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Electrocardiogram criteria of limb leads predicting right coronary artery as culprit artery in inferior wall myocardial infarction

A meta-analysis

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Abstract

Background: Prior studies have proposed several electrocardiogram (ECG) criteria in limb leads for identifying the culprit coronary artery (CCA) in patients with acute inferior wall myocardial infarction (IWMI). The aim of our study was to conduct an evidence-based evaluation and test accuracy comparison of these criteria.

Methods: We searched the PubMed, Embase, and Ovid. Eligible studies to assess the diagnostic performance of ECG criteria predicting CCA in IWMI were reviewed for inclusion. A diagnostic meta-analysis of bivariate approach was performed for pooled estimates of sensitivity and specificity, and meta-regression was implemented to investigate sources of heterogeneity.

Results: Twenty-four studies with 4431 unique participants met the inclusion criteria. The pooled sensitivity and specificity for ST-segment elevation (STE) in III > II, ST-segment depression (STD) in I, STD in aVL, STD in aVL > I, STE in III > II, and STD in aVL > I were 0.91 (0.88–0.94) and 0.69 (0.53–0.81), 0.80 (0.73–0.87) and 0.69 (0.62–0.76), 0.90 (0.81–0.95) and 0.41 (0.22–0.62), 0.84 (0.75–0.91) and 0.72 (0.48–0.88), and 0.79 (0.62–0.90) and 1.00 (0.37–1.00), respectively. Heterogeneity investigation showed that whether multi-vessel diseased patients were excluded, sample size, publication year, etc., could influence the diagnostic performance.

Conclusion: STE in III > II performed better than other criteria for predicting RCA as CCA in IWMI, and STE in III > II and STD in aVL > I were potential and simple algorithms. ECG could be an effective tool to identify the CCA, but future studies are clearly needed to address the potential of diagnostic and prognostic value.

Abbreviations: CAD = coronary artery disease, CAG = coronary angiography, CCA = culprit coronary artery, 95% confidence interval = 95% CI, ECG = electrocardiogram, IVUS = intravascular ultrasound , IWMI = inferior wall myocardial infarction, LAD = left anterior descending artery, LCX = left circumflex coronary artery, MI = myocardial infarction, PCI = percutaneous coronary intervention, RCA = right coronary artery, sROC = summary receiver operating characteristic, STD = ST-segment depression, STE = ST-segment elevation.

Keywords: culprit artery, diagnostic meta-analysis, electrocardiography, inferior wall myocardial infarction

1. Introduction

Myocardial infarction (MI) is a major cause of death and disability worldwide. The electrocardiogram (ECG) is an integral part of the diagnostic work-up of patients with suspected MI.[1] Inferior wall MI (IWMI), which accounts for 40% to 50% of all acute MIs, can be usually caused by the occlusion of right coronary artery (RCA), less often the left circumflex coronary artery (LCX), and rarely the left anterior descending artery (LAD).[2] Patients with occlusion of RCA especially when involving the right ventricle have a worse prognosis than those

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Table 1

Search strategy (up to October 31, 2017).

No. 1	Fields	Items	Resuts	
			PubMed	Embase
#1	Title/abstract	ECG or EKG or Electrocardiogram	81,662	50,669 (lim not Medline)
#2	Title/abstract	Inferior myocardial infarction	1308	485 (lim not Medline)
#3	Title/abstract	#1 and #2	303	166 (lim not Medline)

with occlusion of LCX.[3,4] The early and accurate identification of the culprit coronary artery (CCA) from the ECG can help physicians to predict the location of myocardium at risk and guide the decisions regarding the urgency of revascularization strategy.[5–7] Several ECG criteria based on ST-segment deviation in limb leads have been proposed for prediction of RCA as CCA in IWMI. However, due to variations of research design, sample size, etc., the studies could not reach an agreement, limiting clinical practice. Therefore, it is time to undertake a definitive systematic review and meta-analysis to provide evidence-based evaluation of the clinical ECG utility for identifying the CCA.

2. Methods

Our study was reported according to the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines. The analysis was based on previously published studies, so the ethics approval was not applicable.

2.1. Search strategy

It has been reported that the use of filters to identify reports of diagnostic test accuracy studies in electronic databases may miss a considerable number of relevant articles and is therefore not generally considered appropriate.[8] Our searching concentrated on terms for index tests and target conditions to avoid the omission (Table 1). We searched the following electronic databases for English and non-English literature (up to October 31, 2017): PubMed, Embase, and Ovid Database. In addition, recent conference proceedings and reference lists of all included studies were scanned to identify additional potentially relevant studies.

2.2. Study selection

The inclusion criteria were as follows:

Study participants included patients who met the following inclusion criteria of IWMI: chest pain accompanied by ST elevation 0.1 mV in at least 2 of the 3 inferior leads (II, III, and aVF); and elevation of the creatine kinase and its muscle/brain fraction to greater than twice of the upper limit.

ST-segment deviations in limb leads of ECG to identify right artery as the culprit (the index test).

Underwent coronary angiography (CAG) during hospitalization, where CCA were confirmed (the reference standard).

Reported cases in absolute numbers of true positive, false positive, true negative, and false negative results or stated data adequate to derive this information.

The exclusion criteria were as follows:

Normal healthy volunteers or patients with alternative diagnosis as controls.

Included <10 patients and case reports.

Reviews or letters.

Duplicate or self-contradictory reports.

Two reviewers independently scanned the titles and abstracts that met the inclusion criteria. Full copies of all selected articles were retrieved and reviewed by the same 2 reviewers, who independently selected relevant articles. A third author was available to arbitrate final decisions to include or exclude.

2.3. Data extraction

Data were extracted independently by 2 reviewers. Inconsistencies were resolved by discussion and consensus. We extracted year of publication, size, study design (prospective or retrospective), clinical setting, etc. Index test included ST-segment elevation (STE) in III > II, ST-segment depression (STD) in I, STD in aVL, and STD in aVL > I.

2.4. Quality assessment

Two reviewers independently assessed the methodologic quality of full-text studies using a revised tool for the quality assessment of diagnostic accuracy studies (QUADAS-2).[9] The tool was tailored to this study by adding or omitting signaling questions to judge the risk of bias. Disagreements were resolved by consensus or arbitration by a third reviewer.

2.5. Data synthesis and analysis

Extracted data were constructed to create forest plots graphically presenting the sensitivity and specificity values, with corresponding 95% confidence intervals (CIs), for the individual studies. We applied bivariate model[10] to combine estimates of sensitivity. Bivariate summary receiver operating characteristic (sROC) curves were conducted when the test contained 5 or more studies, with summary operating points for sensitivity and specificity on the curves and a 95% confidence contour ellipsoid. Test accuracy of different criteria was also compared through bivariate model. To detect publication bias, we constructed effective sample size funnel plots vs the log diagnostic odds ratio and carried out a regression test of asymmetry ($n > 10$). We quantitatively assessed the presence of between-study heterogeneity with the χ^2-based Q statistic (significant if $P < .1$) and I^2. Heterogeneity where the number of studies for the test was sufficient ($n \geq 10$) was investigated by univariable meta-regression analysis of one or multiple covariables.

Forest plots and bivariate sROC curves were generated by RevMan 5.3 (The Nordic Cochrane Centre, The Cochrane Collaboration, Copenhagen, Denmark). We used the MIDAS and METANDI modules for STATA (version 12; StataCorp, College Station, TX) to produce summary estimates of sensitivity and specificity and their 95% CI, publication bias detection, heterogeneity assessment, and meta-regression analysis.

3. Results

3.1. Flow diagram

The flow diagram of electronic database and hand searching are outlined in Figure 1. After screening titles and abstracts in 474 citations, 80 potentially relevant full-text articles were retrieved. Finally, 24 studies were selected for inclusion in the meta-analysis, and 54 were excluded because of self-contradictory data, not possible to calculate absolute numbers from the presented data, overlapping data, culprit artery only identified by V1-V5, and

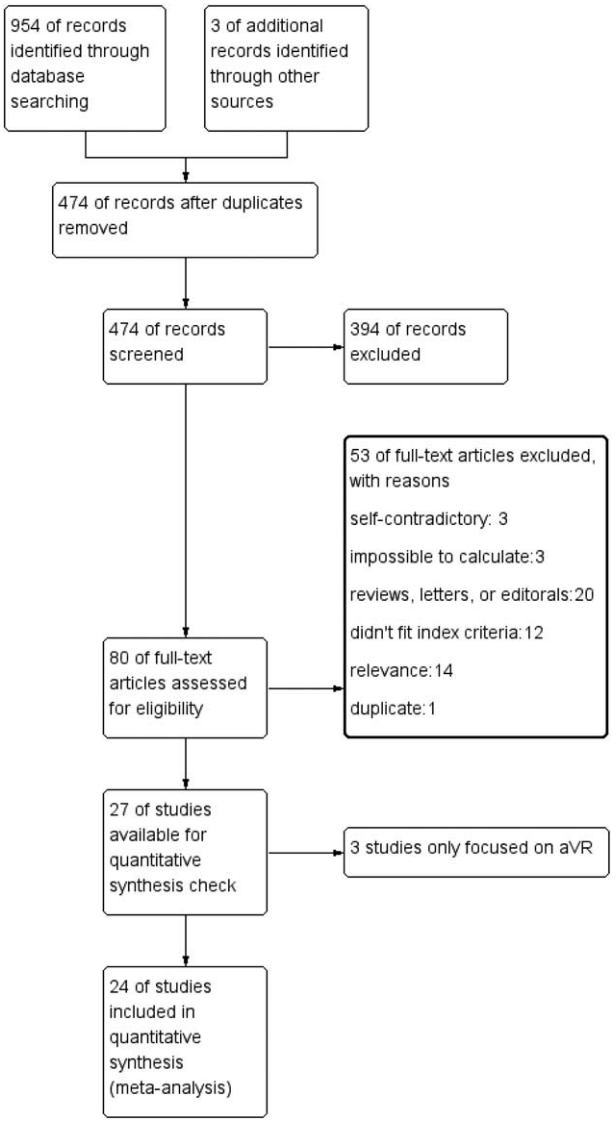

Figure 1. Flow diagram of review process. Search and study selection process for this review.

reviews or letters. Three studies focused on aVR were not included temporarily (aVR was now only for predicting LCX as CCA).

3.2. Characteristics of studies

Two were reported in languages other than English: Chinese and Korean. Table 2 summarized study and population characteristics of the included studies. Data were extracted from 24 studies with a total of 4431 patients for meta-analysis. About 16 studies used a prospective study design, and 8 studies used a retrospective study design. All the studies enrolled patients who met inferior wall STE MI criteria (cutoff value 0.05 or 1 mm), and divided into RCA- or LCX-related infarction groups by angiographic criteria. However, some studies excluded patients with multi-vessel stenosis or infarct-related artery could not be unequivocally determined.

3.3. Quality assessment of studies

The quality assessment of each study (QUADAS-2) was shown in Figure 2 and each domain was summarized in Figure 3. In the patient selection domain, 17 studies had a high risk of bias. For the index test domain, the readers were not clear blinded to the reference test or cutoff level in 12 studies. For the reference standard domain, we discarded 1 signaling question (Is the reference standard likely to correctly classify the target condition?) because all the culprit arteries were confirmed by angiography; 11 studies revealed an unclear risk because the reference standard was interpreted without blinding to the index test. For the flow and timing domain, we removed one question (Did all patients receive the same reference standard?) and modified the signaling question (Were all patients included in the analysis?) to a more specific one (Were patients with stenosis of both RCA and LCX included in the analysis?). Thirteen studies were regarded as high risk. All studies were assigned low concern regarding applicability to our review question, because the samples were all IWMI patients defined by the same electrocardiographic criteria.

3.4. Diagnostic performance and comparison of tests

A forest plot of the study estimates of sensitivity and specificity for each test is shown in Figure 4. The pooled sensitivity and specificity were as follows:

STE in III > II: 0.91 (0.88–0.94) and 0.69 (0.53–0.81).
STD in I: 0.80 (0.73–0.87) and 0.69 (0.62–0.76).
STD in aVL: 0.90 (0.81–0.95) and 0.41 (0.22–0.62).
STD in aVL > I: 0.84 (0.75–0.91) and 0.72 (0.48–0.88)
STE in III > II and STD in aVL > I: 0.79 (0.62–0.90) and 1.00 (0.37–1.00).

Figure 5 depicts the bivariate sROC curves of sensitivity and specificity. The curve of STE in III > II and STD in aVL > I could not be drawn for the small number of studies ($n < 5$). The curves indicated that the accuracy of the 4 tests from high to low was STE in III > II, STD in aVL > I, STD in I and STD in aVL. STD in aVL was not further involved in accuracy comparison due to the low specificity. Table 3 showed that there was statistical significance in expected sensitivity and/or specificity between STE in III > II and STD in I, and further analysis revealed the difference was in sensitivity. The sensitivity also differed between STE in III > II and STD in aVL > I.

3.5. Heterogeneity assessment and investigation

There was heterogeneity between studies in each test (Fig. 4). We added covariates (prospective design, cutoff value, stenosis of both RCA and LCX included, concomitant stenosis of LAD included, size, year, risk of biases) to our bivariate model to explore the source of heterogeneity of STE in III > II, STD in I, and STD in aVL > I. Table 4 showed heterogeneity ($I^2 \geq 50$) focused on covariates of sample size, publication year, cutoff value, whether stenosis of both RCA and LCX patients was included, and risk of biases in patient selection and flow and timing.

3.6. Publication bias

The slope coefficients for Deeks funnel plots (Fig. 6) for detection of STE in III > II ($P = .10$) and STD in I ($P = .21$) suggested symmetry in the data without significant publication bias.

4. Discussion

Identifying the culprit artery from ECG is still an interesting issue in cardiology which has been explored for more than 30 years,

Table 2

Characteristics of included studies.

Author	Year	n	Men	RCA	Age	Prospective design?	Angiography time after admission	Prior MI included?	Index tests and cutoff value	Stenosis of both RCA and LCX included?	Concomitant stenosis of LAD included?	Language
Abdul Ahahs and Al-Jumaily[11]	2011	56	42	46	65±7.2	Yes	<3 mo	No	STE in III>II; STD in aVL>I	No	No	English
Almansori et al[12]	2010	710	539	539	59.7±11.7	No	<150 min	No	STE in III>II; STD in I; STD in aVL>I	UN	UN	English
Assali et al[13]	1999	83	68	66	57.6±12	Yes	UN	No	STD in aVL>1 mm	No	UN	English
Bairey et al[14]	1987	41	37	29	57	No	<12 h	Yes	STD in I and/or aVL≥1 mm	No	Yes	English
Baptista et al[15]	2004	53	38	38	59.1±3.9	No	UN	No	STE in III>II; STD in I and/or aVL	No	Yes	English
Cha et al[16]	1998	85	69	65	58.85±10.06 vs 56.05±7.74	No	During hospitalization	Yes	STD in I and/or aVL≥1 mm	Yes	Yes	Korean
Chia et al[17]	2000	92	77	72	54±9	Yes	During hospitalization	No	STE in III>II; STD in I; STE in III>II and STD in I	No	Yes	English
Chiang et al[18]	2006	40	33	32	63	Yes	During hospitalization	No	STE in III>II; STD in I≥1 mm; STD in aVL≥1 mm;STD in aVL>I; STE in III>II and STD in aVL>I	No	Yes	English
Fiol et al[19]	2004	63	50	50	58±11	No	<12 h	No	STE in III>II; STD in I≥0.5 mm	No	No	English
Hasdai et al[20]	1995	62	UN	46	UN	Yes	During hospitalization	Yes	STD in I≥1 mm;STD in aVL≥1 mm	No	UN	English
Herz et al[21]	1997	83	68	66	57±12	Yes	During hospitalization	No	STE in III>II; STD in I≥1 mm; STD in aVL≥1 mm; STD in aVL>I; STE in III>II and STD in aVL>I	No	Yes	English
Huang et al[22]	2016	194	171	166	59±11	Yes	During hospitalization	No	STE in III>II; STD in I≥0.5 mm; STD in aVL≥0.5mm;STD in aVL>I	Yes	No	English
Jin and Qü[23]	2012	432	320	328	63.45±11.09 vs 59.2±10.51	Yes	<1 wk	No	STE in III>II; STD in I and aVL≥1 mm; STD in aVL>I; STE in III>II and STD in aVL>I	No	No	Chinese
Kabakci et al[24]	2001	149	126	123	55±9	No	<24 h	No	STE in III>II; STD in aVL>I; STE in III>II and STD in aVL>I	No	UN	English
Kanei et al[25]	2010	106	78	86	60±15	Yes	During hospitalization	No	STE in III>II; STD in I≥0.5 mm	Yes	Yes	English
Karbalaie et al[26]	2014	76	61	56	56±10	No	<1 wk	No	STD in I≥0.5 mm	No	No	English
Kontos et al[27]	1997	109	UN	90	UN	Yes	During hospitalization	Yes	STD in I≥0.5 mm; STD in aVL≥0.5 mm	Yes	Yes	English
Nair and Glancy[28]	2002	30	UN	25	UN	Yes	<1 wk	No	STE in III>II; isoelectric or STD in I	UN	UN	English
Sun et al[29]	2007	90	62	70	54.5±10.3	Yes	During hospitalization	No	STE in III>II; STD in aVL>I	No	UN	English
Taglieri et al[30]	2014	365	UN	270	UN	No	70 min, median	Yes	STE in III>II; STD in I	Yes	Yes	English
Verouden et al[31]	2009	1131	810	895	61.1±12.5	Yes	During hospitalization	Yes	STE in III>II; STD in I≥1 mm; STD in aVL≥1 mm; STD in aVL>I; STE in III>II and STD in aVL>I	Yes	Yes	English
Wong et al[32]	2004	177	UN	150	UN	Yes	UN	No	STE in III>II; STD in I	No	Yes	English
Zhan et al[33]	2009	135	84	117	60±12	Yes	<12 h	No	STE in III>II; STD in aVL>I	UN	UN	English
Zimetbaum et al[34]	1998	69	UN	52	UN	Yes	During hospitalization	Yes	STE in III>II	UN	UN	English

LAD = left anterior descending artery, LCX = left circumflex coronary artery, MI = myocardial infarction, RCA = right coronary artery, STD = ST-segment depression, STE = ST-segment elevation, UN = Unclear.

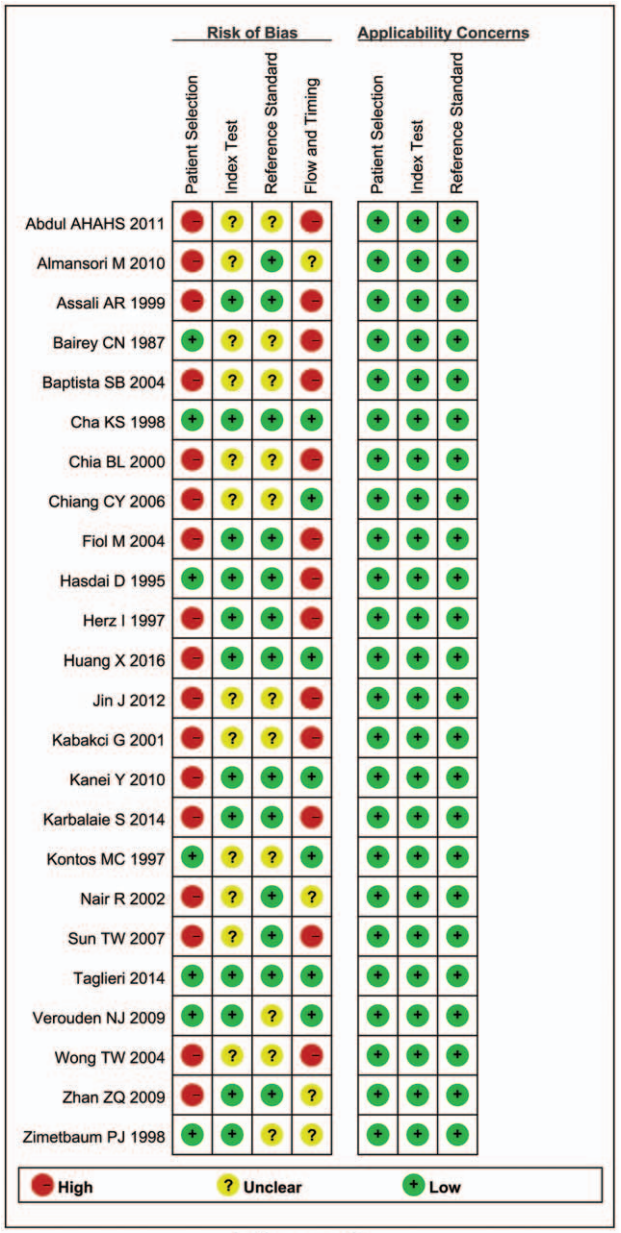

Figure 2

Figure 2. Risk of bias applicability concerns of each study. Green circle = low risk of bias; red circle = high risk of bias; yellow circle = unclear risk of bias.

because the early and accurate identification of CCA on the ECG was helpful for guidance of decisions regarding the urgency of revascularization.[6] There was no better way to identify the CCA so conveniently and early than the ECG before reperfusion therapy. However, the criteria for predicting RCA as CCA were various, and there was no strong evidence on which criteria was better. We ignored the utility of aVR lead, because it was often applied for prediction of LCX as CCA, as well as the limited accuracy.[15] The results showed that the accuracy of these criteria from high to low was: STE in III > II and STD in aVL > I, STE in III > II, STD in aVL > I, STD in I and STD in aVL. We found many more STE in III > II data sources than others: STE in III > II studies (n = 18) were overrepresented. Surprisingly, just using STE in III > II had achieved high accuracy (sensitivity 0.91 [0.88–0.94] and specificity 0.69 [0.53–0.81]) on predicting RCA as CCA. The Cabrera sequence makes it easy to understand these differences in the direction and degree of inferior STE caused by RCA. Because the right inferior myocardium is mainly supplied by RCA blood, when the RCA is occluded, the spatial vector of the ST-segment will be directed, resulting in greater STE in lead III than in lead II.[35] STE in III > II and STD in aVL > I performed best in specificity, but it was not conclusive enough for the small number of studies (n = 4). Previous study reported ST depression occurred more frequently in aVL than in any other lead, so despite poor specificity of STD in aVL (0.41), it was still valuable due to a sensitive early electrocardiographic sign of acute WIMI.[36] Some researchers combined these criteria to establish algorithms[37] to improve the sensitivity and specificity by their own experience. Our meta-analysis provided evidence that STE in III > II (sensitivity: 0.91 and specificity: 0.69) was ideal for the first step to identify RCA as CCA, and if combined STD in aVL > I as next step, the specificity would intend to be improved significantly, which would be a potential and simple algorithm.

A high risk of bias appeared in the patient selection domain (17/24) and flow and timing domain (13/24) due to exclusion prior MI and stenosis of both RCA and LCX. Blinding or not accounted for unclear risk of index test and reference standard domains. These risks lowered the reliability of the results, somehow. The heterogeneity was significant in each criterion of our study ($P < .05$, I^2 values >50% may be considered substantial heterogeneity). Heterogeneity is unavoidable in meta-analysis of diagnostic accuracy studies, because in spite of important early initiatives, the methodology for evaluation of diagnostics is not yet as crystallized as the deeply rooted principles of the randomized controlled trial on therapeutic effectiveness and of etiologic study designs.[38] Diagnostic research appears to be more comprehensive and complex than treatment research as it evaluates the connection between diagnostic and prognostic assessment with choosing optimal

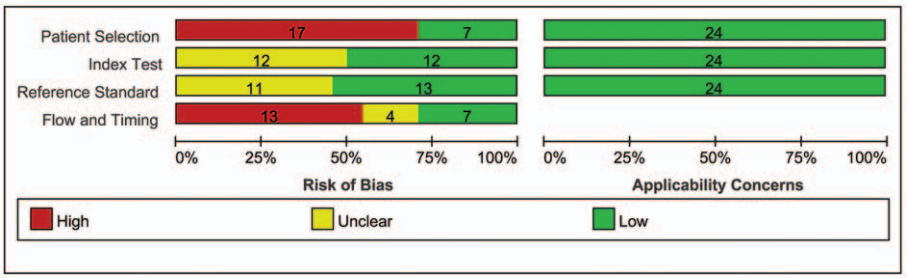

Figure 3. Risk of bias applicability concerns summary of each domain. Methodological quality matters on patient selection and flow and timing.

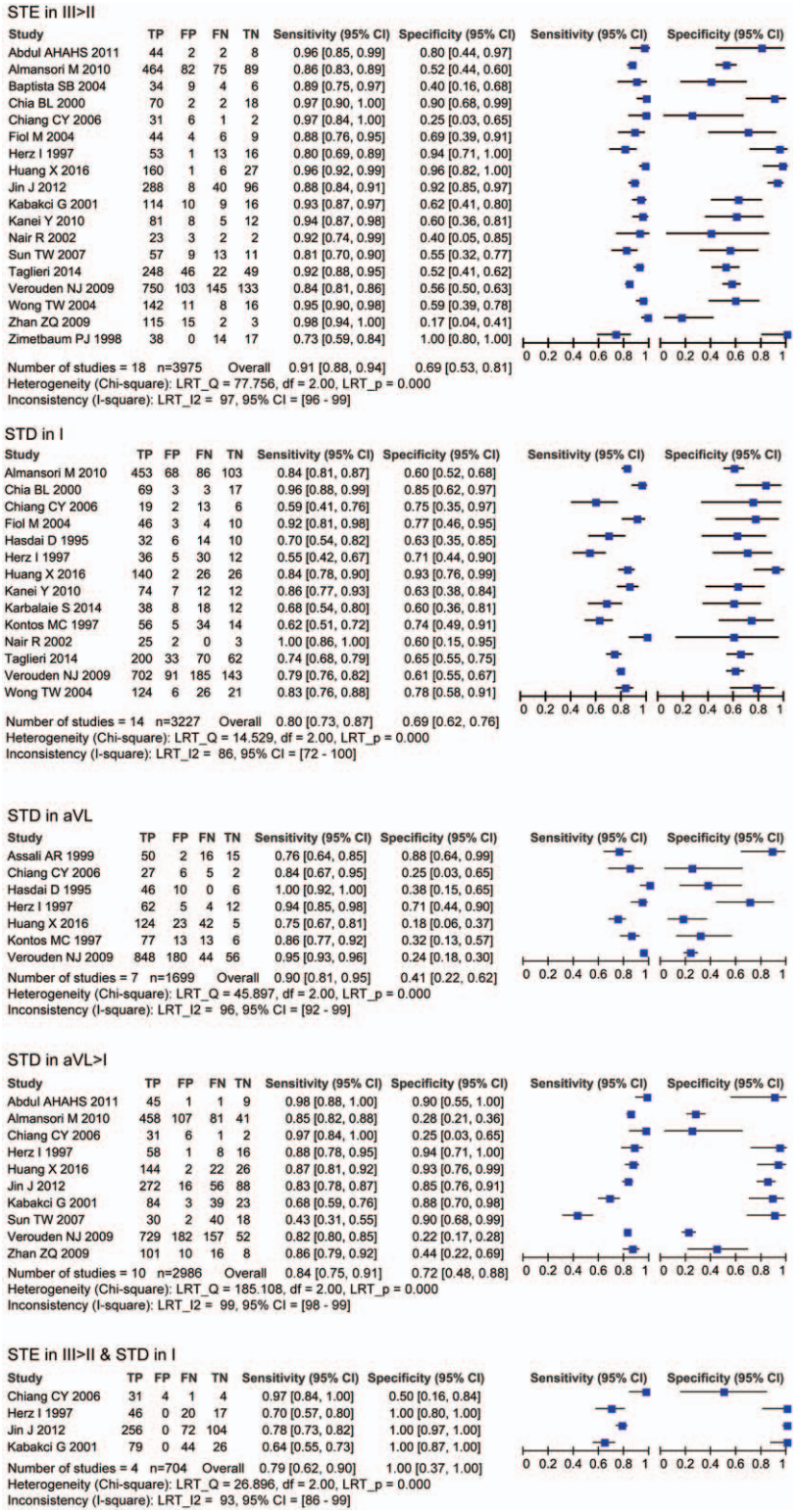

Figure 4. Forest plot of sensitivity and specificity and heterogeneity assessment. The pooled sensitivity and specificity for STE in III > II, STD in I, STD in aVL, STD in aVL > I, STE in III > II, and STD in aVL>I. Cochran *Q* and I^2 statistics for included studies suggested a high level of statistical heterogeneity. Solid squares = point estimate of each study (area indicates relative contribution of the study to meta-analysis); horizontal lines = 95% confidence interval (CI).

interventions.[39] In our study, risk of biases in patient selection, flow and timing and sample size were the main sources of heterogeneity, which also proved the methodological arbitrariness. Not all studies explicitly stated whether they were performed in a prospective design, so we regarded implicitly described studies as prospective ones to include as many prospective studies as possible without introducing additional bias, and prospective or retrospective did not cause the heterogeneity. The definition of AMI and the timing of ECG and angiogram recording after the onset varied from 1980s to last

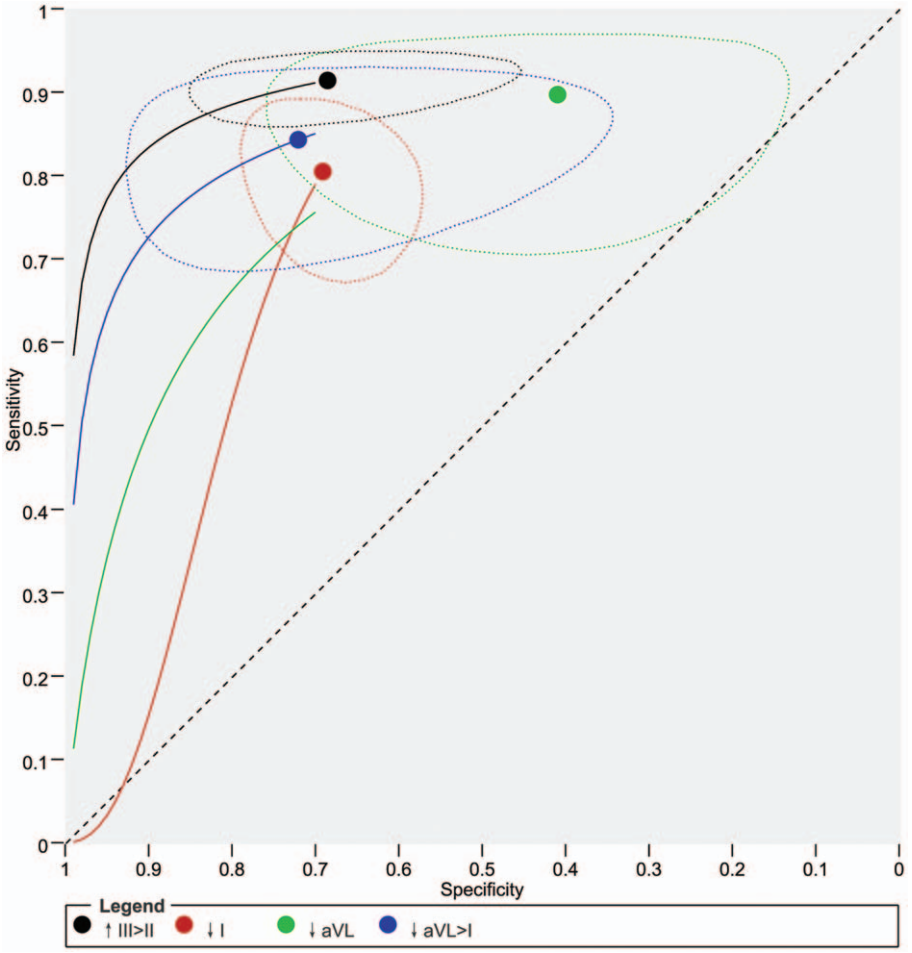

Figure 5. Bivariate summary receiver operating characteristic curves for tests. ↑III > II = STE in III > II; ↓I = STD in I; ↓aVL > I = STD in aVL > I; Circle dot on the curve = a summary operating point for sensitivity and specificity; Dashed area = a 95% confidence region.

year. Thus, publication year in meta-regression helped to compare data from studies using primary percutaneous coronary intervention (PCI) vs older studies that used more delayed angiography, and it revealed obvious heterogeneity on STD in aVL ($I^2 = 68$). Besides, the ability to identify either RCA or LCX as CCA in IWMI was affected by the potential factor of RCA dominance or non-dominant RCA, and patients with non-dominant RCA were more likely to be misdiagnosed,[30] because an acute occlusion of a dominant RCA will usually result in a larger area of myocardium at risk and a subsequent higher sensitivity of the ECG criteria.[31]

The CAG was recognized as the gold standard for the diagnosis of coronary artery disease (CAD), and previous meta-analysis for diagnosing coronary artery lesions also used CAG as reference standard.[40,41] Most of original studies described the CAG criteria for identifying the culprit artery, such as total or subtotal occlusion of 1 artery supplying the area of asynergy as seen on left ventriculography, or arteriographic features suggestive of acute thrombus or a ruptured plaque, but smaller infarct size induced by LCX and distal RCA occlusion[42] or artery spasm[43] might cause acute MI with angiographically normal coronary arteries, though the ECG showed signs of acute MI. Therefore, ECG could not only diagnose acute MI at early stage, but also helps physicians to recognize the CCA during CAG. For example, a concomitant distal RCA occlusion mistaken as the normal small RCA could be easily distinguished from ECG criteria. Identifying the "culprit" is so important because high-grade evidence showed that it is not recommended to perform PCI for non-culprit vessels in patients.[44,45] It was difficult for discrimination between prior and new in multi-vessel diseased patients. The equivocal judgment did not only lead to falsely intervening on a chronic lesion but also resulting in the acute occlusion being ignored.[28] Some new technologies were thought to be better than CAG to identify the CCA to make the right decision of intervention, for example, intravascular ultrasound (IVUS)[46] and fractional flow reserve (FFR).[47] Nevertheless, IVUS or FFR was not widely applied in most hospitals, and only ECG could compensate for some of the shortcomings of CAG.

Sohrabi et al reported that patients with ECG finding in favor of LCX occlusion should be considered as high risk,[48] and another study showed the 30-day prognostic outcome was less

Table 3

Test accuracy comparison.

Test	Overall		Sensitivity		Specificity	
	LR χ^2	*P*	LR χ^2	*P*	LR χ^2	*P*
↑III > II vs ↓ I	9.62	.008*	9.61	.002*	0.26	.608
↑III > II vs ↓aVL > I	4.61	.100	4.46	.035*	0.04	.838
↓ I vs ↓aVL > I	0.50	.780	0.48	.488	0.03	.856

↑III > II = STE in III > II, ↓ I = STD in I, ↓aVL > I = STD in aVL > I.
* Statistical significance $P < .05$.

Table 4

Meta-regression to investigate sources of heterogeneity.

	STE in III > II			STD in I			STD in aVL			STD in aVL > I		
Parameter	χ^2	*P*	$\hat{I}^2$	χ^2	*P*	$\hat{I}^2$	χ^2	*P*	$\hat{I}^2$	χ^2	*P*	$\hat{I}^2$
Prospective	2.49	.29	20	1.98	.37	0	1.68	.49	0	1.07	.59	0
Size	3.16	.21	37	5.00	.08	60*	1.74	.42	0	5.81	.05	66*
Year	1.82	.40	0	0.42	.81	0	6.29	.04	68*	0.44	.80	0
Cutoff Value	–	–	–	3.95	.14	49	6.15	.05	67*	–	–	–
Both	1.21	.55	0	2.01	.37	0	5.84	.05	66*	0.57	.75	0
LAD	0.83	.66	0	1.75	.42	0	1.82	.40	0	3.24	.20	38
Selection	3.54	.17	43	2.95	.23	32	4.88	.09	59*	3.21	.20	38
Index	0.70	.70	0	0.81	.67	0	1.24	.54	0	0.15	.93	0
Reference	0.39	.82	0	0.34	.85	0	2.06	.36	3	0.66	.72	0
Flow and timing	0.73	.70	0	3.71	.16	46	12.21	.00	84*	0.33	.85	0

Both = stenosis of both RCA and LCX included, Cutoff value = cutoff value defined or not, Flow and timing = flow and timing bias, Index = index bias, LAD = concomitant stenosis of LAD included, Prospective = perspective design or not, Reference = reference bias, Selection = selection bias, Size = sample size, STD = ST-segment depression, STE = ST-segment elevation, Year = publication year.
* $\hat{I}^2 > 50\%$.

favorable in LCX-related IWMI compared with RCA-related IWMI undergoing primary PCI.[49] However, in 80% of IWMI cases the infarct related artery is RCA, and proximal RCA occlusion is likely to suffer right ventricle infarction and cardiac shock.[4] We are planning to perform another complicated meta-analysis concerning coronary artery occlusion location and prognosis with sub-group analysis. The ECG would truly guide the decisions regarding the urgency of revascularization and reperfusion strategy in emergent management by predicting prognosis.

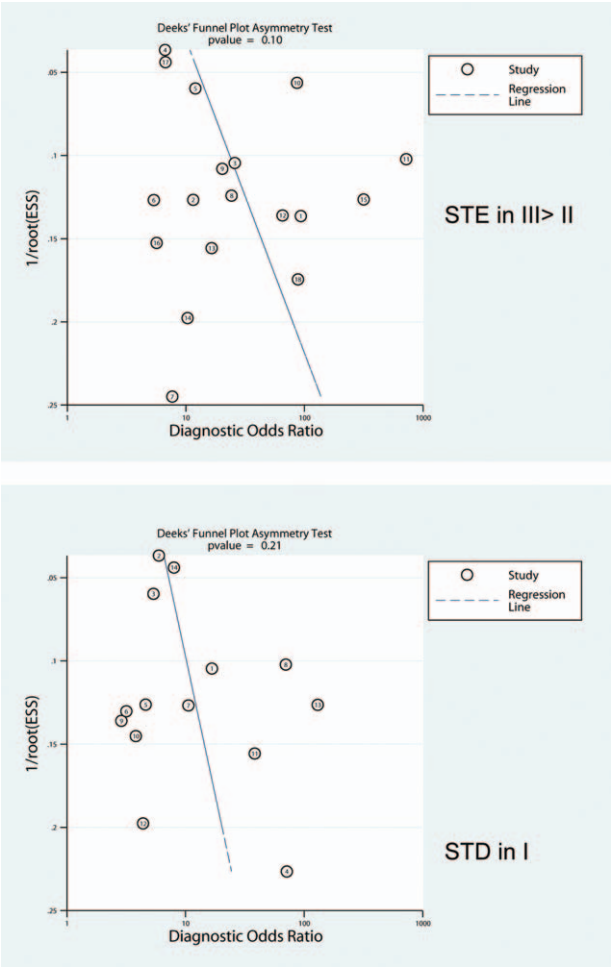

Figure 6. Funnel plots along with Egger tests for publication bias. Funnel plots and Egger test of STE in III > II and STD in I suggested a low level of bias.

4.1. Limitations

There were some limitations. First, the specificity of the ECG in acute MI is affected by the presence of preexisting CAD, particularly in patients with a previous MI, collateral circulation, or previous coronary-artery bypass surgery. That is why lots of studies excluded the patients with previous MI, stenosis of both RCA and LCX, and concomitant stenosis of LAD. Moreover, site of proximal or distal culprit lesion, left coronary artery dominance were associated with failure to predict the culprit artery of IWMI.[50] The mechanism of different manifestation of electrocardiographic changes in different CCA is still controversial.

Second, the rarely used ECG criteria for prediction reported by individual studies, such as arithmetic score by taking into account more leads[51] and notably R/S ratio in aVL[13] could not be involve in meta-analysis. There is no sign yet that their test accuracy would be better than STE in III > II.

Third, to improve diagnostic accuracy for differentiation between RCA and LCX occlusion, some algorithms have been created based on self-observation or individual experience. Algorithm-based ECG criteria could improve the accuracy by steps and combination, but meta-analysis is unavailable for the limited number of studies. Moreover, the absolute numbers of each step could not be extracted from these studies, and the results were unable to pool into the meta-analysis.

Fourth, it is not clear that STE in III > II 0.91 (0.88–0.94) and 0.69 (0.53–0.81) was worse than STE in III > II and STD in aVL > I 0.79 (0.62–0.90) and 1.00. It is a tradeoff between reduced sensitivity and increased specificity so perhaps a ROC curve would help but the curve of STE in III > II and STD in aVL > I could not be drawn for the small number of studies (n < 5).

5. Conclusion

Our study confirmed the value of ECG on identifying CCA in IWMI. STE in III > II was superior to other lead ST-segment deviation criteria for predicting RCA as CCA in IWMI. STE in III > II and STD in aVL > I was a potential and simple algorithm for the prediction. Multi-vessel diseased arteries, publication

year, and sample size could affect the performance of ECG criteria. ECG could be an effective tool to identify the "culprit," but future studies are clearly needed to address the potential of diagnostic and prognostic value for IWMI from ECG.

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