SPANDIDOS PUBLICATIONS

Experimental model of two-colonoscope surgery for superficially spreading colonic tumors larger than 3 cm in the right colon

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Abstract. In the present study, we experimentally examined the feasibility of two-colonoscope surgery using two types of forceps to achieve safe, reliable, and complete endoscopic mucosal resection (EMR)/endoscopic submucosal dissection (ESD) of large superficial tumors in the right colon. It was confirmed at all experimental sessions that the two pairs of forceps intersected with each other over a wide angle of at least 90˚ in the cecum, and that the tips of the forceps could be moved by at least 180˚ in the longitudinal and horizontal directions. In another experiment, a piece of tissue measuring 3x3 cm or larger could be safely resected from a chicken thigh as the pseudo-tumor. Based on these results, two-colonoscope surgery is considered clinically promising as a next-generation EMR/ESD technique for safe, reliable, and complete resection of superficial tumors of the right colon measuring 3 cm or more in diameter.

Introduction

Endoscopic mucosal resection (EMR) is now indicated for a wide variety of large bowel tumors, including superficially spreading colonic neoplasms or so-called laterally spreading tumors (LST), such as flat tubular adenoma in focal mucosal cancer, and focal sm 1 cancer with limited invasion of the superficial submucosal layer (1-4). Conventionally, a single endoscope is used to strangle the tumor with a snare wire or cut it with a hooked knife or cutting needle (5-9). Local submucosal injection of an appropriate solution has been reported to be important for safe EMR that avoids the risk of large bowel perforation, which is one of the most serious complications of EMR. The utility of local submucosal injection of Bosmin in 0.5% sodium hyaluronate has often been reported (5-9). However, EMR is still associated with the following drawbacks when used for the treatment of large superficial tumors of the large intestine that are 3 cm or more in diameter of the right colon: i) a risk of perforation of the thin large bowel wall, ii) inability to completely collect resected tissues and reinsert the endoscope deep into the right colon when the tumor is broken up with multiple tissue pieces during resection, and iii) difficulty with manipulating the endoscope and forceps. Although various techniques, including total colono-tubing endoscopy using three-channel outer tubes and two-channel endoscopy, have been attempted to overcome these drawbacks, none of them have been widely accepted. The disadvantage common to such techniques is that the range of motion of two pairs of forceps is unexpectedly small due to inability to move the forceps approximately 180˚ in the longitudinal or horizontal direction, they can be advanced or retracted together tangentially or in the direction of the long axis of the large bowel. Although inserting two colonoscopes is considered most efficient for improving this problem, no experimental or clinical reports except for the upper gastro-intestinal lesions have been published on two-colonoscope surgery of the right colon (10-12). To investigate the feasibility of EMR for large superficial tumors 3 cm or more in diameter in the right colon, the present study experimentally examined whether using two colonoscopes could allow the two pairs of forceps to achieve about 180˚ of movement in the longitudinal and horizontal directions.

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Abbreviations: EMR, endoscopic mucosal resection; ESD, endoscopic submucosal dissection; LST, laterally spreading tumor

Key words: two-colonoscope surgery, endoscopic mucosal resection, endoscopic submucosal dissection, laterally spreading tumor, early colorectal cancer, superficial colonic tumor, endoscopic surgery

Materials and methods

Experiment 1. The two types of colonoscopes routinely used at our Endoscopic Center (PCF240I and PCF260AI; Olympus Co., Ltd., Tokyo, Japan) were inserted into a colonoscopy model (LM-044B; Koken Co., Ltd., Yamagata, Japan) to

Figure 1. The first colonoscope can be inserted into the cecum past Bauhin's valve (A, left monitor) and the second colonoscope could be easily inserted to the mid-portion of the ascending colon under guidance from the 1st colonoscope in the cecum (B, right monitor).

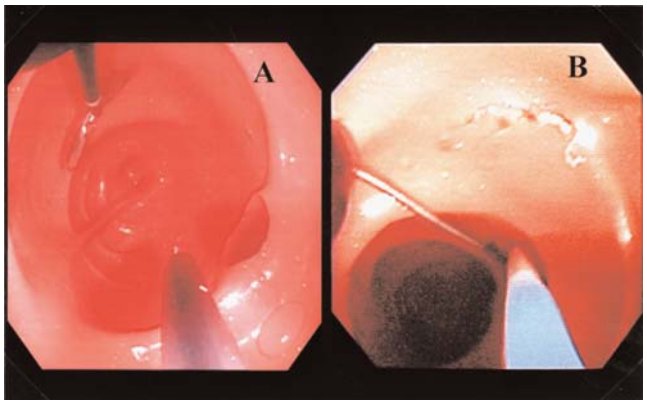

Figure 2. The mucosal grasping forceps and hook-type shaped knife forceps from two colonoscopes intersect in the cecum (A). The tips of the forceps can be moved at an angle of at least 90˚ or at least 180˚ in the longitudinal and horizontal directions, respectively (B).

examine whether they could be smoothly and safely inserted as far as the ascending colon and/or cecum. Two pairs of forceps, which were mucosal grasping forceps (FG-47L-1, Olympus) and a hook-shaped diathermy knife (KD-620LR, Olympus) were then inserted into the cecum to evaluate their range of motion. Five experimental endoscopy sessions were performed to examine whether the two pairs of forceps intersected with each other at about 90˚, and whether their tips could be moved ~180˚ in the longitudinal and horizontal directions.

Experiment 2. Two colonoscopes were inserted into a prototype right colon colonoscopy model ~6 cm in diameter and ~50 cm in length like the ascending colon and cecum in the duralumin box (Koken) to examine the performance of the forceps during resection of the pseudo-tumor. The two pairs of forceps used in experiment 1 were employed again. An attempt was made to pull up the pseudo-tumor using the mucosal grasping forceps and transect the tumor under tension and traction with

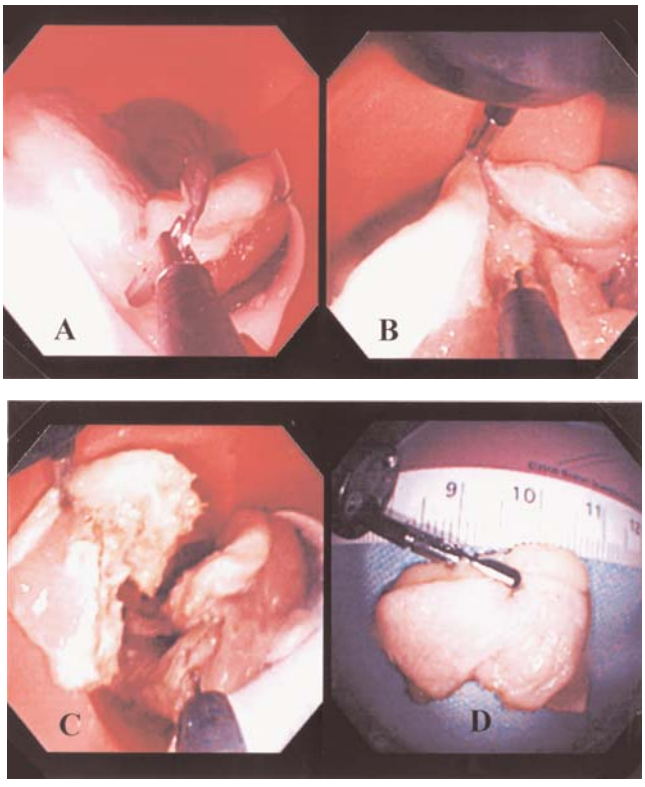

Figure 3. The pseudo-tumor can be easily grasped with the grasping forceps (A) and pulled up to facilitate cutting with the hook-shaped knife forceps horizontally under traction and tension to the vertical direction (B). A piece measuring about 3x3 cm in diameter of the meat with skin attached could be removed from the chicken thigh (10x10 cm) without tissue destruction like that indicating perforation (C and D).

the hook-shaped knife. A piece of fresh chicken thigh meat (10x10 cm) with skin attached was used as the pseudo-tumor. Five experimental sessions were performed to investigate whether part of the meat with skin attached measuring about 3x3 cm could be resected without tissue destruction like that indicating perforation.

Results

Experiment 1. The two colonoscopes were advanced to the cecum in all five experimental sessions (Fig. 1). It was confirmed a total of five times that the mucosal grasping forceps and knife forceps intersected with each other at an angle of at least 90˚ in the cecum, and that the tips of the forceps could be moved through at least 180˚ in the longitudinal and horizontal directions (Fig. 2).

Experiment 2. A 3x3 cm portion of the pseudo-tumor was safely removed in four experimental sessions. In the first session the skin separated from the meat (Fig. 3).

Discussion

In 1999, Yamamoto *et al* first reported the clinical utility of injecting sodium hyaluronate during endoscopic treatment. However, it was employed during EMR/ESD based on a special cutting technique using a transparent tip hood and

ife, which required the surgeon to be familiar with
d separation procedures using endoscopic forceps (5-9). Also, it was difficult to inject 10 ml of 0.5% sodium hyaluronate into the submucosal tissues around a tumor, even using a 21-G needle and a 5-ml syringe, and a volume of 10 ml was inadequate for expanding the submucosal tissue of the large tumor in the right colon. Therefore, we now use a glycerin solution for intravenous infusion instead of sodium hyaluronate because it is less expensive and easier to inject. The glycerin solution can be easily injected at a volume of 50 ml or more using a 23-G needle and a 20-ml syringe, just like injecting physiological saline. Unlike physiological saline, however, the glycerin solution remains in the submucosa to form a thick transparent jelly-like mass. This solution is not absorbed for at least one hour during EMR, and additional injection can be done without leakage from the needle hole to expand the tissue under the lesion.

Resection of a lesion is critical for making a histopathological diagnosis and the only method currently available for larger tumors, 3 cm or more in diameter, in the right colon is piecemeal removal with snare wire strangulations (13-15). Laparoscopic surgery combined with lymph node dissection has been reported to be most suitable for the treatment of larger superficial tumors of the large bowel, including early large bowel cancer (16-19). It has been reported that massive sm cancer is positive for lymph node metastasis in 10-15% of cases, and additional bowel resection is often performed after EMR in Japan (1-4). Since Japanese patients often wish to undergo EMR for larger tumors that have been confirmed to be benign by outpatient biopsy, even minimally invasive laparoscopic surgery under general anesthesia is considered too invasive, although it depends on the therapeutic options available for each patient. It is therefore considered more appropriate to choose EMR first and then decide on the necessity of performing additional resection after complete examination of intramural infiltration and tumor lymphatic and/or vessel infiltrations (ly and/or v factors) from the standpoint of patient-oriented surgery, although a prerequisite is that EMR can be performed safely without large bowel perforation (15,16).

We have already reported various experimental and clinical results on our large bowel EMR technique using two-channel to three-channel outer tubes and needle knives (13-15). However, we found that it was often difficult to accurately manipulate the forceps to treat a target lesion in the right colon because this region is about 150 cm from the anus. In fact, manipulation of most forceps was poor, even when a two-channel or multi-channel outer tube was used, because their motion was limited to the direction of the long axis of the intestine and because horizontal movement of the forceps was limited to the same direction as the tip of the endoscope. Accordingly, such outer tubes could not be applied clinically due to the unexpectedly small range of motion of the forceps. In the present experimental study, it was shown that the first endoscope acted like a guide wire that kept the large bowel lumen open and stabilized the sigmoid colon and transverse colon, thereby allowing the second endoscope to reach the right colon and the cecum, while facilitating reinsertion of the endoscope into the ascending colon as well as the complete collection of large tissue fragments and hemostasis/mucosal suturing procedures. It is expected that two-colonoscope surgery will eventually be clinically applicable as a next-generation EMR/ESD technique that allows the safe, reliable, and complete resection of larger superficial tumors measuring 3 cm or more in the right colon.

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