Endoscopic Improvement of the Adenoma Detection Rate during Colonoscopy – Where Do We Stand in 2015?

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Introduction

Colorectal cancer remains a dangerous threat to the health of mankind [1]. Although colon cancer screening programs were initiated in the industrialized world, the risk of colon cancer development after a negative colonoscopy – defined as interval carcinomas – remains a problem yet to be addressed [2]. Therefore, improving the adenoma detection rate (ADR) during colonoscopy is the future key tool in preventing colorectal cancer mortality and morbidity [3]. The ADR is defined as the fraction of patients undergoing screening colonoscopy in whom at least one or more adenomas can be detected [4].

For example, a mathematical model has shown that an improvement of the ADR of 1% prevents 3% human beings from the often fatal diagnosis of colon cancer [5, 6]. In this review we will highlight factors, improvements and technical advances, which will be important in our future endeavor of preventing colon cancer. In patients undergoing standard colonoscopy for colon cancer screening, an overall quality target ADR of at least 20% is recommended by the American Society of Gastrointestinal Endoscopy [4].

Table 1 gives the readers an overview about current factors influencing the ADR.
Factors Influencing the ADR

Patient-Dependent Factors Influencing the Adenoma Incidence

Age

Age plays a pivotal role in colon cancer development and the likelihood of adenoma detection rises with age. Data from a large Korean cohort have shown that especially over and above the 4th decade of life, the ADR reaches 28% as compared to the 2nd decade of life when it is only 14% [7]. Comparable results were published in a large European register [8, 9]. Data from the United States [10] endorse European and Asian experiences and stress the importance of raising ADR in patients above 50 years of age. Data from Africa are difficult to obtain (just like it is in other developing countries), but newly published data display the same increase of ADR in an African population [11] over and above the 5th decade of life. In conclusion, the positive correlation of higher adenoma incidence with subsequently higher ADRs and higher age is a global phenomenon.

Gender

Knowing that male patients >50 years of age are at a higher risk for having colon adenomas, an ADR of 25% was recommended for male patients, while female patients of the same age peer group should have an ADR of 15% [12]. Male gender was also identified as a risk factor for higher adenoma incidence in a European population [13]. A newly established risk score found a strong association with the male gender (p < 0.0001) [14]. Although in general, male gender is a well-established factor for the adenoma problem of the colon, other factors do also play a role. For example, the parathyroid hormone level is related to advanced adenomas in the distal colon of women [15].

Colonic Distribution of Adenomas

Colon adenomas are not equally distributed in the colon. Recently published data from the Medical College of Wisconsin, from Mississippi and Texas have shown that serrated adenomas are more often found in the cecum and colon ascendens as compared to the colon transversum and colon sigmoideum [16]. Other data show an increased incidence in the left-sided colon as described in a Saudi Arabian cohort [17]. Data from Germany stress the likelihood of polyp detection in the left-sided colon [18], while data from the United States show advanced adenomas in the proximal colon in 20% of the cases [19].

Table 1. Factors influencing the ADR

<table>
<thead>
<tr>
<th>ADR</th>
<th>Examiner-dependent factors</th>
<th>Patient-dependent factors</th>
<th>Procedure-dependent factors</th>
<th>Endoscopic devices</th>
<th>Technical improvements</th>
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<td>Higher</td>
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<td>Higher</td>
<td>Male gender</td>
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<td>Higher</td>
<td>Optimal bowel preparation</td>
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<td>Higher</td>
<td>No effect</td>
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<td>Higher</td>
<td>Aspirin intake</td>
<td>Higher</td>
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<td>Higher</td>
<td>Presence of fundic gland polyps</td>
<td>Higher</td>
<td>Higher</td>
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<td>No effect</td>
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<tr>
<td>Lower</td>
<td>Vegetable food fibers</td>
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Overall, there is still uncertainty in the colonic distribution debate. Hetzel et al. [20] lined out, that factors correlating with the expertise of both endoscopist and pathologist contribute to this finding.

NSAR

There are several studies involving the question of NSAR intake and adenoma occurrence. Recent data highlighted the growing number of successful correlation of NSAR usage and a decrease in adenoma incidence [21].

Aspirin is long said to be beneficial for the prevention of colorectal cancer. Recent data have shown a protective effect for low-dose aspirin [22]. Especially, proximal adenoma development seems to be positively influenced. Patients with familial adenomatous polyposis also seem to profit from less adenoma development [23]. However, aspirin intake might be associated with several adverse effects. Future studies are necessary to measure the risk to benefit ratio of chemoprevention with aspirin [24].
Fundic Gland Polyps
On the one hand, Genta et al. [25] have found a correlation of fundic gland polyps (FGP) of the stomach with a higher ADR of colon adenomas in women over 60 years of age. Men seem to have a higher incidence of hyperplastic polyps. On the other hand, Teichmann et al. [26] have shown that the prevalence of colon cancer is higher in all patients with FGP. Studies from Jung et al. [27] figured out that in their FGP cohort, nearly 45% of the patients had adenomas or carcinomas of the colon, whereas in the control group, only 9% had adenomas and 14% hyperplastic polyps. Due to the correlation of FGP and adenomas of the colon, a thorough diagnostic work-up of these patients is recommended.

Nutrition
There is growing evidence that nutrition and body weight have significant impact on the colorectal cancer incidence. Elevated body mass index (BMI) was positively associated with an increased risk for distal colon cancer, whereas physical activity showed an inverse relationship to cancer incidence [28]. Furthermore, the metabolic syndrome itself is associated with an increased colon cancer risk [29]. A BMI >25 kg/m² was identified as an independent risk factor for adenoma development in the colon [30].

The Adventist Health Study proved that cooked green vegetables, dried fruit and legumes significantly reduced the incidence of colonic polyps [31]. Furthermore, total fiber intake was dose dependent and negatively associated with the occurrence of adenomas of the colon [31]. Again, fibers from vegetables seem to be the most effective way to prevent colon cancer. Both a high intake of red meat and a low intake of calcium were associated with polyp growth [32]. Food supplementation such as multivitamin intake and calcium supplementation also seems to be beneficial in this context [33]. Alcohol consumption was associated with an increased risk for advanced adenomas [34].

The COLON study will provide further data on this interesting field of science as it is Europe’s largest ongoing multi-center prospective observational study [35].

Patient-Dependent Factors Influencing the ADR
Bowel Preparation
It is not surprising that a clean bowel is a precondition for the performance of a successful colonoscopy. This simple fact is underlined by multiple studies and guidelines [36–38]. A good bowel preparation is identified as a quality marker for colonoscopy [10]. Thus, insufficient preparation is associated with a significant decrease in adenoma detection [39]. Current data show that the increase in the amount of fluid intake and split dose does have significant impact on the cleanliness level in the colon [40]. Direct controlled, randomized, head-to-head comparisons of bowel preparation agents are rare. For example, the comparisons between 2-liter polyethylene glycol with ascorbic acid vs. sodium picosulfate with magnesium citrate showed no differences in the cleaning outcome [41].

Examiner-Dependent Factors Influencing the ADR
In addition to the aforementioned patient-dependent factors influencing the ADR, there are a couple of important examiner-dependent factors that contribute to an improved ADR.

Endoscopist Expertise
The expertise of the examiner is one important aspect. Rabeneck et al. [42] found that the endoscopist’s specialty, in this case surgeon vs. gastroenterologist, shows a significant impact on incidental colorectal cancer. Baxter et al. [43] found a strong association between a positive screening result and a gastroenterologist specialization of the endoscopist. Furthermore, the factor ‘expertise of the endoscopist’ seems to be more important than other factors like male gender or age for the ADR [44]. Performance improvement programs seem to have the potential of improving the ADR in inexperienced endoscopists [45].

Withdrawal Time
Obviously, the withdrawal time is another important factor for the ADR. Therefore, guidelines recommend at least 6 min of withdrawal time as a quality marker [4, 46, 47]. Longer withdrawal times frequently result in a higher ADR just as data from the QIC study demonstrate [48]. There are several studies that underline this important finding [49, 50]. Although longer withdrawal times seem to improve the ADR, yet there is lack of evidence that this does have an impact on colorectal cancer mortality [51].

Cecal Intubation Rate
A complete colonoscopy is the key to success for the desired screening goal. Therefore, guidelines recommend cecal intubation success rates above 90% [52]. Reasons why this goal might not be achieved are female gender, previous abdominal surgery, colitis and diverticulitis or inadequate bowel preparation [3]. Incomplete colonoscopy was identified as an independent risk factor for colorectal cancer [53].
Participation of a Second Investigator

The principle ‘four eyes see more than two eyes’ becomes true even for determining the ADR. Recent data show that the presence of a gastroenterologist trainee significantly improves the ADR [54].

Surely done to a certain degree in every day’s practice, the alert assistant nurse contributes to an improved ADR. Kim et al. [55] reported an improved polyp detection rate and a trend for an improved ADR. A multicenter, randomized, prospective trial by Lee et al. [56] even showed evidence for an improved ADR, if an experienced nurse was involved as an observer. However, data on this phenomenon are inconsistent and require further investigation [57] and it is unlikely that smaller institutions are able to provide an extra nurse just for observation.

Back-to-Back Colonoscopy

In 1997, Rex et al. [58] conducted the first study to determine the miss rate of colonoscopy by same-day back-to-back colonoscopy. Two consecutive same-day colonoscopies were performed in a total of 183 patients and the overall miss rate for adenomas was 24% showing superiority in adenoma detection by back-to-back colonoscopy. This technique is now often used in studies comparing new endoscopic devices for adenoma detection improvement to overcome the lack of study blinding [59–62]. In another large multicenter study conducted in 2008 by Heresbach et al. [63] with same-day back-to-back video colonoscopy done by 2 different operators in a randomized order and blinded to the other examination, 20% of adenomas that were missed at first colonoscopy could additionally be detected. In conclusion, back-to-back colonoscopy improves the ADR. However, performing 2 colonoscopies would definitely double the risk of procedure-related side effects like bleeding or perforation and would therefore be no option for colon cancer screening programs.

Technical Aspects

Cap-Assisted Colonoscopy

Cap-assisted colonoscopy (CAC) is a procedure technique, in which colonoscopy is done with a transparent cap attached to the distal tip of the colonoscope (fig. 1). The diameter of the cap varies depending on the size of the scope. In most studies, caps with 4 mm depth are used [64, 65]. In recent years, performance of CAC has increasingly become popular among gastroenterologists.

In a prospective and randomized study to evaluate the clinical impact of cap-assisted colonoscopy, Frieling et al. [66] found a significant higher cecal intubation time when using a transparent cap. However, there are contradictory results for improving the ADR. Some studies found ADR improvement when using CAC (ADR 69 vs. 56%, p = 0.009 [67], 35.7 vs. 28.3%, p = 0.012 [64]). On the other hand, a 2-center Dutch trial by de Wijkerslooth et al. [68] failed to show adenoma detection improvement. There is evidence that CAC might improve the detection rate of serrated adenomas as stated by Rzouq et al. [69]. Nevertheless, cap-assisted colonoscopy seems to speed up the cecal intubation and might be of some use. Its role in ADR improvement has not yet been fully defined.

Water Immersion and Water Exchange Colonoscopy

Using water immersion or water exchange during colonoscopy is another interesting technique. One major advantage is the improvement of the colon cleanliness, which has a tremendous effect on the visualization of the colonic mucosa. The more mucosa surface is adequately inspected, the more adenomas can be found. The first randomized controlled trial analyzing water immersion colonoscopy compared to standard colonoscopy was conducted by Leung et al. [70] in 2010. The authors conclude that the use of water immersion technique leads to a decrease in discomfort, time to reach the cecum, and the amount of sedative and analgesic use.
The role of water immersion technique during colonoscopy has not yet been fully defined. However, in a recently published Cochrane meta-analysis including 16 randomized controlled trials consisting of 2,933 colonoscopies, a slightly improved ADR with water infusion (risk ratio 1.16, 95% CI 1.04–1.30, p = 0.007) could be found. Improved adenoma detection might be due to the cleansing effects of water infusions on the mucosa [71]. Although there is evidence that water exchange colonoscopy compared to the water immersion technique further reduces patient discomfort during colonoscopy [72], data showing overall superiority for ADR are still missing. However, Hsieh et al. [73] could find an increased ADR in the right hemicolon in a prospective, single center, patient-blinded trial.

EndoCuff®, EndoVision® and EndoRings®

The EndoCuff (Arc Medical Ltd., Leeds, UK) is a flexible plastic cuff with 2 rows of soft wings that help flatten the colonic mucosa during withdrawal (fig. 2). The first results were published in 2012 in Great Britain by Tsiamoulous and Saunders [74] who used the cuff for complex mucosectomy as stabilizing tool. Meanwhile, this device is approved by the US-American and European authorities for broad colonoscopic use. The first larger case series was published in 2014 by Lenze et al. [75] showing promising results for adenoma detection and no major side effects. In a recently published Swiss feasibility study with analysis of 104 EC-assisted colonoscopies, a good ADR of 47% was measured [76]. Biecker and Floer published 2 larger randomized controlled trials showing superiority of EndoCuff-assisted colonoscopy in terms of ADR [18, 77]. The ADR significantly increased with the use of the EndoCuff compared to standard colonoscopy (35.4 vs. 20.7%, p < 0.0001). A recently published Japanese-simulated randomized study involving an anatomic colorectal model further supports the benefit of EndoCuff application for ADR improvement [78]. On the other hand, in one recently published large randomized controlled trial from the Netherlands, the use of EndoCuff was not associated with a higher ADR [79]. In that study, 1,063 patients were randomized either to EndoCuff or standard colonoscopy. For adenoma detection, the ADR was not significantly different between the 2 groups (52% each, p = 0.92). The mean adenoma number per patient did not differ significantly in the EndoCuff group compared to SC (1.36 vs. 1.17, p = 0.08). One explanation for the non-superiority of EC in terms of ADR might be the highly selected patient cohort with an ADR of 52%. Moreover, the median withdrawal time in the SC group was significantly higher (8 min vs. 7 min, p = 0.01) possibly causing a significant bias in adenoma detection.

Several prospective trials analyzing the role of EndoCuff-assisted colonoscopy in ADR improvement are currently conducted worldwide to possibly let us draw further conclusions in favor or against the use of EndoCuff (ClinicalTrials.gov identifier NCT02340065, NCT01761097, NCT02387593, NCT02374515, NCT02331836, NCT02345889). EndoCuff Vision (Arc Medical Ltd., Leeds, UK), the next generation EndoCuff, differs from EndoCuff in its shape with longer rubber arms and only one row. However, prospective studies comparing EndoCuff and EndoVision for ADR are not yet available.
The EndoRings™ (EndoRings; Endo-Aid, Caesarea, Israel) distal attachment is an endoscopic add-on device made from silicone, a flexible polymer (fig. 3). This device is FDA approved and distributed in the United States and Europe. Its use, however, is similar to the EndoCuff. Instead of flexible wings, EndoRings consist of flexible rings. During withdrawal of the endoscope, the rings center the scope and smooth the colon folds, possibly enhancing the scope’s field of view and improving visualization of the colonic mucosa. Recently, the first tandem study from the United States, Israel and the Netherlands comparing EndoRings assisted with standard colonoscopy has just been completed (ClinicalTrials identifier NCT01955122). Also recently, the first multicenter, randomized trial comparing EndoRings with standard colonoscopy (CLEVER study) was published by Dik et al. [80]. In that study, the adenoma miss rate (15%) in subjects undergoing EndoRing-assisted colonoscopy first was statistically and significantly (p < 0.01) lower compared to subjects who underwent standard colonoscopy first (48%). Further studies are clearly necessary to prove superiority of EndoRings to EndoCuff and standard colonoscopy. One advantage of the EndoCuff compared to EndoRings might be the fact that the intubation of the terminal ileum can easily be performed. In all prospective studies available for EndoCuff, the rate of ileum intubation did not differ statistically compared to standard colonoscopy [18, 77]. Thus, colonoscopy with EndoRings is therefore limited to the colon.

**Retroflexion**

Endoscopic retroflexion during colonoscopy has been used for more than 15 years. It is commonly believed that the visualization of the hemorrhoids and the distal rectum might be enhanced by rectal retroflexion [81]. However, in the prospective study by Saad and Rex [82], the authors concluded that routine performance of retroflexion has a very low yield for neoplasia and is not routinely required to achieve a highly effective colonoscopy. In that study with 1,052 patients, 7 polyps were visualized only by retroflexion (6 hyperplastic sessile polyps, one 4-mm sessile tubular adenoma) without any clinical impact. Moreover, Hanson et al. [83] found only 4 additional rectal polyps by rectal retroflexion. One must also keep in mind that retroflexion maneuver bears a substantial risk of perforation reaching up to 10% [84, 85]. Thus, the value of retroflexion in terms of ADR and higher risk for perforation is limited. Kushnir et al. [86] performed a randomized, controlled, 2-center trial in which patients undergoing screening or surveillance colonoscopy were randomized to a second exam of the proximal colon in forward or retroflexion view, and ADRs were compared. The ADR was similar in both groups (p = 0.75) with no significant benefit in favor of retroflexion of the proximal colon.

**High Definition Television**

High definition television (HDTV) technique is the state-of-the-art technique for the new endoscope generation. Since its introduction, HDTV has become commonly available for screening endoscopy centers in industrialized countries. Although the advantages like a brighter screen, better resolution and imaging are obvious, little scientific data were published on the question of improv-
ing the ADR by HDTV technique in contrast to elderly TV techniques. For example, Schachschal et al. [87] reported an accuracy rate of 76% for the correct distinction of hyperplastic from adenomatous polyps, which is not enough to forego a histopathological examination of these polyps. Another study showed no difference of narrow band imaging (NBI)-HDTV compared to white light HDTV [88]. Due to the fact that older endoscopy systems will be replaced in the future by HDTV techniques, HDTV is regarded as the future standard for screening colonoscopy.

**NBI/FICE, i-Scan**

Image enhancement is technically easy by integrating it into the colonoscopy procedure. Techniques such as i-Scan (PENTAX Europe GmbH, Hamburg, Germany), NBI (Olympus Ltd., Tokyo, Japan) or flexible spectral imaging color enhancement (FICE, Fujifilm Corp., Tokyo, Japan) allow an optically easier detection of irregularities of the mucosa. Therefore, the potential benefits of these techniques were evaluated in a couple of randomized controlled trials addressing ADR. A recent meta-analysis of 42 studies revealed, that neither NBI nor FICE was able to improve significantly the ADR in patients at average risk for a colon carcinoma [89]. A possible value of these methods seems to arise in the IBD setting or in patients at high risk for CRC like Lynch syndrome [90, 91]. Derived from concerns of rising costs for the histopathological examination of small polyps (<5 mm) in conjunction with the low potential of malignancy in these diminutive polyps, an ASGE committee reviewed the possibility of optical biopsy using NBI, FICE or i-Scan [92]. Their data support a ‘diagnose-and-leave’ strategy with a negative predicted value above 90% for malignancy in the rectosigmoid if the colonoscopy was performed in an academic setting by endoscopy experts using NBI.

**Zoom Endoscopy**

Magnifying colonoscopy or ‘zoom’ endoscopy was introduced in the 1990s by Japanese working groups [93]. Early data postulated an accuracy rate as high as 92% for neoplastic lesions [94], which could not be confirmed in later studies [95]. In combination with ‘classical’ chromoendoscopy, the hope was to significantly improve the ADR [96].

A combination of computer-based assessments of polyps with NBI and Zoom was introduced in 2013 and showed an accuracy rate of 96% [97]. In 2015, the combination of NBI and zoom technology showed promising results with a negative predictive value of 96% for assessment of non-neoplastic polyps in the rectosigmoid [98].

Although all zoom techniques have good results in single-center, retrospective and observational trials, powerful randomized multicenter trials are missing. It is unlikely that these trials will be conducted, since the research focus has shifted to newly available ADR-improving technologies.

**New Technical Equipment for ADR Improvement**

Recent technical advances led to the development of new endoscopes. The full-spectrum endoscopy unit (EndoChoice, Alpharetta, Ga., USA) contains additional lateral optics at the tip of the scope, which leads to a panoramic 330° field of view. In a recently published randomized controlled trial, conducted by Gralnek et al. [99], the adenoma miss rate was significantly lower with the use of a novel full-spectrum endoscopy platform as compared to standard colonoscopy. In the NaviAid G-EYE colonoscope (Smart Medical Systems Ltd., Ra’anana, Israel), an integrated inflatable balloon at the tip of the scope helps to flatten the colonic folds. Halpern et al. [100] compared the adenoma detection and miss rates between the G-Eye balloon colonoscope and standard colonoscopy in a randomized tandem study with 126 patients. The authors found a significantly lower adenoma miss rate by use of the balloon colonoscope compared to standard colonoscopy (7.5 vs. 44.7%; p = 0.0002). In contrast to new assembled colonoscopes, the ‘Third Eye Retroscope’ (Avantis Medical Systems, Sunnyvale, Calif., USA) uses an additional tiny endoscope, which is introduced into the working channel of the colonoscope. This enables a retrograde look through the bending of the retroscope to 180°. The first positive results were published by the Third Eye study group in 2010. DeMarco et al. [101] conducted an open-label, prospective, multicenter study at 9 sites located in the United States, involving 298 patients. The use of the Third Eye retroscope in combination with a standard colonoscope was evaluated. The authors found a mean additional detection rate for adenomas of 25.0%. In the study subgroup analysis of the TERRACE study group [102] conducted by Peter Siersema in 2012, patients were scheduled for colonoscopy for screening, surveillance or diagnostic workup, and each underwent same-day tandem examinations with standard colonoscopy and Third Eye colonoscopy, randomized to standard colonoscopy followed by Third Eye colonoscopy or vice versa. In that study with an enrollment of 345 patients...
excess dye on the mucosa following extensive washing to get rid of mucolytic agent like N-acetylcysteine is usually sprayed on the mucosal epithelium. Prior to methylene blue application, the are taken up by actively absorbing tissues such as the co-

In summary, the development of new endoscopes is promising and leads in most cases to an increase of the ADR. However, often complex technical investment is necessary, making broad use in screening programs difficult and expensive.

Staining Techniques during Colonoscopy

Chromoendoscopy or tissue staining in the hope of better visualization of lesions has been used for different parts of the upper and lower GI tract over the last 30 years [105]. Vital stains such as methylene blue or cresyl violet are taken up by actively absorbing tissues such as the colonic epithelium. Prior to methylene blue application, the mucolytic agent like N-acetylcysteine is usually sprayed on the mucosa following extensive washing to get rid of excess dye [106]. A 0.2% solution of cresyl violet can be sprayed after indigo carmine to enhance the diagnosis of characteristic pit patterns of depressed early colorectal carcinomas [105].

One typical representative of contrast stains is indigo carmine. This dye is not absorbed by colonic epithelium. It rather enhances irregular patterns in flat lesions and is used in combination with high definition and magnification endoscopy. The pit pattern classification according to Kudo et al. [93] is often used to further characterize colonic lesions according to their shape. The application of indigo carmine might additionally improve adenoma detection. However, in the study by Apel et al. [107], the overall accuracy rate to distinguish hyperplastic from adenomatous polyps increased after dyeing with indigo carmine from 81 to 83%. The increase of accuracy was even higher in the study by Su et al. [108] showing an accuracy rate of 92.7% for chromoendoscopy compared to 81.8% for standard colonoscopy. In summary, the application of methylene blue or indigo carmine helps to differentiate hyperplastic from adenomatous polyp. In a recently published meta-analysis including 42 randomized controlled trials, the ADR significantly improved by the use of methylene blue (relative risk (RR) 2.39, 95% CI 1.18–4.84) or indigo carmine in patients with ulcerative colitis (RR 1.33, 95% CI 1.20–1.48) [89]. However, its broad use might be limited by the time-consuming effect of dye application.

Discussion

Standard colonoscopy remains the gold standard in the detection of colorectal adenomas. Major factors that need to be focused on for the improvement of the ADR should be the expertise of the investigator of this highly user-de-
dependent technique. ADR improvement should start with optimal bowel-cleansing results, correct withdrawal times, meeting the quality markers for screening colonoscopy as stated by the ASGE and patient adherence to screening intervals. Meanwhile, a whole set of technical innovations are available on the market for further improvement of the ADR. Some of these techniques like FUSE, G-Eye or retroflexion colonoscopy are promising but require new expensive equipment. Staining techniques might be useful in selected patients with ulcerative colitis to better identify adenomatous tissue but are too time consuming for broad use in screening programs. Water infusion technology clearly improves the colon cleanliness and therefore improves ADR. However, whether this laborious procedure will be accepted for colorectal screening is yet a matter of debate. The use of transparent caps does not continuously prove ADR improvement but might be useful to speed up the cecal intubation time.

EndoCuff-assisted colonoscopy is a promising tool to enhance the ADR, but not all randomized trials showed superiority of EndoCuff vs. standard colonoscopy in terms of ADR. More clinical data are necessary to further analyze it usefulness in screening programs. However, the use of EndoCuff is possible in a timely fashion without any major side effects and without the need for the acquisition of technical equipment. Final results of the CLEVER study with EndoRings are now available with positive study results in favor of EndoRings compared to standard colonoscopy.

In summary, the endoscopist’s expertise, optimal bowel preparation and optimal performance of a colonoscopy combined with technical advances help to prevent possible colorectal cancer death.

Disclosure Statement

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Ethics

This review complies with the guidelines for human studies and animal welfare regulations. No animal experiments were performed.
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