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New technique for sigmoid colectomy

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A combination of laparoscopic and rectoscopic procedures has enabled complete resection of the sigmoid colon and eliminated the need for minilaparotomy when constructing the anastomosis or withdrawing the specimen. This combined procedure was performed in different ways in a series of animal models until the definitive technique had been standardized. These techniques were then successfully used in 15 consecutive medium-sized pigs. Histological evaluation of the specimens, including the anastomosis (examined 2–3 weeks after operation) confirmed the efficacy and safety of the method.

Laparoscopic techniques have been used to carry out highly selective vagotomy, nephrectomy and colonic resection. Currently, endoscopic colonic resections are laparoscopically assisted: endoscopic preparation of the bowel is combined with anastomosis or withdrawal of the specimen carried out through a minilaparotomy[1–5]. Laparoscopy and rectoscopy allow completion of the endoscopic resection of the left or sigmoid colon, eliminating the need for minilaparotomy.

A combined laparoscopic–rectoscopic approach to sigmoid colectomy was developed and performed in different animal models during a 1-year *in vivo* study approved by the local committee for animal experiments. The procedure is illustrated and discussed.

Materials and methods

Operations were performed in three species: seven minipigs, nine sheep and 16 medium-sized pigs. Seventeen animals were used to determine the optimal animal model, appropriate apparatus and definitive operative technique. The procedure (as an endoluminal or extraluminal variant) was then performed in 15 medium-sized pigs in a standardized animal trial.

Animals were fasted for 3 days and given a preoperative enema. Antibiotic prophylaxis was not used. All animals were operated on under general anaesthesia with central venous catheterization and cardiac monitoring. After operation, fasting continued for 1–2 days. The animals were killed 2–3 weeks after operation and the specimen, including the anastomosis, was sent for histological study.

Operative procedure

The surgeon and camera operator stood to the right and the assistant to the left of the animal. The video equipment was positioned on the assistant's left. After establishing pneumoperitoneum, four ports were placed in the lower abdomen (*Figure 1*). A 10-mm cannula, inserted to the right of the umbilicus, was used to introduce a 50° telescope (Richard Wolf, Knittlingen, Germany). An 11-mm trocar and a 5-mm silicon cannula were introduced into the lower right quadrant: the first was an operative port placed about 7 cm below and laterally to the umbilicus; the second, close by the anterior iliac spine, allowed insertion of a curved grasper. A 5-mm cannula for graspers was placed in the left lower abdomen, opposite the 11-mm port. Suprapubic catheterization of the bladder was performed and a catheter left *in situ*. The operating table was placed in a mild Trendelenburg position and tilted to the right.

The sigmoid colon was grasped and fixed to the abdominal wall by means of two slings passed through the mesocolon with forceps. Each end of the sling was held by a 3-mm needle-holder introduced into the peritoneal cavity through two small incisions in the left lower quadrant. The vessels were ligated and divided. A polydioxanone extracorporeal slipknot developed for monofilament material (*Figure 2*) was used for vessel ligature. The slings were removed and a modified transanal endoscopic microsurgery rectoscope (Richard Wolf)[6,7] (*Figure 3*) introduced up to the rectosigmoid junction.

Endoluminal procedure. The anvil of a Proximate ILS 29-mm stapler (Ethicon, Norderstedt, Germany) was inserted into the left colon via a custom-made introducer (*Figure 4*). Two polydioxanone 0 slipknots were tightened around the sigmoid colon at its proximal and distal levels, keeping the introducer inside. The anvil was fixed to the descending colon by a polydioxanone 2/0 slipknot and the sigmoid colon divided between ligatures. A cable-binding technique was specially developed to fix the anvil safely. This was prelocked extracorporeally (*Figure 5*) and tightened around the colon by means of a special pusher, reinforcing the polydioxanone ligature. After division of the proximal rectum the specimen, fixed around the introducer, was withdrawn through the rectoscope (*Figure 6*). The loop of another prelocked cable-binder was kept around the rectum, held with graspers, and the rectoscope withdrawn and exchanged for the stapler shaft under laparoscopic control. The spike of the stapler was advanced through the open stump and the cable-binder tightened around it. Any excess tissue was carefully resected. Using a new anvil-holder, the anvil was inserted into the shaft and the stapler closed and fired.

Extraluminal procedure. Two polydioxanone 0 slipknots were tightened around the sigmoid colon at its proximal and distal levels. A small cut was made on the upper rectum, just below the distal ligature, and on the left colon, just over the proximal ligature. The anvil of a Proximate ILS 29-mm stapler was introduced up to the left colon, letting the introducer pass through the two cuts (*Figure 7a*) by gently pushing and twisting it through the operative rectoscope. A polydioxanone slipknot was tightened around the left colon to fix the anvil and the introducer withdrawn. The sigmoid colon was divided,

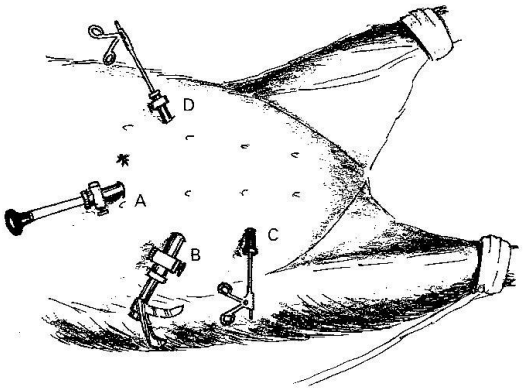

Figure 1 *Positions of the introduction sites. A, 10-mm port for the telescope; B, 11-mm port for operative instruments; C, 5-mm silicon cannula for the curved graspers; D, 5-mm port for grasping forceps*

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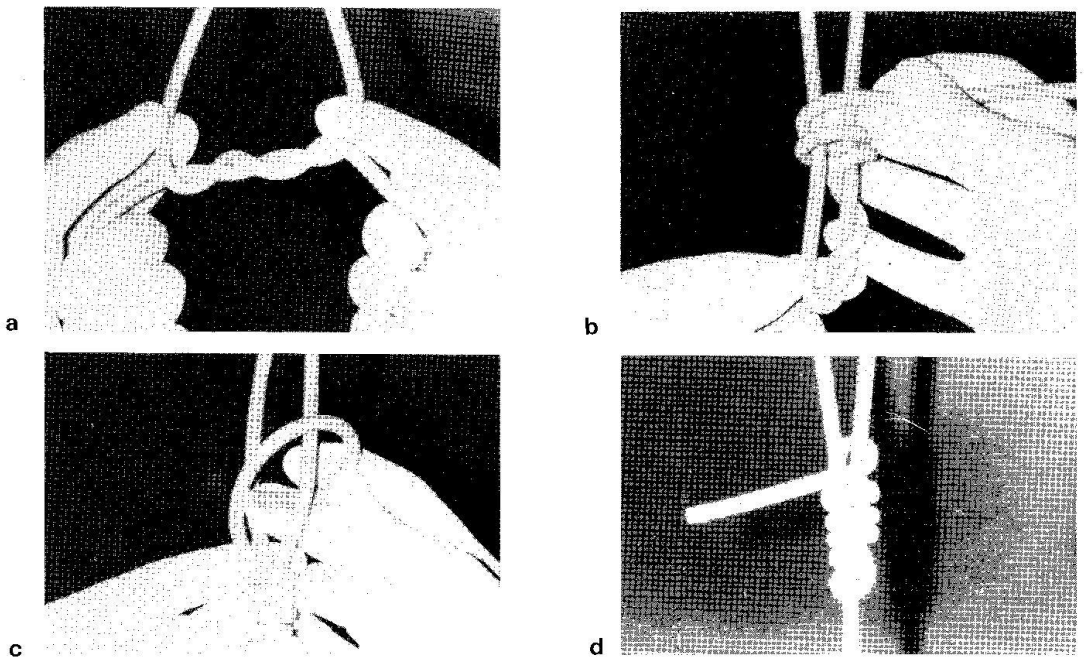

Figure 2 *Technique for the Melzer–Bueß knot.* **a** *First, a surgical knot was made;* **b** *one head of the thread was then twisted twice around the other head, according to the Roeder technique;* **c, d** *the knot was completed by a double-blocking passage*

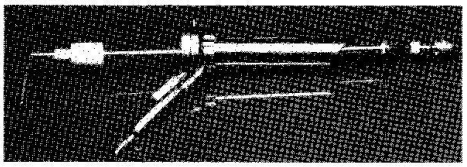

Figure 3 *The Bueß operative rectoscope with the loaded anvil-introducer*

completing the cut between the ligatures. With two graspers holding the upper rectum, the distal cut was completed and the specimen grasped by a forceps inserted through the rectoscope and withdrawn (*Figure 7b*). The spike of the stapler was advanced *per rectum* under laparoscopic control and the cable-binder tightened. A second prelocked cable-binder was tightened around the proximal stump to ensure fixing of the anvil. The anvil was inserted into the shaft, and the stapler closed and fired.

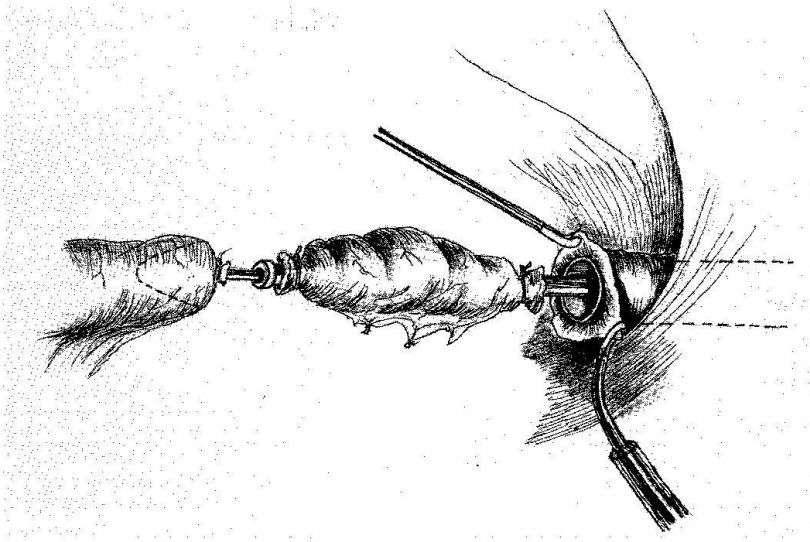

Figure 4 *The anvil was introduced up to the proximal sigmoid colon (endoluminal procedure); the proximal sigmoid was divided between ligatures. A ligature on the proximal stump fixed the anvil temporarily*

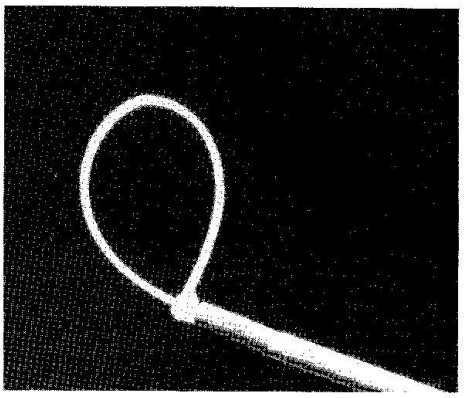

Figure 5 *A prelocked cable-binder inserted into the special pusher. This is a manufactured plastic device with ratchets that do not slip back when tightened*

Results

The mean duration of surgery was 135 (range 100–180) min.

All animals had an uneventful postoperative course with no clinical signs of sepsis. Autopsy in one animal showed a localized encapsulated fluid collection with a few adhesions. In three animals there was a small area of dehiscence with histological signs of abscess formation. These abnormalities were found in the first five animals to be operated on.

Discussion

The main technical difficulties of the laparoscopic approach to left colectomy and sigmoidectomy are formation of the anastomosis and removal of the specimen. Development of the anvil-introducer and the cable-binding technique overcame such problems.

The anvil-introducer is a device with an air-proof system that is fixed to the rectoscope; it avoids any air leakage once the bowel has been opened.

The cable-binding technique has been developed to avoid the intracorporeal purse-string ligature of the two stumps. This

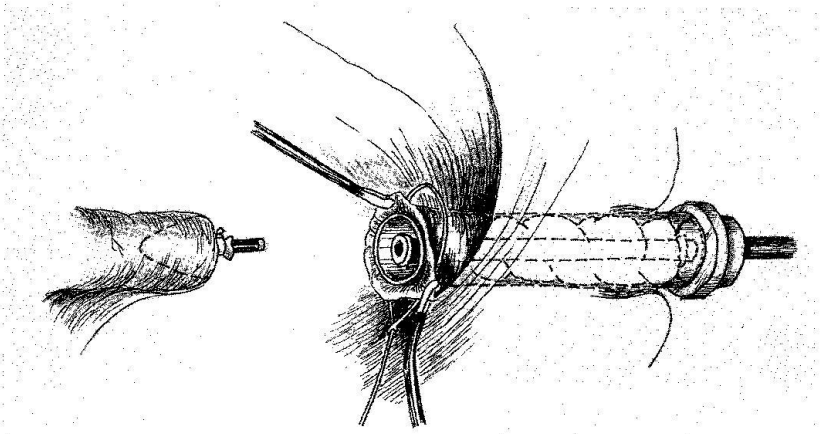

Figure 6 *Specimen retrieval during the endoluminal procedure. A prelocked cable-binder was kept around the distal stump while the resected bowel was withdrawn through the rectoscope via the anvil-introducer*

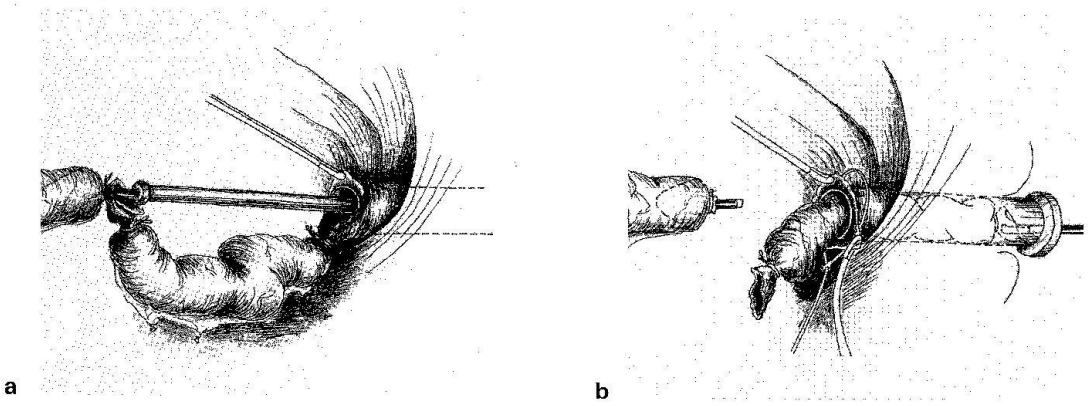

Figure 7 **a** *Introduction of the anvil during the extraluminal procedure: the introducer was gently pushed through two small cuts at the level of the proximal rectum and sigmoid colon.* **b** *Removal of the specimen by means of a grasping forceps inserted through the rectoscope (extraluminal procedure)*

technique is difficult and time consuming when performed laparoscopically. The use of a prelocked cable-binder allows fast and tight closure of the stumps. The use of endoloops or slipknot ligatures is not as safe as that of cable-binders, particularly in the closure of a short rectal stump.

Careful freeing of colonic and rectal stumps from the mesocolon is mandatory: the use of a 50° angled telescope is helpful for a complete check of both sides of the intestinal wall before and after closure of the stapling device.

The extraluminal variant of the combined sigmoidectomy avoids contact between the anvil-introducer and the tumour in case of suspected or proven neoplasm, and such a technique brings the anvil up to the proximal stump in the case of stenosing diverticulitis.

Because of the diameter of the rectoscope, removal of tumours up to 4 cm in size can be performed. Benign and soft neoplasms larger than 4 cm that can be compressed can also be removed.

Laparoscopic lymphadenectomy is possible and safe[8–10] as ligature of the inferior mesenteric vessels is feasible, but extensive and radical lymph node dissection may not be curative.

Clinical application of this method is under way in patients with benign and malignant tumours and complications of diverticular disease.

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