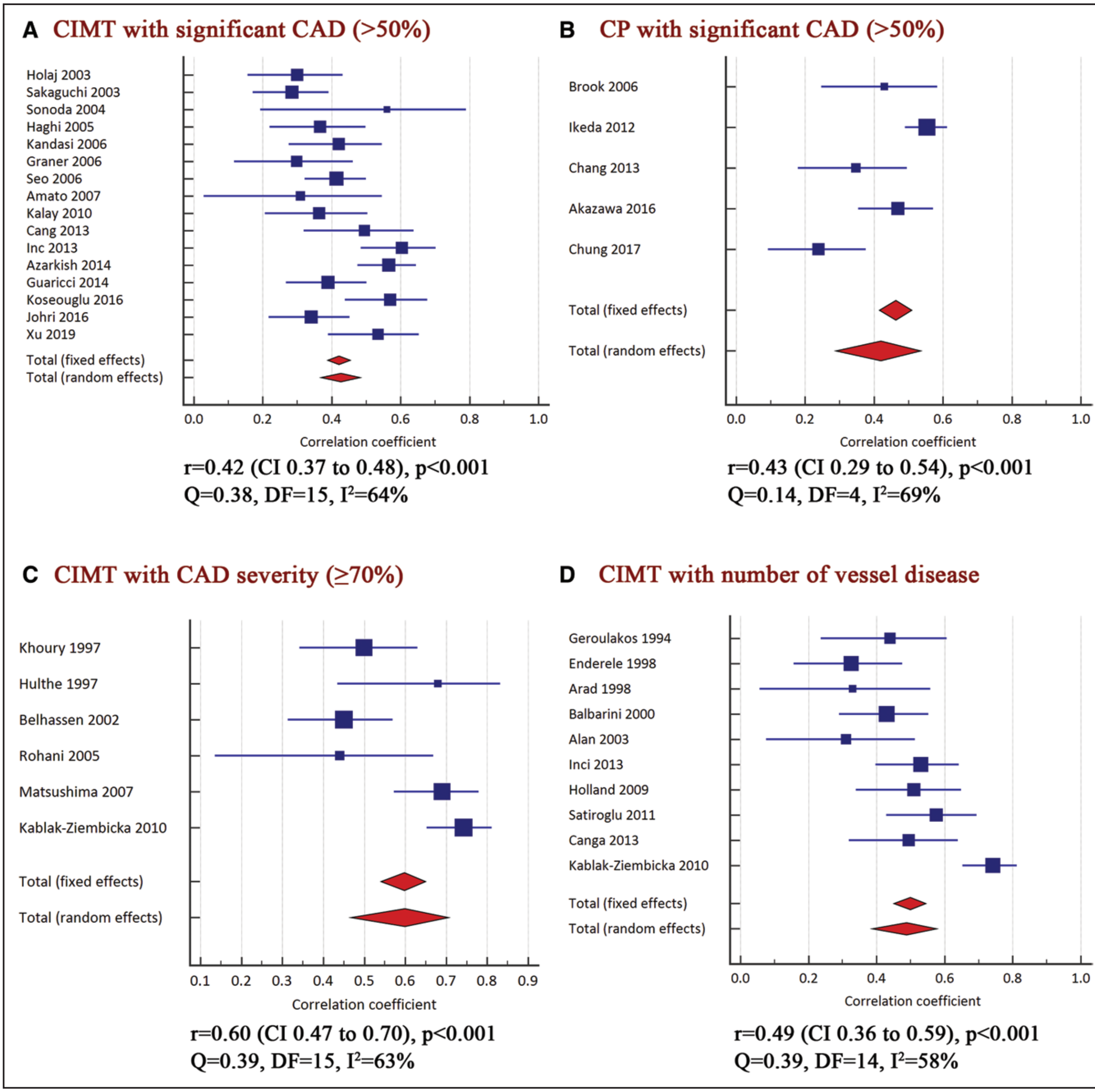

Figure 3. Meta-analysis of correlation between carotid intima-media thickness (CIMT) and coronary artery disease (CAD) disease.

A, Correlation between CIMT and significant CAD; **B**, correlation between CP with significant CAD; **C**, correlation between CIMT with CAD severity; **D**, correlation between CIMT with number of vessel disease. CP indicates carotid plaque.

coronary calcification, *r*=0.61 (0.44–0.82, *P*<0.001), between carotid and coronary stenosis *r*=0.53 (0.41–0.61, *P*<0.001), carotid and coronary plaque presence (*r*=0.48, *P*<0.001) as well as carotid calcification (ultrasonography) and CAD presence (*r*=0.47, *P*<0.001; Figures 2B, 4, and 5). In addition, the LRNC measured by MRI correlated only modestly with coronary plaque formation (*r*=0.48, *P*<0.001, Figure VI in the Data Supplement).

Diagnostic Accuracy of Carotid Ultrasound in Detecting Significant CAD

CIMT≥1.0 mm with a summary sensitivity of 77%,[70–85] summary specificity of 72%,[59–82] positive predictive value of 82%, negative predictive value of 65% and 76% accuracy, and CP presence with summary sensitivity of 80%[66–88] and specificity of 67%,[49–80] positive predictive value of 78%, negative predictive value of 65% and 73% accuracy

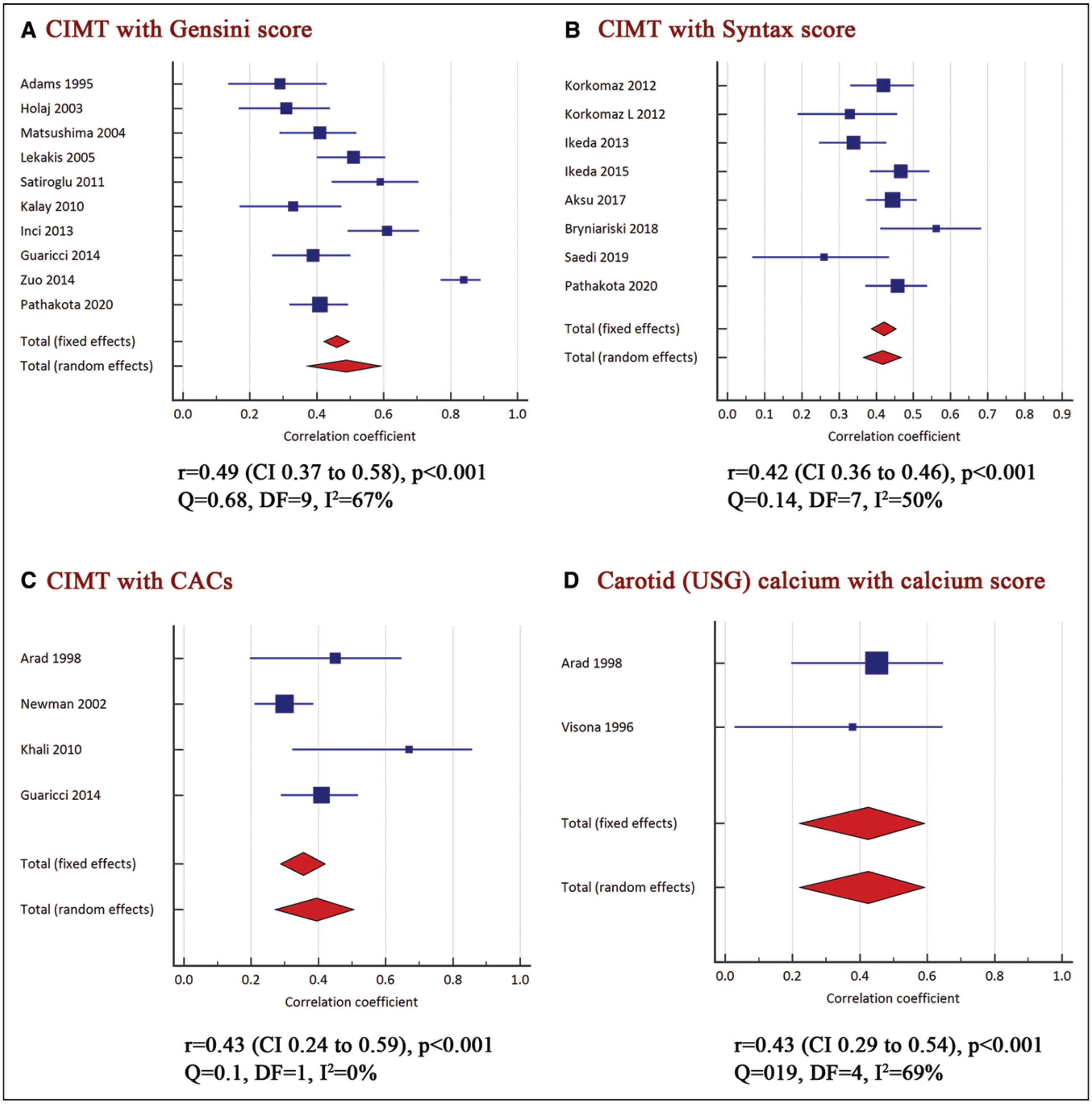

Figure 4. Meta-analysis of correlation between carotid intima-media thickness (CIMT) and coronary artery disease (CAD) score. **A**, Correlation between CIMT and Gensini score; **B**, correlation between CIMT and Syntax score; **C**, correlation between CIMT and CACs; **D**, correlation between carotid (USG) with calcium score. CACs indicates coronary artery calcium score; and USG, ultrasonography.

were the 2 most powerful predictors of significant CAD. The other cutoffs for CIMT had less predicting power for CAD (Figure 6A, Table, Figure VII in the Data Supplement).

We also assessed the predictive value of CIMT≥1.0 mm and CP presence of significant CAD measured by different techniques (angiography versus CTCA). The results showed no difference between the 2 techniques. CIMT had higher summary sensitivity in predicting significant CAD measured by CTCA 88%[78–94] compared with angiography 78%[76–80] but the difference in accuracy was statistically not significant (74% versus 75%, *P*=NS). CP presence had modestly lower accuracy in detecting significant CAD measured by angiography with summary sensitivity 79% and sensitivity 60% compared with CTCA with summary sensitivity 76% and specificity 72% (Figure 6B, Table, Figure VIII in the Data Supplement).

Risk of Bias Assessment

Many of the observational studies have good quality, below 25% of them have fair quality (Table II in the Data Supplement). Also, there was no evidence for publication

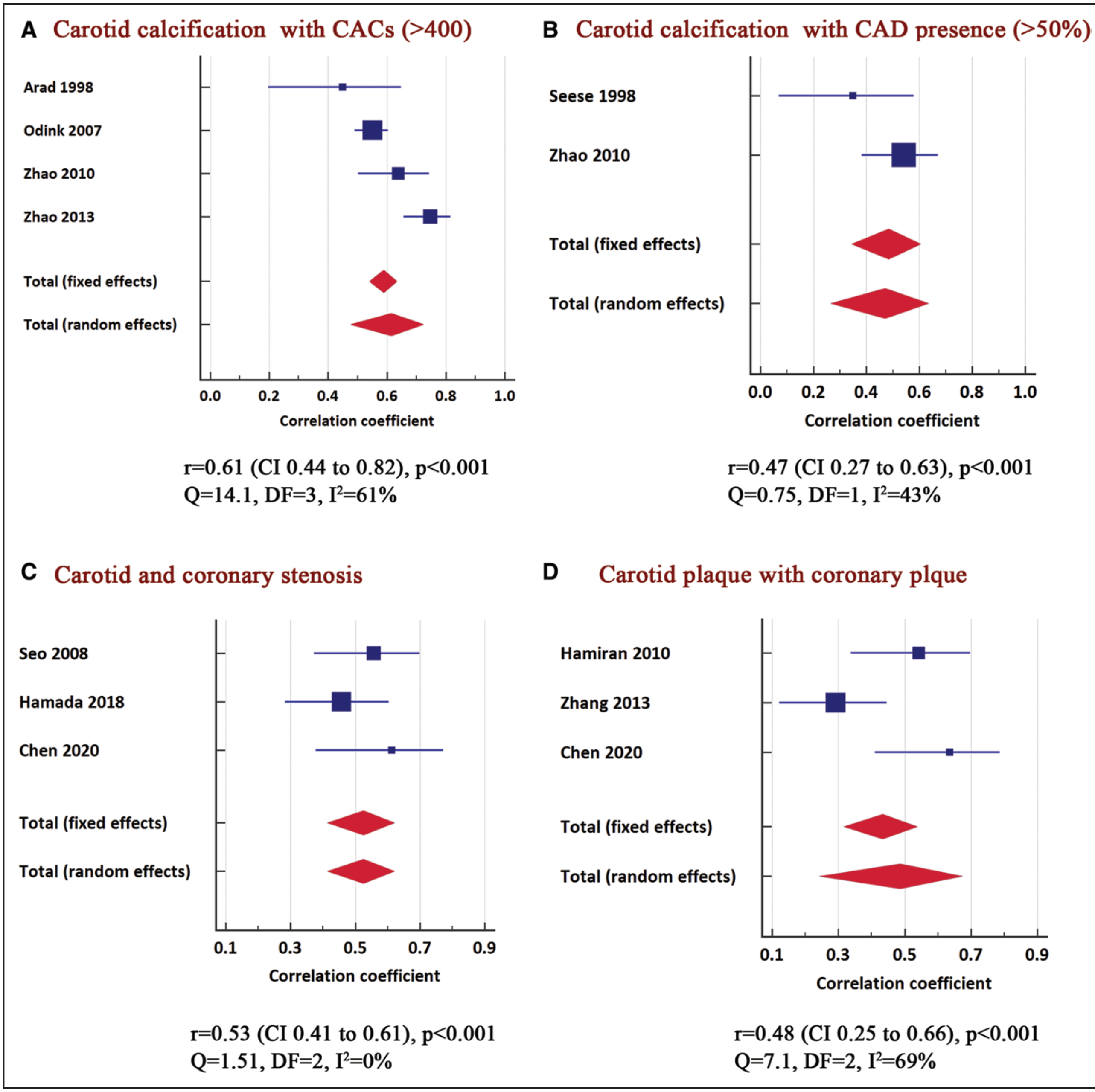

Figure 5. Meta-analysis of correlation between carotid plaque features (magnetic resonance imaging [MRI]/computed tomography angiography [CTA]) and coronary artery disease (CAD) disease.

A, Correlation between carotid calcification and CACs; **B**, correlation between carotid calcification and CAD presence (>50%); **C**, correlation between carotid and coronary stenosis; **D**, correlation between carotid plaque with coronary plaque. CACs indicates coronary artery calcium score.

bias as evaluated by the Egger test for our findings. The heterogeneity was met in mean difference of CIMT, CP presence, and features, and the random effect was used.

DISCUSSION

Findings

The results of this systematic review and meta-analysis of the relationship between carotid and coronary atherosclerosis reveal that (1) CIMT was increased in linear manner proportional to severity of CAD; (2) CP presence and calcification were less prevalent, LRNC was higher, and intraplaque hemorrhage did not differ in nonsignificant compared with significant CAD; (3) CIMT correlated moderately with the number of diseased coronary arteries and with Gensini score; (4) carotid and coronary stenosis and calcification of the 2 systems moderately correlated together; and (5) CIMT≥1.0 mm and CP presence were the best

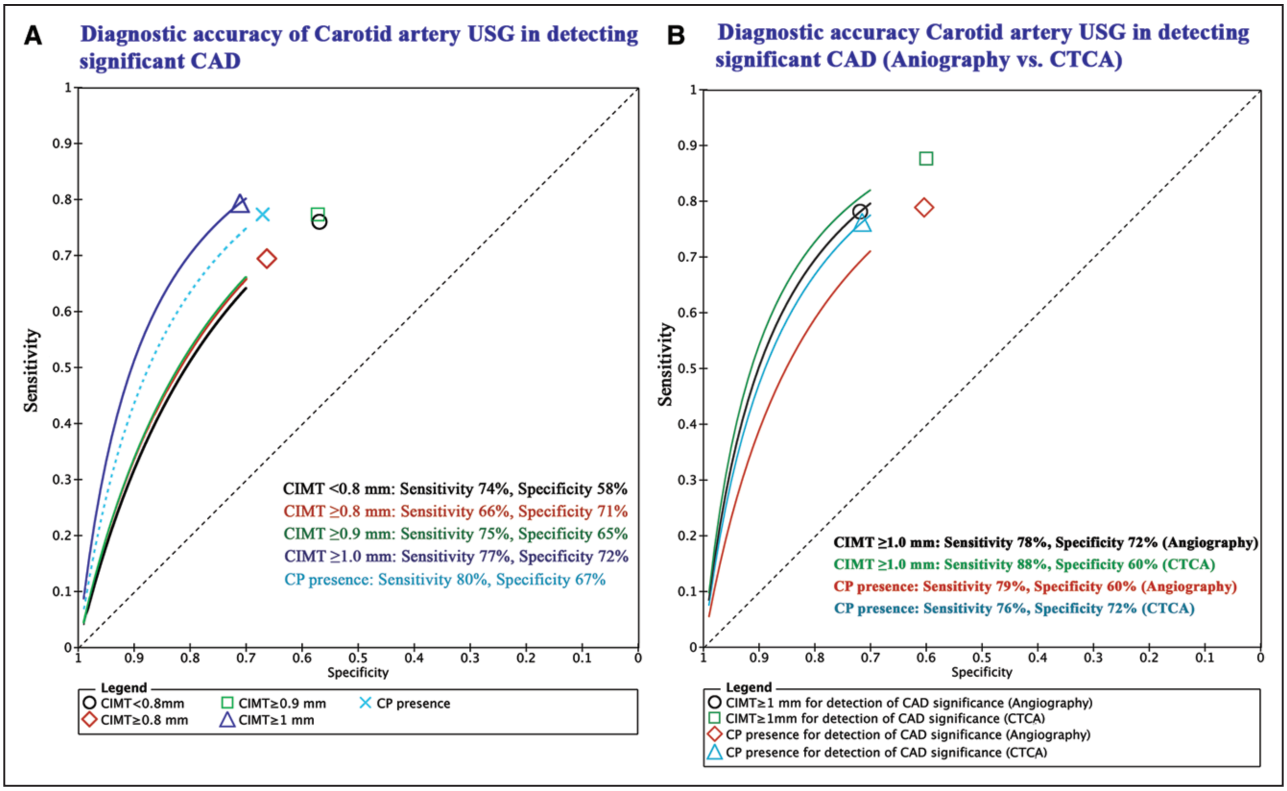

Figure 6. Diagnostic accuracy of carotid ultrasound.

A, Diagnostic accuracy of carotid ultrasound for detection of the significant coronary artery disease (CAD). **B**, Diagnostic accuracy of carotid intima-media thickness (CIMT)≥1.0 mm and carotid plaque (CP) presence for detection of the significant CAD, measured by different techniques (angiography vs CTCA).

predictors of CAD, irrespective of the imaging technique used, angiography or CTCA.

Data Interpretation

Carotid and coronary arteries are the 2 most common systems affected by atherosclerosis. The 2 arterial systems share similar characteristics and mechanisms of atherosclerotic plaque formation irrespective of the location site, however, plaque morphology and features are not identical. The carotid arteries are single arteries that originate from 2 nearby segments of the aortic arch. They divide at the bifurcation into 2 branches supplying 2 different end organs, the brain and the scalp, with different level of pressure resistance that impacts the pattern of blood flow in the 2 branches despite being mainly systolic.[4] However, the 2 coronary arteries (right and left) stem off the same region of the aortic root. Irrespective of their branching

Table. Diagnostic Accuracy of Carotid Ultrasound in Detecting Significant CAD

	Sensitivity	Specificity	PPV	NPV	Accuracy
CIMT<0.8 mm	74 (62–76)	58 (43–72)	71 (69–73)	60 (57–63)	67 (65–69)
CIMT≥0.8 mm	66 (64–64)	71 (57–80)	76 (74–78)	58 (55–60)	68 (66–70)
CIMT≥0.9 mm	75 (62–85)	65 (52–75)	66 (63–69)	69 (65–73)	68 (64–71)
CIMT≥1.0 mm	77 (70–85)	72 (59–82)	82 (80–83)	66 (64–68)	76 (74–77)
CP presence	80 (66–88)	67 (49–80)	78 (75–81)	65 (61–70)	73 (69–76)
CIMT and CP presence in detecting significant CAD (angiography vs CTCA)					
Angiography vs CTCA					
CIMT≥1.0 mm (angiography)	78 (76–80)	72 (69–74)	82 (81–84)	65 (64–67)	75 (74–77)
CIMT≥1.0 mm (CTCA)	88 (78–94)	60 (49–70)	66 (59–70)	85 (75–91)	74 (65–79)
CP presence (angiography)	79 (72–85)	60 (50–70)	75 (70–79)	65 (57–72)	70 (66–76)
CP presence (CTCA)	76 (70–81)	72 (64–78)	81 (76–84)	66 (60–71)	74 (69–78)

CAD indicates coronary artery disease; CIMT, carotid intima-media thickness; CP, carotid plaque; CTCA, computed tomography coronary angiography; NPV, negative predictive value; and PPV, positive predictive value.

pattern, the 2 coronary arteries deliver homogenous blood supply to the myocardium,[102] predominantly in diastole, and share the same level of peripheral resistance.[102] The 2 arterial circulations differ in their distance from the cardiac pump, with the coronary arteries 2 to 3 cm away from the left ventricle but the carotid arteries bifurcation and proximal branches 25 to 30 cm far. Finally, the anatomic design of the 2 systems dictates the carotid blood flow to be antigravity during almost two-thirds of the day, when the individual is standing or sitting, while the coronary flow to be with the gravity. Despite these differences, the 2 arterial systems, according to the available literature, share similar phenotypic pattern of atherosclerosis, in the form of thickened intima-media, plaque formation, luminal narrowing or obstruction by large plaques, and arterial wall calcification. The extent of shared pathology in the 2 systems in the same patient remains debatable, with some showing similar pathology and others not, hence, the objective of this meta-analysis in evaluating the existing evidence.

Over the last decades and with the fast development of noninvasive techniques imaging carotid and coronary atherosclerosis has changed. While invasive coronary angiography is the gold standard for establishing the presence, location, and severity of CAD,[103] carotid ultrasound, CT and MRI have become the conventional imaging modalities of carotid disease because of the subcutaneous location of the arteries.[4,6] This does not negate the current routine use of CT coronary angiography, particularly in patients with atypical symptoms who carry intermediate risk.[7] Carotid CIMT has been shown as a good marker of atherosclerosis and a predictor of cardiac events.[104] Our findings strong support that in showing linear relationship between CIMT and severity of CAD. Also, CIMT significantly correlated with the number of diseased coronary vessels. These findings support the importance of using CIMT for stratifying CAD. The presence of CP, in our analysis, also correlated, although modestly, with the degree of coronary disease. Finally, the degree of carotid stenosis correlated only moderately with coronary stenosis and calcification severity in the 2 arterial systems. It is interesting that the strongest relationship between the phenotypic manifestation of atherosclerosis in the 2 systems was between CIMT and severity of CAD (>70% stenosis, irrespective of the imaging technique used for its diagnosis) as well as between calcification of the 2 systems, as shown by CTA or MRI. Furthermore, CIMT>1.0 mm, rather than plaque formation, proved the strongest predictor of significant CAD. These findings highlight the fact that although the pathological elements of atherosclerosis are the same in all arterial beds, the phenotypic picture is not identical between the carotid and coronary systems. This is supported by the difference in risk factors that predispose to acute vascular events related to the 2 systems which dictates management strategies.[105] This difference is also supported by the differential impact of atherosclerosis in peripheral circulation, carotid versus femoral versus radial with the latter completely spared.[106] Our own results support that difference in showing only modest relationship between carotid and coronary stenosis severities.[107] Finally, the moderate relationship between carotid calcification (CTA/MRI) and coronary calcification is of particular interest since arterial calcification is a known manifestation of atherosclerosis, rather than medial sclerosis commonly seen in isolated chronic kidney disease.[108] Coronary calcification has been described as a manifestation of early atherosclerosis, its counterpart in the carotid system is CIMT, with good statistical association.[72,79] Thus, the moderate calcification relationship between the 2 systems might reflect mature pathology, although not previously described, with well-established disease, since most of these patients were on statins,[90,91,98] which have been shown to be associated with raised coronary calcium score reflecting disease maturity.[109] Previous pathological studies established that a large LRNC is an important feature of vulnerable atherosclerotic plaque and high-risk features for neurovascular events.[94,95] Interestingly, in contrast to these findings, the significant CAD had a similar prevalence of intraplaque hemorrhage or surface disruption compared to nonsignificant CAD, therefore, identification of early features carotid disease may potentially reduce the risk of developing transit ischemic attack or stroke in patients with CAD with appropriate treatment intervention.[95,96,110]

Clinical Implications

The moderate relationship we found between CIMT and severity of CAD and stenosis are important and not only serve in predicting the presence of severe disease, as our analysis has shown, but also help in identifying patients demonstrating established arterial disease who need optimum risk factors control and follow-up management.

Strength and Limitations

This systematic review and meta-analysis assessed the results of all studies using different imaging techniques to investigate the relationship between carotid and coronary atherosclerosis, the 2 most commonly affected systems by atherosclerosis. The large data set analyzed provided many comparisons and relationships that strengthened the relevance of the finding about pathological similarities of the 2 arterial systems. This meta-analysis is based on only 4 available clinical trials and the rest were observational/cohort studies, however, the accuracy of the studies was high. The inclusion of all noninvasive imaging modalities might have contributed to the modest relationships we found because of their known limitations. We did not evaluate clinical outcome because of extended inclusion criteria and large data analysis as well as lack of outcome data. Future studies may be required to determine the optimal cutoff of CP features in predicting CAD as well as cardiac events.

Conclusions

The results of this meta-analysis support the concept that atherosclerosis affects both carotid and coronary systems, although not always in identical phenotypic manner. These findings highlight the potential beneficial examination of carotid arteries whenever CAD is suspected.

ARTICLE INFORMATION

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All authors contributed to (1) substantial contributions to conception and design, or analysis and interpretation of data, (2) drafting the article or revising it critically for important intellectual content, and (3) final approval of the version to be published.

Disclosures

None.

Supplementary Materials

Online Figures I–VII
Online Tables I and II

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