Introduction

Endoscopic submucosal dissection (ESD) has become a popular method for treating early colorectal tumors, and its indication is broadening to target larger lesions. There has been a report of increased rates of adverse events (AEs) for lesions larger than 50 mm, with size reported as an independent risk factor for post-ESD AEs [1]. In addition, expected fatigue from the long procedural time could deter endoscopists from performing ESD on larger lesions. Therefore, it is beneficial for both physicians and patients if a technique can be developed to effectively and safely dissect large tumors.

A previously reported technique, called the multiple tunneling technique, involves creation of multiple straight tunnels beneath the lesion [2]. The technique involves creating multiple straight submucosal tunnels from the anal to the oral side, purposely leaving multiple sheets of submucosal tissues between the tunnels, resembling a palisade. This palisade of submucosal tissues acts as an anchor to prevent the tumor mass from collapsing on the contralateral wall of the colon, which provides
good traction throughout dissection. We believe that this property is the key to this technique and propose renaming the palisade technique as an improved descriptor.

We conducted a case series to investigate outcomes of colorectal ESD for large colorectal tumors using this technique to measure important resection outcomes, including R0 and en-bloc resection rates, speed of dissection, and AEs.

Patients and methods

Patients

From August 2017 to October 2019, 837 colorectal ESDs were performed at NTT Medical Center Tokyo, Tokyo, Japan, a tertiary endoscopic center. Of these, 24 lesions were treated using the palisade technique. Thirteen lesions extended less than half of the luminal circumference and were excluded. The remaining 11 lesions that were over half the luminal circumference were retrospectively analyzed. Clinical data, including patient demographic details, lesion characteristics, and therapeutic outcomes were collected from our database.

This study was approved by the Ethics Committee of NTT Medical Center Tokyo (ID 19-286) and was registered with the University Hospital Medical Information Network (UMIN) Clinical Trials: UMIN 000038101. All ESDs were planned according to Japanese guidelines for ESD and endoscopic mucosal resection of colorectal cancer [3]. Antithrombotic and anticoagulant agents were stopped before the procedure in accordance with current guidelines [4].

palisade technique

All patients were sedated with intravenous flunitrazepam (conscious sedation). ESD was performed using a single-channel endoscope with water jet (PCF-H290AZI; Olympus Medical Systems, Tokyo, Japan). A transparent hood was used in all cases (Elastic touch, L, 16675; TOP co, Tokyo, Japan). Dual knife (KD-620QR; Olympus Medical Systems, Tokyo, Japan) and IT knife nano (KD-612; Olympus Medical Systems, Tokyo, Japan) were used interchangeably according to circumstances in all cases. We used a coagrasper (FD-411QR; Olympus Medical Systems, Tokyo, Japan) for arterial bleeding that was otherwise unmanageable with the dissection knife. Sodium hyaluronate solution mixed with indigo carmine and adrenaline was used as injectate to lift the lesion. Carbon dioxide was used for insufflation. We used an ERBE electrosurgical unit, VIO300D (Erbe, Tübingen, Germany). The settings used were: Endo Cut mode I (effect 2, duration 2, interval 2) for mucosal incision and forced coagulation mode (effect 2, 45 W) for submucosal dissection and vessel coagulation.

▶ Fig. 1 shows a sub-circumferential laterally spreading tumor (LST) in the sigmoid colon that measures 170 mm. Initially, the patient position was adjusted so that the tumor was on the opposite side of gravity, improving access to the submucosal layer after initial incision. The sodium hyaluronate solution was injected on the anal side of the tumor (▶Fig. 2). Using a dual knife, a horizontal mucosal incision on the anal side of the tumor was created as an entrance to create a straight tunnel towards the oral side, being careful not to excessively expand the tunnel diameter horizontally, as that could compromise scope stability. Leaving a thin sheet of submucosal tissue in between, another straight tunnel was made adjacent to the first tunnel. The above procedure was repeated until the entire width of the tumor was undermined by the tunnels, leaving multiple sheets of submucosal tissues in between the tunnels, resembling a palisade (▶Fig. 3). Circumferential resection around the lesion was made after successful creation of the tunnels, after which the sheets of submucosal tissues were dissected with the dual knife, ultimately removing the tumor (▶Fig. 4 and ▶Fig. 5). The specimen was then sent for pathological analysis by a pathologists unaware of the resection technique used.
Outcomes

The primary outcome of this study was the R0 resection rate. Secondary outcomes included en-bloc resection rate, rate of AEs, median submucosal dissection speed (SDS), submucosal dissection time (SDT), and local recurrence rate. SDT was calculated by dividing the lesion area by dissection time. We classified lesion size as follows. Full circumferential lesions extended over the full circumference of the colorectal lumen with no intervening normal mucosa in between the lesion edge, semi-circumferential lesions occupied over half of the lumen, and sub-circumferential lesions we defined as in between these cases. The lesion area was calculated by multiplying half the length by half the width of the lesion and then multiplying the product by 3.14. The longest axis of the lesion was considered the length, and the axis perpendicular to the length was measured as the width. All procedures were performed by expert endoscopists, defined as operators who performed more than 80 colorectal ESD cases [5]. Five experts participated in the study.

A resected specimen was pinned and placed in 20% formalin. All specimens were sectioned serially in 2- to 3-mm intervals and sent for histological evaluation and reported using the Vienna classification. R0 resection was defined as complete resection with negative lateral and vertical margins. En bloc resection was defined as one-piece resection of the tumor with free margins on macroscopic assessment. Immunohistopathological staining was performed to assess the presence of lymphovascular invasion. AEs assessed include delayed bleeding, perforation, and post-colorectal ESD coagulation syndrome (PECS). This was defined as local abdominal pain in the region corresponding to the site of the ESD within 4 days after ESD. We defined delayed bleeding as presence of marked bloody stool after treatment requiring hemostasis. Intraoperative perforation was defined as a full-thickness defect of the colorectal wall that was recognized by the endoscopist as a state in which connective tissue, adipose tissue, and/or serosa are visualized through the defect during ESD. Delayed perforation was defined as perforation of the colon that occurred after the scope had been withdrawn following the completion of ESD in which intra procedural perforation did not occur. We defined post-ESD stricture as stenosis in which an endoscope failed to advance.

Results

A total of 11 patients were included in the study and of them, seven were men (64%). ▶Table 1 lists the characteristics of the patients included in this study. Their median was 69 years
had a 6400-μm submucosal invasion. The patient with adenocarcinoma-in-adenoma and two patients with PECS, both managed conservatively. No perforations occurred. We recorded one case of post-ESD stric-
tination was three in nine cases, five in one case, and four in one case. Of the lesions, 91 % were non-pedunculated in morphology. Six lesions were sub-circumferential, and five were semi-cir-
cumferential. None of the tumors were fully circumferential. We did not have any lesions with extensive submucosal fibrosis.

Treating large colorectal tumors is a challenge faced by endoscopists at many levels. We often recognize that despite large size, certain laterally spreading lesions are able to be cura-
tively resected with endoscopic resection. If the endoscopist decides to treat the lesion endoscopically, a robust strategy is required, given the size and potential difficulty. One of the dif-
ficulties we face is the loss of traction during dissection of such large lesions. With a conventional ESD technique, the dissected lesion hangs into the lumen, which provides traction at the be-

Discussion

In our study, 11 large colorectal tumors growing over half the luminal circumference of the colon were successfully dissected with ESD using the palisade technique.

Table 1: Patient demographics.

| Age          | Median | 69 (43–86) |
|--------------|--------|------------|
| Gender       | Male   | 7          |
|              | Female | 4          |
| Number of submucosal sheets | Three | 9          |
|              | Four   | 1          |
|              | Five   | 1          |
| Location     | Rectum | 4          |
|              | Colon  | 7          |
| Morphology   | Pedunculated | 1          |
|              | Non-pedunculated | 10        |
| Circumferentiality | Full circumferential | 0          |
|              | Subcircumferential | 6          |
|              | Semicircumferential | 5          |

(range 43 to 86). Seven lesions were located in the colon and four lesions in the rectum. The number of sheets made for dis-
section was three in nine cases, five in one case, and four in one case. Of the lesions, 91 % were non-pedunculated in morphology. Six lesions were sub-circumferential, and five were semi-cir-
cumferential. None of the tumors were fully circumferential. We did not have any lesions with extensive submucosal fibrosis.

Table 2: Outcomes of the palisade technique in dissecting large colorectal tumors.

| Outcome                                      |          |
|----------------------------------------------|----------|
| Median lesion length (range), mm             | 103 (56–170) |
| Median lesion area (range), mm²              | 4219.4 (2121.9–12677.8) |
| Median SDT (range), min                       | 170 (43–350) |
| Median SDS (range), mm²/min                   | 23.1 (10.2–77.5) |
| R0 resection, n (%)                           | 5 (45.6%) |
| En bloc resection, n (%)                      | 11 (100%) |
| Perforation, n (%)                            | 0 (0%)   |
| Post ESD bleeding, n (%)                      | 1 (9.1%) |
| PECS, n (%)                                   | 2 (18.2%) |
| Adverse events, n (%)                         | 3 (27.3%) |
| Pathology                                     |          |
| Adenoma, n (%)                                | 3 (27.2%) |
| Adenocarcinoma in adenoma, n (%)             | 6 (54.5%) |
| Adenocarcinoma, n (%)                         | 2 (18.2%) |
| SDT, submucosal dissection time; SDS, submucosal dissection speed; ESD, endoscopic submucosal dissection; PECS, post-colorectal ESD coagulation syndrome. |          |

(Table 1: Patient demographics.

(Table 2: Outcomes of the palisade technique in dissecting large colorectal tumors.)
that regard, our study demonstrated favorable results in comparison to conventional ESD, where the perforation rate is reported at 4.5% [7]. Rates of delayed bleeding, however, were higher than previously reported (2.4% in Asian countries) [7, 8]. Half of the lesions in this study were located in the rectum higher than previously reported (2.4% in Asian countries) [7, 8]. Rates of delayed bleeding, however, were higher than previously reported (2.4% in Asian countries) [7, 8]. Half of the lesions in this study were located in the rectum.

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In conclusion, the palisade technique can be safe and effective in dissecting large colorectal tumors that would otherwise be difficult to treat with conventional ESD methods. Due to larger tumor size, delayed bleeding may occur at a higher rate than conventionally reported, but can be safely managed endoscopically. Further prospective studies for treatment of these large lesions is necessary.

**Conclusion**

In conclusion, the palisade technique can be safe and effective in dissecting large colorectal tumors that would otherwise be difficult to treat with conventional ESD methods. Due to larger tumor size, delayed bleeding may occur at a higher rate than conventionally reported, but can be safely managed endoscopically. Further prospective studies for treatment of these large lesions is necessary.

**Competing interests**

The authors declare that they have no conflict of interest.

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