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Review Article

Underwater Resection of Neuroendocrine Tumors of the Gastrointestinal Tract: A Systematic Review

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Abstract

Background and objectives: Over the past decade, the approach to gastrointestinal (GI) neuroendocrine tumors (NETs) has increasingly included endoscopic resection (ER) techniques. Underwater endoscopic mucosal resection (UEMR) has been introduced as a potential alternative to conventional mucosectomy. The objective of this systematic review is to investigate the feasibility and outcomes of UEMR in the treatment of GI NETs and to provide a reference for clinical management options.

Methods: A systematic search of PubMed, Cochrane Library, and EMBASE was performed to identify guidelines and primary literature published up to 8 August 2023.

Results: Our review did not find any UEMR results for esophageal NETs. For gastric NETs, there is only one case series pilot study with two patients with G1 tumors, that were completely resected without complications. For duodenal NETs eligible for ER, a total of 11 cases are reported, with success in all procedures. For ileum NETs, there is only one report, for an outlier case. Finally, UEMR is best indicated for rectal tumors, where it is an alternative to endoscopic mucosal resection or endoscopic submucosal dissection techniques, as shown in four comparative studies.

Conclusions: UEMR is presented as a good option for selected cases, as it has notable advantages in that it can achieve a complete histological resection at a lower cost, with a short procedure time, and does not require advanced endoscopic skills to ensure good results.

Introduction

Neuroendocrine tumors (NETs) are rare and heterogeneous tumors that arise from the neuroendocrine cell system. NETs are more commonly found in the gastrointestinal (GI) tract, with the most common sites being the stomach (23%), appendix (21%), small bowel (15%), rectum (14%) and pancreas (10%). Esophageal and colonic NETs are rare and account for a small percentage of GI NETs.[1] The incidence of GI NETs has gradually increased over the last few decades due to improved detection and an aging population.[2] The prognosis of these tumors is highly variable and depends on several factors including site, size, grading, depth of invasion, and local lymphadenopathy. Correct evaluation of the tumor and the clinical context has important prognostic implications. Careful assessment will also help determine the treatment modality. Over the past decade, the approach to GI NETs has progressively included endoscopic resection (ER) techniques. The indication for endoscopic treatment does not include NETs of the appendix, colon, or biliary tree.[3] For pancreatic NETs, the appropriate endoscopic approaches are restricted to ablative techniques.[1] For other sites, ER briefly includes endoscopic mucosal resection (EMR), endoscopic

Keywords: Underwater endoscopic mucosal resection; Gastrointestinal neuroendocrine tumour; Systematic review; Endoscopy.

Abbreviations: EMR, endoscopic mucosal resection; ER, endoscopic resection; ESD, endoscopic submucosal dissection; GI, gastrointestinal; JBI, Joanna Briggs Institute; NET, neuroendocrine tumor; PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses; UEMR, underwater endoscopic mucosal resection.

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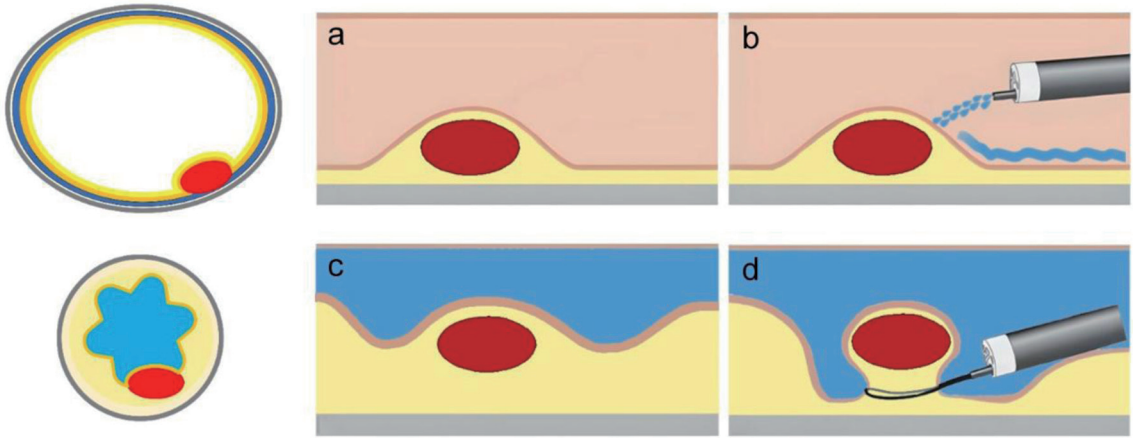

Fig. 1. UEMR technique. Initially the luminal gas is aspirated (a) and water is infused (b) until the mucosal lesion floats in a completely water-filled lumen to lift the lesion and create a pseudopedicle (c), making it feasible to use a snare (d).

submucosal dissection (ESD), and full-thickness resection.

Although ESD appears to be a good alternative as it allows *en bloc* resection of large lesions, this technique requires advanced skills and is not widely available, and it is also prone to postoperative adverse events such as bleeding or perforation.[4–6] In comparison, EMR may fail to completely remove submucosal tumors.[5]

Binmoeller *et al*.[7] also developed an alternative method of lesion removal without submucosal injection. Underwater endoscopic mucosal resection (UEMR) is a new method that presents as an alternative to the conventional EMR. UEMR is performed without lifting the lesion with submucosal injection, but rather using the ability of water to lift the lesion. Filling the lumen with water allows the lesion to be lifted and the mucosa and submucosal tumor separate from the muscularis propria, creating a pseudopedicle that facilitates the use of a snare (Fig. 1).[5,8–11] Many articles have been published showing reasonable technical success rates, with a low incidence of adverse events with UEMR. However, the vast majority of these studies have been of UEMR for the resection of colorectal adenomas.[7,12–18] Since the first description by Kawaguti *et al*.,[19] only a few studies of UEMR in GI NETs have been described.

Methods

Protocol registration

This systematic review was registered at the International Prospective Register of Systematic Reviews (PROSPERO) under protocol CRD42023451193. This study was designed according to the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement guidelines.[20]

Search strategy and study selection

We systematically searched PubMed, EMBASE, and Cochrane Library databases to identify studies (published up to August 8, 2023) reporting the use of UEMR technique in GI NETs. The search strategy was (underwater OR UEMR) AND (neuroendocrine OR NET OR carcinoid) (tumor OR tumors OR lesion OR lesions) AND (gastrointestinal OR (esophagus OR oesophagus) OR (gastric OR stomach) OR (small bowel OR (duodenal OR duodenum) OR (ileum OR ileal) OR (colon* OR colorectal) OR (rectum OR rectal).

Two authors (PAES and MHGS) independently screened all studies identified by the database search, initially based on titles and abstracts. Subsequently, full texts of potentially relevant articles were reviewed for inclusion if they met the predefined criteria. We also analyzed references from relevant original articles and literature reviews to identify additional studies that were not encompassed in the initial database searches. Disagreements were resolved through consensus. Studies meeting the following inclusion criteria were included: (1) observational study (including case report, case series, cohort studies and RCTs); (2) comparing UEMR with other ER technique; (3) in patients with GI NET; (4) reporting outcomes of interest. Abstracts, editorials, reviews, and meta-analyses were excluded.

Data extraction and quality assessment

For all eligible studies, we extracted data including (1) study characteristics: first author, study design, publication year, country; (2) study population: number of cases, age, sex, NET site and tumor characteristics (location, size, and grade); (3) outcomes of interest. Primary outcomes were *en bloc* resection, R0 resection, complete resection, and complications. Secondary outcomes were procedure time and cost. *En bloc* resection was defined as the removal of a lesion in a single piece confirmed by endoscopy. R0 resection was defined as *en bloc* resection with both horizontal and vertical margins free of any adenomatous tissue, as confirmed by histological analysis. Complete resection was defined as the lack of visible lesions on a macroscopic scale on endoscopic examination. Complications were defined as any adverse event during or after the procedure.

The quality assessment of included studies was independently performed by two authors (PAES and MHGS) using modified versions of the Joanna Briggs Institute (JBI) critical appraisal tool to evaluate the risk of bias in case reports, case series, and cohort studies.[21,22] The JBI critical appraisal checklist consists of confirmatory questions about study characteristics that are scored as yes/no, unclear or not applicable (Supplementary Table 1). Disagreements were resolved by consensus.

Data synthesis and analysis

We provided a narrative analysis of the results of the included studies. For didactic purposes, the topics were divided into specific organs. We summarized the main reports on the use of the UEMR

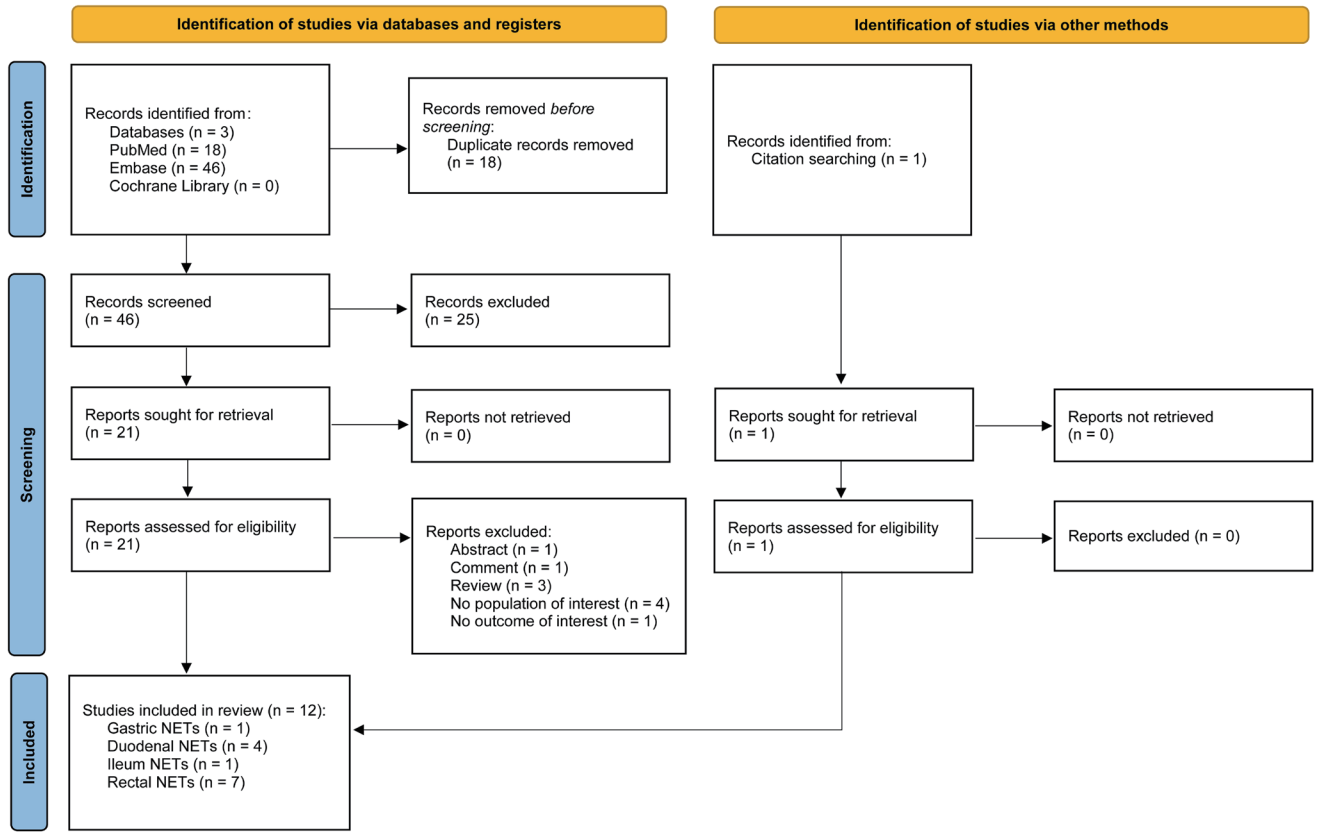

Fig. 2. PRISMA flow diagram of study screening and selection. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

technique in each GI NET site and assessed the feasibility of this technique from a comprehensive perspective. Reference clinical management options recommended by the European Neuroendocrine Tumor Society (ENETS) and the North American Neuroendocrine Tumor Society (NANETS) guidelines were also highlighted. Data from each eligible article were synthesized, described qualitatively, and presented in tabular form. Categorical variables were reported as raw numbers (percentages). Continuous variables were reported as means ± SD, medians (range), or medians (IQR).

Results

The literature search initially identified 64 records. After removing 18 duplicate records and 25 unrelated studies based on the titles and abstracts, we identified 21 potentially eligible studies that were screened for inclusion and exclusion criteria. Marui *et al*.[23] were also identified by citation searching. Ultimately, 12 studies were included in this review. This process is illustrated in the PRISMA flow diagram (Fig. 2).

Characteristics of included studies

Overall, these studies aggregate data from 98 cases of the UEMR technique in GI NETs. Of these, two cases were in gastric NETs, 11 cases were in duodenal NETs, one case was in ileum NET, and 84 cases were in rectal NETs. Seven studies were conducted in Asia (South Korea, Japan, and China), three studies were conducted in Brazil, and two studies were conducted in Europe (Italy and Spain). Table 1 summarizes the main characteristics of the included studies. As reported in Table 2,[5,9,19,23–31] based on the JBI critical appraisal checklist assessment tool, the quality assessment ranged from 7/11 to 11/11, suggesting a moderate overall risk of bias.

UEMR in esophageal NETs

NETs are extremely rare in the esophagus, accounting for less than 0.04% of all NETs. They are characterized by early dissemination, aggressive behavior, and poor prognosis. Due to their rarity, no standardized guidelines have been proposed for the treatment of esophageal NETs (eNETs), although general recommendations suggest surgery with adjuvant chemoradiotherapy as the treatment of choice.[32–34]

Few cases of endoscopic removal of eNETs have been described, usually by EMR or ESD and more recently by submucosal tunneling ER.[35,36]

We found only three studies of underwater esophageal resection. One case of UEMR for a protruding well-differentiated intramucosal adenocarcinoma, one report of UEMR for a granular cell tumor and one series of nine patients with superficial esophageal tumors treated with underwater ESD.[37–39] However, our research did not find any UEMR results for eNETs.

UEMR in gastric NETs

Gastric NETs (gNETs) can be divided into three types, type 1 and 2, which are associated with chronic atrophic gastritis and

Table 1. Characteristics of included studies

NET site	Study characteristics		Study population						Outcomes			
	First author (country, year)	Study design	Number of cases	Sex, female/male	Age, years	Location	Size, mm	Grade, G1/G2	*En bloc* resection, *n* (%)	R0 resection, *n* (%)	Complete resection, *n* (%)	Complication
Gastric	Kim (South Korea, 2022)[24]	Case series	2	1/1	65 and 68	Greater curvature of stomach: 2	11 and 5	2/0	2 (100)	2 (100)	2 (100)	No
Duodenal	Anderloni (Italy, 2016)[25]	Case report	1	0/1	68	Anterior wall of the duodenal bulb	15	0/1	1 (100)	1 (100)	1 (100)	No
	Kim (South Korea, 2022)[24]	Case series	7	3/4	Median (range): 60 (36–67)	Duodenal bulb: 5; superior descending angle: 1; near ampulla: 1	Median (range): 6 (3–15)	7/0	7 (100)	7 (100)	7 (100)	No
	Uchima (Spain, 2022)[26]	Case report	1	0/1	64	Duodenal bulb	13	1/0	1 (100)	1 (100)	1 (100)	No
	Lee (South Korea, 2022)[27]	Case series	2	0/2	36 and 61	Duodenal bulb: 2	3 and 6	2/0	2 (100)	1 (50)	NA	No
Ileum	Rezende (Brazil, 2021)[28]	Case report	1	0/1	64	Distal ileum	10	1/0	1 (100)	1 (100)	1 (100)	No
Rectal	Kawaguti (Brazil, 2015)[19]	Case report	1	1/0	51	Distal rectum	10	1/0	1 (100)	1 (100)	1 (100)	No
	Marui (Japan, 2016)[23]	Case report	1	0/1	63	Lower colorectal area	8	1/0	1 (100)	1 (100)	1 (100)	Minor bleeding
	Yamashina (Japan, 2018)[31]	Case series	6	3/3	Median (range): 55.5 (47–86)	Rectum above the peritoneal reflection: 2; rectum below the peritoneal reflection: 4;	Median (range): 5.5 (4–10)	6/0	6 (100)	5 (83.3)	NA	No
	Coutinho (Brazil, 2021)[30]	Case series	11	9/2	Median (range): 55 (30–73)	Rectum	Median (range): 6 (3–12)	9/2	11 (100)	9 (81.8)	NA	No
	Park (South Korea, 2020)[9]	Retrospective cohort	36	14/22	Median (range): 44 (23–76)	Distance from anal verge (cm), median (range): 5 (3–15)	Median (range): 5 (2–10)	36/0	≥31 (86.1)*	31 (86.1)	NA	No
	Shi (China, 2022)[5]	Retrospective cohort	22	8/14	Mean (SD): 46.4 (9.3)	Distance from the anal margin (cm), mean (SD): 7.7 (1.6)	Mean (SD): 7.2 (1.6)	NA	NA	NA	21 (95.5)	No
	Okada (Japan, 2022)[29]	Retrospective cohort	7	3/4	Median (IQR): 65 (50.5–67.5)	Rectum	Median (IQR): 4 (3–5)	7/0	7 (100)	7 (100)	NA	No

IQR, interquartile range; NA, not available; NET, neuroendocrine tumor; SD, standard deviation. *Park et al. (8) does not provide the values of *en bloc* resection; however, we assume that it is greater than or equal to the value of R0 resection.

Table 2. Quality assessment of included studies according to JBI critical appraisal tool

First author, year	Study design	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Total
Anderloni, 2016[25]	Case report	Y	Y	Y	Y	Y	Y	Y	Y	–	–	–	8/8
Uchima, 2022[26]	Case report	Y	Y	Y	Y	Y	Y	Y	Y	–	–	–	8/8
Rezende, 2021[28]	Case report	Y	Y	Y	Y	Y	Y	Y	Y	–	–	–	8/8
Kawaguti, 2015[19]	Case report	Y	Y	Y	Y	Y	Y	Y	Y	–	–	–	8/8
Marui, 2016[23]	Case report	Y	Y	Y	Y	Y	Y	Y	Y	–	–	–	8/8
Yamashina, 2018[31]	Case series	Y	Y	Y	Y	Y	Y	Y	Y	Y	U	–	9/10
Kim, 2022[24]	Case series	Y	Y	Y	Y	U	Y	Y	Y	Y	U	–	8/10
Lee, 2022[27]	Case series	Y	Y	Y	Y	U	Y	Y	Y	Y	U	–	8/10
Coutinho, 2021[30]	Case series	Y	Y	Y	Y	Y	Y	Y	Y	Y	U	–	9/10
Park, 2020[9]	Retrospective	U	Y	Y	Y	N	Y	Y	Y	U	N	Y	7/11
Shi, 2022[5]	Retrospective	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	11/11
Okada, 2022[29]	Retrospective	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	11/11

JBI, Joanna Briggs Institute. N, no; NA, not applicable; Q, question; U, unclear; Y, yes; –, respective question does not exist.

Zollinger-Ellison syndrome, respectively, and type 3, which is rare but aggressive.[40] Surgical resection with lymphadenectomy is recommended for type 3 tumors due to their high-grade malignancy. In contrast, conservative management strategies are preferred for types 1 and 2 gNETs, with ER being recommended for tumors ≥10 mm.[40] However, ER is not indicated for type 3 gNETs. Recommendations for ER differ between the ENETS and NANETS guidelines. ENETS recommends surgical removal for all lesions ≥10 mm without muscularis propria invasion, whereas NANETS recommends surgical removal for lesions >20 mm and for lesions measuring 10–20 mm in size if *muscularis propria* invasion is present.[40,41] The first and only UEMR procedure for gNETs was performed and reported by Kim *et al*.[24] in 2022 in a case series pilot study involving two patients with G1 NETs (5 mm and 11 mm lesion size) located in the greater curvature of the stomach. In both cases, the tumors were R0 and completely resected without complications.

UEMR in duodenal NETs

ER of duodenal NETs (dNETs) is indicated for lesions ≤10 mm confined to the submucosal layer, without lymph node involvement or metastases. For intermediate lesions (10–20 mm), ER or surgery may be considered. Surgical resection is recommended for large G1/G2 dNETs (≥20 mm) without metastases and for dNETs with lymph node metastases.[40] The first UEMR for dNETs procedure was described in 2016 by Anderloni *et al*.[25] in a case of a 15 mm lesion in the anterior wall of the duodenal bulb, which was classified as a G2 NET. Following this case, other authors have also described case reports of UEMR for dNETS.[26,27] Kim *et al*.[24] also published a series including seven patients with lesions ranging from 3 to 15 mm. NETs were classified as G1, predominantly located in the duodenal bulb (duodenal bulb: five; superior descending angle: one; near the ampulla: one). All lesions were R0 resected without complications. These publications (11 cases in total) reported technical success in all procedures, without adverse events.[24,26,27] One case of water intoxication was reported after an infusion of approximately 5 L of water during a prolonged UEMR for resection of nonampullary duodenal adenoma.[42] Although this report was not for NET resection, one should be aware of the risk of this adverse event after UEMR in the upper digestive tract regardless of the type of lesion.

UEMR in ileum NETs

The distal ileum is the most common site of origin for small bowel NETs.[43] Ileal NETs (iNETs) are characterized by a worse prognosis than other sites, with an overall median survival of 88 months (vs. stomach: 124 months; duodenum: 99 months; rectal: 240 months).[44] Rezende *et al*.[28] in 2021 described, for the first and only time, a case of a 10 mm lesion in the distal ileum, classified as a G1 NET and resected by the UEMR procedure. This was an outlier case in a patient who had previously undergone a colectomy with ileorectal anastomosis, and given the difficulties of surgical approach, ER presented as a less invasive treatment. Whenever feasible, surgical resection with lymphadenectomy should be considered the treatment of choice for small bowel NETs.

UEMR in rectal NETs

ER of rectal NETs (rNETs) is indicated for lesions 5–20 mm in size and classified as G1/G2.[2,29,30,45,46] In this setting, UEMR has recently been introduced as a viable alternative to the EMR technique (Fig. 3). The first case of UEMR in rNETs was described in 2015 by Kawaguti et al.[19] in a patient with a 10 mm lesion in the distal rectum, classified as a G1 NET, that was completely resected without complications. One year later, Marui *et al*.[23] reported an *en bloc* resection without complications of an 8 mm diameter carcinoid rectal tumor classified as a G1 NET. Another case report study of six patients with rectal G1 NETs≤10 mm in diameter reported *en bloc* resection and R0 resection in 100% and 83% of cases, respectively, with no adverse events.[45] In addition, a retrospective study in Brazil evaluated the efficacy and safety of the UEMR technique in 11 patients with rNETs ≤ 12 mm (G1: 9; G2: 2). This study achieved a 100% *en bloc* resection rate and an 81% R0 resection rate with no adverse events.[30] The utility of the UEMR technique in rNETs has also been compared with ESD. Shi *et al*.[5] also compared both techniques in 78 patients (UEMR: 22; ESD: 56) with≤10 mm rectal G1/G2 NETs and found a slightly lower complete resection rate in the UEMR group (UEMR: 95.5% vs. ESD: 96.4%, $p = 0.840$), with

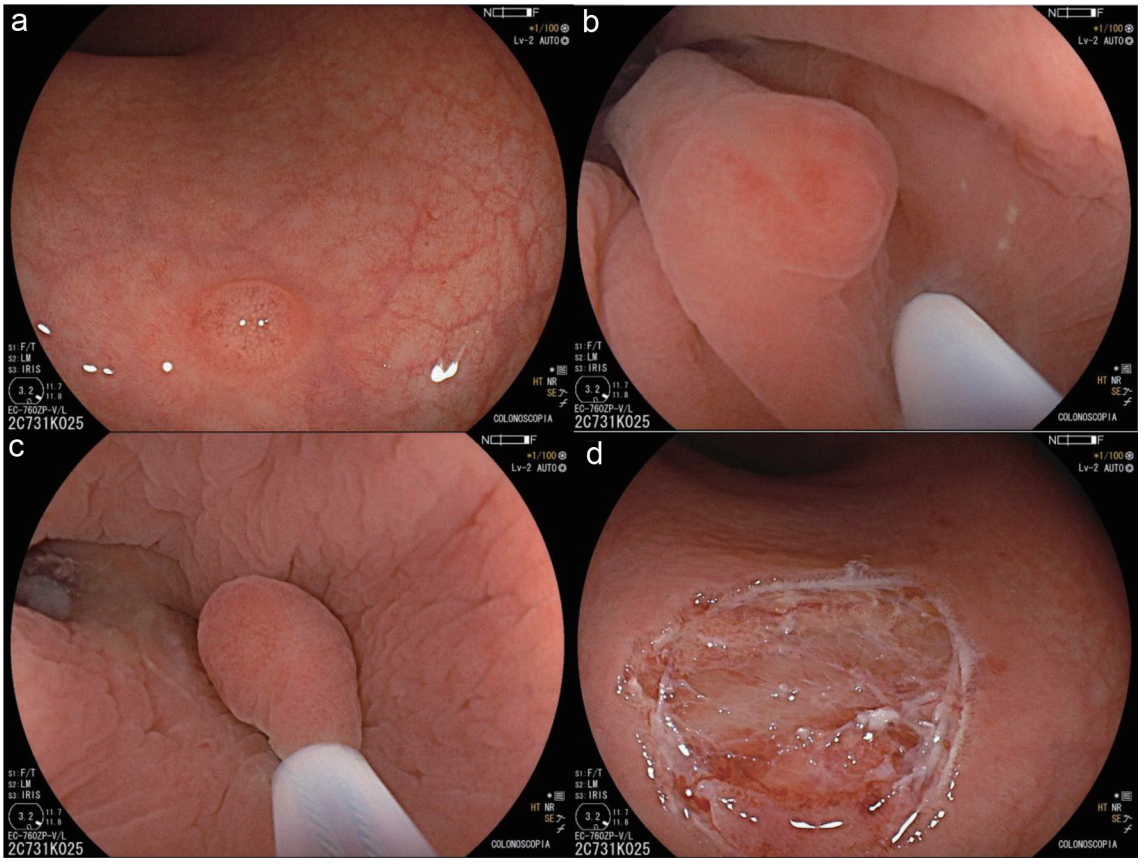

Fig. 3. UEMR procedure for rectal NET. After switching from the endoscopic view with air (a) to the underwater view (b), the lesion is captured (c) and subsequently presented with that view after resection (d). We declare that the patient has provided consent for the procedure, and it should be noted that the image of the technique is purely illustrative. No patient-identifiable information is presented. NET, neuroendocrine tumor; UEMR, underwater endoscopic mucosal resection.

one complication in the ESD group and no complications in the UEMR group. Another study also comparing UEMR with ESD in 115 patients (UEMR: 36; ESD: 79) with rectal G1 NETs ≤ 10 mm in size, found similar R0 resection rates (UEMR: 86.1% vs. ESD: 86.1%, $p = 0.996$) with 2.5% (2/79) of adverse events in the ESD group and no adverse events in UEMR group. The procedure time was significantly longer in the ESD group than in the UEMR group (mean 26.6 ± 13.4 m vs. 5.8 ± 2.9 m, $p < 0.0001$). Although not included in the title or primary objectives of this study, Park *et al*.[9] also compared UEMR with precut EMR (EMR-P) or cap-assisted EMR (EMR-C). The prevalence of lateral margin positivity was significantly lower in the UEMR group (UEMR vs. EMR-P/EMR-C, 5.6% vs. 20.8%, $p = 0.039$). R0 resection rates were higher in the UEMR group, but the difference did not reach statistical significance (UEMR vs. EMR-P/EMR-C, 86.1% *vs.* 72.7%, $p = 0.115$). The procedure time was significantly shorter in the UEMR group (UEMR vs. EMR-P/EMR-C, mean 5.8 ± 2.9 m vs. 18.5 ± 11.2 m, $p < 0.001$). Finally, a retrospective study compared UEMR and endoscopic submucosal resection with a ligation device (ESMR-L) in 32 patients (UEMR: 7; ESMR-L: 25) with predominantly G1 NETs < 10 mm. This study achieved 100% *en bloc* resection and R0 resection rates in both groups, with two adverse events in the ESMR-L group and no adverse events in the UEMR group.[29] A summary of comparative studies of UEMR with other endoscopic techniques for resection of rNETs is shown in Table 3.[5,9,29]

Discussion

ER plays an important role in the management of NETs. However, the best technique for resection remains controversial, and clear recommendations have yet to be made. As most NETs involve the submucosa, conventional hot snare polypectomy or EMR has been reported inadequate for R0 resection and rarely result in free vertical margins.[2,29,46] ESD has been shown to be a good alternative, achieving R0 resection in 80.6–100% in some studies,[9] but this method requires greater technical skill, has a longer procedure time, a high risk of adverse events, and is not widely used worldwide.[11] Endoscopic full-thickness resection has also been described as an option for endoscopic treatment of rectal NETs. However, it has specific adverse events such as stenosis, adhesion, or damage to extraluminal structures, and the potential to interfere with subsequent surgery if required.[47] Given these limitations, other methods have been described that attempt to ensure complete histological resection without adding disadvantages to the endoscopic management of these lesions. EMR-C has shown promising results in the removal of submucosal subepithelial lesions, but the size of the cap limits its functionality to the removal of tumors smaller than 10 mm.[24] Another technique described is ESMR-L, which is commonly used in Japan for resection of small rectal

Table 3. Summary of comparative studies of UEMR with other endoscopic techniques for resection of rNETs

First author, year	Endoscopy type		*p*-value
Park, 2020[9]	UEMR	ESD	
R0 resection	86.1%	86.1%	0.996[a,b]
Complications	0%	2.5%	1.0[a]
Procedure time in m, mean ± SD	5.8 ± 2.9	26.6 ± 13.4	<0.001
Park, 2020[9]	UEMR	EMR	
R0 resection	86.1%	72.7%	0.115[a]
Complications	0%	0%	–
Procedure time in m, mean ± SD	5.8 ± 2.9	18.5 ± 11.2	<0.001[b]
Shi, 2022[5]	UEMR	ESD	
Complete resection	95.5%	96.4%	0.840[c]
Complications	0%	1.8%	–
Procedure time in m, median/IQR	5.0 ± 1.4	26.6 ± 8.1	<0.001[b]
Total cost in USD, mean ± SD	$328 ± 20.6	$1,759.0 ± 72.6	<0.001[b]
Okada, 2022[29]	UEMR	ESMR-L	
R0 resection	100%	100%	1.0[a]
Complications	0%	8%	1.0[a]
Procedure time in m (median/IQR)	6/5–8	12/9–14	0.002[d]
Total cost in USD, median/IQR	$90.45/83.64–108.41	$274.73/265.86–292.45	<0.001[d]

ESD, endoscopic submucosal dissection; ESMR-L, endoscopic submucosal resection with a ligation device; IQR, interquartile range; UEMR, underwater endoscopic mucosal resection. SD, standard deviation. USD, United States dollar. [a]Fisher exact test; [b]Student's *t*-test; [c]chi-square test; [d]Mann-Whitney *U*-test.

NETs and is performed using an elastic band to excise the deep submucosal layer. ESMR-L results in better R0 resection rates than EMR and comparable rates to ESD.[9]

UEMR has some notable strengths. In particular, it has shown positive results, especially for ER of rNETS, with a high rate of technical success and a high rate of R0 resection. The UEMR is also a very safe procedure, with a low incidence of adverse events. And what is most appealing about this technique is its simplicity. In addition, it is inexpensive, easy to master (can be performed by beginners without a learning curve), requires no special accessories, and has a short procedure time. For these reasons, UEMR can even be considered the first-line technique for rNETS resection.[4,5,9,11,17,30,31]

However, UEMR also has some limitations and there are few disadvantages to mention. For upper GI NETs, there are some concerns about UEMR due to the risk of bronchoaspiration. The use of an overtube or endotracheal intubation could reduce this risk.[39] Due to the aggressiveness of esophageal NET, any endoscopic treatment has a limited role.[33,36] When analyzing gastric lesions, the stiffer gastric submucosal layer may not float as well as expected, which may limit the results of UEMR for lesions that are not confined to the mucosa.[48] Although small, the risk of hyponatremia with UEMR cannot be ignored.[42] This risk may be reduced by performing the procedure with saline infusion. UEMR, like any endoscopic treatment, is the exceptional choice for ileal NETs, reserved only for patients who are not surgically fit.[28] Although the rectum is the main niche for UEMR of GI NETs, more prospective and randomized studies with longer follow-up are needed comparing UEMR with other endoscopic techniques.

Conclusions

UEMR has notable advantages as it can achieve complete histological resection at a lower cost, short procedure time, and does not require advanced endoscopic skills to ensure good results. It must be said that further research is needed to make this a reality in clinical practice, as adverse events still exist, and it may not be the best approach depending on tumor location, morphology, and histology.

Supporting information

Supplementary material for this article is available at https://doi.org/10.14218/JTG.2023.00031.

Supplementary Table 1. Dummy caption Dummy caption Dummy caption Dummy caption Dummy caption Dummy caption Dummy caption.

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Conflict of interest

The authors PAES, MHGS, IKGSS, FSK, and LL do not have any

relevant competing interests to disclose regarding the content of this article. FMF discloses that he has served on advisory boards for Boston Scientific, Olympus, Medtronic, and Cook in the last 3 years.

Author contributions

Contributed to study concept and design (LL), acquisition of the data (PAES, MHGS, and IKGSS), data analysis and drafting of the manuscript (PAES, MHGS, IKGSS, and LL), critical revision of the manuscript (FSK, FMF, LL), and supervision (FMF, LL)

Data sharing statement

No additional data are available.

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