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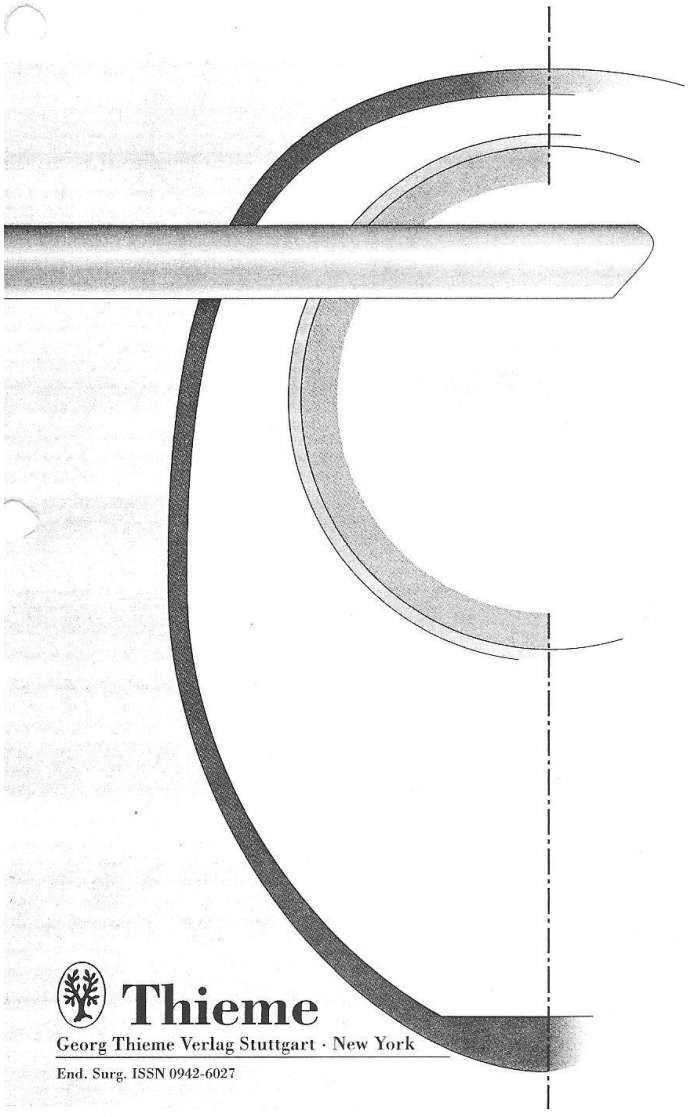

- Colorectal Surgery
- 3D-Vision

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State of the Art of Laparoscopic Colorectal Surgery

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Introduction

After the rapid acceptance of laparoscopic cholecystectomy, there are at the moment two main topics in endoscopic surgery of the abdomen: the procedures in the area of the gastro-oesophageal junction and the resections of the colon and rectum.

The first endoscopic procedures were performed in the rectum. We introduced the technique of transanal endoscopic microsurgery clinically in 1983 (1,2,3) and have since performed 500 operations in the last years. During this period we have resected a series of complete segments of the rectum with end to end anastomoses performed transanally. Tension on the suture line was a limitation of our technique, so that we had to combine it with a laparoscopic procedure to extend the resections. In 1989 we started the development of procedures for combined laparoscopic and rectoscopic resections of the left colon and the rectum. At the same time *Jakobs* et al. started their first activities in the United States (4). To our knowledge laparoscopic and perineal rectal excision followed by a colostomy was first performed by *Köckerling* (5,6). *Darzi* (7), *Leahey* (8) and *Beard* (9) focused on combining laparoscopic mobilisation and dissection of the mesocolon with minilaparotomy for resection and for anastomosis. The first complete laparoscopic resections were performed by *Jakobs* (10).

Laparoscopic colonic surgery is still in the stage of methodological and technical development. Only laparoscopic assisted colonic resection is in the stage of clinical evaluation. Although results show the feasibility of the techniques, all statements on indication, especially in cancer surgery, must be regarded as preliminary.

The nomenclature for the colonic procedures is confusing at present. In most procedures performed today more or less extensive parts of the operation are performed after a minilaparotomy and make use of conventional techniques such as ligation of the vessels, retrieval of the resected colon and colonic anastomosis.

The following expressions should be used:

- laparoscopic colonic resection, when all parts of the procedure including tissue retrieval are performed under constant endoscopic conditions without adding a minilap;
- combined endoscopic procedure, when different endoscopic techniques are combined such as laparoscopic and rectoscopic procedures;
- laparoscopic assisted operation, when parts of the procedure are performed in a conventional technique following a minilaparotomy.

Indication for colorectal resection

The optimal situation for starting the procedures is found in the case of extended villous adenomas. Sigmoid resection in diverticulitis can be difficult in the case of extended inflammatory reactions. In our view the resection of small carcinomas is acceptable if the basic rules are observed, i.e. central ligation of the vessels and lymph node dissection.

Preparation of the patient

As in all new endoscopic procedures extended informed consent of the patient is necessary. He must be told about the typical complications, but also of the fact that, because of the lack of experience, the rate of lesions to, for example, the ureter might be higher than after conventional operations. We add that in new procedures also unprecedented complications might occur.

Perfect bowel preparation is mandatory because clamping and cleaning are limited. According to our extended experience with the TEM procedure we recommend our standard preparation of giving a 10 l saline lavage via a nasogastric tube on the evening before the operation. In left colonic resection it must be ensured that the long operation time in combination with the lithotomy position of the legs does not result in the compartment problems known from comparable procedures (11,12,13). The location of the ureter to prevent injury during the dissection should be facilitated by the use of illuminable urethral catheters (Bush Ureteral Illuminator, Rüsch International, W-7050 Waiblingen, Germany).

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Operative technique

Basic technical steps of the colonic procedures

Grasping the colon

Before starting the dissection, the bowel has to be lifted up to indicate the dissection planes. This has to be performed using atraumatic graspers. The graspers typically used to hold the gallbladder during dissection are not big enough, too sharp at the edges and tend to induce traumatisation of the bowel wall. An essential tool is an instrument of the Babcock or Ellis type. In our experience 5 mm instruments are traumatic due to their small size and the joints are not stable enough for the procedure. Preferable are 10 mm instruments; we have had excellent results using PCI instruments (W-7026 Liptingen, Germany).

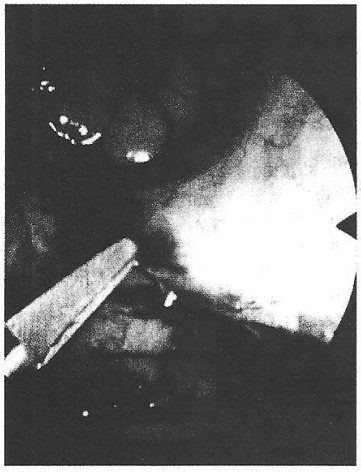


Figure 1: Dissection of the white line at the descending colon. An isolated scissor is used and areas containing small vessels are cut during activation of monopolar coagulation.

Dissection of the colonic adhesions

The postfetal adhesions of the colon can be dissected in all areas with an optimal view if the colon is lifted in the right direction. The optimal cutting instrument is an electric scissor (Figure **1**). Peritoneal layers without vessels are cut mechanically whereas areas containing vessels are first coagulated by means of monopolar high-frequency.

Sling lift of the colon

To grasp the colon at the beginning of the dissection an atraumatic Babcock or Ellis grasper has to be used. After the mesentery is defined at the areas where the bowel is to be divided, the further manipulation of the bowel is limited by the design of the graspers available today. A sling is easier to handle and less traumatic to the issue. Two types of slings can be used. The first (external sling) is the introduction of a vessel loop by direct puncture using a 3 mm needle holder of the Semm type: A 4 mm incision is performed at the site where the sling is to hold the colon. The vessel loop is inserted into the jaws of the needle holder and pushed directly through the abdominal wall (Figure **2a**). A bent Cushieri-type grasper is guided around the colon and used to take the sling and carry it around the colon to return it into the small needle holder (Figure **2b**). The sling is pulled through the abdominal wall with the needle holder and fixed with the desired tension using a clamp (Figure **2c**). The "external sling" has the advantage that no additional instrument has to be used to hold the sling, but also the disadvantage that the direction of tension cannot be freely changed.

The "internal sling" is introduced directly via one of the ports. Here stronger flexible materials such as Penrose drains can be used. After placing the sling around the colon according to the aforementioned technique, the sling is held with a grasper, thus giving the colon the desired direction (Figure **3**).

Dissection of the mesocolon

The technique of dissecting the mesocolon depends on whether central ligation is mandatory or not. If there is no cancer, the technique of cut and clip can be performed close to the bowel, where no big vessels are to be expected. With the use of monopolar technique the mesentery is coagulated preliminarily or directly during cutting. When a larger vessel is seen, two clips are placed and the vessel is divided between the clips. For larger vessels two clips are used towards the mesentery. Often the vessel is only seen when bleeding. The bleeder is located and clipped.

In the case of central ligation of the vessels, which is used in all patients in resection of the rectum, and in the case of cancer operation on the whole colon the cut and clip technique is not acceptable, because the bleeders tend to be too strong to be stopped with the clip technique.

In central ligation the mesentery has to be dissected completely and tissue bundles containing the main vessels have to be formed. Ligation is performed with PDS ligatures using the Melzer Buess external knot (Figure **4**). The disadvantage of this technique is that the procedure is time consuming, and, when the knot is not prepared accurately, it might block during pushing. Another still unsolved problem is to cut safely between two ligatures without cutting one of the threads. New techniques will be available in the future to facilitate the procedure of ligation and cutting.

The safest technique for the ligation of larger vessels is at the moment the use of endoscopic staplers. After forming a tissue bundle a thread is guided around the vessel to form a compact bundle which is pulled between the jaws of the stapler (Figure **5a,b**).

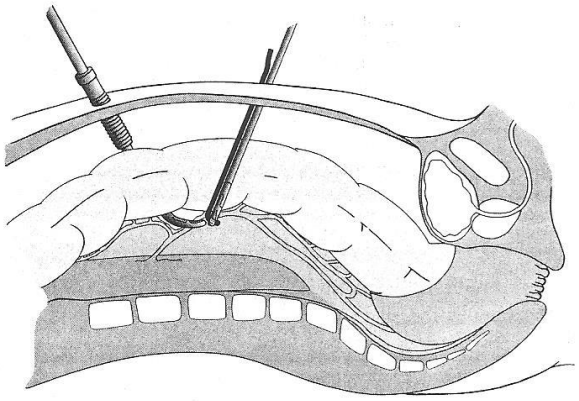
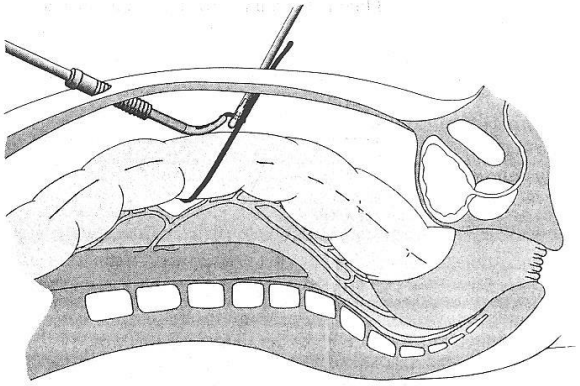
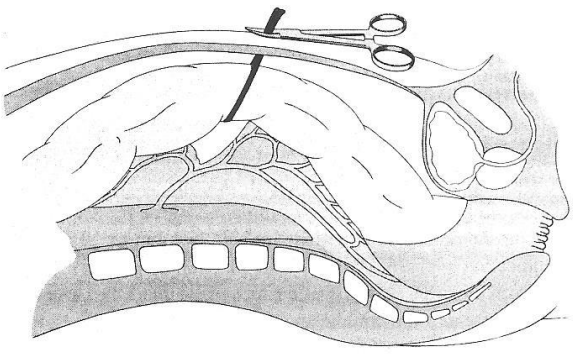


Figure 2: Positioning of an external sling to hold the colon:
a Using a Semm 3 mm needle holder, the vessel loop is pushed through the abdominal wall by direct puncture, and the loop is taken by the bent grasper.



b The loop is guided around the colon and back into the needle holder.



c The loop is pulled to the desired tension by means of a clamp.

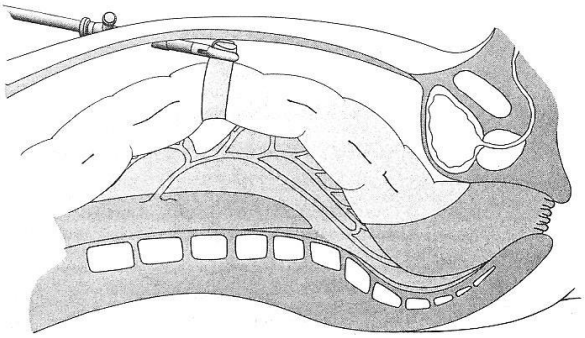


Figure 3: An internal sling introduced via a port is guided around the colon and held by a grasper.

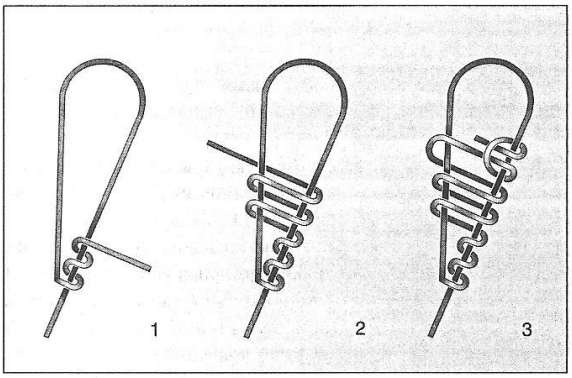


Figure 4: External ligation using the Melzer Buess knot upon PDS.

Specific procedures

Laparoscopic assisted procedures on the right and left colon

These procedures consist mainly in the dissection of the colon from its adhesions using laparoscopic techniques, followed by a more or less extended laparotomy to ligate the vessels, resect the colon and perform a conventional anastomosis (7,8,9,14). The detailed technique for this procedure is described in the article of *Darzi* et al. (same issue, p.13).

In this article no data are given to the results, so that we add the results presented by *Monson* (15). The group operated a consecutive series of 53 patients, 38 with malignant, two with benign tumours and 13 with non neoplastic disease. 46 procedures were successful, 7 were abandoned. The operations included 22 right and 7 left hemicolectomies. Ligation of the mesenteries was first performed outside the abdomen and the anastomosis always outside, after performing a minilaparotomy. The main complications reported for the first 30 days were 2 anastomotic leaks and two respiratory problems. One patient died after a complication. The average hospital stay was 8 days.

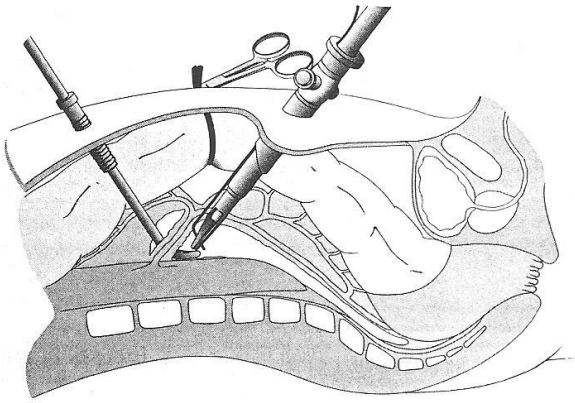
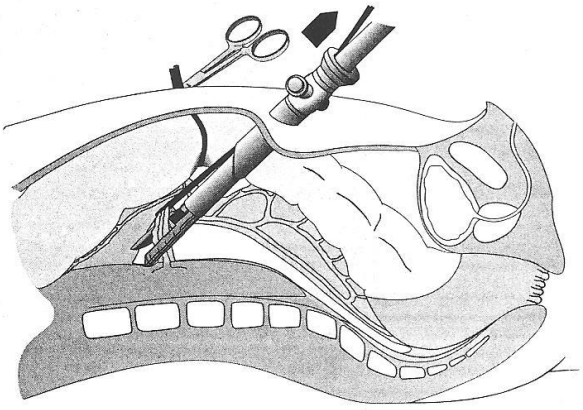


Figure 5:
a A thread is guided around the vessel.



b The bundle containing larger vessels is pulled into the jaws of the endoscopic stapler to prevent it from slipping out of the stapling area.

The resected specimen showed an average length of more than 20 cm, the tumour stages were: 1 Dukes A, 16 Dukes B and 12 Dukes C, the average number of resected nodes was 10 (5 – 21). The average operation time was 210 minutes for the right and 240 for the left resection.

Combined abdominosacral excision of the rectum

This procedure corresponds mainly to the laparoscopic part of the rectal resection (see below). After the lower third of the rectum has been reached by dissection and the central ligation of the vessels and stapler transsection of the descending colon have been performed, the perineal surgeon is shown the dissection plane on the Fascia of Waldeyer. The sacral part of the operation is performed in the conventional way and a terminal colostomy is placed at the position of the lower left port. The details of this operation are described in the article of *Köckerling* et al. (same issue, p.16).

Laparoscopic assisted rectal resection and throughstapling anastomosis

In this procedure the rectum is dissected laparoscopically according to the guidelines given below. After defining the resection plane on the rectum, the bowel is trans sected using an endoscopic stapler. A minilaparotomy is performed in the lower left quadrant, the rectum pulled out via the laparotomy, the vessels transsected and the bowel resected in the conventional technique. After placing a purse string suture on the mobilised descending colon, the anvil of the stapler is introduced. At this stage, the operation returns to laparoscopic procedures. The anvil is grasped with an anvil holder from the right lower port and the minilap is closed to allow gas insufflation again. The circular stapler is introduced via the anus and the stapler line is centrally perforated. The anvil is connected to the stapler by means of the anvil holder.

Laparoscopic resection and anastomosis

Two different techniques are described. Small benign tumours can be locally excised, followed by hand sutured closure of the defect by direct suturing. Segmentally resected specimen are removed via the rectum and the bowel is reanastomosed using the circular stapler after hand-sutured purse string (17, 18, 19).

Combined endoscopic resection of the rectum, the Tuebingen procedures

Following extended development work (20), two different techniques have come into use for the dissection of the lower rectum depending on the level of the lower tumor margin. At a level where anastomosis is facilitated by good visual access to the rectum, we apply a special technique of stapling anastomosis ("Tuebingen-I-procedure"). At the lower rectum, which is often difficult to visualise laparoscopically, dissection and anastomosis are performed in the TEM technique ("Tuebingen-II-procedure"). According to the technique developed by us in Tuebingen, the clinical application includes the following steps:

Positioning of the patient and draping: Because the operation also includes rectoscopic procedures, the patient has to be put in a lithotomy position as in abdominoperineal procedures. To prevent problems through long operation time we recommend the following rules:

1. The right arm should be not abducted to allow the surgeon and the cameraman an optimal working position. Draping should keep the right side of the patient free for standing.
2. The shoulders of the patient are held by supports attached to the table to prevent the patient from slipping during the head-down position, which would cause pressure to the calves and might result in a compartment syndrome.
3. The stirrups for the legs should only be definitively positioned after bringing the patient into an extreme head-down position so that the shoulders are pressed onto the supports to prevent the patient from slipping and thus moderate the pressure on the calves during the operation.

4. The legs of the patient are fixed to the stirrups in a way that the legs can be moved by an assistant to prevent constant pressure during further operation.
5. At least for the first operations ureter catheters should be positioned to facilitate anatomical orientation during dissection and thus help prevent damage to the ureter. The catheters can be palpated through the peritoneum and thus located far more easily. Another possibility is to use a catheter system with integrated glass fibres. In phantom experiments we could see the ureter shining through if a strong light source for flexible catheter fibres was used and the power of the laparoscopic light source was reduced. During the only clinical application of the system we could not see the ureter.

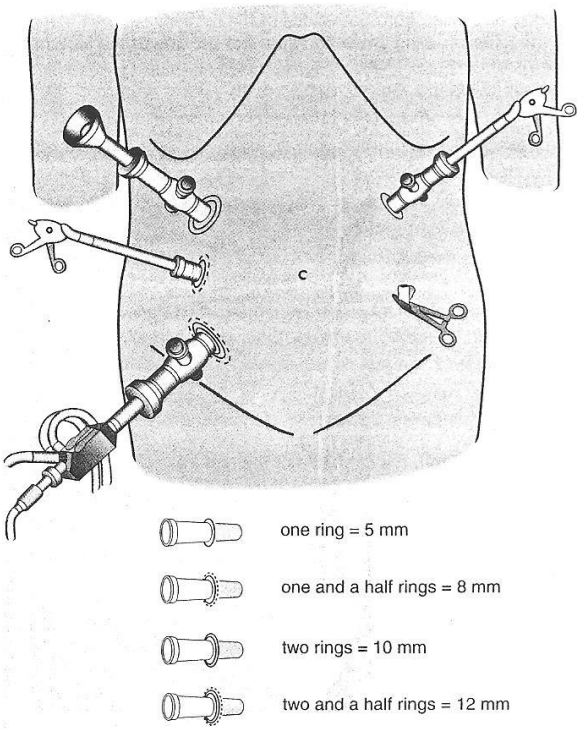


Figure 6: The ports for the Tuebingen procedure.

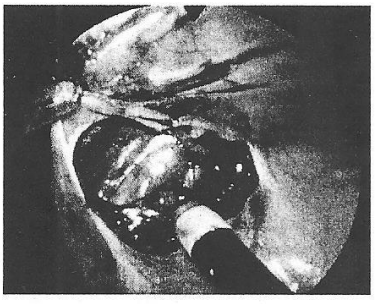


Figure 7: Dissection of the left ureter.

The ports for the Tuebingen procedure (Figure **6**). Optic, flexible port and the 12 mm working port are placed in the right perirectal line. A 10 mm port and the sling lift in the left pararectal line.

The instruments needed for the Tuebingen procedure: In the Tuebingen procedure we combine two different types of endoscopic procedures in a way that could be compared to abdominoperineal rectal excision in conventional surgery. The rectoscopic part of the operation is an endoluminal procedure as defined by *Cushieri* (21).

The endoluminal technique of Transanal Endoscopic Microsurgery (TEM), which is described precisely elsewhere (22,23, 24), has been used by our working group for the transanal excision of rectal tumors in 470 cases on extended sessile adenomas from 1983 to August 1992. In these operations we performed a series of complete segmental resections including the complete rectal wall (full-thickness resections) followed by circular transanal anastomosis. In view of the problems arising from the combination of endoscopic procedures with minilaparotomy, tissue removal via the rectum, dissection and anastomosis in the low rectum, we see strong arguments in favour of the combined procedure.

The operative equipment for TEM consists of:

- The rectoscope with a diameter of 40 mm and two different lengths.
- The stereoscopic endoscope for direct vision and an additional optic for the video camera.
- A complete set of surgical instruments to cover all needs of dissection and suturing in the rectum.
- A unit for insufflation, rinsing of the optic and defined suction using a roller pump.

The TEM technique is used in the Tuebingen procedure (see below) for defining the lower resection line, dissecting the lower rectum, removing the specimen and, in resections close to the pelvic floor, also for transanal hand-sutured anastomosis.

The steps of operation

1. Dissection of the postfetal adhesions (Figure **1**). The colon is carefully grasped with a 10 mm Babcock forceps in such a way that not only the edge of the bowel but a substational fold of the whole wall is held. The colon is lifted upwards and pulled slightly medially to put tension on the area of the white line. The resection line is defined according to the rules of conventional colonic resection, and the descending colon is mobilised to allow tension-free anastomosis. During dissection in the expected area of the left ureter, care has to be taken not to dissect along too deep a plane.
2. Dissection of the left ureter and location of the position of the right ureter. After orientation by palpation with the blunt tip of the combination instrument, which is significantly facilitated by the urethral catheter (Figure **7**), the peritoneum is opened and the ureter precisely localised. The right ureter

is located by blunt palpation through the peritoneum and the position marked by one or two clips. When location by palpation is not possible in fat patients, the right ureter should also be dissected.

3. Sling around the rectum. During the dissection of the rectum and the ligation of the mesentery constant and atraumatic traction upon the rectum is necessary. Although the 10 mm Babcock type forceps does hold the colon better than other instruments, slipping may occur and there is also the danger of traumatising the wall. A lift sling is safer and easier to handle. We prefer the internal sling (see above, Figure 3), as it permits better manipulation. The sling is guided through the mesentery between the promontory and the rectosigmoid junction. The bowel can be handled best at this point and in combination with the 50° optic, which is turned appropriately, an optimal overview can be achieved in all stages of dissection.
4. Ligation of the mesentery. Theoretically, in diverticulitis, just as in adenomas, the ligation of the vessels could be performed close to the bowel. In our experience this technique is difficult in diverticulitis because of the thickened mesentery and the need for multiple ligatures. We therefore prefer the central ligation of the inferior mesenteric vessel.

After dissection of the ureters, the peritoneum is incised towards the pelvic floor and the dissection towards the presacral fascia starts below the promontory on the left side of the rectum. During this stage the rectum has to be pulled to the right side (Figure **8a**). Next comes the dissection of the right side (Figure **8b**). The presacral fascia is dissected from the right side by blunt dissection. This dissection plane is then extended upwards towards the inferior mesenteric vessel. After marking the resection line on the sigmoid, the mesentery is dissected, so that a bundle is formed containing the main vessels (Figure **5b**). Using a bent grasper a thread is guided around the bundle to pull it into the endoscopic stapler and prevent it from slipping out of the stapler as it closes.

Steps of the Tuebingen-I-procedure:

PDS Ligatures are put onto the bowel on both sides close to the intended resection lines and the area for the planned anastomosis is carefully dissected, so that the muscular layer is exposed over a distance of about 5 cm.

The anvil of the stapler is now introduced into the rectum by means of an anvil holder. In low anastomoses we prefer the direct transanal application and in higher located sites the route via the operative rectoscope.

A window is cut into the anterior wall of the rectum one cm higher than the intended line of anastomosis and the stapler head is guided through this window into the intraperitoneal space. Another window is cut into the prepared area on the descending colon. Care has to be taken not to make the opening wider than one third of the circumference of the colon, thus enabling the anvil head to slip into the lumen by a side guidance (Figure **9**). In our experience the introduction of the anvil into

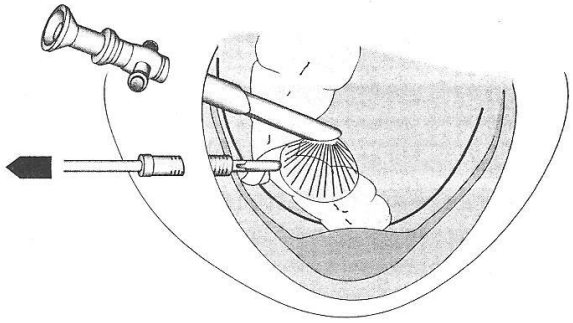
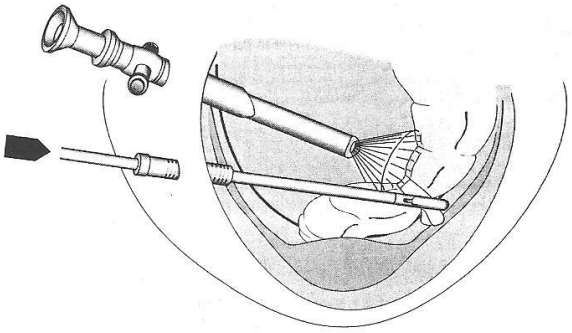


Figure 8: During dissection of the rectosigmoid the rectum is retracted by the internal lift sling held by a grasper. The use of the different positions of the 50° optic guarantees an optimal overview during dissection from both sides of the rectum.
a Conditions during dissection from the left side of the rectum.



b Dissection from the right side of the rectum.

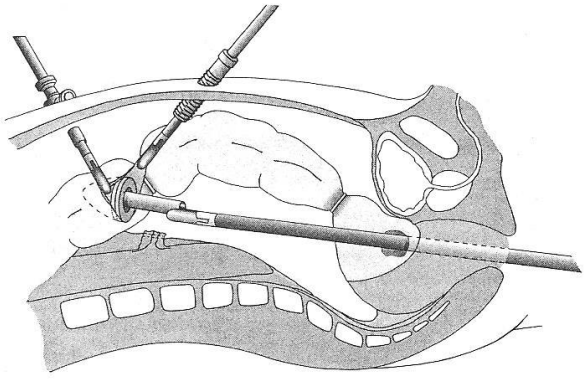


Figure 9: Introduction of the anvil into the window cut in the descending colon. Two graspers are used to pull the bowel over the anvil.

the bowel in this way is much easier compared with the introduction after cutting the whole circumference. For reintroduction two graspers are usually sufficient to hold the anterior wall.

A PDS ligature with the Melzer Buess knot (20) is used to fix the bowel to the central shaft. With this technique the further manipulation has to be performed very carefully, as pulling the bowel might let the bowel slip through and lead to incomplete anastomosis. Moreover, when cutting the bowel, care has to be taken not to cut too close to the thread or even cut the ligature. Because of this we currently use an additional cablebinder put over the PDS ligature. The cablebinder is strong enough to hold the bowel wall safely in place and the protruding bowel can be cut directly at the edge of the binder.

A new type of cablebinder is in the stage of development to facilitate the procedure (with Ethicon, Hamburg): A slit in the lock of the binder allows the binder to be introduced endoscopically without any problem (Figure **10**). The binder is locked to the predefined point by means of an automatic technique and cut exactly at the desired position. The circular Ethicon staplers of the type Proximate ILS can be used down to a diameter of 29 mm. Other staplers do not provide enough space to accommodate the banding during the stapling procedure.

At this stage the anvil is deposited and the rectum is completely transsected. The resected specimen is pulled out of the abdominal cavity via the operative rectoscope (Figure **11 a, b**). As the inner diameter of the scope is close to 40 mm, its removal usually poses no problems. At present we are designing techniques together with *Harry Espiner* using special retrieval bags for the resection of larger tumours.

The stapler is equipped with a device put on the spike of the anvil. It consists of metal hooks that catch hold of the bowel wall. During insertion these hooks are covered by a tube-like protective cap. When the stapler is correctly positioned within the rectal cavity, the central shaft of the stapler is moved forward. The protective cap comes into vision and is removed via a laparoscopic port. The free margins of the rectum are now caught by the spikes to facilitate correct positioning of the cablebinder (Figure **12**).

After stable fixation of the rectum, the position of the central rod is corrected, so that the cablebinder can be placed at the optimal point. The protruding parts of the rectum wall are cut directly beside the cablebinder with a bent scissor.

The stapler is closed (Figure **13**) under precise endoscopic vision.

At this stage the 50° optic offers the great advantage that by turning the optic all areas of the anastomosis can be visualised, even the dorsal parts, which are difficult to see in open surgery.

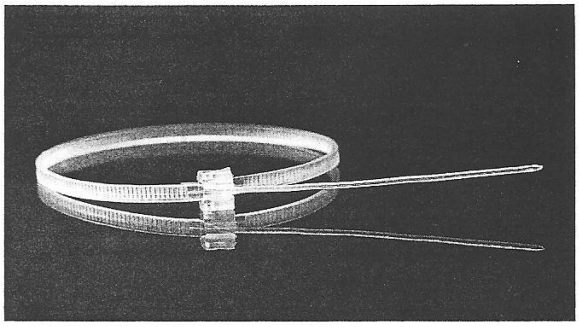
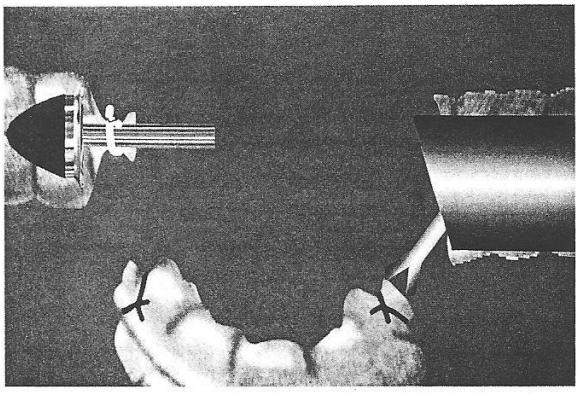
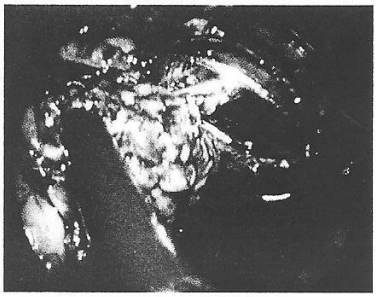


Figure 10: Newly designed bowel binder: A slit in the lock allows the thin part of the binder to be introduced with ease.



a drawing



b endophoto

Figure 11: Removal of the resected specimen via the rectoscope.

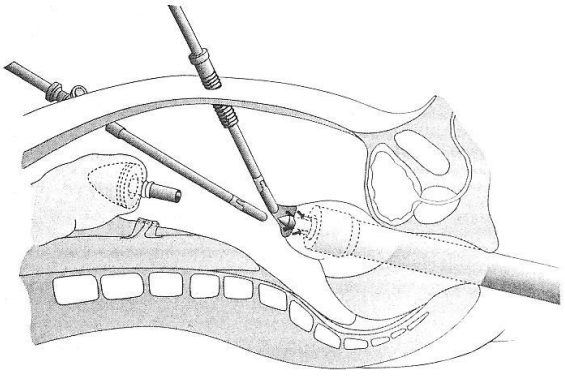


Figure 12: The free margins of the rectal stump are fixed to the stump holder.

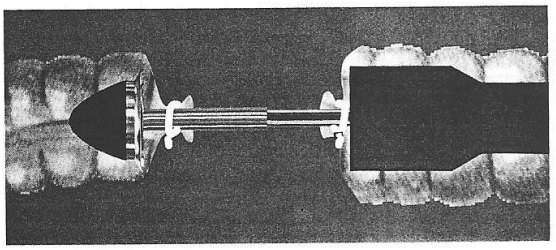


Figure 13: The stapling procedure.

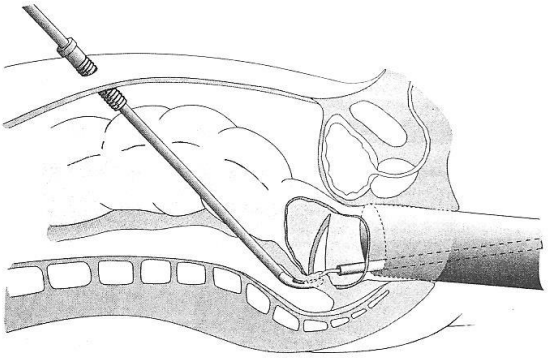


Figure 14: The complete circumference of the rectum is already dissected from the side of the rectoscope leaving the correct margin of clearance. The laparoscopic surgeon uses a blunt instrument to indicate the correct dissection plane.

The Tuebingen procedure with transanal hand-sutured anastomosis (Tuebingen-II-procedure)

In our experience anterior resection of the rectum down to its middle third is feasible. We have encountered problems in the lower third when dissection approaches the area of the prostate. In women the exposure of that area can be facilitated by means of a Hegars dilator placed transvaginally into the cavity so that mechanical traction widens the lower pelvis. In men the area of the prostate is difficult to expose laparoscopically, because no suitable mechanical retractors for pulling the prostate forward together with the bladder are available. In contrast to laparoscopic access, the rectoscopic technique allows optimal access to this area (21, 22, 23, 24). This part of the operation is performed in two teams to save time and improve the coordination of the laparoscopic and the rectoscopic work.

Operative steps:

- definition of the resection line:
  The tumour is visualised and the margin of clearance is defined under optical control via the rectoscope. The bowel wall including the complete muscular layer is trans sected.
- definition of the perirectal dissection plane:
  Starting on the anterior wall with the use of a blunt instrument, the abdominal surgeon indicates the dissection plane from the laparoscopic side by probing (Figure 14).
- dissection of the perirectal area in the lower rectum:
  This part of the operation is performed by both surgeons in close cooperation. From one side the tissue is exposed, so that the surgeon on the other side can continue with his dissection under optimal conditions.
- hand-sutured anastomosis:
  According to the technique routinely used in the TEM procedure, the mobilised left colon is approximated to the lower rectum to eliminate any tension. To facilitate the exposure of the colon for anastomosis at this stage the laparoscopic surgeon helps expose the colon until stay sutures for the anastomosis are applied. The anastomosis is performed by continuous suture in the one-layer technique. One thread is usually used for 5 stitches. The thread is fixed by means of a silver clip.

Discussion

Endoscopic techniques in colonic surgery are certain to become an important field in Minimal Invasive Surgery. Some steps in this operation, such as dissection of the postfetal adhesions of the colon are relatively easy to perform, but other steps are difficult and time consuming, especially the techniques of endoscopic anastomosis.

In laparoscopic assisted colonic resection the easier procedures such as mobilisation of the colon are performed laparoscopically, whereas the difficult parts are done using an open operative technique.

The advantage of this procedure is that the extent of the abdominal incision is significantly reduced, and the fact that no mechanical retractors are used as in open surgery might be a crucial factor in reducing the stress on the abdominal organs.

We have no experience of our own with the combined procedure, because of our policy to focus upon the complete endoscopic procedures. According to the presentations of other authors (7), *Leahey* (8) and *Beard* (9), postoperative atonia and postoperative pain are significantly reduced compared with conventional procedures. Clinical trials have to be performed to gain objective data.

Abdominoperineal rectum excision and colostomy represent a more extended endoscopic procedure; the sacral part of this procedure will continue to be performed in the conventional open way. The sigmoid and the rectum can be mobilised under excellent viewing conditions. Owing to the described technique of central ligation using an endoscopic stapler this part of the procedure is also relatively fast and safe. *Köckerling* (same issue, p.16) has seen no complications, but the complications we had in one of our first patients oblige us to give two precautionary rules: The long operation time in combination with the pressure on the lower limb can cause more or less extended compartment syndromes. These complications are well known from other prolonged procedures (11,12,13). The aforementioned rules for positioning the patient should prevent such problems in the future and with more experience and shorter operation times they will lose significance. The second problem we had in an abdominoperineal resection was a lesion to the left ureter. We put a sling around the mesenteric vessels at a relatively early stage. Using the bent grasper the left ureter was passed below and thus pulled into the same bundle together with the vessels. The lesion was seen intraoperatively and sutured after laparotomy. We think that in future the ureters should be dissected before the vessels are prepared for central ligation. The location of the ureters is facilitated by urethral catheters, in our last case we used catheters with integrated glass fibers, which should have facilitated the dissection by translucency, but we could not see the light. The dissection was nevertheless significantly easier due to the mechanical stabilisation. Compared with endoscopic rectal resection and anastomosis, abdominoperineal excision is significantly easier and faster to perform. The retrieval of the tissue via the sacral incision solves the problems we have had in laparoscopic techniques. Abdominoperineal rectal excision is therefore the appropriate procedure to start endoscopic operations on the rectum.

The combined procedures we are currently developing in Tuebingen are technically more difficult and more time consuming. The procedure using the operative rectoscope for dissection and hand-sutured anastomosis has been solved technically except for the problem of retrieval of the extended specimen. The rectal part of the operation is not easy and needs a surgeon with extended experience in the technique of TEM.

The combined technique with rectal anastomosis is still in its development. The new design of the bowelbinder, which is hopefully in its final stage of development, is the crucial feature of this technique. We see the following advantages over the conventional purse string technique: If there is only an opening on the anterior wall, the insertion of the anvil is significantly facilitated, as it is automatically guided into the correct position when introduced. The conventional purse string has the same disadvantage as in open surgery, namely that a leak can occur if not all layers of the bowel are included and just a small part slips out while establishing the anastomosis. In contrast to this, our results in phantom and animal experiments show that the cablebinder guarantees complete and safe fixation of the bowel. The bowel wall can be cut close to the binder. Because of the rigidity of the binder material, the binder cannot be cut accidentally. We have also employed the alternative technique used by *Jakobs*, the fixation using a PDS loop, in a series of experiments. Fixation using a loop is less safe and makes the point for cutting the projecting bowel less precise. Keeping a wider border can result in too much material being enclosed in the stapler. Too close cutting might lead to complete trans section of the thread.

The important innovative feature of the bowelbinder is the slit in the lock allowing the thin end of the band to be introduced easily and the oblique running of the band through the lock, which gives a stable hold on the bowel over the whole circumference. A crucial future development will be to gain enough stability for the new lock by keeping a small diameter. If this succeeds, it will also make this technique available to open surgery and offer full use of its main advantage in anastomosis close to the pelvic floor in the narrow pelvis.

In conclusion, the endoscopic approach to the colon and rectum shows a great potential. The dissection of the postfetal adhesion can be performed under optimal vision, the ligation of the mesentery is possible by ligatures, which are time consuming, or by means of the endoscopic stapler, which is expensive. New developments will soon allow ligation and dissection of the mesentery with approximately the same speed and safety as in open surgery. Resections of the right colon will stay laparoscopic assisted procedures, because of the necessity of tissue retrieval. In our view the resection of the left colon and the rectum will ideally be performed in combined procedures. Rectoscopic interventions will facilitate the operation in the lower rectum, and tissue retrieval will be perfectly possible. The performance of the anastomosis is still difficult. We are convinced that the use of new instruments, especially the cablebinder, will make this procedure safe and easy.

The teaching of surgeons in courses for colonic procedures should in our view only be started when the technological and methodological development of the procedure has reached a certain standard. Well-equipped MIS centres with a wide experience in methods and technologies have to go ahead in this important area.

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