POTENTIAL RISK DURING ENDOSCOPIC MANAGEMENT OF LARGE DUODENAL POLYPS

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ABSTRACT

Introduction: *With steady advances in endoscopic techniques and devices over the past decades, endoscopic intervention has largely supplanted the common surgical approaches of the past. Endoscopic resection is now confidently and safely performed to manage large colon polyps, which historically were managed surgically, having a report of less than 5% recurrence. While there is a robust body of evidence on the endoscopic management of colonic polyps, data on outcomes of large duodenal polyps managed endoscopically are scarce. With an increasing number of esophagogastroduodenoscopies (EGDs), and depending on the clinical presentation, endoscopic features and histopathology, the rate of duodenal adenomas found incidentally increased, however, the pathogenesis characteristics of small intestinal adenomas and adenocarcinomas is not fully revealed. Duodenal polyps are found to be occurred sporadically, and belonging to familial adenomatosis polyposis (FAP) syndrome. It is postulated that the adenoma to carcinoma progression sequence of colorectal cancer is the same observed phenomenon in small bowel tumors. This study aimed to review the patient characteristics, EMR techniques, procedure outcomes, adverse events, and recurrence of large duodenal polyps.*

Materials and methods: *Patients were included if they had pathologically confirmed non-ampullary duodenal polyps that were either sporadic or familial adenomatous polyposis syndrome-related and, had received EMR with at least one follow-up EGD for surveillance. Descriptive statistics were employed to report findings.*

Results: *A total of 65 patients underwent a total of 90 EMRs for large duodenal polyps. The mean age was 65.4 years and including 29 female patients. Complete resection of the visible mass was achieved in 96.9% of cases. Intraprocedural hemostatic intervention was required in 18.5% of patients. Delayed bleeding was noted in 9%, and delayed perforation required surgical intervention in 2.2% of patients with no mortality. Surgical intervention after EMR was needed in 12.7%: in two patients for delayed perforation, in three for recurrence of high-grade dysplasia, and in one patient each for resection of a full-thickness lesion, resection of a carcinoid tumor near the pylorus, and resection of a difficult to access adenoma with a concurrent ampullary lesion. Eleven (16.9%) patients had recurrent duodenal polyps on follow-up EGD.*

Conclusion: *The talented endoscopists are critically required for endoscopic management of large duodenal polyps. While most immediate adverse events can be managed endoscopically, all Preventive measures for delayed perforation should be applied before completing EMR as these usually require surgical intervention.*

Keywords: *Duodenal endoscopic mucosal resection, large polyps, management of perforation.*

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Introduction

With steady advances in endoscopic techniques and devices over the past decades, endoscopic intervention has largely supplanted the common surgical approaches of the past[(1)]. Endoscopic resection is now confidently and safely performed to manage large colon polyps, which historically were managed surgically, having a report of less than 5% recurrence[(2-5)]. While there is a robust body of evidence on the endoscopic management of colonic polyps, data on outcomes of large duodenal polyps managed endoscopically are scarce. With an increasing number of esophagogastroduodenoscopies (EGDs), and depending on the clinical presentation, endoscopic features and histopathology, the rate of duodenal adenomas found incidentally increased[(6)], however, the pathogenesis characteristics of small

intestinal adenomas and adenocarcinomas is not fully revealed[7]. Duodenal polyps are found to be occurred sporadically, and belonging to familial adenomatosis polyposis (FAP) syndrome[8]. It is postulated that the adenoma to carcinoma progression sequence of colorectal cancer is the same observed phenomenon in small bowel tumors[9]. While it remains unclear how fast an adenoma in the duodenum progresses to carcinoma, Okada et al. reported that duodenal adenomas with 20 mm or larger in size having a high risk of progression to high-grade adenomas[10, 11].

Endoscopic resection of large duodenal adenomas continues to be one of the most feared procedures even for the most skilled endoscopists[12]. This is mainly due to the inherent elements that pose potential and real risks of complications from endoscopic resection, mainly immediate or delayed perforation[13]. Duodenal perforation of a significant size (>2cm) is challenging to manage not only by endoscopic methods but also with a surgical approach[14]. Duodenal perforation is of significant morbidity when associated with the setting of malignancy, and not standardized, thus the definitive treatment may eventually require a pancreatoduodenectomy depending on the specific location of the perforation in the duodenum[15].

This study aimed to review the characteristics of patients with large duodenal polyps, techniques involved in managing the patients, procedure outcomes, complications, and recurrence.

Materials and methods

Patients

This was a multi-center retrospective study. All patients including in this study were referred to Gansu Medical College Affiliated Hospital, The Second People's Hospital of Bengbu City, First Affiliated Hospital of Anhui University of Science and Technology and Gansu Provincial People's Hospital for endoscopic mucosal resection (EMR) of one or more duodenal polyps from 2010 to 2021. This study was approved by Gansu Medical College Affiliated Hospital institutional review board..

All authors had access to the study data and approved the final manuscript. Patients were included if they had pathologically confirmed non-ampullary polyps that were either sporadic or FAP-related and had received EMR with at least one follow-up EGD for surveillance. If more than one EMR was performed, the reason for intervention was further typified as early recurrence, late recurrence, and resection of a separate or new lesion. Patients who only received biopsy, thermal therapy, standard snare resection, and surgical intervention, all without EMR of the duodenal adenoma, were excluded from this study. The follow-up interval was defined as the time from EMR to death, or the day of last contact with patient, who thereafter was lost to follow-up.

Endoscopic procedure technique

All patients received either total intravenous (IV) anesthesia or general endotracheal intubation under supervision, at the discretion of the endoscopist and anesthesia time. EMR was performed using either an upper endoscope (Olympus GIF-Q180, Olympus America) with or without a clear EMR cap (Olympus EMR Kit, Olympus America) or a duodenoscope (Olympus TJF-160, Olympus America), or both. Endoscopic ultrasound (EUS) was performed sporadically depending on the size and location using a radial echoendoscope or a 12 or 20-MHz catheter ultrasound probe (MAJ-935; Olympus America) to assess the depth of invasion and ensure the preservation of the muscularis propria layer. Injection solution to lift the polyps was made of a mixture of 500 mL 0.9% saline, 10 mL of epinephrine (1:10,000), and minimal indigo carmine or methylene blue. EMR was performed using a 10 mm, 15mm, or 20-mm conventional or duckbill snare (AcuSnare; Cook Medical, Winston-Salem, NC) and blended current (Endocut Q mode VIO 300D; Erbe).

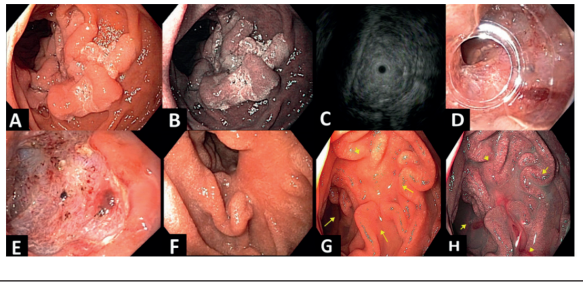

Figure 1: Endoscopic mucosal resection of a large duodenal adenoma and follow-up. (A) 7.5 cm duodenal adenoma in the third portion of the duodenum. (B) Endoscopic ultrasound demonstrating adenoma confined in the mucosal layer. (C) Cap-assisted EMR with gentle and controlled suction at the center of the adenoma that was difficult to grab with a snare. (D) Complete adenoma resection. (E) Resection site 1 year later. (F, G, H) Resection site without recurrence 9 years later.

In cases where a snare could not be placed around the polyp, an EMR cap (Olympus America) was used with gentle suction to grab only the mucosa and part of the submucosal layer (Figure 1).

Outcome of interest and adverse events

Clinical remission was defined as biopsy negative and endoscopic absence of evidence of adenomatous tissue at the time of the last follow-up EGD, the timing of which varied at the discretion of the treatment team. Initial follow-up EGD was typically performed three months following EMR. Early recurrence was defined as any amount of endoscopically visible or pathologically demonstrated adenomatous tissue at the EMR site on initial follow-up EGD. If the initial follow-up EGD was negative, but subsequent EGDs were endoscopically or histologically significant for adenomatous tissue, late recurrence was noted.

EMR related adverse events (AEs) included bleeding, perforation, and hospitalizations due to AEs. Immediate persistent bleeding during the EMR procedure often required more attention other than endoscopic intervention, which including coagulation or the placement of clips for hemostasis. Delayed bleeding was any bleeding that required subsequent EGD following the initial EMR session. Immediate perforation was defined as the perforation observed during the endoscopic session, and delayed perforation was defined as any perforation that occurred more than 24 hours after the initial endoscopic session. All the above procedures were described as following flowchart (shown in Figure 2).

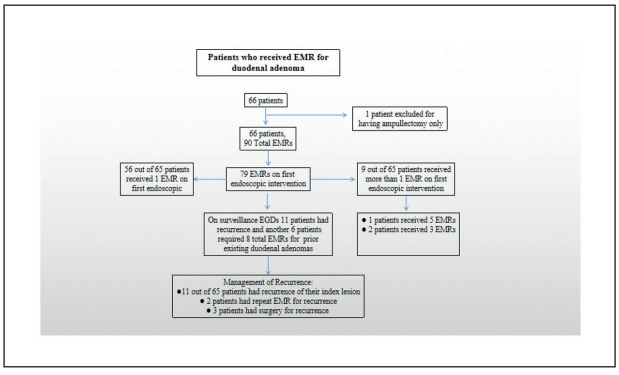

Figure 2: Flowchart of the study.

Results

A total of 66 patients were diagnosed with one or more ampullary or non-ampullary duodenal polyps; one was excluded as they had an ampullary adenoma only. Another eight patients had both ampullary and non-ampullary polyps for which they received EMR. A total of 65 patients (16 with FAP, 24.6%) underwent a total of 90 duodenal EMRs for large duodenal polyps. The mean age was 65.4 years (30.5-93.8 years), and 29 (44.6%) of the patients were females (Table 1). Of the 65 patients, nine (13.8%) had previously undergone colectomy with ileoanal anastomosis, and four (6.2%) had undergone colectomy with end ileostomy; all 13 who had surgery before EMR were diagnosed with FAP. A majority of the patients were Caucasian (46; 70.8%).

Age in years (mean, range)	65.4, (30.5-93.8)
Female gender	29 (44.6%)
Race	
Caucasian	46 (70.8%)
African American	6 (9.2%)
Asian	3 (4.6%)
Other/unknown	10 (15.4%)
Ethnicity	
Hispanic	10 (15.4%)
Non-Hispanic	55 (84.6%)
Primary Cancers	
Gastrointestinal	15 (37.5%)
Pulmonary	1 (2.5%)
Hematologic	6 (15.0%)
Skin	5 (12.5%)
Prostate	1 (2.5%)
Breast	2 (5.0%)
Thyroid	4 (10.0%)
Renal	2 (5.0%)
Oropharyngeal	2 (5.0%)
Ovarian	1 (2.5%)
Uterine	1 (2.5%)
Prior Surgeries	
Colectomy with ileoanal anastomosis	9
Colectomy with end ileostomy	4
Diagnosis of FAP	13

Table 1: Patient demographics.

Of the 65 patients, 33 (50.8%) had concomitant extra-duodenal cancer; malignancies of gastrointestinal origin were the most common, reported in 15 (45.5%) of the patients. Most patients were classified as ASA 3 (44; 67.7%), whereas only one patient was deemed to be ASA 4 (1.5%).

Duodenal polyps were most commonly identified when endoscopy was prompted due to symptoms (22; 33.8%), followed by detection on endoscopy being performed in patients with FAP (16; 24.6%), and incidental detection on endoscopy were performed for other indications (14; 21.5%). The most common presenting symptom was abdominal pain (9, 40.9%), whereas gastrointestinal

bleeding, dysphagia, and gastroesophageal reflux were reported in five patients each (22.7%) (Table 2). Polyps were most commonly located in the D2 (45; 56.8%), followed by the duodenal bulb (27; 34.6%). EUS was performed in 43 (66.2%) patients to assess the depth of adenomatous involvement and visualize the infiltrating or surrounding vasculature. The average size of the resected lesions was 25 mm (minimal:4mm, maximum:110 mm). Twenty-two patients (32.8%) had multiple lesions, with a mean of 5.33 lesions (range; 2-50).

Screening/Surveillance	9 (13.8%)
Incidental on endoscopy	14 (21.5%)
Abnormal labs	2 (3.1%)
Abnormal imaging	2 (3.1%)
Prior diagnosis of FAP	16 (24.6%)
Symptoms	22 (33.8%)
Abdominal pain	9 (40.9%)
Vomiting	3 (13.6%)
GI Bleed	5 (22.7%)
Weight loss	1 (4.5%)
Dysphagia	5 (22.7%)
Change in bowel habit	3 (13.6%)
GERD	5 (22.7%)

Table 2: Reasons for endoscopic intervention.

A total of 79 of 90 EMRs (87.7%) were performed at the time of the first endoscopic intervention (Table 3). Of note, nine out of 65 patients (13.8%) needed more than one EMR for multiple duodenal lesions: one patient underwent five EMRs (for NETs); two patients received three EMRs (both patients had NETs); and six patients received two EMRs (one patient had NETs and the rest, adenomas).

The procedure time was from 19-254 minutes (mean: 78.1 minutes) including fellow training time. En-bloc resection was successfully performed in 22 (27.8%) and piecemeal resection in 57 (72.2%) patients. Of note, in 26 patients (32.9%), cap-assisted EMR (C-EMR) was performed. In 63 of the 65 patients (96.9%), complete resection of the visible mass was achieved. Post-resection ablation was performed after 52 EMRs: argon plasma coagulation (APC; 0.4-0.8 liters per minute, 20 Watts) was utilized for 35 lesions, soft coagulation (setting effect 5/60 Watts) for 12 lesions, and both for five lesions.

During EMR, control of bleeding was required in 12 patients (18.5%); hemostasis was achieved using coagulation in 10 patients (83.3%), clips and epinephrine injection in one patient each (8.3%). Delayed bleeding was noted in six patients (9%); all were successfully managed by endoscopic therapy with a conservative approach of observation. No significant post-EMR strictures were noted over the follow-up period. No intraprocedural perforations were noted. Regrettably, however, there were two delayed perforations requiring surgical intervention (2.2%). Three patients required hospitalization for AEs: two for the management of the above-mentioned perforations, and one for delayed bleeding.

Distribution of Polyps (Total - 79)	
Duodenal Bulb	27 (34.6%)
Second Portion	45 (56.8%)
Third Portion	6 (7.4%)
Fourth Portion	1 (1.2%)
Procedure Details	
Mean procedure time in minutes (range)	78.1 (19-254)
Size in mm (range)	25.0 (4 - 110)
En-bloc Resection	22 (27.8%)
Piecemeal Resection	57 (72.2%)
Adverse Events	
Delayed Perforation	2 (2.5%)
Delayed Bleeding	6 (7.6%)
Recurrence (number of patients)	11 (16.9%)
Pathology	
Adenoma	54 (68.4%)
Adenocarcinoma	1 (1.3%)
Neuroendocrine Tumor	20 (25.3%)
Both Adenoma/Neuroendocrine	1 (1.3%)
Brunner's Gland hamartoma	2 (2.5%)
Reactive Hyperplasia	1 (1.3%)
Duodenal Adenoma	
Grade	
Low-Grade	1 (1.8%)
High-Grade	21 (38.2%)
Not High-Grade	33 (60.0%)
Histology	
Tubular	21 (40.4%)
Tubulovillous	28 (53.8%)
Villous	3 (5.8%)
Neuroendocrine Tumor	
Grade	
Low-Grade	20 (95.2%)
Intermediate-Grade	0 (0%)
High-Grade	1 (4.8%)
Mitotic Index	
0 per HPF	7 (41.2%)
1 per HPF	8 (47.1%)
2 per HPF	2 (11.8%)
Ki-67 mean (range)	2.97 (2.0-4.2)

Table 3: Characteristics of first endoscopic intervention.

Another four patients were kept for observation overnight and discharged after repeat EGD the next day for delayed bleeding; all these four patients were successfully managed without further intervention.

Due to the large size of mucosal defects after resection and the semi-rigidity of the duodenum, no attempts were made to close the post-EMR mucosal defects in most patients except for a small subset of patients who underwent through scope clip (TTSC) placement. Endoscopic suturing of the mucosal defect(s) was performed in two (3%) patients due to the failure of initial hemostasis.

Most lesions had adenomatous histology (54; 68.4%), of which 28 (58.3%) were tubulovillous adenomas, and 21 (39.6%) were tubular adenomas with high-grade dysplasia (HGD). One patient (1.3%) was found to have adenocarcinoma on histopathological analysis. Twenty-one lesions had neuroendocrine histology, of which 20 (90%) had low grade and one (10%) high-grade differentiation, respectively. No regional or distant lymph node involvement was noted. The mean Ki-67 index was 2.97 (range; 2.0-4.2). Fourteen (73.7%) lesions were positive for synaptophysin, and 16 (84.2%) were chromogranin positive.

A total of eight (12.7%) patients needed surgical intervention after EMR: two patients underwent surgery for delayed perforation after EMR as mentioned above; three patients underwent surgery for recurrence of HGD after EMR; one patient underwent surgery to resect a full-thickness lesion; one patient underwent surgical resection of a carcinoid tumor near the pylorus not amenable to endoscopic resection; and one patient underwent an adenoma resection that was difficult to access for EMR due to unusual anatomy and a concurrent ampullary lesion needing resection.

Recurrence

On repeat EGD after initial EMR, a total of 11 patients were found to have recurrence; two required repeat EMR, three underwent surgical resection for high grade dysplasia, four received endoscopic ablation therapy with APC, and two were conservatively managed with observation. Regarding the two patients that underwent repeat EMR for recurrence of their index lesion: one patient required repeat EMR for a 20-mm recurrent lesion in the duodenal bulb at the site of the previously resected 20-mm lesion. The other patient had a 40-mm lesion in D3 which was resected incompletely on the initial attempt, requiring a repeat EMR of the 25-mm remnant lesion a few months later. Thirteen years later, this patient required a third EMR for a recurrent lesions of the same area measuring 40 mm. Piecemeal resection with soft coagulation post-resection ablation was performed in all three EMRs for recurrence. All lesions were found to be tubulovillous adenomas without HGD.

Distribution of Polyps (Total - 8)	
Duodenal Bulb	2 (25.0%)
Second Portion	6 (75.0%)
Procedure Details	
Mean procedure time in minutes (range)	53.6 (34-80)
Size in mm (range)	9.9 (5.0-25.0)
En-bloc Resection	3
Piecemeal Resection	5
Adverse Events	
Delayed Perforation	0
Delayed Bleeding	0
Pathology	
Adenoma	4 (50.0%)
Adenocarcinoma	0
Neuroendocrine Tumor	2 (25.0%)
Gastric Heterotopia	2 (25.0%)
Duodenal Adenoma	
Grade	
Low-Grade	0
High-Grade	0
Not High-Grade	5 (100.0%)
Histology	
Tubular	4 (80.0%)
Tubulovillous	0
Villous	1 (20.0%)
Neuroendocrine Tumor	
Grade	
Low-Grade	2 (100.0%)
Intermediate-Grade	0
High-Grade	0
Mitotic Index	
0 per HPF	0
1 per HPF	2 (100.0%)
2 per HPF	0

Table 4: Characteristics of subsequent endoscopic interventions.

In addition to EMR for recurrent lesions, six patients (9.2%) underwent eight EMRs for other existing duodenal lesions (Table 4); these 6 patients had more than one duodenal lesion at the initial presentation when only the most dominant one was resected. Two of the 8 polyps were in the duodenal

bulb (25%), and six in D2 (75%). These lesions was at average 9.9 mm large (5.0-25.0 mm) and two out of six patients had multiple lesions. All eight lesions were fully endoscopic resected; En-bloc resection was performed of three lesions (37.5%), and piecemeal resection of five lesions (62.5%). C-EMR was performed for three lesions (37.5%). Post-resection ablation was performed on five lesions with APC (62.5%), and on two lesions with soft coagulation (25%). Intra-procedural hemostatic intervention was not required in any of the cases. However, delayed bleeding was noted in one patient (16.7%) requiring a repeat EGD with TTSC placement. No perforations were noted in repeat EMRs. Histopathological analysis revealed four of the lesions to be adenomas (50%), two to be neuroendocrine tumors (25%), and two lesions to gastric heterotopia (25%).

Our study illustrates that duodenal EMR can be performed safely. Complete resection of the visible mass was achieved in 97% of patients at the index session, with a low recurrence rate. We are experienced that a side-viewing endoscope is suitable for lesions on the anterior and medial duodenal wall, and a pediatric colonoscope is preferable for those on the posterior and lateral duodenal wall, especially which has the opening therapeutic channel at 5 o'clock.

Discussion

In the current study, eight patients underwent surgical resection for the aforementioned reasons. Two patients required EMR for recurrence of their index lesion, while six patients received eight EMRs for other existing duodenal lesions. Multiple investigators have reported experiences similar to our own. Tomizawa et al. reported complete mucosal resection in 93% of patients who underwent duodenal EMR, with 53% of en-bloc resection, and 23% of local or residual recurrence[16]. No perforation was observed, EMR-related bleeding associated with increased lesion size occurred in 11% of cases. Interestingly, recurrence was only correlated with lesion size but not with endoscopic or histologic features ($p<0.001$).

We employed C-EMR in locations where placing a snare on the remnant lesion was not possible, mostly due to fibrosis that had commonly developed from repeated biopsies by referring physicians. Previous study reported outcomes of C-EMR of 26 large duodenal polyps within 96% of the patients by fully eradication. They noted no perforations but did report three intraprocedural bleeding events. Residual adenomas were seen in three patients, with one adenocarcinoma eight months post-EMR over a median follow-up of six years[17]. Jamil et al. also reported similar results that 49 sporadic non-ampullary duodenal adenomas resected by C-EMR, which showed no recurrence during 17 months follow-up. AEs were reported in 16.9% of the cases, with intraprocedural bleeding accounting for 10.2%, delayed bleeding for 5.1%, and perforation for 1.7% of events[18]. One caveat in performing C-EMR is that only controlled, limited suction should be applied before placing a snare on the target lesion to prevent full-thickness resection. Therefore, this method should only be tried by experts in EMR with skills in closing perforations. In our series, we did not encounter any perforation with C-EMR. Another approach to resecting fibrosed segments of duodenal adenomas, as reported by Tashima et al., is to place an over-the-scope clip (OTSC) at the duodenal epithelial lesions with fibrosis, with subsequent resection of the residual lesion(s)[19]. Underwater EMR is another modality for managing duodenal adenomas where the magnifying effect of water allows for clear margin resection. A clinical research reported that 12 patients with sporadic laterally spreading non-ampullary duodenal adenomas by using underwater EMR, in which 10 complete resections at the index session and one complete resection in two sessions. One patient eventually needed a pancreaticoduodenectomy[20, 21]. A total of five AEs were reported in four patients: delayed bleeding in three, stricture in one, and water intoxication syndrome in one patient.

While EMR of duodenal large polyps is efficacious, our study clearly shows serious AEs could happen in duodenal EMR. EMR of large duodenal polyps is challenging, as has been reported in previously published data by other investigators, stemming from the difficulty in maneuvering an endoscope in the duodenum due to the narrow and confined space of the C-loop, which results in a paradoxical advancement of the scope while trying to perform an endoscopic resection. Visualizing and placing the endoscope at the targeted lesion(s) was also challenging because of the difficulty in rotating the scope freely in D2, D3, and D4. If a polyp is located at 12 o'clock or 12 to 4 o'clock, visualizing the polyp en the face becomes difficult or impossible while using a forward-viewing endoscope, not to mention the difficulties in resecting the lesion and closing the mucosal defects.

Commonly, early endoscopic closure could effectively avoid duodenum perforation which is not well tolerated by patients, and surgical repair and placement of multiple drains. Delayed recognition of perforation will result in worse outcomes, longer hospital stay, AEs that often necessitate more complicated surgical interventions, and potential for mortality. High risk factors for duodenal perforation mainly comes from thinner wall and high concentrate pancreatic proteolytic enzymes exposure in luminal. Placement of a nasopancreatic tube (NPT) can effectively prevent delayed perforation caused by the pancreatic secretions at mucosal defect. While no intraprocedural perforations were encountered in our series, regrettably two delayed perforations occurred. These perforations were possibly attributed to pancreatic proteolytic enzymes exposure to the second portion of the duodenum, subsequently inducing injury to muscle tissue at the base of the EMR defects out of protection. It is customary to admit the patient for observation for 3-5 days. In our center, we regularly observed for 1-2 days in case of polyp is greater than 3 cm or a large defect after EMR cannot be closed. Both patients who experienced a perforation in our series underwent surgical repair while being inpatients and did well.

Since the perforation events, we have been making every effort to close the mucosal defects as we can. In clinical practices, physicians have tried many different ways to close post-EMR mucosal defects, such as placement of TTSC, OTSC and polymer gels or sheets to restrain the defects; additionally, endosuturing, or combination of TTSC and end loop cinching were also the effective methods. We have utilized clips plus endoloop cinching, and endosuturing. The Apollo X-Tack suturing device (X-Tack Endoscopic Helix Tracking System; Apollo Endosurgery, USA) that was recently introduced to therapeutic endoscopy to close post-EMR mucosal defects, allows the placement of four tacks embedded into the deep submucosa or muscularis propria across the mucosal defect and the tacks can be cinched to close the defect[22, 23].

However, this device has a steep learning curve and requires training before attempting in a clinical case, especially in the duodenum. TTSC attached to a string of dental floss may be deployed on the normal mucosa at 5-10 mm distal and proximal to the margin of the mucosal defect[24, 25]; the dental floss is then pulled, thus opposing the margins of the mucosal defect. Lastly, TTSCs are placed across the defect closing it. In general, more than one dental floss attached to TTSC can be placed in the distal and proximal ends of the resection margins and be pulled up together. Although there are various sizes of TTSCs, deploying a TTSC in the duodenum is complicated by angulation, confined space of the duodenal anatomy, and visibility.

An innovative endoscopic closure technique, laparoscopy, endoscopy cooperative surgery (LECS), proposed by Ichikawa et al., having the preference to suture mucosal defect based on the endoscopically decided incision line of a full-thickness wall. This two layers of sutures can avoid postoperative complications effectively[26].

Conclusions

Potential risk exists during the endoscopic management of large duodenal polyps, EMR should be performed by experienced endoscopists, who are proficient in closing mucosal defects, also a multidisciplinary approach is pivotal to the successful EMR. Immediate adverse events can be managed endoscopically, delayed perforations usually require surgical management; all preventive measures for delayed perforations should be applied before completing EMR.

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