Systematic Review and Meta-Analysis

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Diagnostic value of magnetic resonance versus computed tomography colonography for colorectal cancer

A PRISMA-compliant systematic review and meta-analysis

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Abstract

Background: Advanced colorectal cancers were associated with poor prognosis, and early diagnosis was important for high-risk patients. Colonography is commonly used for diagnosing colorectal cancer. However, a few studies reported the diagnostic value of magnetic resonance colonography (MRC) versus computed tomography colonography (CTC). This study aimed to compare the diagnostic value of MRC versus CTC for colorectal cancer.

Methods: Twenty-three studies on the diagnosis of colorectal cancer using MRC or CTC were obtained from PubMed, Embase, and the Cochrane Library databases until July 2017. The ratios of sensitivity, specificity, positive likelihood ratio (PLR), negative likelihood ratio (NLR), and receiver operating characteristic (ROC) curve were calculated to compare the diagnostic value of MRC versus CTC.

Results: The summary sensitivity, specificity, PLR, NLR, and area under the ROC for MRC were 0.97 (0.81–1.00), 0.92 (0.80–0.97), 11.71 (4.46–30.73), 0.03 (0.00–0.24), and 0.98 (0.97–0.99), respectively, for diagnosing colorectal cancer. The pooled estimates for CTC in diagnosing colorectal cancer were as follows: sensitivity, 0.96 (0.90–0.98); specificity, 1.00 (0.99–1.00); PLR, 197.32 (73.21–531.85); NLR, 0.04 (0.02–0.11); and area under the ROC, 1.00 (0.99–1.00). No significant differences were found between MRC and CTC for sensitivity, specificity, and NLR. MRC was associated with lower PLR and area under the ROC for diagnosing colorectal cancer compared with CTC.

Conclusion: This study demonstrated MRC and CTC as potential diagnostic approaches for colorectal cancer. CTC had a higher diagnostic value of PLR and area under the ROC for colorectal cancer.

Abbreviations: AUC = area under the curve, CIs = confidence intervals, CT = computed tomography, CTC = computed tomography colonography, MR = magnetic resonance, MRC = magnetic resonance colonography, NLR = negative likelihood ratio, PLR = positive likelihood ratio, PRISMA = Preferred Reporting Items for Systematic reviews and Meta-Analyses, QUADAS = Quality Assessment of Diagnostic Accuracy Studies, ROC = receiver operating characteristic.

Keywords: colorectal neoplasms, computed tomography colonography, diagnosis, magnetic resonance imaging, meta-analysis

1. Introduction

Colorectal cancer is the most common gastrointestinal malignancy and the second cause of cancer-related deaths, accounting for around 40,340 new cases in the United States in 2013.[1] Early detection and removal of polyps before malignant transformation could reduce the incidence of colorectal cancer, determine the treatment strategy, and improve the quality of life.[2–4] Colonography is widely recognized as a reliable method for colorectal cancer diagnosis to distinguish colorectal lesions. However, it is still associated with several limitations. First, observer error and polyp in a blind area might cause inaccuracy in detecting diminutive lesions. Second, the application of colonoscopy is not suitable for obstructing colonic lesions. Finally, a traditional colonoscopy is invasive and uncomfortable for diagnosing colorectal cancer.

Currently, magnetic resonance (MR) and computed tomography (CT) colonography, noninvasive methods based on cross-sectional imaging, are recommended for diagnosing colorectal cancer.[5,6] Although the findings of MR colonography (MRC) and CT colonography (CTC) were associated with a higher

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SS and CY contributed equally to this work.

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diagnostic value for colorectal cancer, the impact of ionizing radiation burden was not neglected.[7,8] However, the ratio between MRC and CTC for diagnosing colorectal cancer was not calculated. Further, the diagnostic value for colorectal cancer was not compared within groups of patients categorized by potential confounders. Numerous recent studies have explored the diagnostic value of MRC versus CTC for colorectal cancer. In this study, a meta-analysis was performed to evaluate the diagnostic value of MRC and CTC for colorectal cancer and compare these diagnostic values among studies or patients with different characteristics.

2. Methods

2.1. Data sources, search strategy, and selection criteria

The present study was performed in accordance with the guidelines for the Preferred Reporting Items for Systematic reviews and Meta-Analyses.[9] Ethics approval was not necessary for this study because only de-identified pooled data from individual studies were analyzed. Electronic databases PubMed, Embase, and the Cochrane Library were searched through July 2017 to identify studies on MRC or CTC in diagnosing colorectal cancer. The following core search terms were used: CTC, MRC, virtual colonoscopy, and colorectal cancer. The additional publications in reference lists and citation sections of recovered articles were also searched. Letters, abstracts, and conference proceedings were excluded due to discrepancies common between meeting abstract results and final publication results. Publication languages were limited to English.

The inclusion criteria were as follows: the study had to have a prospective design; the study used MRC or CTC; the study should have regarded conventional colonoscopy with biopsy as the golden standard; participants included in the study had a high risk of colorectal cancer; and the study provided true-positive, false-positive, false-negative, and true-negative results. The literature search and study selection were independently undertaken by 2 authors, and any inconsistencies were resolved by group discussion.

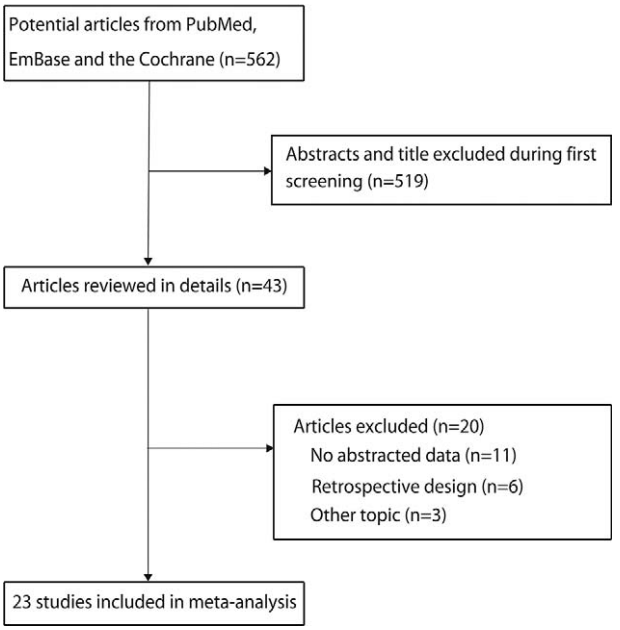

Figure 1. Flow chart of study selection process.

2.2. Data collection and quality assessment

Two authors first reviewed the abstract independently and then summarized the full selected studies. Any inconsistencies were settled by group discussion until a consensus was reached. The

Table 1

Characteristics of the studies included in the meta-analysis.

Author	Year	Country	N	Mean age, y	Percentage of males	Imaging modality	Gold standard	True positive	False positive	True negative	False negative
Ajaj et al[18]	2003	Germany	120	60.2	46.7	MRC	Biopsy	11	2	107	0
Pappalardo et al [19]	2000	Italy	70	59.0	60.0	MRC	Biopsy	53	2	14	1
Lauenstein et al [20]	2002	Germany	24	57.0	50.0	MRC	Biopsy	13	2	9	0
Lauenstein et al [21]	2001	Germany	12	NA	NA	MRC	Biopsy	4	0	2	0
Luboldt et al [22]	2001	Germany	17	66.0	64.7	MRC	Biopsy	12	2	3	0
Leung et al [23]	2003	China	156	55.2	47.4	MRC	Biopsy	3	32	118	3
Ajaj et al [24]	2004	Germany	55	59.0	54.5	MRC	Biopsy	8	1	46	0
Cotton et al [25]	2004	USA	600	61.0	45.0	CTC	Biopsy	6	2	592	0
Laghi et al [26]	2002	Italy	165	62.0	47.9	CTC	Biopsy	30	0	135	0
Wong et al [27]	2002	USA	71	62.0	53.5	CTC	Biopsy	5	0	66	0
Spinzi et al [28]	2001	Italy	96	NA	NA	CTC	Biopsy	7	1	88	0
Fenlon et al [29]	1999	USA	100	62.0	60.0	CTC	Biopsy	3	0	97	0
Taylor et al [30]	2003	UK	54	69.0	40.7	CTC	Biopsy	5	1	48	0
Miao et al [31]	2000	UK	201	71.0	41.3	CTC	Biopsy	13	0	186	2
Yee et al [32]	2001	USA	300	62.6	97.0	CTC	Biopsy	8	0	292	0
Hoppe et al [33]	2004	Switzerland	100	66.0	62.0	CTC	Biopsy	7	1	92	0
Morrin et al [34]	2000	USA	34	64.2	58.8	CTC	Biopsy	16	0	16	2
Munikrishnan et al [35]	2003	UK	80	68.0	56.3	CTC	Biopsy	28	1	50	1
Chung et al [36]	2005	Korea	51	63.0	62.7	CTC	Biopsy	20	0	31	0
MACS group [37]	2006	Australia	38	NA	NA	CTC	Biopsy	10	1	27	0
von Atzingen et al [38]	2014	Brazil	85	61.0	37.6	CTC	Biopsy	13	0	71	1
Sali et al [39]	2010	Italy	49	60.5	61.2	CTC	Biopsy	20	2	14	13
White et al [40]	2009	USA	150	60.9	48.7	CTC	Biopsy	17	2	130	1

CTC = computed tomography colonography, MRC = magnetic resonance colonography.

Table 2

Quality evaluation of the included studies using the QUADAS tool.

	Question about study design characteristics													
Study	Representative patient spectrum	Reporting of selection criteria	Reference standard	Absence of disease progression bias	Absence of partial verification bias	Absence of differential verification bias	Absence of incorporation bias	Description of index text execution	Description of reference standard execution	Reference standard blinded	Index test blinded	Absence of clinical review bias	Reporting of uninterpretable/ intermediate results	Withdrawal
Ajaj et al [18]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Pappalardo et al [19]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Lauenstein et al [20]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Lauenstein et al [21]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Luboldt et al [22]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Leung et al [23]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Ajaj et al [24]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Cotton et al [25]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Laghi et al [26]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Wong et al [27]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Spinzi et al [28]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Fenlon et al [29]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Taylor et al [30]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Miao et al [31]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Yee et al [32]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Hoppe et al [33]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Morrin et al [34]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Munikrishnan et al [35]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Chung et al [36]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
MACS group [37]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
von Atzingen et al [38]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Sali et al [39]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
White et al [40]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

QUADAS = Quality Assessment of Diagnostic Accuracy Studies.

relevant data abstracted were as follows: first author, publication years, country, sample size, mean age, percentage male, imaging modality, and true and false positive and negative. Quality Assessment of Diagnostic Accuracy Studies (QUADAS)[10,11] was used to evaluate the quality of the studies included in this meta-analysis independently by the 2 authors. Each of the assessment had 7 items and response as "yes," "no," or "unclear." The answer of "yes" meant that a study's risk bias could be judged as low, whereas "no" and "unclear" meant that the risk of bias could be judged as high.

2.3. Statistical analysis

The sensitivity, specificity, positive likelihood ratio (PLR), negative likelihood ratio (NLR), and corresponding 95%

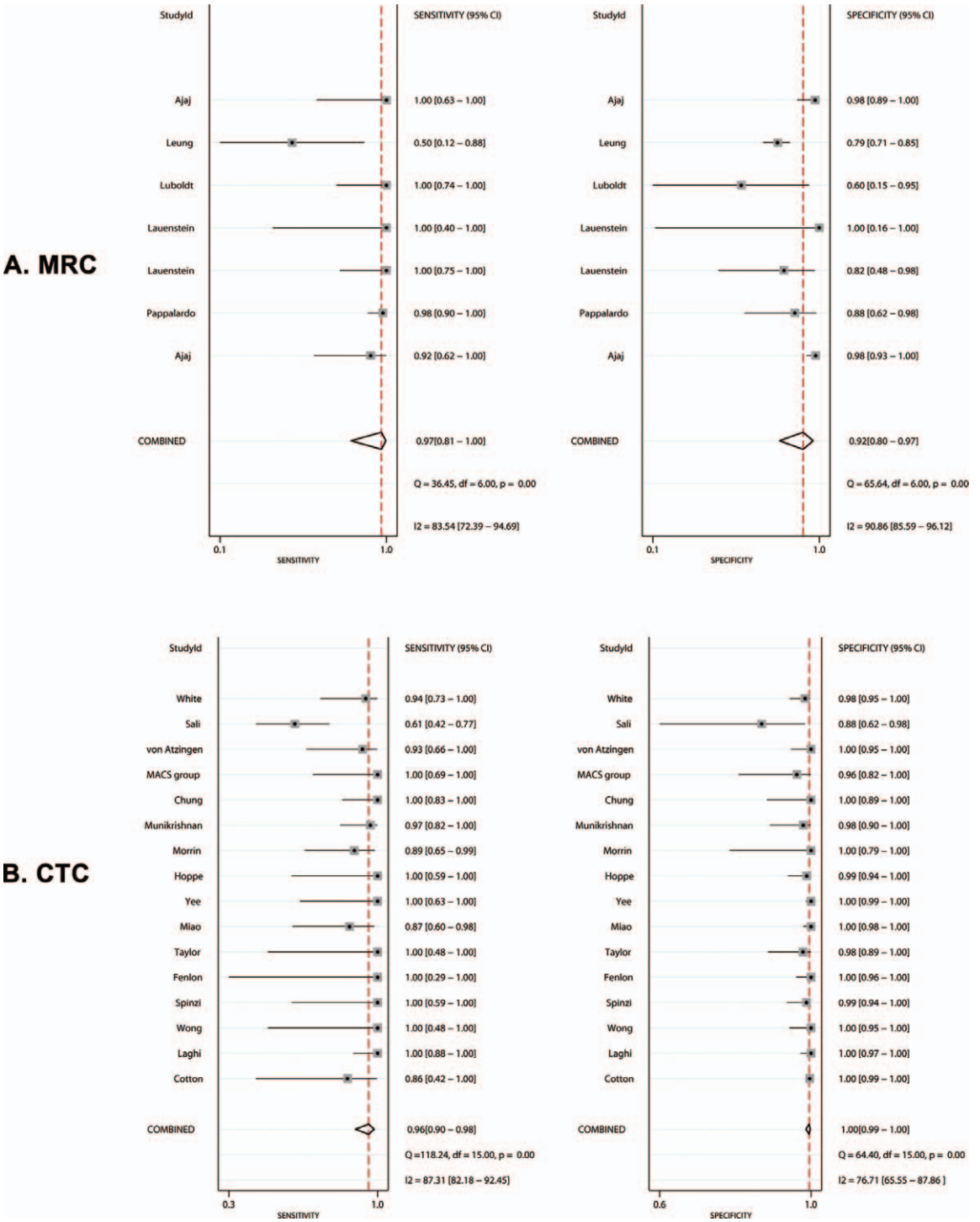

Figure 2. Forest plots showing sensitivity and specificity for the diagnosis of colorectal cancer. (A) Magnetic resonance colonography (MRC); (B) computed tomography colonography (CTC). Each solid square represents an individual study. Horizontal solid lines passing through solid squares represent 95% CI. Diamond indicates the pooled sensitivity and specificity for all of the studies.

confidence intervals (95% CIs) were calculated from true-positive, false-positive, false-negative, and true-negative results, which were extracted from each study before data pooling. The bivariate random-effects model [12] was used to summarize the sensitivity, specificity, PLR, and NLR, and the hierarchical regression model was used to summarize receiver operating characteristic (ROC) curve and the area under the curve (AUC).[13] Q statistic was used to estimate the heterogeneity of individual studies contributing to the pooled estimate. A P value $>.10$ indicated no significant heterogeneity, whereas a P value $\leq .10$ indicated significant heterogeneity for the Q statistic.[14,15] Subgroup analyses were conducted for the sensitivity, specificity,

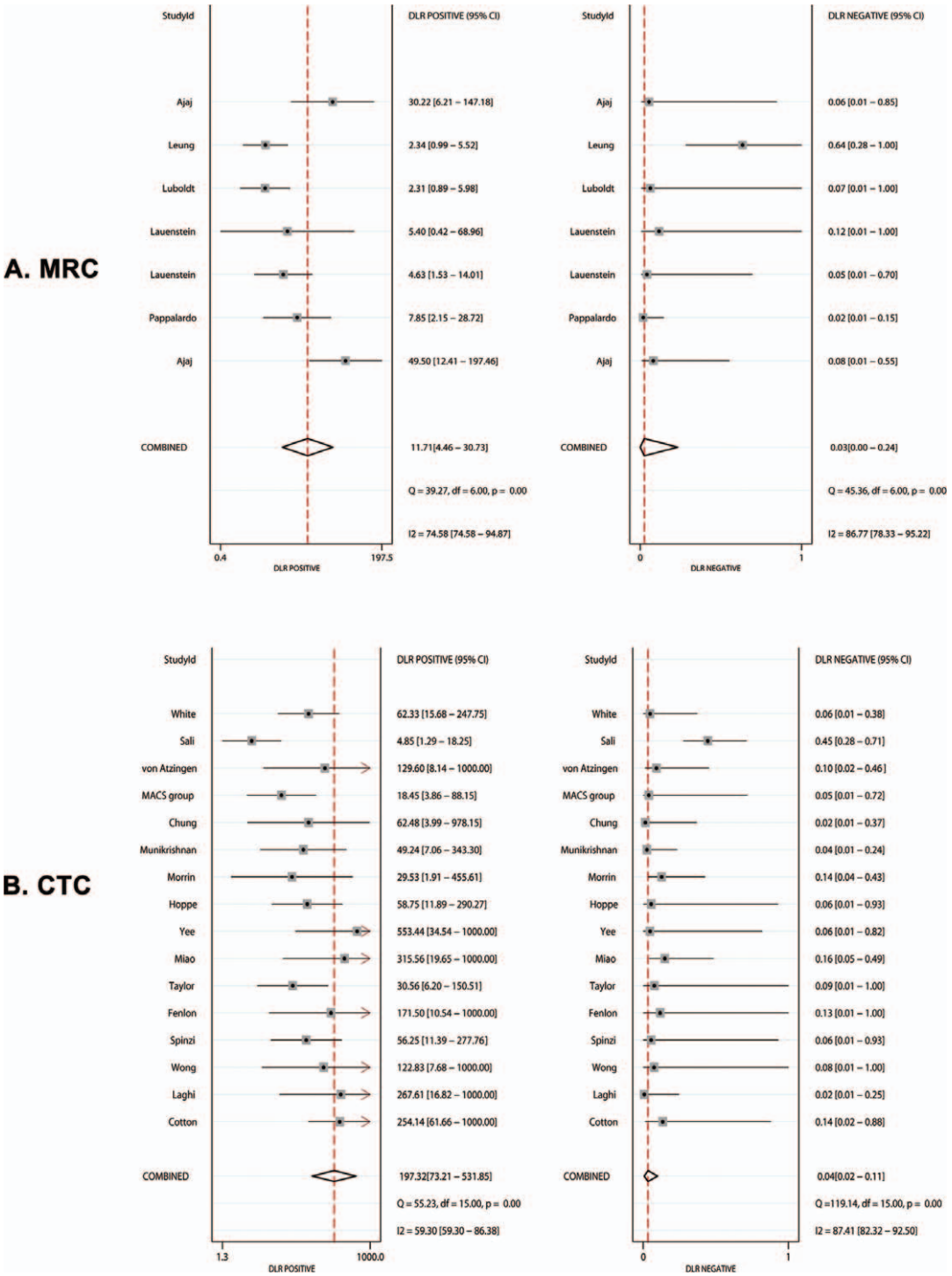

Figure 3. Forest plots showing positive likelihood ratio (PLR) and negative likelihood ratio (NLR) for the diagnosis of colorectal cancer. (A) Magnetic resonance colonography (MRC); (B) computed tomography colonography (CTC). Each solid square represents an individual study. Horizontal solid lines passing through solid squares represent 95% CI. Diamond indicates the pooled sensitivity and specificity for all of the studies.

PLR, NLR, and AUC on the basis of sample size, mean age, and percentage of males. The ratios of summary sensitivity, specificity, PLR, NLR, and AUC and the corresponding 95% CIs were estimated according to specific summary effect estimates and 95% CIs after considering the sample size, mean age, and percentage of males.[16] Visual inspections of funnel plots were performed using Deeks' asymmetry test for MRC and CTC.[17] All reported *P* values were 2-sided, and *P* values <.05 were considered statistically significant for all included studies. Statistical analyses were performed using Stata software (version 10.0; Stata Corporation, TX).

3. Results

The results of the study selection process are shown in Fig. 1. The initial electronic search identified 562 studies; of these, 519 studies that were duplicate and irrelevant were excluded. A total of 43 potentially eligible studies were selected. After reviewing the full text of each study and browsing the results, 20 studies that did not meet the inclusion criteria were eliminated. Finally, 23 prospective studies with a total of 2628 patients were included in this systematic review and meta-analysis.[18–40] The characteristics of each study are presented in Table 1. A total of 7 studies reported the diagnostic value of MRC,[18–24] and 16 studies reported the diagnostic value of CTC.[25–40] The QUADAS quality assessment of the individual study is presented in Table 2.

A total of 7 studies evaluated the diagnostic accuracy of MRC for colorectal cancer. The summary results showed that sensitivity was 0.97 (0.81–1.00; Fig. 2A), specificity was 0.92 (0.80–0.97; Fig. 2A), PLR was 11.71 (4.46–30.73; Fig. 3A), and NLR was 0.03 (0.00–0.24; Fig. 3A). The summary ROC curve was also calculated, and the AUC was 0.98 (0.97–0.99; Fig. 4A). Similarly, 16 studies reported the diagnostic value of CTC for colorectal cancer. The pooled sensitivity was 0.96 (0.90–0.98; Fig. 2B), specificity was 1.00 (0.99–1.00; Fig. 2B), PLR was 197.32 (73.21–531.85; Fig. 3B), NLR was 0.04 (0.02–0.11; Fig. 3B), and AUC was 1.00 (0.99–1.00; Fig. 4B). Further, no significant differences were found between MRC and CTC for the outcomes of sensitivity (ratio of sensitivity: 1.01; 95% CI: 0.90–1.13; *P* = .858), specificity (ratio of specificity: 0.92; 95% CI: 0.84–1.01; *P* = .094), and NLR (ratio of NLR: 0.75; 95% CI: 0.04–13.23; *P* = .844). The ratio of PLR for diagnosing colorectal cancer when comparing MRC and CTC significantly reduced (ratio of PLR: 0.06; 95% CI: 0.02–0.24; *P* < .001). Also, the ratio of area under the ROC for diagnosing colorectal cancer (MRC vs CTC) significantly reduced (ratio of area under the ROC: 0.98; 95% CI: 0.97–0.99; *P* = .001).

Four potential confounders, including sample size, mean age, and percentage of males, were stratified in the subgroup analysis of sensitivity, specificity, PLR, NLR, and AUC for colorectal cancer. The results are presented in Table 3. The difference in PLR for diagnosing colorectal cancer between MRC and CTC was prominent if the sample size was less than 100 [0.13 (0.03–0.61)], mean age less than 65.0 years [0.03 (0.00–0.35)], and percentage of males greater than 50% [0.04 (0.00–0.36)]. No other significant differences were found in sensitivity, specificity, PLR, NLR, and area under the ROC.

Publication bias was also calculated according to Deeks' asymmetry test. The findings of Deeks' asymmetry test suggested no evidence of publication bias for MRC or CTC for diagnosing colorectal cancer (*P* value for MRC: .170; *P* value for CTC: .130; Fig. 5).

4. Discussion

This study evaluated the diagnostic value of MRC and CTC for diagnosing colorectal cancer. Most of the included studies had high methodological quality. The findings indicated that both MRC and CTC had high pooled sensitivity, specificity, PLR, NLR, and area under the ROC for diagnosing colorectal cancer. Further, CTC was found to be superior to MRC for detecting colorectal cancer in terms of PLR and area under the ROC. This higher diagnostic value was mainly related to study sample size less than 100, mean age less than 65.0 years, and percentage of males greater than 50%.

A previous meta-analysis indicated that the pooled sensitivity of MRC in diagnosing colorectal cancer was 0.91 (95% CI: 0.79–0.97), the pooled specificity was 0.98 (95% CI: 0.96–0.99), the pooled diagnostic odds ratio was 576.41 (95% CI: 135.00–2448.56), and the area under the ROC was 0.98. Further, the summary sensitivity of CTC was 0.96 (0.92–0.99), the specificity was 1.00 (0.99–1.00), the diagnostic odds ratio was 1461.90 (544.89–3922.30), and the area under the ROC was 0.99. These findings suggested that the diagnostic accuracy of MRC and CTC was high.[41] The inherent limitation of the previous meta-analysis was that the diagnostic value of MRC and CTC in a specific subpopulation was not available, and hence the ratio of effect estimate between MRC and CTC according to potential confounders remained controversial. Therefore, the present systematic review and meta-analysis was performed to evaluate the diagnostic value of MRC and CTC in diagnosing colorectal cancer and the diagnostic accuracy in a specific subpopulation.

Most of the included studies also suggested that the diagnostic value of MRC was appropriate. Ajaj et al[18] suggested that MRC had a higher accuracy for detecting colonic lesions greater than

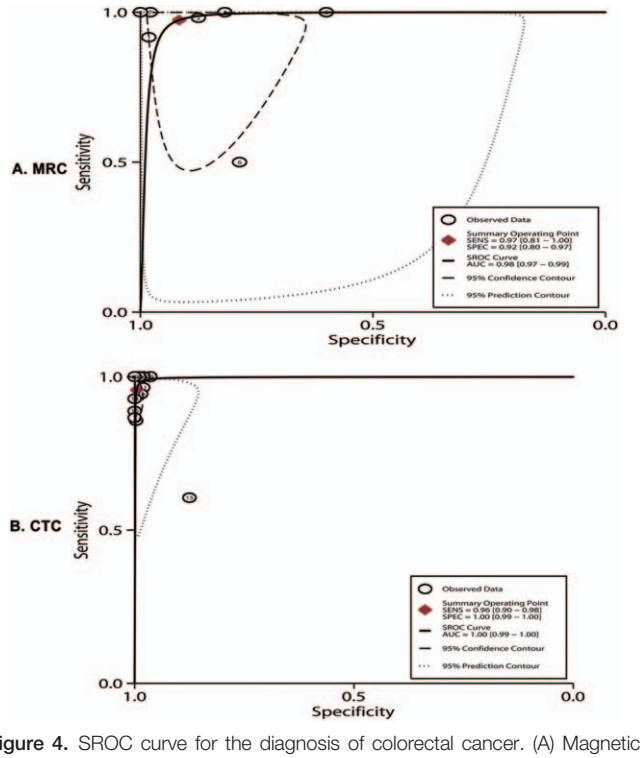

Figure 4. SROC curve for the diagnosis of colorectal cancer. (A) Magnetic resonance colonography (MRC); (B) computed tomography colonography (CTC). Each ellipse represents individual study estimates. The diamond is the summary point representing the average sensitivity and specificity estimates. The ellipses around this summary point are the 95% confidence region (dashed line) and the 95% prediction region (dotted line).

Table 3

Subgroup analysis.

Outcomes	Variable	Subgroups	Diagnostic tool	Number of studies	Effect estimate and 95% CI	*P* for heterogeneity	Ratio between MRC and CTC
Sensitivity	Sample size	≥100	MRC	2	–	–	–
			CTC	7	0.96 (0.87–0.99)	.36	
		<100	MRC	5	0.99 (0.93–1.00)	.91	1.03 (0.94–1.13)
			CTC	9	0.96 (0.84–0.99)	<.01	
	Mean age, y	≥65.0	MRC	1	–	–	–
			CTC	4	–	–	
		<65.0	MRC	5	0.96 (0.76–0.99)	<.01	1.02 (0.88–1.19)
			CTC	10	0.94 (0.84–0.98)	<.01	
	Percentage of males (%)	≥50.0	MRC	4	0.99 (0.92–1.00)	.82	1.06 (0.96–1.18)
			CTC	8	0.93 (0.81–0.98)	<.01	
		<50.0	MRC	2	–	–	–
			CTC	6	0.94 (0.87–0.98)	.44	
Specificity	Sample size	≥100	MRC	2	–	–	–
			CTC	7	1.00 (0.99–1.00)	.13	
		<100	MRC	5	0.90 (0.74–0.97)	.05	0.91 (0.79–1.04)
			CTC	9	0.99 (0.96–1.00)	<.01	
	Mean age, y	≥65.0	MRC	1	–	–	–
			CTC	4	–	–	
		<65.0	MRC	5	0.93 (0.83–0.98)	<.01	0.93 (0.86–1.01)
			CTC	10	1.00 (0.98–1.00)	<.01	
	Percentage of males (%)	≥50.0	MRC	4	0.89 (0.71–0.97)	.03	0.89 (0.76–1.04)
			CTC	8	1.00 (0.97–1.00)	<.01	
		<50.0	MRC	2	–	–	–
			CTC	6	1.00 (0.99–1.00)	.13	
PLR	Sample size	≥100	MRC	2	–	–	–
			CTC	7	296.17 (115.06–762.34)	.15	
		<100	MRC	5	9.87 (3.51–27.76)	.01	0.13 (0.03–0.61)
			CTC	9	76.42 (23.90–244.40)	<.01	
	Mean age, y	≥65.0	MRC	1	–	–	–
			CTC	4	–	–	
		<65.0	MRC	5	14.72 (5.18–41.82)	<.01	0.03 (0.00–0.35)
			CTC	10	487.52 (53.85–4413.59)	<.01	
	Percentage of males (%)	≥50.0	MRC	4	9.17 (3.13–26.89)	.01	0.04 (0.00–0.36)
			CTC	8	235.94 (33.11–1681.40)	<.01	
		<50.0	MRC	2	–	–	–
			CTC	6	219.19 (90.05–533.53)	.10	
NLR	Sample size	≥ 100	MRC	2	–	–	–
			CTC	7	0.04 (0.01–0.14)	.28	
		<100	MRC	5	0.01 (0.00–0.09)	.05	0.25 (0.00–29.42)
			CTC	9	0.04 (0.01–0.17)	<.01	
	Mean age, y	≥65.0	MRC	1	–	–	–
			CTC	4	–	–	
		<65.0	MRC	5	0.04 (0.01–0.31)	<.01	0.57 (0.08–4.32)
			CTC	10	0.07 (0.02–0.17)	<.01	
	Percentage of males (%)	≥50.0	MRC	4	0.01 (0.00–0.09)	.15	0.14 (0.00–15.74)
			CTC	8	0.07 (0.02–0.21)	<.01	
		<50.0	MRC	2	–	–	–
			CTC	6	0.06 (0.02–0.14)	.35	
AUC	Sample size	≥100	MRC	2	–	–	–
			CTC	7	1.00 (0.99–1.00)	–	
		<100	MRC	5	0.99 (0.98–1.00)	–	0.99 (0.98–1.00)
			CTC	9	1.00 (0.99–1.00)	–	
	Mean age, y	≥65.0	MRC	1	–	–	–
			CTC	4	–	–	
		<65.0	MRC	5	0.98 (0.96–0.99)	–	0.99 (0.97–1.01)
			CTC	10	0.99 (0.98–1.00)	–	
	Percentage of males (%)	≥50.0	MRC	4	0.99 (0.98–1.00)	–	1.00 (0.99–1.01)
			CTC	8	0.99 (0.98–1.00)	–	
		<50.0	MRC	2	–	–	–
			CTC	6	1.00 (0.99–1.00)	–	

AUC = area under the curve, CI = confidence interval, CTC = computed tomography colonography, MRC = magnetic resonance colonography, NLR = negative likelihood ratio, PLR = positive likelihood ratio.

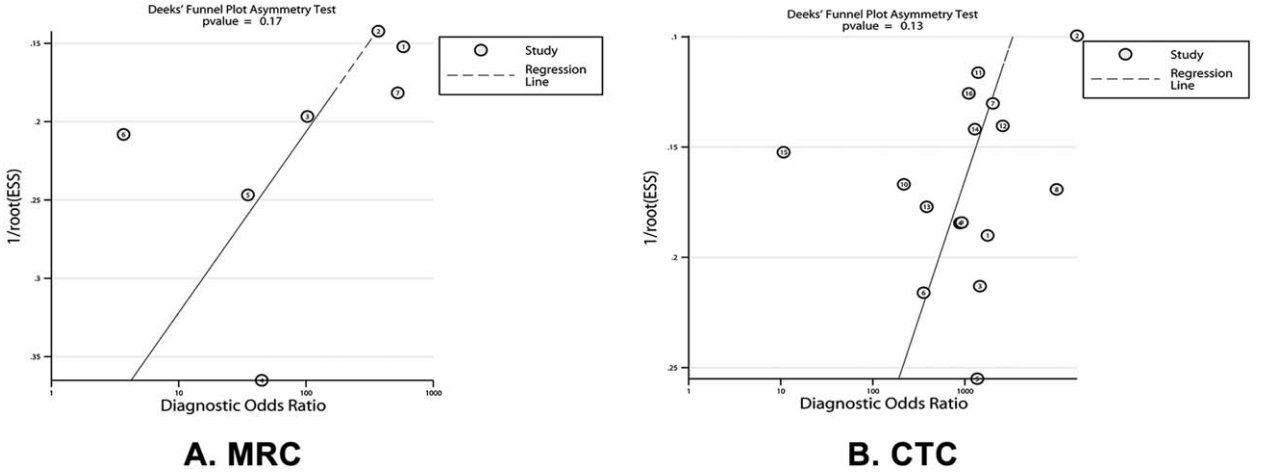

Figure 5. Deeks' funnel plot with a regression line. (A) Magnetic resonance colonography (MRC); (B) computed tomography colonography (CTC).

5 mm, and was associated with 93% sensitivity and 100% specificity. Pappalardo et al[19] showed that MRC was associated with similar diagnostic accuracy for diagnosing colonic endoluminal lesions compared with conventional colonoscopy. Lauenstein et al[20,21] indicated that barium-tagged MRC was promising for detecting all lesions more than 8 mm in diameter. Luboldt et al[22] found that MRC was promising for filtering out individuals with obvious colorectal mass lesions. Leung et al[23] recruited 165 patients and correctly identified 3 patients with 75% sensitivity and 99.3% specificity. This moderate diagnostic value of MRC could be because the images of MRC were unsatisfactory for interpretation irrespective of the bowel preparation and distension status.[23] Ajaj et al[24] included 50 patients and suggested that MRC was permitted using water or air for colonic distension. Furthermore, all included studies suggested that CTC was associated with a higher accuracy for diagnosing colorectal cancer.[25–40] The present study also indicated that MRC and CTC had a high accuracy for diagnosing colorectal cancer. Future studies are still needed to directly compare the diagnostic value of MRC with CTC in a specific population.

The subgroup analysis suggested that the difference in PLR between MRC and CTC for diagnosing colorectal cancer was mainly associated with a study sample size less than 100, mean age less than 65.0 years, and percentage of males greater than 50%. This was probably because that most included studies had a smaller number of patients and higher statistical power. Furthermore, the difference in the ratio of effect estimate was found to be marginal for the area under the ROC in several subsets. Hence, the conclusions might be variable and need verification through large-scale studies in the future. Therefore, the present study was conducted to provide just relative results and a synthetic and comprehensive review.

This study had several strengths. First, a standard protocol and a comprehensive search strategy were used. Furthermore, bivariate random-effects model and hierarchical ROC analyses were also employed in the study. In addition, the large sample size was pooled, and the findings of this study were more robust than those of any individual study. Finally, the ratios of effect estimate were used to compare the diagnostic value of MRC and CTC for diagnosing colorectal cancer in groups of studies or patients categorized by potential confounders.

The study also had some limitations. First, the sources of heterogeneity could not be explored by meta-regression because detailed baseline characteristics were reported only in few studies. Second, the analysis used summarized data, which restricted more detailed analysis. Third, publication bias is always an inevitable problem in a meta-analysis of published studies.

The findings of this study indicated that MRC and CTC for diagnosing colorectal cancer were associated with higher sensitivity, specificity, PLR, NLR, and area under the ROC. When indirectly comparing MRC and CTC, CTC was found to be associated with higher PLR and area under the ROC for diagnosing colorectal cancer compared with MRC. Subgroup analyses suggested that the sample size, mean age, and percentage of males might be important for PLR of MRC and CTC in diagnosing colorectal cancer. Future studies should focus on specific characteristics of individuals to directly compare the diagnostic value of MRC and CTC for colorectal cancer.

Author contributions

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