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Effect of add-on devices with projections on screening colonoscopy: a systematic review and meta-analysis

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Abstract

Background Add-on devices with projections, e.g., Endocuff, Endocuff Vision, EndoRings, and Wingcap, placed on the distal tip of the colonoscope promise to improve the detection of precancerous lesions. We performed a meta-analysis to evaluate the performance of these devices exclusively among individuals undergoing colonoscopy for screening purpose.

Methods A computerized literature search was performed across MEDLINE and Cochrane Library databases for randomized controlled trials that compared standard colonoscopy (SC) to procedures using add-on devices. The primary outcome was adenoma detection rate (ADR), while secondary outcomes included polyp detection rate (PDR), advanced ADR (AADR), and sessile serrated lesion detection rate (SSLDR). The effect size on study outcomes was calculated using a random-effects model and presented as the risk ratio (RR) and 95% confidence interval (CI).

Results Seven studies enrolling a total of 5785 patients were included. The use of add-on-devices with projections was associated with a higher ADR compared to SC: 45.9% vs. 41.1%; RR 1.18, 95%CI 1.02-1.37; P=0.03; I^2=79%. Although PDR was higher in screening colonoscopies assisted by add-on devices as compared to SC, the difference failed to reach significance: 55.1% vs. 50.8%; RR 1.10, 95%CI 0.96-1.26; P=0.17; I^2=75%. No difference was found between procedures assisted by add-on devices with projections and SC colonoscopies in terms of AADR (18.5% vs. 17.6%; RR 1.00, 95%CI 0.79-1.27; P=0.98; I^2=56%) or SSLDR (6.8% vs. 5.8%; RR 1.17, 95%CI 0.95-1.44; P=0.15; I^2=0%).

Conclusion Colonoscopy assisted by add-on devices with projections achieves a better ADR compared to SC among individuals undergoing screening for bowel cancer.

Keywords Screening, colonoscopy, adenoma, detection, add-on device

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Conflict of Interest: None

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Introduction

Colorectal cancer (CRC) is the third most common type of cancer worldwide and is considered curable in its early stages [1]. Colonoscopy is an endoscopic technique [2] with high percentages of CRC detection; however, it remains imperfect, since it entails a percentage adenoma miss rate, considered to be the key point in the detection of precancerous lesions. The reasons standard colonoscopy (SC) is subject to failure vary from poor bowel preparation to limited visualization of haustral folds and flexures. Zhao *et al* demonstrated in a meta-analysis that 26% of adenomas are not detected during SC [3].

The introduction of various add-on devices, attached to the tip of the endoscope, helps unfold the lumen while also

providing the operator with a better view of the epithelium. These devices consist of various single-use components, such as cylinders, rings and wings, and aid the unfolding of the mucosa. Since they have an easier learning curve, especially for novice colonoscopists, add-on devices tend to be widely utilized in colonoscopies [4,5]. The first generation of Endocuff, and its successor Endocuff-Vision, are single-use devices mounted on the tip of the scope, consisting of a cylindrical core and 1 or 2 rows of flexible projections [6]. Likewise, Endoring (EndoAid Ltd., Caesarea, Israel) is another device that flattens the intestinal folds, incorporating a 2-layer silicon ring [7], while WingCap (A&A Medical Supply LLC, Seongnam, South Korea) is manufactured in 2 layers, each consisting of 6 wings [8]. However, there is lack of sufficient evidence regarding the prevalence and efficacy of add-on devices exclusively in the setting of screening colonoscopy.

In this context, we aimed to accumulate data on add-on devices with projections and compare their performance to SC, by assessing adenoma detection rate (ADR) as a primary outcome, and polyp detection rate (PDR), advanced ADR (AADR), and sessile serrated lesion detection rate (SSLDR) as secondary outcomes.

Materials and methods

This review was based on the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) 2020 guidelines [9] (Supplementary Table 1), and a predefined protocol was registered at the International Prospective Register of Systematic Reviews (PROSPERO), under registration number CRD42022363186.

Eligibility criteria

The main question was based on the validated PICO (population, intervention, control, and outcomes) framework for systematic reviews and included the comparison between add-on devices with projections and SC with regard to ADR [10]. Only randomized controlled trials (RCTs) were assessed for eligibility, when: (A) patients: adult patients underwent screening colonoscopy for CRC, without symptoms; (B) interventions: screening colonoscopy using add-on devices with projections, including Endocuff, Endocuff- Vision, Endoring and Wingcap; (C) comparators: subjects underwent screening colonoscopy with conventional endoscopes and without assisting techniques (e.g., artificial intelligence); and (D) outcomes: studies not written in the English language, missing substantial data for analysis, nonrandomized prospective or retrospective studies, reviews, editorials, case reports, case series, narrative reviews, and conference abstracts were excluded. Studies not including ADR as outcome were also excluded.

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Definitions

ADR is defined as the number of colonoscopies with adenomas detected divided by the total number of colonoscopies, multiplied by 100. PDR is defined as the number of colonoscopies with polyps detected divided by the total number of colonoscopies, multiplied by 100. The other studied variables, AADR and SSLDR were calculated similarly.

Search strategy

Between September and November, 2022, 2 investigators (MM and GT) conducted a detailed literature search across the Medline (PubMed) database and Cochrane Central Register of Clinical Trials Studies using the terms "add-on-device", "endocuff", "endoring", "g-eye", "amplifeye" and "adenoma detection rate", as medical subject heading (MeSH) and free-text terms. These results were combined using the Boolean set operator "AND" with the term "screening colonoscopy" as a MeSH and free-text term. The initial electronic search was followed by a manual search of references from retrieved studies to identify additional suitable bibliography. All retrieved articles were screened for eligibility, first by 1 reviewer (MM) and afterwards by 2 independent senior authors (PG and GT), using the predetermined inclusion criteria. Initially, the titles and abstracts of all results were reviewed; the full-text content of eligible studies was obtained and reassessed independently for eligibility. For studies with missing or unavailable data, we attempted to contact the corresponding author to provide the missing information. In cases of multiple publications from the same study, only the most recent and complete article was included. Additionally, when both parallel design and crossover arm trials were found, only the parallel group was studied.

Data collection process

All eligible studies were reviewed by 2 investigators and relative data were extracted in a predefined extraction form. Through this process, any discrepancy was resolved either by consensus or following the senior authors' (PG and GT) judgment.

Data items

Data on study-, participant- and intervention-related parameters were retrieved into a standardized form by 2 investigators (MM and GT), and a third author (AP) checked the 2 independent datasets for any discrepancies. Disagreements were resolved after consulting a senior investigator (PG) to reach a consensus.

Risk of bias in individual studies

Two authors (MM and GT) assessed all the studies independently for risk of bias and any discrepancies were resolved after discussion with a third author (PG). We used the Cochrane collaboration's risk of bias assessment tool to assess the studies. This particular tool evaluates different domains of potential sources of bias: random sequence generation and allocation concealment (selection bias), blinding of participants and personnel (performance bias), blinding of outcome assessment (detection bias), incomplete outcome data (attrition bias), and selective reporting (reporting bias). All studies were classified by the reviewers as having high, low, or unclear risk of bias for each domain.

Statistical analysis

Extracted data were analyzed using the statistical software Review Manager (RevMan 5.4.1; Copenhagen, Denmark; The Nordic Cochrane Centre, The Cochrane Collaboration, 2020). For the primary and all secondary endpoints, relative risks (RRs) and 95% confidence intervals (95% CIs) were calculated. Forest plots were created for visual presentation of the results, and all outcomes were compared using either the fixed-effects model (Mantel and Haenszel method) or the random-effects model (DerSimonian and Laird method) in the absence or presence of significant heterogeneity, respectively. The presence of heterogeneity was calculated using I^2 tests with I^2<30% interpreted as low-level heterogeneity and I^2 between 30% and 60% as moderate heterogeneity. Any potential publication bias was verified through the visual assessment of funnel plots. We repeated the meta-analysis excluding 1 study at a time to assess whether its exclusion altered the heterogeneity's significance level. Funnel plots, constructed by plotting the log-ORs vs. the precision of individual studies per outcome, were assessed visually for symmetry to exclude potential publication bias.

Quality of evidence

The quality of the provided evidence was rated based on the GRADE criteria. Two independent researchers (MM and GT) graded inconsistency, risk of bias, indirectness, imprecision and publication bias. Overall quality was deemed very low, low, moderate, or high, using GRADEpro (GRADE Working Group) [11].

Results

Characteristics of included studies

The initial search identified 109 unique records; after application of the exclusion criteria 7 studies [7,8,12-16] were included in this meta-analysis. The PRISMA flowchart showing the study selection process is given in Fig. 1 and Table 1 summarizes the main characteristics of the included studies.

Overall, 5785 patients were recruited in the meta-analysis. The female-to-male ratio was 1:1 and the mean age was approximately 60 years. Four studies were multicenter [7,13,15,16], whereas the remaining 3 were single-center [8,12,14]. The patient recruitment period was between 2014 and 2021 and for each study the timeline of study completion was from 1-3 years. All the studies had a unique origin (Denmark, Italy, Mexico, Germany, Greece, Italy, and South Korea). Three studies [12,13,15] included Endocuff Vision as the add-on-device mounted on the tip of the endoscope, while 2 used the first generation Endocuff [14,16]. Both Endorings (EndoAid Ltd, Caesarea, Israel) [7] and Wingcap (A&A Medical Supply LLC, Seongnam, South Korea) [8] were assessed in 1 study. None of the published studies using NaviAid G-EYE (SMART Medical Systems Ltd., Ra'anana, Israel) or Amplifeye (Medivators Inc., Minneapolis, MN) were confined exclusively to screening colonoscopies and ADR. All studies enrolled individuals undergoing colonoscopy for CRC screening.

Quality assessment

A summarized assessment of the risk of bias per study using the Cochrane Collaboration's risk of bias assessment tool is illustrated in Fig. 2. Participating physicians were not blinded to the equipment used or the measured outcomes in any of the studies. Three [7,8,12] of the 7 studies did not report the exact method of allocation concealment (selection bias). A detailed assessment of the risk of bias is summarized in Supplementary Table 1.

Grade evidence estimate

Confidence in the effect estimates was considered very low. The quality of the body of evidence was downgraded by 3 levels for the primary outcome: 1 due to the risk of bias given that blinding of the endoscopists was not possible; 1 because of the presence of heterogeneity; and 1 because of the presence of evidence indirectness, since the technical intervention was implemented by expert, highly trained specialists in specialist centers and in different populations. A detailed assessment of the evidence grade is summarized in Supplementary Table 2.

Primary endpoint

Colonoscopy with the assistance of add-on devices with projections [7,8,12-16] yielded an ADR of 45.9%, compared

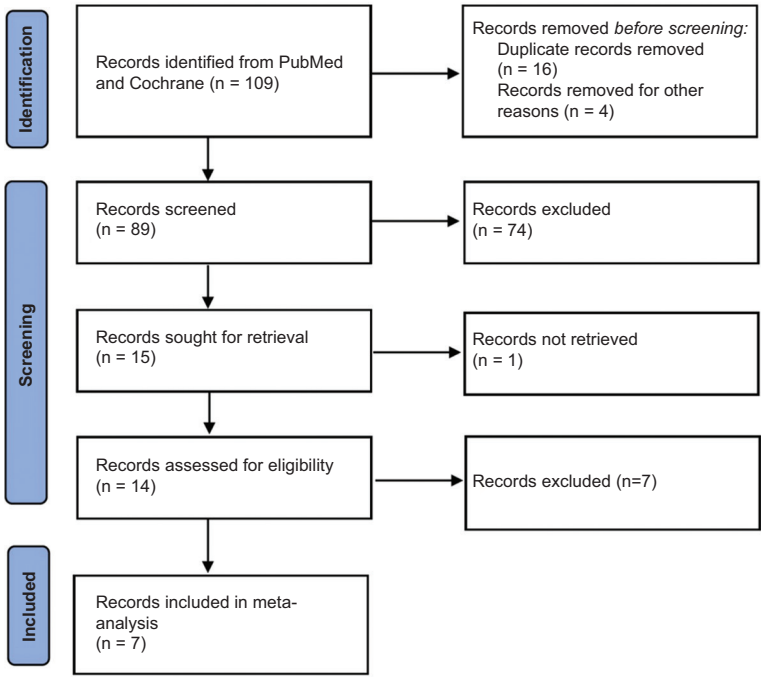

Figure 1 Flow diagram of assessment of the studies identified

Figure 2 Risk of bias of the studies included

to 41.1% for SC. A comparison of the ADR achieved by these techniques found superiority for add-on devices with projections, albeit with high heterogeneity: RR 1.18, 95%CI 1.02-1.37; P=0.03; I^2=79% (Fig. 3). Visual assessment of the funnel plot showed no evidence of publication bias (Supplementary Fig. 1).

In an effort to address heterogeneity, 2 sensitivity analyses were performed. During the step-by-step sensitivity analysis, in which 1 study was excluded at a time, no study was found that could explain this result. Based on the high percentage of patients undergoing screening colonoscopy with the use of Endocuff, a sub-group analysis was performed to compare ADR between the Endocuff group, either first or second generation, and the SC group [12-16]. Our analysis revealed superior ADR rates for the Endocuff-assisted procedures: 46.2% vs. 40.8%; RR 1.18, 95%CI 1.02-1.36; P=0.03; I^2=73%] (Supplementary Fig. 2).

PDR

In terms of PDR, data from 5 studies [7,12,14-16] also favored the use of add-on devices with projections in screening colonoscopies, in comparison to SC, without reaching statistical significance: 55.1% vs. 50.8%; RR 1.10, 95%CI 0.96-1.26; P=0.17; I^2=75% (Fig. 4A). The sensitivity analysis, excluding 1 study at a time, failed to identify a single study accountable for this effect. No evidence of publication bias was found (Supplementary Fig. 3).

AADR

Data acquired by 4 studies [7,13,15,16] showed a lack of difference between the 2 groups in terms of AADR: 18.5% vs. 17.6%; RR 1.00, 95%CI 0.79-1.27; P=0.98; I^2=56% (Fig. 4B). Sensitivity analysis did not detect any study responsible for the detected heterogeneity. There was no evidence of publication bias (Supplementary Fig. 4).

Table 1 Study characteristics

Study, year [ref.]	Recruitment period	Single or multicenter	Country	Add-on device	Patients (N)			Mean age (years)		Male (N)	
					Total	Screening colonoscopy with add-on device attached	Screening standard colonoscopy	Screening colonoscopy with add-on device attached	Screening standard colonoscopy	Screening colonoscopy with add on-device attached	Screening standard colonoscopy
Jaensch *et al*, 2022 [12]	10/2017-12/2018	Single-center	Denmark	ENDOCUFF VISION	1166	583	583	N/A	N/A	N/A	N/A
Zorzi *et al*, 2021 [13]	02/2018-01/2020	Multicenter	Italy	ENDOCUFF VISION	1813	908	905	60.2	60.1	488	487
González-Fernández *et al*, 2017 [14]	04/2014-11/2015	Single-center	Mexico	ENDOCUFF	337	174	163	60	62	50	39
Zimmermann-Fraedrich *et al*, 2022 [15]	09/2017-11/2020	Multicenter	Germany	ENDOCUFF VISION	1416	700	716	61.1	61.1	345	337
Triantafyllou *et al*, 2017 [16]	01/2015-03/2016	Multicenter	Greece	ENDOCUFF	122	63	59	N/A	N/A	N/A	N/A
Hassan *et al*, 2018 [7]	07/2016-08/2017	Multicenter	Italy	ENDORING	634	317	317	62.9	61.8	159	161
Hong *et al*, 2022 [8]	12/2020-07/2021	Single-center	South Korea	WingCap	297	150	147	N/A	N/A	N/A	N/A

N/A, not applicable

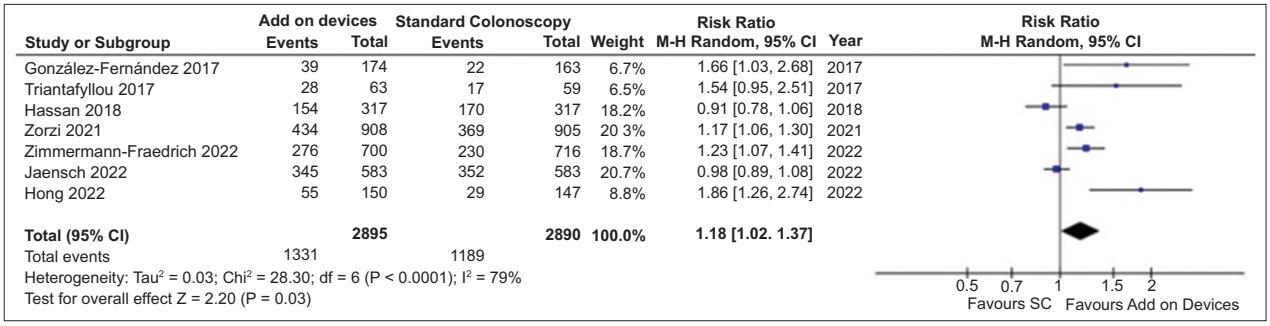

Figure 3 Forest plot assessing the adenoma detection rate of add-on devices vs. standard colonoscopy (SC)
CI, confidence interval

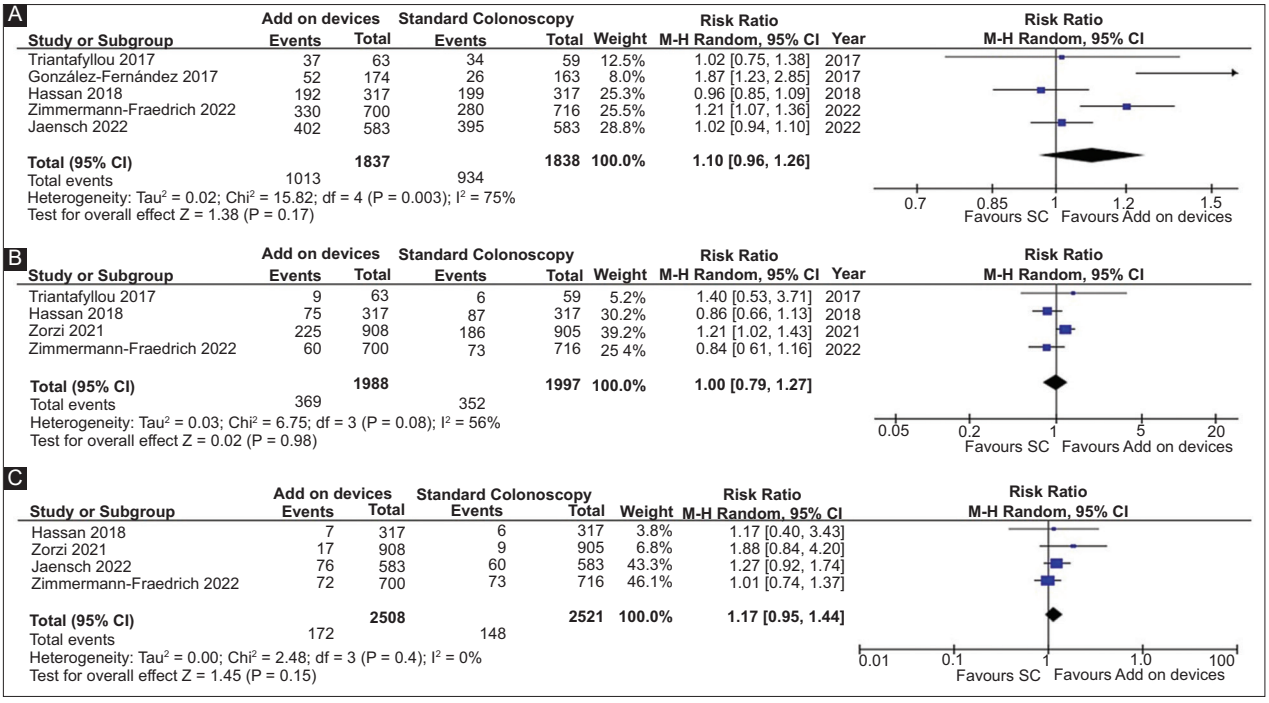

Figure 4 Forest plot assessing effect of add-on devices vs. standard colonoscopy (SC) on A: polyp detection rate; B: advanced adenoma detection rate; C: sessile adenoma detection rate
CI, confidence interval

SSLDR

Similarly, only 4 studies reported the SSLDR [7,12,13,15]. The SSLDR of screening colonoscopies assisted by an add-on device with projections was not superior to that of SC: 6.8% vs. 5.8%; RR 1.17, 95%CI 0.95-1.44; P=0.15; I^2=0% (Fig. 4C). Neither heterogeneity nor publication bias was detected (Supplementary Fig. 5).

Discussion

Our meta-analysis is the first to evaluate add-on devices with projections exclusively in the context of screening colonoscopies, revealing statistically significant higher percentages of ADR, compared to the SC technique. Based on unequivocal inclusion criteria, the outcomes of our meta-analysis are quite solid. Firstly, only prospective RCTs were studied to ensure low rates of bias. Secondly, the selected screening population ensured that the participants neither exhibited gastrointestinal symptoms, nor had a known history of CRC; these variables are associated with higher ADRs. Thirdly, both groups in each study were evenly classified, leading to diminished odds of misrepresentation. Apart from that, the large number of enrolled patients (n=5785) contributed to the validity of the study. The authors, therefore, believe that the findings of the present study may pave the way for more widespread use of add-on device-assisted colonoscopy in the screening population.

Our analysis showed a clear-cut benefit from the use of add-on devices with projections compared to SC in terms of

ADR which is the core quality indicator of the examination and has been inextricably linked to CRC prevention and incidence reduction [17]. Since Endocuff has been widely reported in the bibliography, a further analysis of its usage solely in screening colonoscopies reaffirmed that the insertion of this specific device surpasses SC's ADR. Individual studies [13,18] have also shown that Endocuff exhibits superior rates in adenoma detection compared to SC. Our study concurs with our previously published meta-analysis in 2019 about the importance of Endocuff [6]. Regarding Endoring, a plethora of reviews demonstrates its dynamic; still, the majority of them either skips the comparison to SC [19-21], or includes techniques which are not considered add-on devices, such as full-spectrum (FUSE) [22,23]. As for WingCap, only 1 published study is to be found by Hong *et al* [8] comparing this device to SC. Yet, this is the first systematic meta-analysis to investigate the majority of add-on devices in screening population.

While the use of add-on devices carries an extra cost for the healthcare system, the cost/benefit ratio is yet to be established. Yu *et al* used a decision-analytic Markov model to evaluate the clinical and economic consequences of Endocuff-assisted screening colonoscopies [24]. Although they highlighted the cost-effectiveness of the Endocuff intervention in endoscopy, data on the economic burden associated with these devices varies between regions and depends on the equipment; thus, further studies are needed. Moreover, endoscopists have to receive additional training before performing colonoscopies with add-on devices, adding to the overall cost. It is worth noting that add-on devices may not be suitable for all cases. For instance, in the presence of diverticular disease [12] the attachments had to be removed in order to complete the endoscopy. This is also the case if a polypectomy is needed, and the add-on device hinders the resection.

This systematic review has also some limitations. First, the absence of RCTs on every available tool limits the applicability of our results to those we assessed, even though some commercially available attachments may provide comparable results. A systematic review of different types of add-on devices in screening colonoscopies is needed to further establish the superiority of specific techniques. This was not feasible in our study, since 5 of the 7 chosen publications reported the use of Endocuff [12-16], with the remaining 2 making use of Endoring [7] and WingCap [8]. Undoubtedly, there are other devices attached to the tip of the endoscope which have not been mentioned in this meta-analysis. This is mainly due to the lack of comparison with the SC group, as well as the exclusion of screening populations, leading to selection bias [25,26]. Some of those devices include Amplifeye and G-eye [27,28].

Another drawback is the inability to assess potential confounders affecting ADR. For example, endoscopists' personal ADR is based on experience and training, and may vary among studies. Moreover, bowel preparation, patients' comfort and other parameters affecting the quality of colonoscopy were not assessed, as there were no data amenable to analysis. Another concern is the limited elicited data related to AADR and SSLDR, with only 4 of 7 studies providing such information. Hence, further analyses are needed to correlate the use of add-on devices with these parameters.

To conclude, this systematic review highlights the role of add-on devices with projections in CRC detection among a screening population. Although these devices displayed higher percentages in terms of ADR (primary outcome), compared to SC, more data are needed to reinforce these findings. Ideally, more adults undergoing screening endoscopies should be offered add-on device-assisted colonoscopy, depending on the availability of these technologies.

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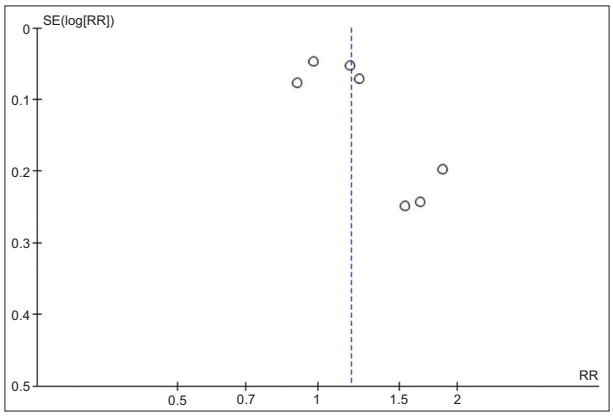
References

1. Lotfollahzadeh S, Recio-Boiles A, Cagir B. Colon cancer. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022. Available from: http://www.ncbi.nlm.nih.gov/books/NBK470380/[Accessed 7 July 2023].
2. Kim SY, Kim HS, Park HJ. Adverse events related to colonoscopy: global trends and future challenges. *World J Gastroenterol* 2019;**25**:190-204.
3. Zhao S, Wang S, Pan P, et al. Magnitude, risk factors, and factors associated with adenoma miss rate of tandem colonoscopy: a systematic review and meta-analysis. *Gastroenterology* 2019;**156**:1661-1674.
4. Tang Z, Zhang DS, Thrift AP, Patel KK. Impact of cap-assisted colonoscopy on the learning curve and quality in colonoscopy: a randomized controlled trial. *Gastrointest Endosc* 2018;**87**:723-732.
5. Choi J, Litten JD, Drozek D. Development of a colonoscopy add-on device for improvement of the intubation process. *Med Devices (Auckl)* 2011;**4**:197-208.
6. Triantafyllou K, Gkolfakis P, Tziatzios G, Papanikolaou IS, Fuccio L, Hassan C. Effect of endocuff use on colonoscopy outcomes: a systematic review and meta-analysis. *World J Gastroenterol* 2019;**25**:1158-1170.
7. Hassan C, Senore C, Manes G, et al. Diagnostic yield and miss rate of EndoRings in an organized colorectal cancer screening program: the SMART (Study Methodology for ADR-Related Technology) trial. *Gastrointest Endosc* 2019;**89**:583-590.
8. Hong SW, Hong HS, Kim K, et al. Improved adenoma detection by a novel distal attachment device-assisted colonoscopy: a prospective randomized controlled trial. *Gastrointest Endosc* 2022;**96**:543-552.
9. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;**372**:n71.
10. Eriksen MB, Frandsen TF. The impact of patient, intervention, comparison, outcome (PICO) as a search strategy tool on literature search quality: a systematic review. *J Med Libr Assoc* 2018;**106**:420-431.
11. Schünemann H, Brożek J, Guyatt G, Oxman A. GRADE handbook for grading quality of evidence and strength of recommendations [Internet]. 2013. Available from: https://gdt.gradepro.org/app/handbook/handbook.html [Accessed 7 July 2023].
12. Jaensch C, Jepsen MH, Christiansen DH, Madsen AH, Madsen MR. Adenoma and serrated lesion detection with distal attachment in screening colonoscopy: a randomized controlled trial. *Surg Endosc*

2022;**36**:1-9.
13. Zorzi M, Hassan C, Battagello J, et al; ItaVision Working Group. Adenoma detection by Endocuff-assisted versus standard colonoscopy in an organized screening program: the "ItaVision" randomized controlled trial. *Endoscopy* 2022;**54**:138-147.
14. González-Fernández C, García-Rangel D, Aguilar-Olivos NE, et al. Higher adenoma detection rate with the endocuff: a randomized trial. *Endoscopy* 2017;**49**:1061-1068.
15. Zimmermann-Fraedrich K, Sehner S, Rösch T, et al. Second-generation distal attachment cuff for adenoma detection in screening colonoscopy: a randomized multicenter study. *Gastrointest Endosc* 2023;**97**:112-120.
16. Triantafyllou K, Polymeros D, Apostolopoulos P, et al. Endocuff-assisted colonoscopy is associated with a lower adenoma miss rate: a multicenter randomized tandem study. *Endoscopy* 2017;**49**:1051-1060.
17. Kaminski MF, Wieszczy P, Rupinski M, et al. Increased rate of adenoma detection associates with reduced risk of colorectal cancer and death. *Gastroenterology* 2017;**153**:98-105.
18. Ngu WS, Bevan R, Tsiamoulos ZP, et al. Improved adenoma detection with Endocuff Vision: the ADENOMA randomised controlled trial. *Gut* 2019;**68**:280-288.
19. Thayalasekaran S, Alkandari A, Varytimiadis L, et al. To cap/cuff or ring: do distal attachment devices improve the adenoma detection? *Expert Rev Gastroenterol Hepatol* 2019;**13**:119-127.
20. Pamudurthy V, Lodhia N, Konda VJA. Advances in endoscopy for colorectal polyp detection and classification. *Proc (Bayl Univ Med Cent)* 2020;**33**:28-35.
21. Gkolfakis P, Tziatzios G, Spartalis E, Papanikolaou IS, Triantafyllou K. Colonoscopy attachments for the detection of precancerous lesions during colonoscopy: A review of the literature. *World J Gastroenterol* 2018;**24**:4243-4253.
22. Brand EC, Dik VK, van Oijen MGH, Siersema PD. Missed adenomas with behind-folds visualizing colonoscopy technologies compared with standard colonoscopy: a pooled analysis of 3 randomized back-to-back tandem colonoscopy studies. *Gastrointest Endosc* 2017;**86**:376-385.
23. Gkolfakis P, Tziatzios G, Facciorusso A, Muscatiello N, Triantafyllou K. Meta-analysis indicates that add-on devices and new endoscopes reduce colonoscopy adenoma miss rate. *Eur J Gastroenterol Hepatol* 2018;**30**:1482-1490.
24. Yu TM, Tradonsky A, Tang J, Arnold RJ. Cost-effectiveness of adding Endocuff to standard colonoscopies for interval colorectal cancer screening. *Clinicoecon Outcomes Res* 2019;**11**:487-504.
25. Verheyen E, Castaneda D, Gross SA, Popov V. Increased sessile serrated adenoma detection rate with mechanical new technology devices: a systematic review and meta-analysis. *J Clin Gastroenterol* 2021;**55**:335-342.
26. Rex DK, Sagi SV, Kessler WR, et al. A comparison of 2 distal attachment mucosal exposure devices: a noninferiority randomized controlled trial. *Gastrointest Endosc* 2019;**90**:835-840.
27. Hocke M, Frieling T, Eckardt AJ, Teubner D, Kiesslich R. Discovery AI combination with G-eye colonoscopy significantly increases adenoma detection rate - results of a multicenter study. *Gastrointest Endosc* 2022;**95**:AB217.
28. Halpern Z, Gross SA, Gralnek IM, et al. Comparison of adenoma detection and miss rates between a novel balloon colonoscope and standard colonoscopy: a randomized tandem study. *Endoscopy* 2015;**47**:238-244.

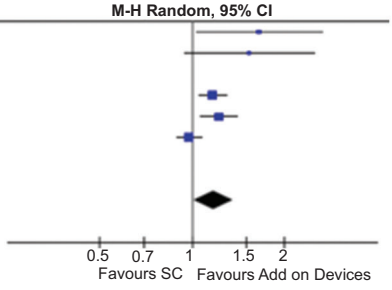
Supplementary material



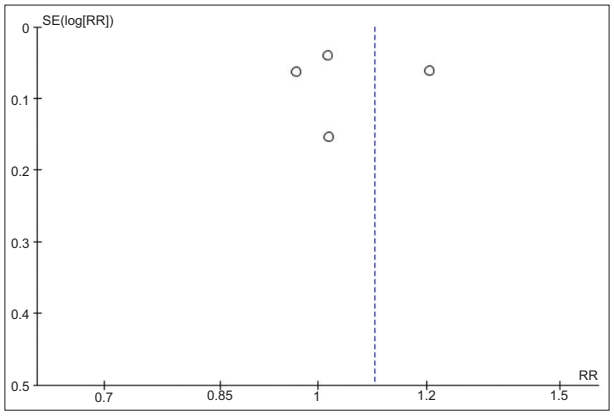
Supplementary Figure 1 Funnel plot for studies assessing adenoma detection rate

Study or Subgroup	Add on devices Events	Total	Standard Colonoscopy Events	Total	Weight	Risk Ratio M-H Random, 95% CI	Year
González-Fernández 2017	39	174	22	163	7.4%	1.66 [1.03, 2.68]	2017
Triantafyllou 2017	28	63	17	59	7.1%	1.54 [0.95, 2.51]	2017
Hassan 2018	154	317	170	317	0.0%	0.91 [0.78, 1.06]	2018
Zorzi 2021	434	908	369	905	29.3%	1.17 [1.06, 1.30]	2021
Zimmermann-Fraedrich 2022	276	700	230	716	36.1%	1.23 [1.07, 1.41]	2022
Jaensch 2022	345	583	352	583	30.1%	0.98 [0.89, 1.08]	2022
Hong 2022	55	150	29	147	0.0%	1.86 [1.26, 2.74]	2022
Total (95% CI)		**2428**		**2426**	**100.0%**	**1.18 [1.02, 1.36]**	
Total events	1122		990				

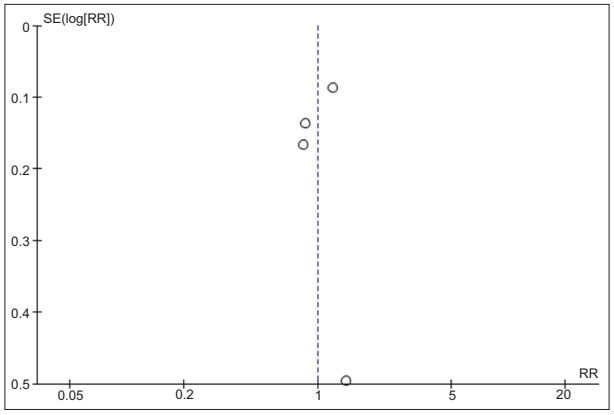
Heterogeneity: $Tau^2 = 0.02$; $Chi^2 = 14.83$; df = 4 (P = 0.005); $I^2 = 73\%$
Test for overall effect Z = 2.18 (P = 0.03)



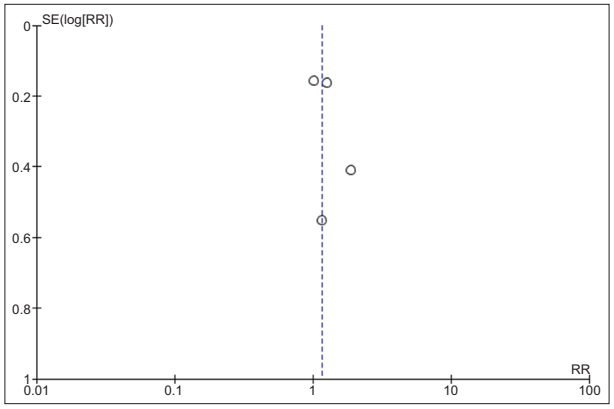
Supplementary Figure 2 Forest plot assessing the adenoma detection rate of Endocuff-assisted colonoscopies vs. standard colonoscopy (SC)
CI, confidence interval



Supplementary Figure 3 Funnel plot for studies assessing polyp detection rate



Supplementary Figure 4 Funnel plot for studies assessing advanced adenoma detection rate



Supplementary Figure 5 Funnel plot for studies assessing sessile serrated lesion detection rate

Supplementary Table 1 Assessment of the risk of bias for each study

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Prior to study start randomization envelopes were produced, block randomization with a block size of twenty was used to ensure a balance in sample size across groups over time."
Allocation concealment (selection bias)	Unclear risk	Authors do not report the exact method of allocation concealment.
Blinding of participants and personnel (performance bias)	High risk	"Patients and endoscopists were not blinded as to whether Endocuff Vision was used or not."
Blinding of outcome assessment (detection bias)	High risk	Investigators were not blinded to the method applied. Outcome assessment is likely to be influenced by lack of blinding.
Incomplete outcome data attrition bias)	Low risk	Per protocol analysis performed after exclusion of balanced proportion of patients with similar reasons between the 2 allocation groups. "In 6 cases data were missing due to stenosing cancer and in 1 other case because the cecum was not reached. Five more patients were excluded from analysis because bowel prep was not acceptable and the patients did not wish to participate in a new colonoscopy."
Selective reporting (reporting bias)	Low risk	The study protocol is available and the main of the study's pre-specified outcomes (except the advanced adenoma detection rate) that are of interest in the review have been reported in the pre-specified way.

Risk of bias for study Jaensch *et al* 2021

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Randomization was based on a computer-generated randomized block (n=8) sequence."
Allocation concealment (selection bias)	Low risk	"Group assignment occurred automatically after the patient characteristics that were relevant for randomization had been recorded in the EPICLIN database (a web-based application for management of clinical studies: www.epiclin.it, developed by CPO Piemonte.)"
Blinding of participants and personnel (performance bias)	High risk	The authors do not report whether participants were informed or not regarding the allocation group. As for the personnel, authors make the following statement: "Only after entering the characteristics of each enrolled patient in this study database could the endoscopist see the randomization arm assigned to that patient."
Blinding of outcome assessment (detection bias)	High risk	Blinding of the endoscopists was not possible due to the add-on device used.
Incomplete outcome data (attrition bias)	Low risk	Per protocol analysis performed after exclusion of balanced proportion of patients with similar reasons between the 2 allocation groups.
Selective reporting (reporting bias)	Low risk	The study protocol is available and the study's main pre-specified outcomes (except the polyp detection rate) that are of interest in the review have been reported in the pre-specified way.

Risk of bias for study Zorzi *et al* 2021

Random sequence generation (selection bias)	Low risk	"The randomization of patients was carried out through the webpage randomization.com."
Allocation concealment (selection bias)	Unclear risk	Authors do not report the exact method of allocation concealment.
Blinding of participants and personnel (performance bias)	High risk	Investigators were not blinded to the method applied; blinding of participants is not reported. Outcome is likely to be influenced by lack of personnel blinding.
Blinding of outcome assessment (detection bias)	High risk	Investigators were not blinded to the method applied. Outcome assessment is likely to be influenced by lack of blinding.
Incomplete outcome data (attrition bias)	Low risk	Per protocol analysis performed after exclusion of balanced proportion of patients with similar reasons between the 2 allocation groups.
Selective reporting (reporting bias)	Low risk	The study protocol is available and the study's main pre-specified outcomes (except the advanced adenoma detection rate and the sessile adenoma detection rate) that are of interest in the review have been reported in the pre-specified way.

Risk of bias for study González-Fernández *et al* 2017

Random sequence generation (selection bias)	Low risk	"Randomization into intervention arm (using ECV) or control arm (without ECV) was by center using blocks of sealed envelopes sent to the individual centers and was done prior to introduction of the colonoscopy."
Allocation concealment (selection bias)	Low risk	Authors used sealed envelopes.
Blinding of participants and personnel (performance bias)	High risk	Investigators were not blinded to the method applied; blinding of participants is not reported. Outcome is likely to be influenced by lack of personnel blinding.
Blinding of outcome assessment (detection bias)	High risk	Investigators were not blinded to method applied. Outcome assessment is likely to be influenced by lack of blinding.
Incomplete outcome data (attrition bias)	Low risk	No attrition bias.
Selective reporting (reporting bias)	Low risk	The study protocol is available and the main of the study's pre-specified outcomes that are of interest in the review have been reported in the pre-specified way.

Risk of bias for study Zimmermann-Fraedrich *et al* 2022

Random sequence generation (selection bias)	Low risk	"We randomly assigned participants (1:1), by computer-generated randomization with a block design (10 patients per block), to undergo same-day back-to-back tandem colonoscopy with either Endocuff-assisted colonoscopy or conventional colonoscopy being performed first, followed immediately by the other procedure, performed by the same endoscopist."
Allocation concealment (selection bias)	Low risk	"Just before starting the examinations, the site study coordinator opened the concealed envelope to reveal group allocation to the endoscopist."
Blinding of participants and personnel (performance bias)	High risk	Investigators were not blinded to the method applied; blinding of participants is not reported. Outcome is likely to be influenced by lack of personnel blinding.
Blinding of outcome assessment (detection bias)	High risk	Investigators were not blinded to method applied. Outcome assessment is likely to be influenced by lack of blinding.
Incomplete outcome data (attrition bias)	Low risk	Per protocol analysis performed after exclusion of balanced proportion of patients with similar reasons between the 2 allocation groups.
Selective reporting (reporting bias)	Low risk	The study protocol is available and all the study's pre-specified outcomes (except the sessile adenoma detection rate) that are of interest in the review have been reported in the pre-specified way

Risk of bias for study Triantafyllou *et al* 2017

Random sequence generation (selection bias)	Low risk	"FIT+patients were randomized in a 2:2:1:1 ratio by the screening center and endoscopist to undergo colonoscopy with or without the Endorings in a parallel or crossover design, based on a computer-generated randomized blocks sequence."
Allocation concealment (selection bias)	Unclear risk	Authors do not report the exact method of allocation concealment.
Blinding of participants and personnel (performance bias)	High risk	Investigators were not blinded to the method applied; blinding of participants is not reported. Outcome is likely to be influenced by lack of personnel blinding.
Blinding of outcome assessment (detection bias)	High risk	Investigators were not blinded to the method applied. Outcome assessment is likely to be influenced by lack of blinding.
Incomplete outcome data (attrition bias)	Low risk	Per protocol analysis performed after exclusion of balanced proportion of patients with similar reasons between the 2 allocation groups.
Selective reporting (reporting bias)	Low risk	The study protocol is available and all of the study's pre-specified outcomes that are of interest in the review have been reported in the pre-specified way

Risk of bias for study Hassan *et al* 2018

Random sequence generation (selection bias)	Low risk	"Before the procedure, an independent investigator ran a pre-specified random number generator based on the RAND function in Microsoft Excel (Microsoft Corp, Redmond, Wash, USA), and the patients were randomized into the WingCap-assisted group or the standard colonoscopy group at a ratio of 1:1 according to the results of the program."
Allocation concealment (selection bias)	Unclear risk	Authors do not describe the exact method of allocation concealment
Blinding of participants and personnel (performance bias)	High risk	Investigators were not blinded to the method applied; blinding of participants is not reported. Outcome is likely to be influenced by lack of personnel blinding.
Blinding of outcome assessment (detection bias)	High risk	Investigators were not blinded to the method applied. Outcome assessment is likely to be influenced by lack of blinding.
Incomplete outcome data (attrition bias)	Low risk	Per protocol analysis performed after exclusion of balanced proportion of patients with similar reasons between the 2 allocation groups.
Selective reporting (reporting bias)	Low risk	The study protocol is available and the study's main pre-specified outcomes that are of interest in the review have been reported in the pre-specified way.

Risk of bias for study Hong *et al* 2022

Supplementary Table 2 Quality of body of evidence - Summary of Findings Table (GRADE)

Add-on devices compared to Standard Colonoscopy (SC) for screening

Certainty assessment							Summary of findings				
Participants (studies) Follow-up	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Overall certainty of evidence	Study event rates (%)		Relative effect (95% CI)	Anticipated absolute effects	
							With SC	With add-on devices		Risk with SC	Risk difference with add-on devices
ADR											
5785 (7 RCTs)	serious[a]	serious[b]	serious[c]	not serious	none	⨁◯◯◯ Very low	1189/2890 (41.1%)	1331/2895 (46.0%)	RR 1.18 (1.02 to 1.37)	411 per 1000	74 more per 1000 (from 8 more to 152 more)
PDR											
3675 (5 RCTs)	serious[a]	serious[b]	serious[c]	not serious	none	⨁◯◯◯ Very low	934/1838 (50.8%)	1013/1837 (55.1%)	RR 1.10 (0.96 to 1.26)	508 per 1000	51 more per 1000 (from 20 fewer to 132 more)
AADR											
3985 (4 RCTs)	serious[a]	serious[b]	serious[c]	not serious	none	⨁◯◯◯ Very low	352/1997 (17.6%)	369/1988 (18.6%)	RR 1.00 (0.79 to 1.27)	176 per 1000	0 fewer per 1000 (from 37 fewer to 48 more)
Sessile ADR											
5029 (4 RCTs)	serious[a]	not serious	serious[c]	not serious	none	⨁⨁◯◯ Low	148/2521 (5.9%)	172/2508 (6.9%)	RR 1.17 (0.95 to 1.44)	59 per 1000	10 more per 1000 (from 3 fewer to 26 more)

a. This domain was downgraded by 1 point, because there was evidence of performance and detection bias in all studies included this review

b. This domain was downgraded by 1 point, because there was evidence of heterogeneity in this outcome

c. This domain was downgraded by 1 point, because of differences in population (applicability), interventions, and outcomes measures (surrogate outcomes) among the studies

ADR, adenoma detection rate; PDR, polyp detection rate; AADR, advanced adenoma detection rate; CI, confidence interval; RR, risk ratio

explanations