Ther Adv Gastroenterol

2025, Vol. 18: 1–12

DOI: 10.1177/17562848251338672

New chapter in precision medicine: strategies for endoscopic resection of 10–20 mm non-pedunculated colorectal polyps

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***Abstract*:** The preferred resection methods for 10–20 mm non-pedunculated lesions remain unclear. This review summarizes the current methods and novel technologies for resecting 10–20 mm non-pedunculated colorectal polyps, mainly focusing on hot snare polypectomy, cold snare polypectomy (CSP), endoscopic mucosal resection (EMR), and endoscopic submucosal dissection (ESD). The application of novel techniques involving bipolar snares and low-power pure-cut is expected to reduce adverse events (AEs) related to thermal damage, but prospective studies are needed to confirm their reliability. CSP, including conventional CSP and submucosal injection CSP (SI-CSP), maintains resection efficacy with dedicated snares or submucosal injection for regular non-pedunculated polyps and serrated lesions with a low AE rate of 0.0%–3.4%. Modified EMR techniques such as underwater EMR, tip-in EMR, and EMR-circumferential precutting demonstrate a 15.0%–20.0% increase in en bloc resection rates compared with conventional EMR while also reducing AEs. ESD is recommended as the preferred method for medium-sized colorectal lesions with suspected submucosal invasion, fibrosis, particularly when the procedure is technically challenging. In addition, optical diagnosis is essential for pathological assessment and precise resection. Also, postoperative follow-up is needed for high-risk lesions and cases with unsatisfactory resection.

Keywords: cold snare polypectomy, endoscopic mucosal resection, endoscopic submucosal dissection, hot snare polypectomy, medium-sized, non-pedunculated colorectal polyps

Received: 22 January 2025; revised manuscript accepted: 12 April 2025.

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Introduction

Colorectal cancer (CRC) is one of the most common malignancies, currently ranking third in newly diagnosed cases and second in cancer-related deaths.[1] Moreover, there is an increasing shift in incidence toward the younger population, which poses a severe challenge to public health.[2,3] CRC primarily evolves through the "adenoma–carcinoma" pathway.[4] With advancements in endoscopic technologies, it has been observed that polyps smaller than 10 mm constitute approximately 90% of all detected colorectal polyps. Among these, diminutive (⩽5 mm) and small (6–9 mm) polyps rarely exhibit high-grade dysplasia (HGD).[5] By contrast, polyps ⩾10 mm are associated with significantly higher risks of advanced pathologies, including tubulovillous adenomas, HGD, as well as intramucosal carcinoma, which account for approximately three-quarters of such cases.[6,7] Advanced lesions are linked to an increased mortality rate in CRC, highlighting the importance of timely and effective management of high-risk non-pedunculated polyps.[8–10]

Various endoscopic methods, including hot snare polypectomy (HSP),[11] CSP,[12] endoscopic mucosal resection (EMR),[13] and endoscopic submucosal dissection (ESD),[14] have been applied in resecting colorectal lesions. Compared to surgery, endoscopic polypectomies have several advantages, such as precise excision, minimal invasion,

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few AEs, and quicker recovery, which have become the preferred strategies for early gastrointestinal polyps.[15–17] Currently, the available data suggest that CSP is optimal for regular, benign colorectal polyps <10 mm,[16,18,19] while EMR or ESD should be reserved for adenomatous lesions with large size (>20 mm), HGD or carcinoma with submucosal invasion.[20–22] Nevertheless, for the resection of 10–20 mm non-pedunculated polyps, which are high risk and strongly associated with the development of carcinoma,[23,24] current evidence does not definitively favor a single resection technique[15,25–27] (Table 1); high-quality prospective evidence remains limited to guide optimal clinical practice (Table 2). This narrative review aims to summarize current research on the endoscopic resection of 10–20 mm non-pedunculated polyps, serving as a clue for selecting the appropriate methods in clinical practice and guiding future investigation.

Hot snare polypectomy

HSP (Figure 1(a)) remains a recommended technique for the removal of 10–20 mm non-pedunculated colorectal polyps.[21,22] Nevertheless, HSP faces challenges, primarily due to HSP-associated AEs such as bleeding and abdominal pain caused by electrocoagulation-induced thermal damage.[28] It is imperative to modify techniques for reducing the risk of complications. This section aims to review novel strategies designed to improve the safety of HSP.

The introduction of bipolar snares is designed to enhance safety during HSP, which can restrict the current to the lesions, thus reducing thermal injury to surrounding tissues. When resecting polyps measuring 10–15 mm in ex vivo porcine models, unlike conventional monopolar snares, hot polypectomy using a bipolar snare resulted in no perforations. Furthermore, thermal injury was limited to the superficial submucosal layer, with minimal depth of tissue damage. These preliminary findings suggested that bipolar snares might provide a safety profile for medium-sized polyp resection.[29] The study by Minakata et al. also found comparable performance between HSP versus EMR using bipolar snares, with en bloc resection rates of 93.2% versus 92.3% ($p = 0.81$) and complete resection rates of 77.8% versus 80.3% ($p = 0.64$) for 10–15 mm polyps.[30] It should be noted that these findings are based on small samples and retrospective analyses, which may be subject to selection bias and confounding factors. Prospective, randomized controlled trials are needed to validate these results.

A novel low-power pure-cut HSP (LPPC HSP, power: 110 W) is developed and utilized in a porcine model. Imai et al. initially found that LPPC demonstrated a low AE rate with the rate of muscularis propria damage of 0.0%, compared to 13.0% for the conventional blend current (Endocut, power: 340 W). Prospective clinical trial revealed that LPPC resection achieved a complete resection rate of 85.7% (84/98) for 10–14 mm sessile adenomas.[31] Compared to conventional EMR, Kimura et al. further demonstrated that LPPC HSP achieved comparable efficacy in sessile adenoma resection, with en bloc resection rates of 95.8% versus 97.5% ($p = 0.72$) and complete resection rates of 90.0% versus 91.7% ($p = 0.82$). Importantly, no delayed bleeding or perforations were observed.[32] The novel method is expected to reduce the risk of complications while maintaining resection efficiency comparable to traditional techniques.

AEs associated with HSP must be given sufficient attention. Preliminary evidence suggested that the introduction of bipolar snares and LPPC represented a novel advancement in reducing thermal injury, which might be particularly beneficial for patients with coagulation disorders. However, given the limited high-quality evidence supporting the practical application,[33] these technologies should be used with caution. More high-quality prospective trials are urgently needed to evaluate the performance and safety profiles of these techniques for treating 10–20 mm non-pedunculated polyps. While novel modifications demonstrate promising safety, the limitations of HSP prompt further examination of alternative techniques such as EMR.

Endoscopic mucosal resection

EMR (Figure 1(b)) is widely used for treating non-pedunculated adenomatous polyps with a middle size (10–20 mm), large size (>20 mm), or advanced pathology, as well as carcinoma with potential submucosal invasion.[13,34–36] However, concerns remain regarding the effectiveness and safety of EMR for 10–20 mm non-pedunculated colorectal polyps. First, submucosal injection

Table 1. Current resection methods only for 10–20 mm non-pedunculated lesions recommended by guidelines and the resection outcome from studies.

Techniques	Relevant guidelines	Evidence grades	Recommendation grades	En bloc resection rates (%)	Complete resection rates (%)	Rates of AEs (%)	Recommendations
HSP	UMTF[21]; ESGE[22]	UMTF: low-quality evidence; ESGE: high-quality evidence.	UMTF: conditional recommendation; ESGE: strong recommendation.	68.0–93.2	77.8–82.0	0.4–1.6	UMTF: 10–19 mm non-pedunculated lesions; ESGE: 10–19 mm non-pedunculated adenomatous polyps.
Bipolar snares for HSP[30]	NA	NA	NA	93.2	77.8	1.7	NA
LPPC HSP[31,32]	NA	NA	NA	95.8	85.7–90.0	0.0	NA
Conventional EMR[36,44,47,48]	UMTF	NA	Uncertain	73.1–86.0	50.0–98.1	2.0–6.4	10–19 mm noninvasive non-polypoid lesions and serrated lesions proximal to the sigmoid colon; 10–19 mm lesions with suspected minimal or moderate risk for submucosal invasion if complete resection is feasible and safe; difficult location to completely remove using other methods.
U-EMR[44,43]	NA	NA	NA	81.5–89.0	69.0–97.9	2.8–4.1	NA
EMR-P[47,48]	NA	NA	NA	94.3–98.0	78.8–87.8	9.1	NA
Tip-in EMR[49–52]	NA	NA	NA	81.6–94.7	70.2–90.2	0.0–11.0	NA
ESD	UMTF; ESGE	UMTF: NA; ESGE: moderate-quality evidence.	UMTF: NA; ESGE: strong recommendation.	NA	NA	NA	UMTF: 10–19 mm lesions with suspected minimal or moderate risk for submucosal invasion if complete resection is feasible and safe; difficult location to completely remove using other methods; non-lifting lesions. ESGE: the suspected superficially invasive carcinoma that cannot be removed en bloc by other polypectomies.
CSP[12,26,56,57]	UMTF	Low-quality evidence.	Conditional recommendation.	73.2–98.8	71.0–100	0.0–0.1	10–19 mm non-pedunculated lesions
SI-CSP/Cold EMR[15,62,63]	ESGE	Moderate-quality evidence.	ESGE: strong recommendation.	62.2–96.2	63.8–99.0	0.0–3.4	SSLs of all sizes without suspected dysplasia.

AEs, adverse events; CSP, cold snare polypectomy; EMR, endoscopic mucosal resection; EMR-P, EMR-circumferential precutting; ESD, endoscopic submucosal resection; ESGE, European society of gastrointestinal endoscopy; HSP, hot snare polypectomy; LPPC HSP, low-power pure-cut hot snare polypectomy; NA, not applicable; SI-CSP/cold EMR, submucosal injection cold snare polypectomy/cold endoscopic mucosal resection; SSLs, sessile serrated lesions; Tip-in EMR, the tip of the snare in endoscopic mucosal resection; U-EMR, underwater endoscopic mucosal resection; UMTF, US multi-society task force.

Table 2. Prospective trials of different polypectomies for 10–20 mm colorectal non-pedunculated polyps.

Author	Year	Study design	Patients/ polyps	Polypectomy	Polyp size (mm)	Morphology	R0 resection rate	En bloc resection rate	Rate of adverse events
Takeshi Yamashina et al.[44]	2019	Multicenter, randomized, controlled study	210 polyps from 210 patients	U-EMR vs C-EMR	10–20	Non-pedunculated	69% vs 50%, $p=0.011$	89.0% vs 75.0%, $p=0.007$	2.8% vs 2.0%, $p>0.05$
Yohei Yabuuchi et al.[62]	2020	Single-arm, prospective, observational study	80 polyps from 72 patients	Cold EMR/SI-CSP	10–14	Non-pedunculated	63.8%	82.5%	0.0%
Zhang Xue-Qun et al.[47]	2022	Multicenter, randomized, controlled study	220 polyps from 220 patients	EMR-P vs C-EMR	10–20	Non-pedunculated	81.1% vs 76.6%, $p=0.521$	94.3% vs 86.0%, $p=0.041$	9.1% vs 6.4%, $p=0.449$
Dileep Mangira et al.[15]	2023	Multicenter, prospective, observational study	350 polyps from 295 patients	CSP/cold EMR/ SI-CSP	10–19	Non-pedunculated	NA*	NA	3.4%

R0 resection/the histological complete resection: the en bloc resection with a pathologically negative vertical margin and no neoplastic tissue obtained from the margin of the mucosal defect.
*The incomplete resection rate (IRR) of the CSP/cold EMR are 1.7% based on margin biopsies and 0.3% based on central biopsies.
AEs, adverse events; C-EMR, conventional EMR; CSP, cold snare polypectomy; EMR, endoscopic mucosal resection; EMR-P, EMR-circumferential precutting; NA, not applicable; SI-CSP, submucosal injection CSP; U-EMR, underwater endoscopic mucosal resection.

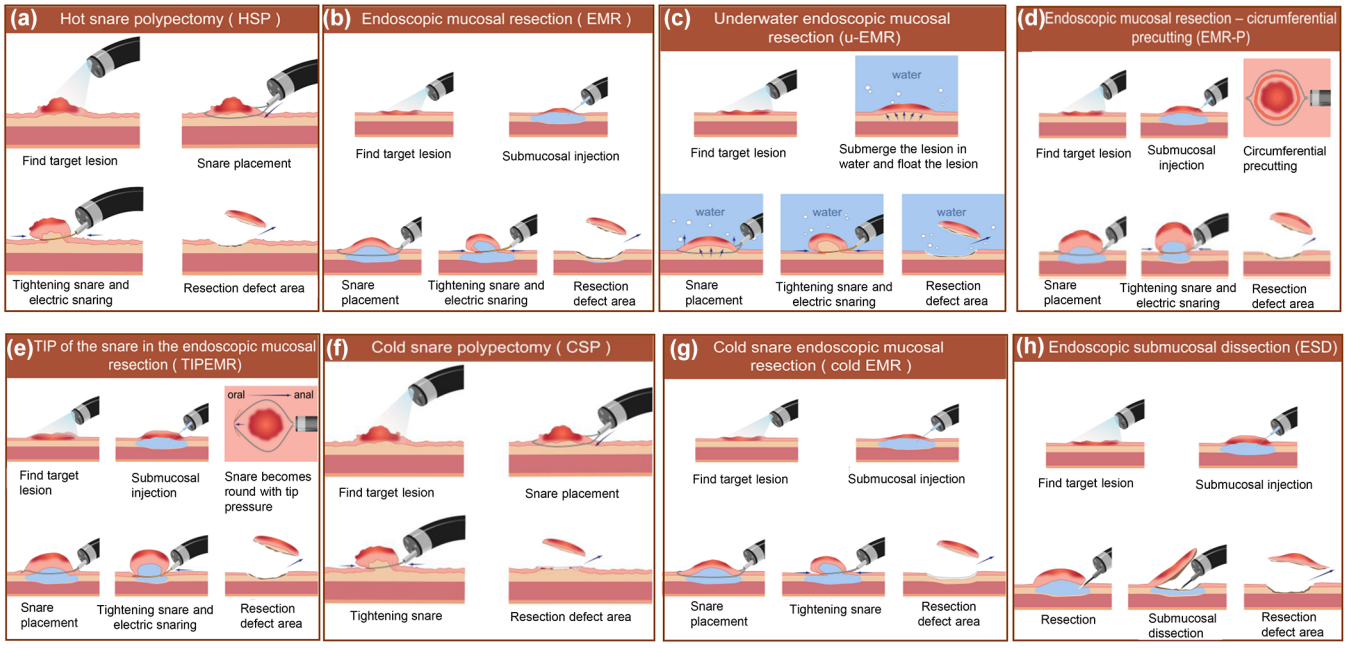

Figure 1. Conventional and novel polypectomies for the removal of 10–20 mm non-pedunculated colorectal polyps. (a) Hot snare polypectomy. (b) Endoscopic mucosal resection. (c) Underwater endoscopic mucosal resection. (d) Endoscopic mucosal resection–circumferential precutting. (e) The tip of the snare in endoscopic mucosal resection. (f) Cold snare polypectomy. (g) Cold endoscopic mucosal resection/submucosal injection cold snare polypectomy. (h) Endoscopic submucosal dissection.

flattens and enlarges lesions, complicating snaring. The efficacy of conventional EMR for 10–20 mm polyps remains suboptimal, with studies reporting unacceptably high incomplete resection rates (IRRs) ranging from 23.3% to 28%.[26,37,38] Second, the use of electrocautery and the risky

resection depth increase the risks of bleeding and perforation.[27] To address these limitations, modified techniques have been developed to enhance the performance of EMR for managing 10–20 mm non-pedunculated polyps. This section summarizes the emerging techniques.

Underwater endoscopic mucosal resection (U-EMR) (Figure 1(c)) is a technique that submerges non-pedunculated polyps in the fluid, making them appear "pedunculated," thereby avoiding submucosal injection and facilitating snaring,[39] which was an efficient and safe alternative to EMR.[40] A meta-analysis by Tziatzios et al. showed that, compared to conventional EMR, U-EMR had a higher en bloc resection rate with a risk ratio (RR) of 1.26 (95% CI: 1.01–1.58)[41] and a lower recurrence rate (RR: 0.52, 95% CI: 0.28–0.94). Another meta-analysis by Wang et al. also indicated that U-EMR can achieve higher rates of en bloc resection (OR: 1.69, 95% CI: 1.36–2.10, $p < 0.00001$) and complete resection (OR 1.67, 95% CI: 1.06–2.62, $p = 0.03$) for sessile and flat polyps ⩾10 mm.[42] Results from another clinical trial by Siau K and colleagues further supported the effectiveness and safety, finding that 97.9% of clinically significant non-pedunculated polyps (⩾10 mm, and 90% adenomatous lesions) were completely resected by U-EMR with a bleeding rate of only 4.1%.[43] A recent multicenter randomized controlled trial conducted by Yamashina et al. compared the performance of U-EMR versus conventional EMR in resecting 10–20 mm non-pedunculated polyps. The findings showed that U-EMR significantly increased the complete resection rate (69.0% (95% CI: 59.0%–77.0%) vs 50.0% (95% CI: 40.0%–60.0%), $p = 0.011$), and the en bloc resection rate (89.0% (95% CI: 81.0%–94.0%) vs 75.0% (95% CI: 65.0%–83.0%), $p = 0.007$), without an increase in AEs (2.8% vs 2.0%).[44] Further post hoc analysis confirmed that the maximum and average resection depth of resected specimens by U-EMR were 1317 and 619 μm, showing no significant difference compared to conventional EMR (1290 and 545 μm).[45] As reported by Rajat Garg, the low recurrence rate of 7.3% (95% CI: 4.3%–12%) after resecting 10–19 mm non-pedunculated polyps with U-EMR further suggested the sufficient resection efficacy.[46] These results indicated that "underwater resection" could be a promising approach for difficult 10–19 mm non-pedunculated polyps that are technically challenging to resect en bloc using conventional EMR.

An emerging technique, EMR-circumferential precutting (EMR-P) (Figure 1(d)), involves using the snare tip to incise the surrounding mucosa prior to polyp removal. Zhang et al. compared EMR-P with conventional EMR for resecting 10–20 mm non-pedunculated polyps and found that EMR-P achieved a significantly higher en bloc resection rate (94.3%, 95% CI: 88.2%–97.4% vs 86%, 95% CI: 78.2%–91.3%, $p = 0.041$). The advantages of EMR-P became increasingly evident with lesions becoming larger, demonstrating a higher en bloc resection rate (92.0% vs 58.8%, $p = 0.029$).[47] Furthermore, Naohisa et al. conducted a retrospective analysis of EMR-P for polyps difficult to remove with conventional EMR, reporting en bloc and complete resection rate of 98.0% vs 85.7% ($p = 0.004$) and 87.8% vs 67.3% ($p < 0.001$), respectively, even when the majority of the polyps were non-polypoid lesions.[48] These findings suggested that EMR-P might serve as an effective alternative to conventional EMR, particularly for 10–20 mm challenging polyps. However, the quality of retrospective evidence is limited by confounding factors and selection bias. Prospective clinical studies are needed to validate its safety, residual rates, and recurrence rates, etc. The Tip of The Snare in Endoscopic Mucosal Resection (Tip-in EMR) (Figure 1(e)) is another technique that is designed to improve the en bloc resection rate of medium and large polyps (⩾10 mm). This method involves anchoring the snare tip to the normal mucosa incision proximal to lesions, followed by one-piece resection, achieving an en bloc resection rate of 90.7% vs 69.8% for tip-in EMR vs conventional EMR when resecting non-pedunculated polyps.[49] Two retrospective studies found that tip-in EMR achieved en bloc resection rates of 82.8% to 94.7% and complete resection rates of 70.2% to 76.3%, significantly outperforming standard EMR for ⩾10 mm polyps, even for non-pedunculated or fibrotic polyps that could not be effectively lifted and resected in one piece by conventional EMR.[50,51] Kenichiro et al. further compared tip-in EMR with conventional EMR in a prospective trial for ⩾ resecting 15 mm non-pedunculated colorectal polyps, demonstrating an en bloc resection rate of 90.2% (37/41; OR: 3.6, 95% CI: 1.06–13.6; $P = 0.040$).[52] Available evidence suggested that tip-in EMR is an effective option for complete resection of difficult non-pedunculated adenomatous polyps. Similarly, the limitations inherent in certain retrospective findings warrant cautious interpretation when

applying these techniques. High-quality clinical research evidence is urgently required to elucidate the effectiveness of U-EMR, EMR-P, and tip-in EMR in the removal of 10–20 mm difficult non-pedunculated lesions, providing robust guidance for selecting optimal polypectomy in clinical practice. Furthermore, the risks associated with EMR and the demand for low AE rates have prompted growing research interest in CSP, attributed to its avoidance of electrocautery and consequent reduction in thermally induced AEs.

Cold snare polypectomy

CSP has been established as the preferred technique for removing small polyps due to its adequate resection depth and favorable safety profile.[53] In recent years, CSP has been increasingly used for more larger polyps, with studies demonstrating acceptable en bloc resection rates and reduced risks of perforation and bleeding for ⩾10 mm polyps.[12,54,55] This section summarizes the current findings on CSP for resecting 10–20 mm non-pedunculated polyps.

Conventional CSP

Hirose et al. retrospectively analyzed conventional CSP (Figure 1(f)) for resecting 10–14 mm benign polyps diagnosed by magnifying endoscopy, reporting an en bloc resection rate of up to 98.8% and an extremely low bleeding rate of 0.1%.[56] Similarly, a prospective trial by Ma et al. investigating the IRR of CSP found an IRR of 3.45% for 10–15 mm non-pedunculated polyps (86% of which were regular adenomatous polyps), with no significant difference compared to polyps <10 mm (3.45% vs 1.98%, $P=0.411$).[26] And Van et al. reviewed the outcomes of CSP for resecting non-pedunculated polyps >10 mm (86% of which were adenomas), finding the high resection efficacy of CSP with a residual rate of only 5.5%.[25] These findings suggested the suitability of CSP for 10–20 mm regular non-pedunculated adenomas. Kimoto compared the performance of CSP between senior and junior endoscopists, showing no significant difference in complete resection rates (100% vs 100%, $p=1.000$) and en bloc resection rates (73.2% vs 75.6%, $p=0.240$), suggesting the ease of use and potential for widespread adoption.[57] Moreover, dedicated CSP snares, which are 33% thinner than conventional snares and effectively "grasp" the non-pedunculated lesions, have achieved a resection rate of up to 91.0% for small polyps, significantly outperforming conventional snares, and potentially enhancing the efficacy of CSP for 10–20 mm regular benign non-pedunculated polyps.[58,59] However, CSP has certain limitations, a retrospective study by Hirose et al. identified intramucosal carcinoma, HGD, and sessile serrated adenoma as significant factors for incomplete resection of CSP,[56] consistent with a prospective study that considered sessile serrated lesions (SSLs) as the independent risk factor(OR: 6.45, 95% CI: 1.48–28.03, $p=0.013$).[26] These limitations may be partially attributed to the relatively shallow resection depth without submucosal injection.[34,53,56] Therefore, while conventional CSP is effective for regular benign noninvasive adenomas (10–20 mm), it is not optimal for large polyps (>20 mm), SSLs, or lesions with suspected submucosal invasion. Specifically, for large colorectal polyps, the practical application of CSP faces several challenges. First, snare diameter limitations often lead to polyp slippage, particularly with irregularly shaped lesions, such as branching or multi-nodular lesions, which are challenging to snare effectively. Second, large polyps risk incarceration during resection, resulting in incomplete removal and necessitating "forced CSP" or conversion to HSP to complete the procedure. Finally, large polyps often exhibit deeper submucosal invasion and higher malignant potential, leading to higher residual lesion rates and, consequently, higher local recurrence. Thus, CSP is not recommended for en bloc resection of large, high-risk, or suspected invasive lesions. In addition, given the retrospective data, selection bias and confounding factors exist, which affect the results; thus, prospective studies are needed for further validation. The limitations of CSP in certain resections have led to the development of submucosal injection CSP (SI-CSP/cold EMR).

Cold endoscopic mucosal resection/submucosal injection CSP

A follow-up study conducted by Pohl H et al. identified incomplete resection as the strongest risk factor for metachronous neoplasia.[60] To enhance complete resection of ⩾10 mm non-pedunculated lesions while reducing the AEs, researchers have proposed submucosal injection before CSP (cold endoscopic mucosal resection/submucosal injection CSP, cold EMR/SI-CSP) (Figure 1(g)). A residual rate of only 8.0% (95%

CI: 5.0%–12.1%) for >10 mm SSLs resected by cold EMR/SI-CSP at the first follow-up was reported in a retrospective study.[61] Similarly, Yabuuchi found that cold EMR/SI-CSP achieved en bloc and complete resection rates of 82.5% and 63.8%, respectively, for 10–14 mm non-pedunculated adenomas without postoperative bleeding in patients taking anticoagulants, providing a safe alternative for ⩾10 mm SSL resection.[62] While the results need to be interpreted cautiously due to the risk of potential bias inherent in the respective study and single-center study. Another systematic review comparing cold EMR/SI-CSP with conventional EMR for ⩾10 mm SSLs reported a residual rate of only 1% for 10–20 mm and a low AE rate of 0.0% (95% CI: 0.0%–1.1%) compared to hot EMR.[63] Abdallah's meta-analysis further supported these findings, demonstrating a lower recurrence rate for SSLs resected by cold EMR/SI-CSP (5.7%, 95% CI: 3.2%–9.9%).[64] Although operation time increases (42.1s, 95% CI: 14.5s–69.7s),[65] the efficacy and safe profile of cold EMR/SI-CSP make it a recommended option for SSL resection, particularly in patients with impaired coagulation. Jiang et al. conducted a prospective randomized controlled non-inferiority study comparing cold EMR/SI-CSP with hot EMR for 10–20 mm non-pedunculated polyps, evaluating complete resection rates, en bloc resection rates, and incidence of AEs.[66] The publication of the results will provide comprehensive and robust evidence to guide resection method selection.

Ma et al. reported no delayed bleeding or perforation in four hundred and forty 10–15 mm polyps resected using CSP.[26] Similarly, Mangira et al. resected 350 non-pedunculated polyps (10–19 mm) using conventional CSP and cold EMR/SI-CSP, with AEs occurring in only 3.4% of patients in the multicenter study.[15] Furthermore, Ket et al. compared the outcomes of 10–20 mm non-pedunculated colorectal polyps resected by HSP and CSP, identifying 11 significant postprocedural bleeding cases with HSP, while CSP resulted in no AE among 346 polyps.[67] Kimoto's study further supported the reliability of CSP, reporting the AE rate of only 2.8% for junior endoscopists, with no significant difference compared to senior endoscopists.[57] The consistently low AE rates indicated minimal damage to normal tissue and blood vessels caused by conventional CSP/cold EMR/SI-CSP, highlighting potential benefits for patients with multiple polyps or impaired coagulation. The lack of prospective high-quality studies and the bias in retrospective studies necessitate caution in interpreting the results. To further validate these findings, multicenter prospective clinical studies should be conducted to evaluate the performance, long-term outcomes, and cost-effectiveness of conventional CSP and cold EMR/SI-CSP for en bloc resecting 10–20 mm non-pedunculated polyps, in comparison with other resection methods under standardized conditions (e.g., unified definitions, biopsy criteria, and pathological examination). Such studies would provide robust evidence to guide clinical practice. Although CSP/SI-CSP offers high safety and considerable efficacy for resecting 10–20 mm regular non-pedunculated polyps and SSLs, it is less suitable for high-risk lesions or suspected invasive adenocarcinomas. In such cases, ESD may be the preferred alternative for achieving en bloc and complete resection.

Endoscopic submucosal dissection

Polyps characterized by fibrotic changes, irregular and complex morphologies, suspected submucosal invasion, and large sizes (⩾10 mm) are significantly associated with incomplete resection or carcinoma, which require the en bloc resection whenever possible to achieve no residual lesion.[56,68,69] ESD (Figure 1(h)), with less invasion than surgery,[70] is the preferred method, offering a superior en bloc resection rate of 90%. Therefore, for 10–20 mm non-pedunculated polyps with high-risk malignancy and suspected submucosal invasion, as well as fibrotic changes that are difficult to resect with other methods, existing limited research supported the preferential use of ESD. However, it might not be the best choice for benign or shallow invasive lesions due to the high incidence of bleeding and perforation (2.3%–5.5%).[71] Other methods, such as EMR, HSP, and CSP should be prioritized. Moreover, ESD requires specialized training due to its technical complexity.

All lesions require careful optical diagnosis,[16] particularly those appearing "normal" under white-light endoscopy, to evaluate the potential pathology, invasion depth, and boundaries, thereby guiding the selection of appropriate resection methods to balance the efficacy and

complication risks. Magnifying narrow-band imaging[72] and clinical endoscopic classification[73–75] can facilitate diagnostic accuracy, while artificial intelligence may further refine strategy selection for optical diagnosis.[76] Surveillance colonoscopy is equally critical for reducing interval cancers. Based on guidelines,[77–79] individuals with three or more adenomas or advanced pathologies such as HGD, villous components, and polyps ⩾10 mm should undergo postoperative surveillance within 3 years, whereas those with 1–2 non-advanced adenomas may follow a 5- to 10-year interval. Long-term follow-up is essential to evaluate recurrence rates associated with emerging techniques and identify recurrence factors. According to the follow-up data from current research,[12,15,43,80,81] shorter surveillance intervals and increased frequencies should be considered for non-pedunculated polyps with advanced pathology or unclear resection margins. In addition, routine surveillance colonoscopy is recommended when endoscopists lack confidence in the resection quality to minimize metachronous neoplasia incidence.

Conclusion

This narrative review summarizes the current studies of emerging techniques for resecting 10–20 mm non-pedunculated colorectal polyps. Specifically, HSP, EMR, CSP, and ESD are the primary modalities. The risk of bleeding and perforation from HSP should be taken seriously. The development and clinical application of bipolar snares and LPPC potentially benefit patients with coagulation dysfunction, but these techniques should be used with caution due to limited evidence. Modified EMR techniques such as U-EMR, EMR-P, and tip-in EMR offer alternatives for resecting non-pedunculated polyps that are difficult to resect using conventional EMR. CSP has gradually been applied to the resection of polyps ⩾10 mm and has been proven to be suitable for en bloc resection of ordinary, benign, and superficial non-pedunculated polyps. In addition, cold EMR/SI-CSP has been introduced to resect SSLs. ESD is the optimal treatment for resecting 10–20 mm polyps with suspected submucosal invasion, high risk of malignancy, complex morphologies, and fibrotic changes. Regardless of the resection methods chosen, thorough optical diagnosis should be performed to assess pathology and suspected depth of invasion, which would help boost endoscopist confidence and improve the treatment outcomes. Although many methods for polypectomy are available, high-quality clinical evidence regarding different techniques is still lacking. In the future, prospective multicenter trials and postoperative follow-up studies are urgently needed to evaluate the effectiveness, safety, and feasibility of novel techniques.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Author contributions

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Acknowledgements

The authors gratefully acknowledge Junfeng Xu for his professional support in data curation, formal analysis, and investigation.

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: The study was

supported by the Capital Health Development Scientific Research Project (Grant No. 2022-1-5082).

Competing interests

The authors declare that there is no conflict of interest.

Availability of data and materials

Not applicable.

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