



# Anatomical features of duodenal folds: a key feature to consider during endoscopic resection of duodenal neoplasms

Yoshimasa Miura, MD, PhD, Hiroyuki Osawa, MD, PhD, Yoshie Nomoto, MD, Hironori Yamamoto, MD, PhD

## INTRODUCTION

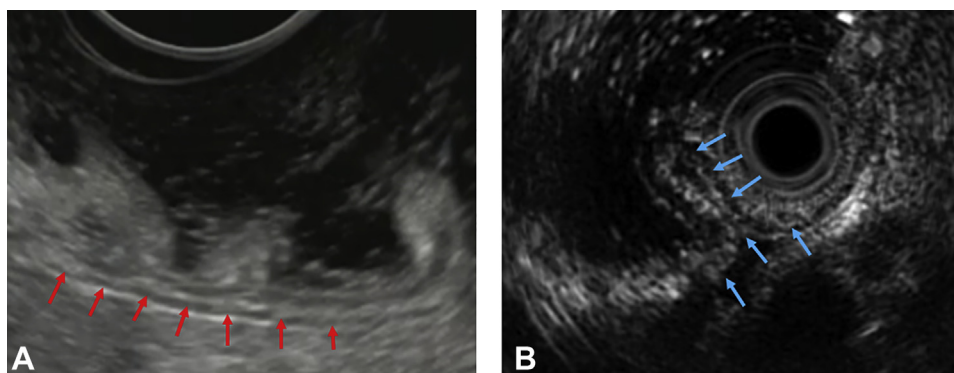
Endoscopists should take care not to snare the muscularis propria during EMR and not to damage the muscularis propria during endoscopic submucosal dissection (ESD) of GI lesions. Duodenal ESD is particularly difficult because of the high risk of intraprocedural or delayed perforation.<sup>1</sup> Thermal damage to the muscularis propria may cause delayed perforation. Therefore, it is ideal to dissect the submucosa under direct vision to avoid such damage. We have used the pocket-creation method (PCM) for various GI neoplasms, including those in the duodenum, and reduced the frequency of perforation.<sup>2</sup> Nevertheless, it is sometimes difficult to perform duodenal ESD. We considered other factors that make ESD difficult. Therefore, we pay attention to the anatomic features of the duodenal folds.

The duodenal folds are anatomically different from the colonic folds. To successfully treat lesions in the duodenum, we need to understand that there are 2 anatomic differences between the colon and duodenum: (1) Colonic folds contain muscularis propria, whereas duodenal folds (Kerckring's folds) do not; and (2) the submucosa of the duodenum is thick in the folds and thin in the flat wall between folds.

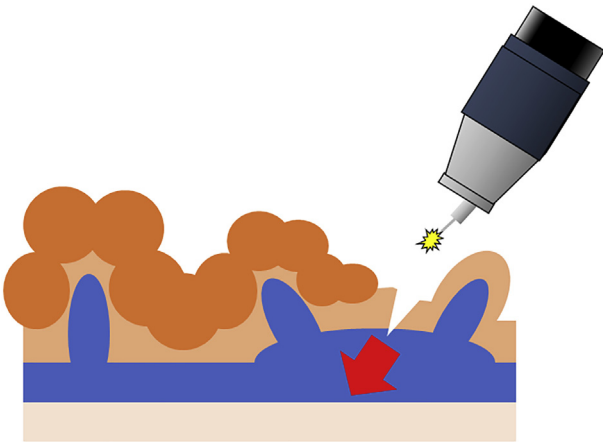
## METHODS

There is no muscularis propria on duodenal folds, which is demonstrated by EUS. EUS in the duodenum shows that the duodenal folds are formed with the mucosal and submucosal layers, whereas the muscularis propria remains flat under water along the long axis (Fig. 1A). In contrast, the colonic folds are formed with whole colonic wall layers, including the muscularis propria (long-axis view) (Fig. 1B). Therefore, it is especially important to recognize that endoscopists do not need to be concerned about cutting duodenal folds during endoscopic resection.

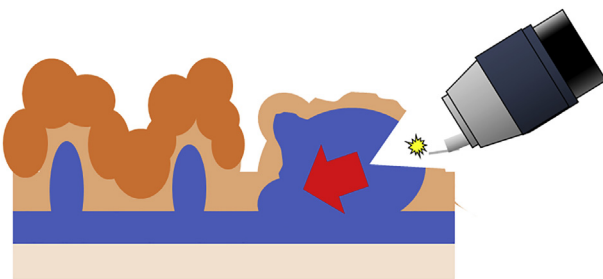
During ESD, if a colonic lesion is located on a fold, the endoscopist must avoid making the entrance just at the site of the fold because the muscularis propria is vertically visualized after mucosal incision owing to its presence in the fold. Rather, the initial incision site should be placed in the flat part at a sufficient distance from the lesion's edge, which has thicker submucosa than the duodenum. This colonic anatomic feature allows the endoscope to enter the submucosal space with relative ease. However, solution injected in the flat wall between folds of the duodenum disperses easily in the surrounding submucosa without making a protrusion, even if injecting a viscous solution such as sodium hyaluronate into the submucosa (Fig. 2).



**Figure 1.** **A**, EUS in the duodenum shows that the duodenal folds are formed with the mucosal and submucosal layers, whereas the muscularis propria remains flat under water along the long axis (*red arrows*). **B**, In contrast, the colonic folds are formed with whole colonic wall layers including the muscularis propria (long-axis view using a microprobe) (*blue arrows*).



**Figure 2.** Illustration of injection of viscous solution in the flat lumen between duodenal folds. Even if a viscous solution such as sodium hyaluronate is locally injected in the flat area of the lumen, it easily disperses widely in the duodenal submucosa without creating a protrusion.



**Figure 3.** Illustration of injection of viscous solution in a duodenal fold. Local injection into the fold facilitates submucosal protrusion and entry into the submucosa at the beginning of endoscopic submucosal dissection, possibly owing to denser and longer fibers in the submucosa of the folds.

Therefore, endoscopists need to choose the appropriate site for the initial mucosal incision to get into the broad submucosal space and advance to the next step of duodenal ESD. Injecting the solution into the duodenal fold allows easy entrance to the submucosa. The initially thicker submucosal space becomes much wider, leading to easily elevated mucosa. The entrance incision should be placed at the middle of the site raised by injection. After mucosal incision, the submucosal space can be opened easily, and the tip of the endoscope can directly enter the fold because the duodenal fold has no muscularis propria (Fig. 3).

To understand the differences in these anatomic features, we present 2 cases of duodenal neoplasms, including one with injection of sodium hyaluronate in the flat wall between folds and another with injection in the fold.

### Case 1

A 40-mm neoplasm was located in the descending portion of the duodenum. We attempted to perform ESD. After marking, we injected sodium hyaluronate into

the submucosal layer in the flat wall between folds. However, the injected solution dispersed laterally to the flat lumen between folds. We started the mucosal incision on the near side of the marking. After the mucosal incision and several passes to dissect the submucosa, we repeatedly tried to enter the submucosal space but could not easily open or enter the submucosal space. Neither additional injection of solution nor the use of a small-caliber-tip transparent hood improved the situation. In duodenal ESD, thermal damage to the muscularis propria should be avoided because it is associated with intraprocedural and delayed perforation. However, we could not avoid blindly dissecting the submucosa despite the potentially high risk of perforation (Fig. 4).

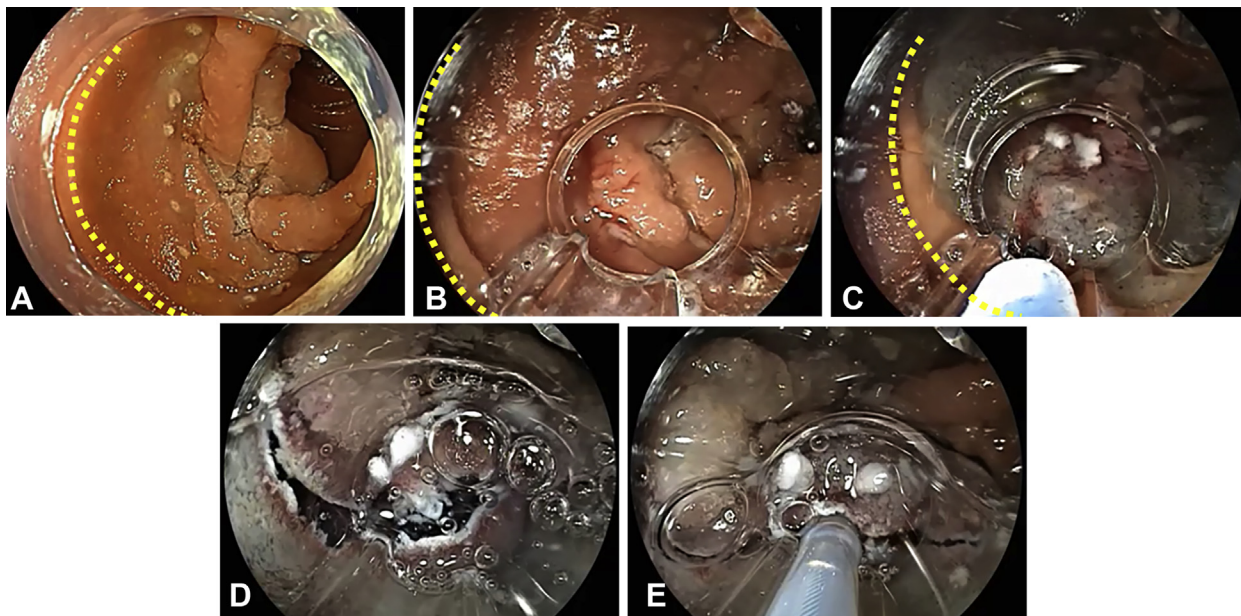
### Case 2

A 50-mm neoplasm was located at the inferior duodenal angle. After marking, we intentionally injected sodium hyaluronate into the submucosal layer at the duodenal fold just in front of the lesion. We started the mucosal incision from the middle area of the fold raised by the injection. With a mucosal incision alone, we could open the submucosal space easily without submucosal dissection and enter the submucosal space. Subsequently, using the PCM with a small-caliber-tip transparent hood, we could safely dissect the submucosa even with the tight and limited space under the flat portion between folds (Fig. 5).

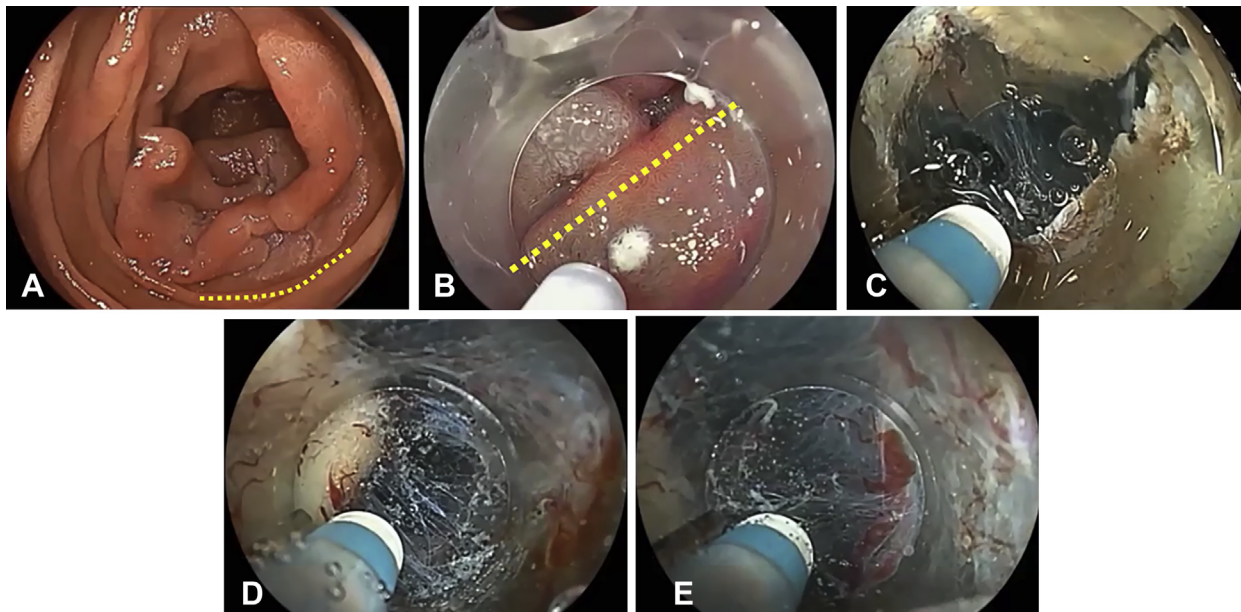
## DISCUSSION

The difference in the submucosal space in the duodenum may be caused by the presence of denser and longer submucosal fibers in the folds than in the flat areas. In addition, a duodenal fold has no muscularis propria, unlike a colonic fold. An initial incision at the site of a protruded fold facilitates diving into the submucosa more easily and subsequently dissecting it. These features can be taken advantage of for the treatment of lesions in the descending and horizontal portions of the duodenum but not in the duodenal bulb, which has no folds.

The PCM enables stabilization of the tip of the endoscope and reduces the rate of intraprocedural perforation of duodenal ESD.<sup>2</sup> However, even if using the PCM, it is sometimes difficult to enter the submucosal space at the beginning of duodenal ESD. The water pressure method is also useful for duodenal ESD.<sup>3</sup> This method may be useful for entering the submucosal space by opening the submucosal space aided by water pressure. Regardless of whether one performs PCM or water pressure method, we believe that understanding this anatomic feature may facilitate easy entrance into the submucosal space, leading to safe and reliable duodenal ESD.



**Figure 4.** Case 1. Duodenal endoscopic submucosal dissection with injection of sodium hyaluronate in the flat wall between folds. **A**, A 40-mm neoplasm is in the descending portion of the duodenum. Observation after marking. *Yellow dotted line* shows a duodenal fold on the proximal side of the tumor edge. **B**, After aspiration of intraluminal gas. A duodenal fold appears clearly (*yellow dotted line*). **C**, After injection into the submucosa in the flat part between folds. Injected solution disperses laterally in the flat part between the folds. **D**, After mucosal incision and several passes at submucosal dissection, entering the submucosal space is not easy even when using a small-caliber-tip transparent hood. **E**, Blind submucosal dissection is necessary to enter the submucosa.



**Figure 5.** Case 2. Duodenal endoscopic submucosal dissection with injection of sodium hyaluronate in the fold. **A**, A 50-mm duodenal neoplasm is located at the inferior duodenal angle. *Yellow dotted line* shows a fold proximal to the lesion. **B**, Intentional injection into the submucosa in the fold. Initial mucosal incision is at the site of the fold raised by injection. **C**, Easy entrance to the submucosal space using a small-caliber-tip transparent hood. **D**, Submucosal dissection under the flat part. Submucosal space is narrow and tight. **E**, Submucosal dissection under the fold. Submucosal space is wide and rough.

## CONCLUSIONS

Endoscopists do not need to fear cutting a duodenal fold, because it has no muscularis propria. Local injection into the fold can make a prominent submucosal protrusion and facilitates entering the submucosa at the beginning of duodenal ESD.

## DISCLOSURE

*Dr Yamamoto has patents for ESD devices and double-balloon endoscopy produced by Fujifilm Corporation. Drs Yamamoto and Osawa have a consulting relationship with the Fujifilm Corporation and have received honoraria, grants, and royalties from the company. Dr Miura has received honoraria from Fujifilm Corporation. All other authors disclosed no financial relationships relevant to this publication.*

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*Abbreviations: ESD, endoscopic submucosal dissection; PCM, pocket-creation method.*

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Department of Medicine, Division of Gastroenterology, Jichi Medical University, Shimotsuke, Japan.

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