

Laparoscopic Right Colectomy with CME and CVL (Total Right Mesocolectomy)

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INTRODUCTION

Complete Mesocolic Excision (**CME**) is characterized by sharp division of the primitive mesocolon from the primitive parietal peritoneum, developing the avascular plane in the mesofascial (mesocolon and fascia are surgically separated with the Toldt's fascia left in situ; figure 1a) or retrofascial interface (the mesocolon/fascia complex is separated from the underlying retroperitoneum; figure 1b) [1-4], both separations being integral to CME as shown by Hohenberger, et al [5]. These interfaces are crucial for developing the correct mesocolic surgical planes and allow for a proper colonic mobilization [6].

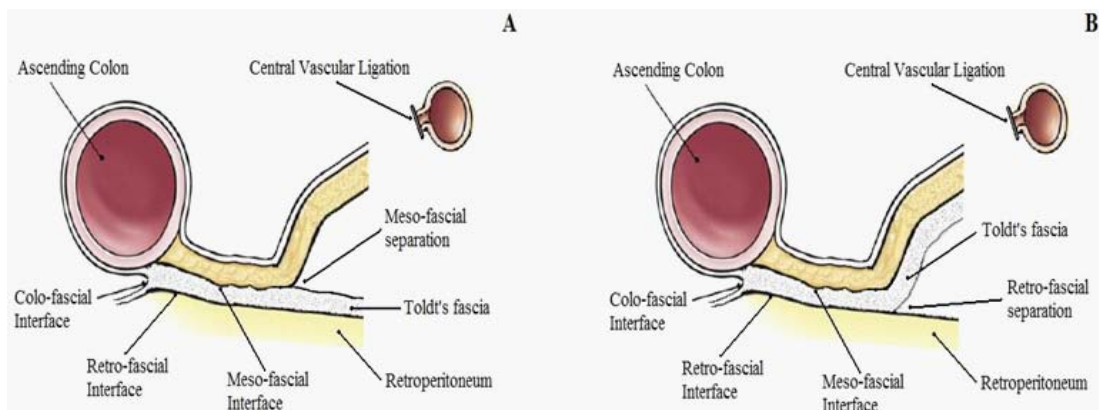


Figure 1: Schematic drawing showing the Meso-structures and related surgical planes of dissection. A. Meso-fascial Separation. The mesocolon and fascia are surgically separated with the Toldt's fascia left in situ; B. Retro-fascial Separation. The mesocolon/fascia complex is separated from the underlying retroperitoneum.

The mesocolon must thus be excised as an intact “package”, preventing any breach of its surface and underlying structures which may threaten the radial margin and disrupt the lymphatic network of the “meso-structure” with spillage of cancerous cells within the surgical field.

Central Vascular Ligation (CVL or D3 lymphadenectomy) is integral to CME in regional control for micrometastatic clearance of apical nodes, which are frequently involved in advanced stages, and thus responsible for loco-regional recurrence and systemic dissemination. Particularly, in cancer of the hepatic flexure and proximal transverse colon, metastatic subpyloric and right gastroepiploic nodes are detected in about 5-20% of patients [7]; thus central transection of middle colic vessels, right gastroepiploic vessels, and harvesting of subpyloric nodes seem oncologically advisable, especially in stages IIIA/C cancers.

Room set-up. The patient lies supine, with the right arm abducted (figure 2); a vacuum pack system is arranged to contain the left arm and shoulder so to allow an adequate left tilt.



Figure 2: Patient positioning: the patient lays supine on the left edge of the surgical bed, with the right arm abducted; a vacuum pack system envelopes the left side of the patient so to allow an adequate left tilt of the table.

The surgeons and nurse are arranged as shown in figure 3.

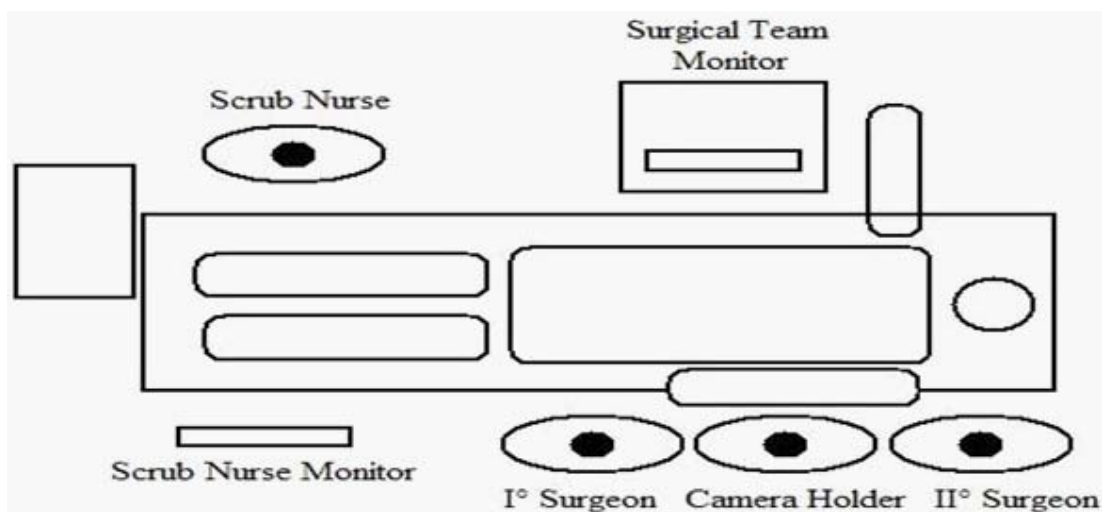


Figure 3: Room set-up.

Trocars positioning. The pneumoperitoneum is induced by an open technique or with a Verress needle placed in the left upper quadrant (Palmer's point); the procedure is conducted with intraperitoneal CO₂ pressure of 10-12 mmHg.

The trocars layout is shown in figure 4: the first trocar (T1; 12mm; for the 30° optic) is placed halfway the xifoid and the pubis on the left pararectal line; under direct vision, the second trocar (T2; 12mm; for the right hand of the operating surgeon) is placed in the same line more cranially and not too close to the subcostal arcade; the remaining 2 trocars of 5mm are placed in the midline, halfway the pubis and the umbilicus (T3; for the left hand of the operating surgeon) and just under the xifoid (T4; for the assistant).

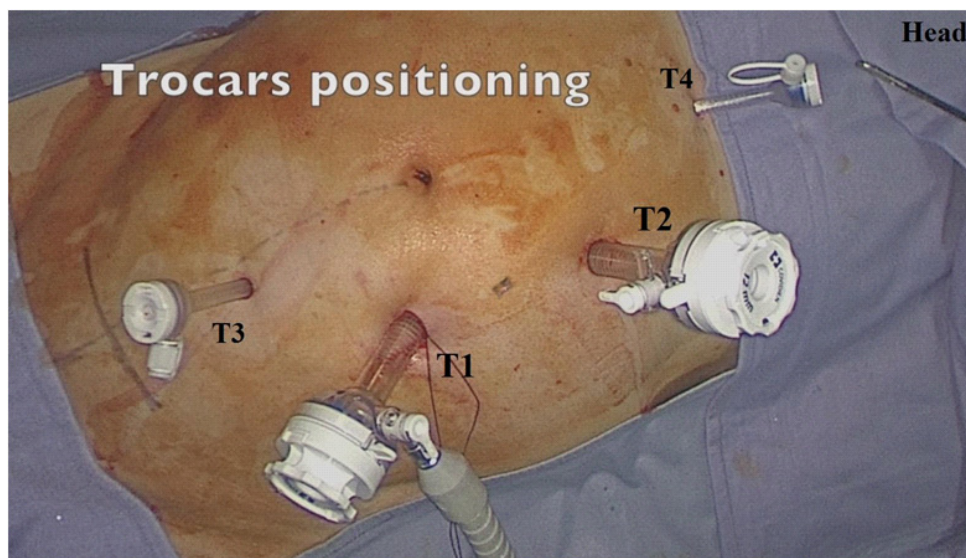


Figure 4: Trocars positioning. T1 = camera port, 12mm. T2 = surgeon right hand port (for dissection and stapling), 12mm. T3 = surgeon left hand port (for grasping and traction), 5mm. T4 = assistant port (for counter-traction), 5mm.

Exposure. Once the pneumoperitoneum is fully established (starting from 3L/min of CO₂, reaching 12mmHg of intraabdominal pressure and thus rising insufflations to 40L/min), the peritoneal cavity is explored: the liver is fully visualized and possibly explored with an intraoperative ultrasound; the peritoneum is inspected thoroughly to assess macroscopic carcinomatosis; a washout is carried out in the main recesses of the peritoneum (right/left paracolic gutter, suphepatic and subphrenic spaces, Douglas pouch, mesenteric root).

At this point, the patient is generously rotated to the left so to displace by gravity the intestinal loops in the left quadrants and allows for a clear view of the vascular axis of the superior mesenteric vessels: the mesentery containing the ileocolic vessels (ileocaecal fold) is thus stretched upward and caudally so to enhance the view of the Treves' arcade, exposing the "surgical trunk" and its branches (figure 5).

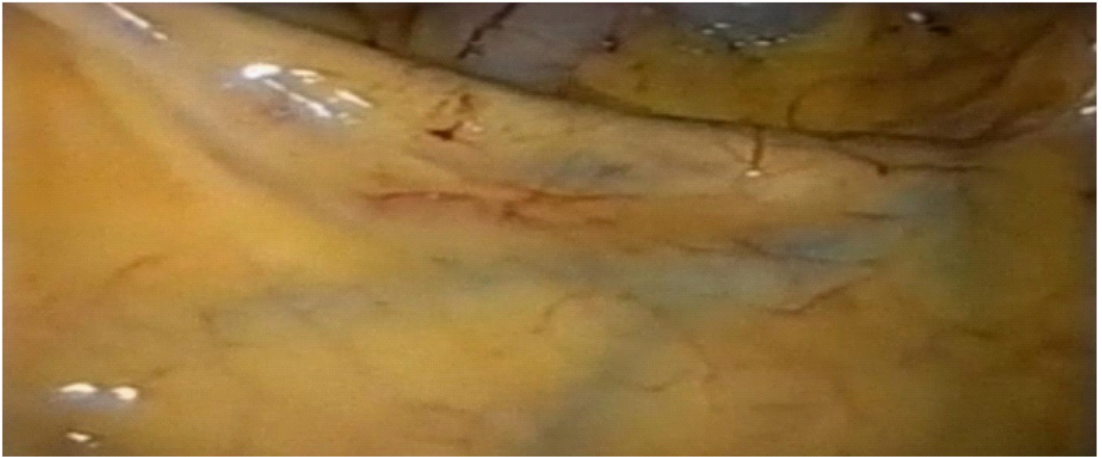


Figure 5: Exposure of the Treves' arcade: the mesentery containing the ileocolic vessels just proximal to the ileocecal junction are grasped and stretched upwards and caudal so to open the angle between the ileocecal and the superior mesenteric vessels, where the peritoneal incision will take start.

Right (Extended) Mes colectomy. With the surgical trunk stretched, the peritoneum is incised just under the projection of the ileocolic vessels, downward to the ileocecal junction and upward to the base of the mesocolon transversum (transverse peritoneal fold), over the left side of the superior mesenteric vein, i.e. the surgical trunk (figure 6).

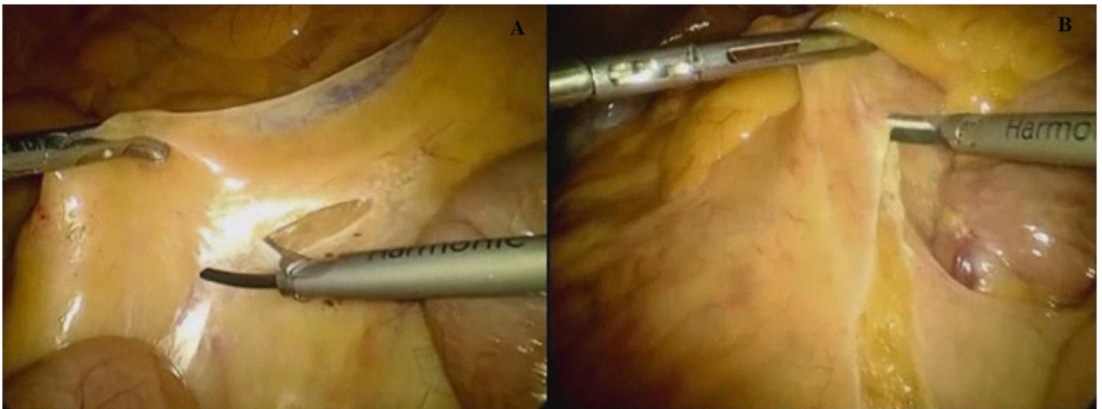


Figure 6: A. Incision of the peritoneal leaf just beneath the projection of the ileocolic vessels in up to bottom direction towards the ileocecal junction. B. The previous incision is continued cephalad to the base of the mesocolon transversum, staying on the left side of the superior mesenteric vein.

Once fully incised, the mesofascial/retrofascial interface is progressively developed in a medial to lateral direction up to the colo-fascial interface (i.e. the apposition of the ascending colon and the posterior parietal peritoneum), and from bottom to top towards the duodenum, which is the first anatomic landmark (figure 7).

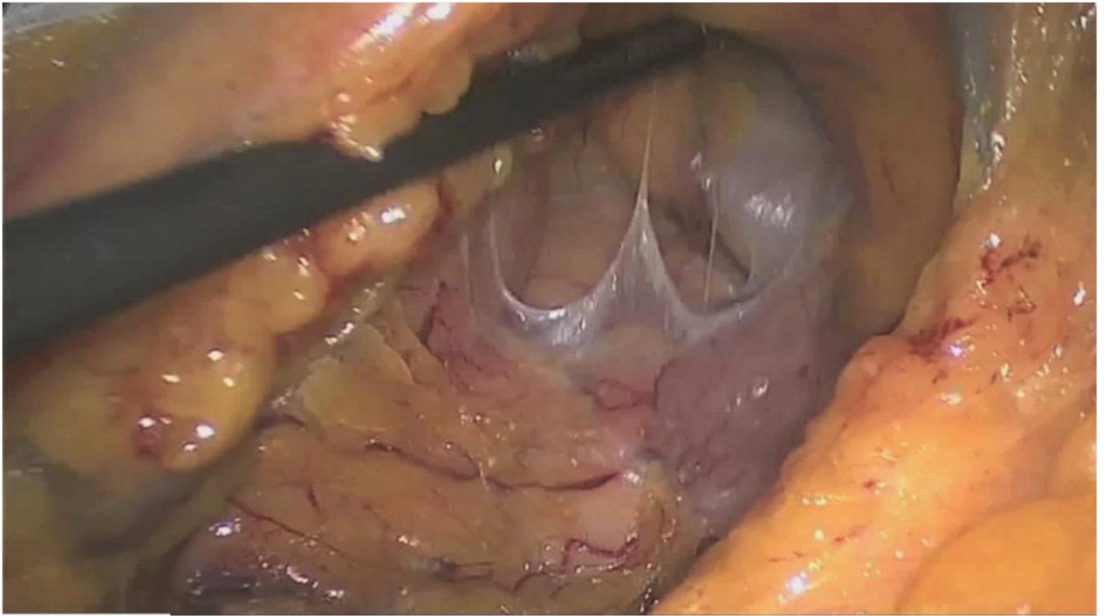


Figure 7: C.M.E. developed in a medial to lateral (up to the colo-fascial interface) and bottom to top direction. In this dissection, the duodenum represents the first anatomic landmark and must be accurately preserved along with the retroperitoneal structures (right ureter and gonadic vessels).

Dissection of this interface must be meticulous and gentle (absolutely no rough gestures), so to prevent any breach of the mesocolic structure, which may determine detrimental spillage of neoplastic cells within the surgical field.

At this point, the ileocolic vessels are skeletonized (the assistant stretches the ileocaecal fold caudal and upward, while the surgeon dissect the vessels by means of a traction/countertraction technique; figure 8), clipped and severed at their roots branching off the surgical trunk.

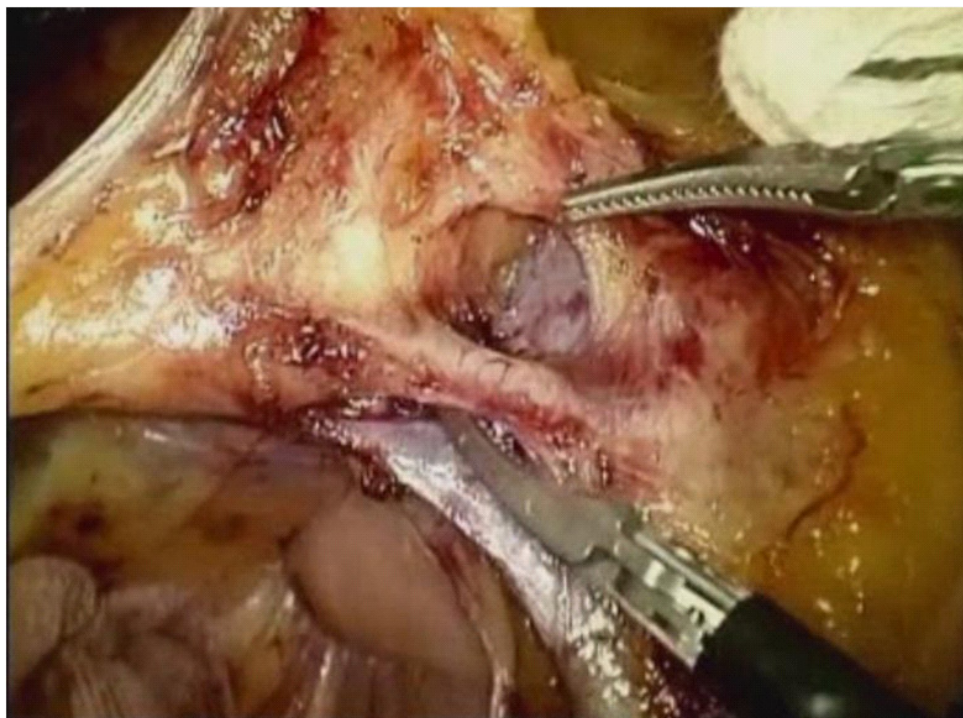


Figure 8: The ileocolic vessels are dissected and singularly skeletonized so to allow a proper Central Vascular Ligation at their root. Even in this case, the traction/counter-traction exerted is crucial to dissect properly and safely the vascular structures.

Keeping an adequate upward and slight rightward tension on the mesocolic leaf with the left hand grasper, the mesofascial/retrofascial interface of the preduodeno-pancreatic fascia of Fredet is developed, always in a medial to lateral and bottom to top direction (figure 9).

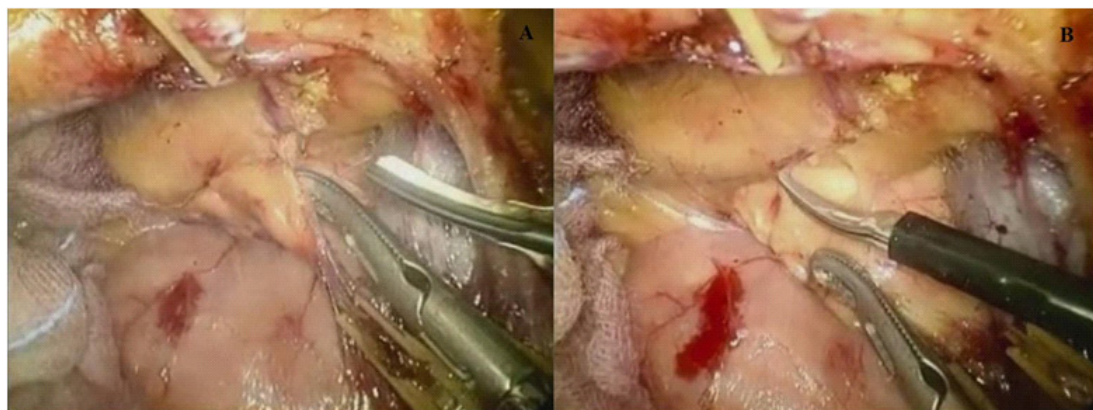


Figure 9: CME continues developing the meso/retro-fascial interface at the level of the preduodenopancreatic fascia of Fredet, progressing in a medial to lateral and from bottom to top fashion, minimizing energy sources to prevent duodenal and pancreatic thermal injuries.

The inconstant (about 30% of cases) right colic vessels are encountered, skeletonized and severed at their origin, fully exposing the surgical trunk (i.e. S.M.V.), as shown in figure 10.

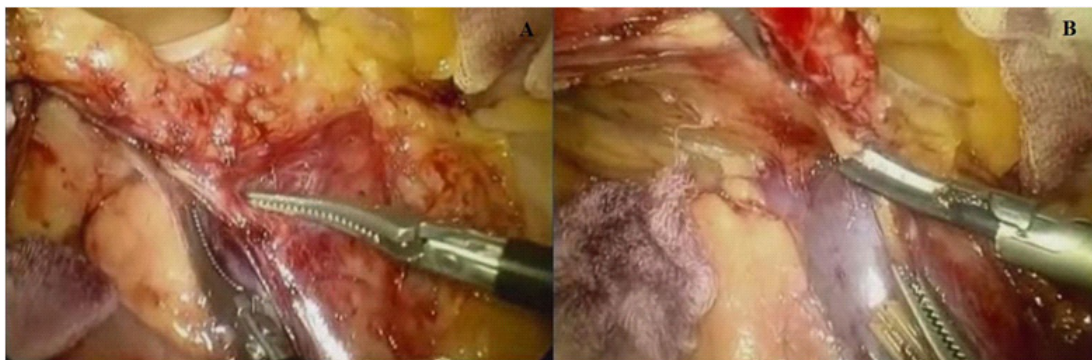


Figure 10: A. Proceeding in the upward dissection of the surgical trunk, the inconstant (30% of cases) right colic vessels are skeletonized and clipped. B. Upward dissection of the surgical trunk progresses up to the pancreatic uncus, where the gastroduodenal trunk of Henle is usually present.

Dissection of the surgical trunk is developed in the sub-adventitial space of the vessel, and if carried out gently with a step-by-step procedure, usually easy.

Upward dissection on the S.M.V. continues with the skeletonization of the middle colic vessels (figure 11): these vessels are clipped and severed at their roots in case of flexural or proximal transverse colonic cancer (Extended Right Mesocolectomy); alternatively, the right branches are severed in case of caecal or ascending colonic cancer (Right Mesocolectomy), as shown in figure 12.

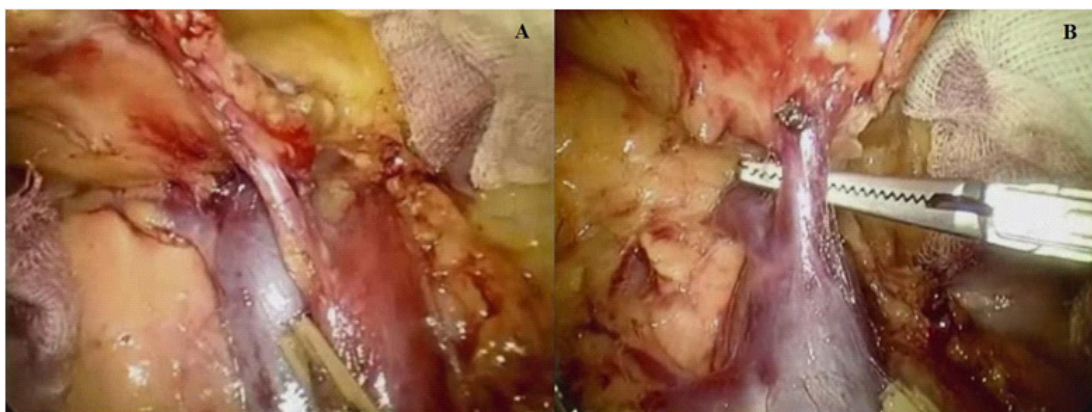


Figure 11: The middle colic vessels are dissected to be transected at their roots (right extended mesocolectomy), or at their right branching (right mesocolectomy). In A, the middle colic artery dissected; in B, the middle colic vein skeletonized.



Figure 12: Section of the right branch of the middle colic artery in case of Right Mesocolecotomy.

In case of flexural or proximal transverse colon cancer, the incidence of metastases in the subpyloric and right gastroepiploic nodes ranges from 5 to 20%⁷, so it seems advisable, especially in the advanced stages, to harvest these lymphonodal groups. The Henle's trunk is skeletonized, identifying its components, which more commonly are (in 60% of cases) the inferior pancreatic vein (the most caudal branch and the main landmark), the right gastroepiploic vein (running upwards to the right of the gastrocolic ligament) and the middle colic vein (running upwards and medially to the mesocolon transversum); in the remaining 40% of cases, these 3 vessels branch off the SMV variously, but can be identified with relative ease on the basis of their proper direction. The right gastroepiploic vein is severed at its root (figure 13a) and immediately beneath it, the right gastroepiploic artery is visible, being severed at its root too (figure 13b); in this way, it is possible to fully harvest the subpyloric nodes en-bloc with the specimen.

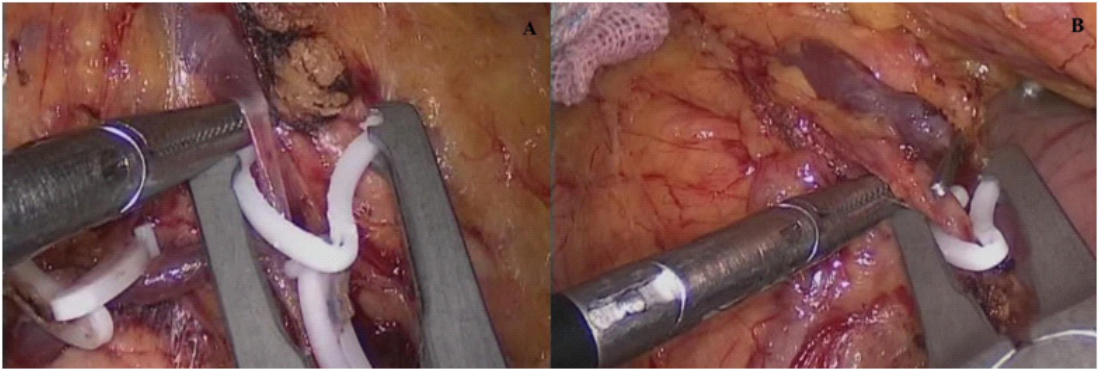


Figure 13: The right gastroepiploic vein is dissected and clipped (A); just behind it, it is visible the right gastroepiploic artery which is skeletonized and clipped at its root (B). This allows the harvesting of the subpyloric lymph nodes.

CME is thus completed in the most cranial portion, between the duodenum and the right hepatic flexure, always developing the correct plane of dissection in the mesofascial/retrofascial interface, as shown in figure 14, up to expose and thus incise the root of the right transverse mesocolon (the transverse peritoneal fold) in a medial to lateral direction (figure 15).

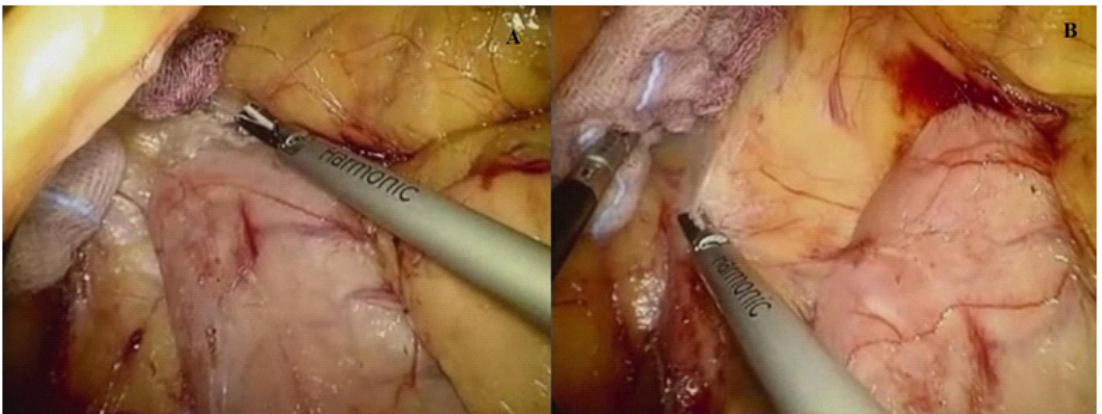


Figure 14: CME is fully completed with progressive medial to lateral and bottom to top division of the meso/retrofascial interface in the most upper and right aspect, just beneath the right hepatic flexure; the latter is almost completely mobilized but the cholecystoduodenocolic and phrenocolic ligaments (hepatocolic peritoneal fold) which will be severed later.

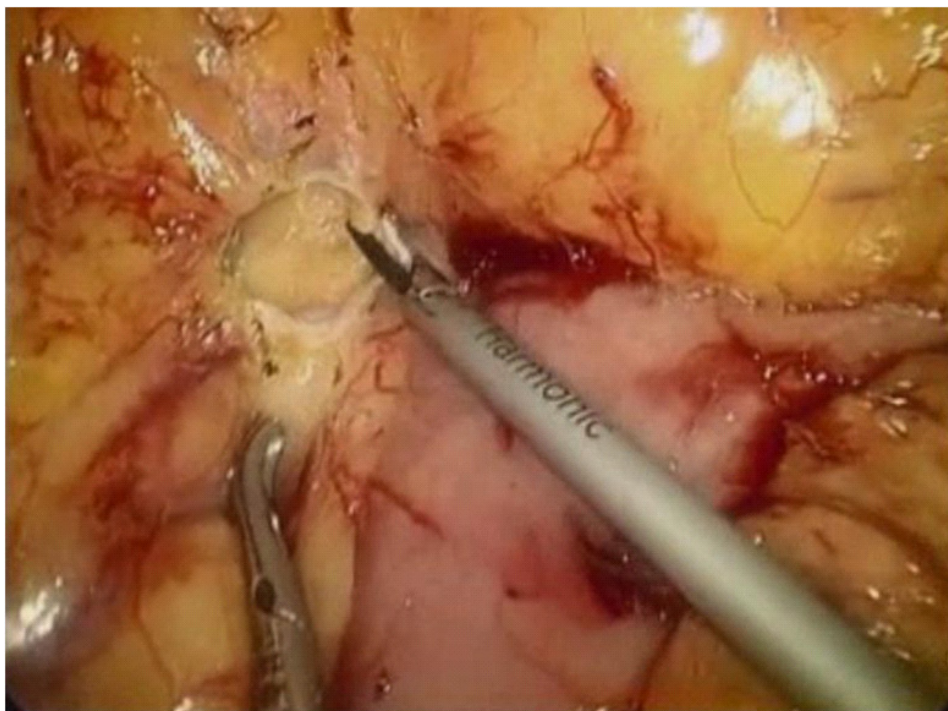


Figure 15: The mesocolon transversum is incised at its root (transverse peritoneal fold) just to the right of the middle colic vessels or onto the projection of the incision of the mesocolon transversum towards the point of colon transversum which will be subsequently stapled (at least 10-15 cm off the distal end of the tumor). The mesocolon transversum is thus detached from its insertion always in a medial to lateral fashion up to the hepatic flexure.

Once the CME and CVL with D3 lymph node dissection is completed, the juxta-colic portion of the gastro-colic ligament is incised in its mid portion (at the Wislow's point, i.e. where the right and left gastro-epiploic vessels joint together), exerting an upward traction of the ligament itself and a downword traction on the colon trasversum (figure 16).

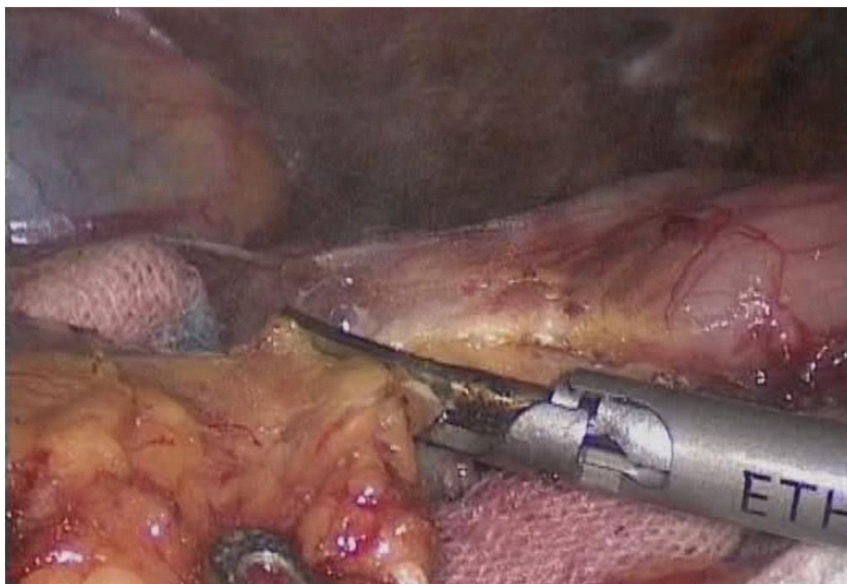


Figure 16: The omentum is stretched upwards and the transverse colon pulled downwards, dividing the gastrocolic ligament at the level of the Wislow's point (midway the junction between the right and left gastroepiploic arcade).

The gastrocolic ligament is fully incised towards the greater curvature of the stomach: in case of right mesolectomy, the gastro-epiploic arcade is spared, while in right extended mesolectomy, the arcade is clipped and severed at the Wislow's point (figure 17a), skeletonizing the right portion of the greater curvature, always in a medial to lateral direction, as shown in figure 17b.

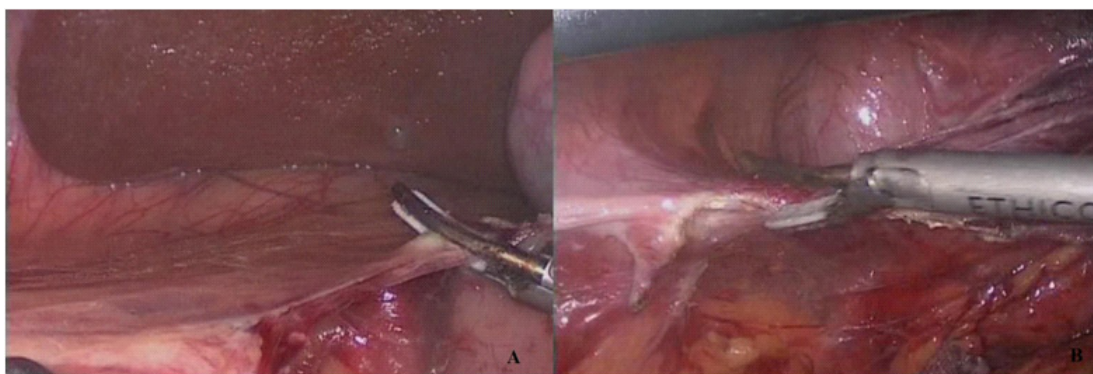


Figure 17: A. The gastroepiploic vessels are clipped at the Wislow's point. B. The greater curvature is skeletonized in a medial to lateral direction, harvesting all the nodes in the right gastroepiploic arcade.

Once reached the pylorus, the subpyloric nodes, previously detached from the bottom-up dissection, are freed and harvested en-bloc with the specimen (figure 18).

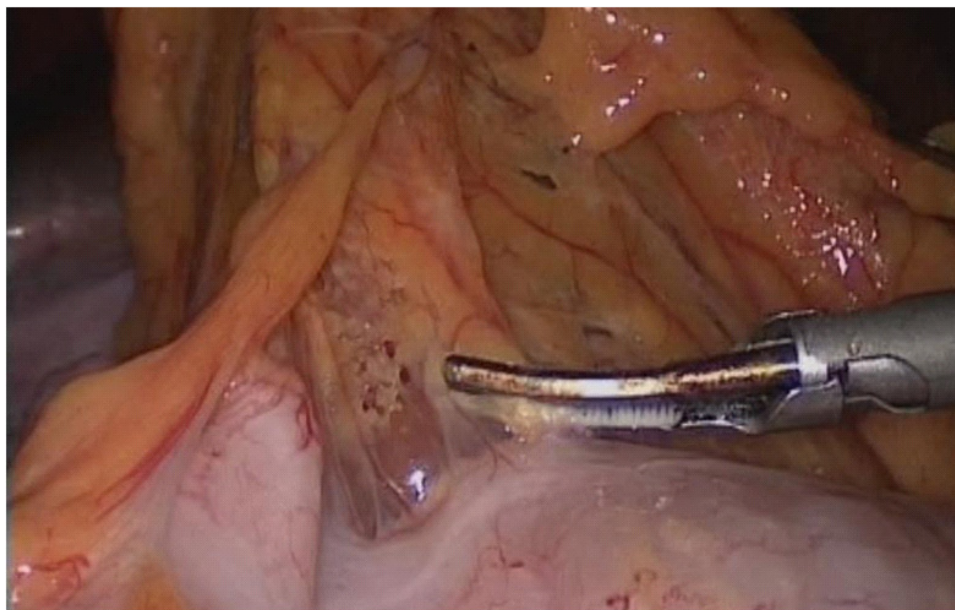


Figure 18: The most right lateral aspect of the gastroepiploic arcade is severed from the pylorus, connecting the plane of dissection with that of the subpyloric nodes, which are harvested en-bloc with the specimen.

The specimen is freed with full mobilization of the right hepatic flexure (in a medial to lateral direction, from the subpyloric region, towards the cholecysto-duodenocolic and phrenocolic ligaments, these latter currently and more properly called hepatocolic peritoneal fold; figure 19a), the right lateral peritoneal fold (from up to bottom) and finally of the caecum (stretching the caecum in an upward direction, the medial and lateral caecal ligaments or ileocaecal peritoneal fold are progressively severed; figure 19b); all these incisions connect the mesofascial/retrofascial interface previously developed, with the colo-fascial interface (the apposition between the colon and the posterior parietal peritoneum), completing the CME and fully mobilizing the specimen.

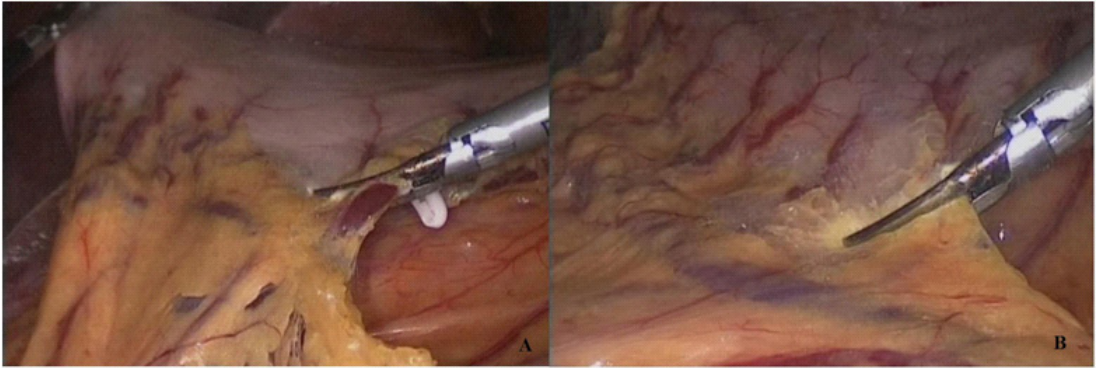


Figure 19: A. The hepatocolic fold (made of the cholecistoduodenocolic ligament medially and phrenocolic ligament laterally) is progressively severed from medial to lateral; dissection will continue to mobilize the right lateral peritoneal fold downwards. B. The ileocaecal peritoneal fold is sharply divided bottom to top and laterally onto the right lateral peritoneal fold, mobilizing completely the specimen.

Stapling and Specimen extraction. The transverse colon fully mobilized is stapled at least 10cm off the tumor, with a staple cartridge for medium thickness tissues, avoiding any devascularized cul-de-sac (figure 20a); similarly, the last 10-15cm of ileum are transected with the same kind of cartridge (figure 20b), freeing the specimen, which is put into a plastic bag.

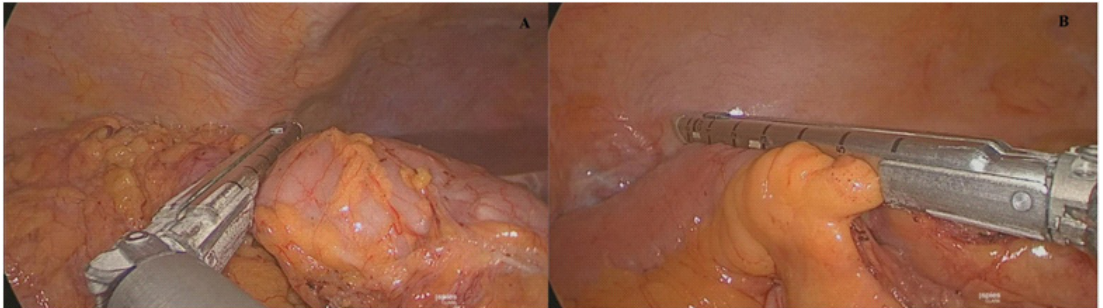


Figure 20: The colon transversum (A) and the ileum (B) are stapled with a 45mm medium thickness cartridge. After both transections, the specimen is completely free and put in an endo-bag.

A small 5cm Pfannestiel incision is carried out, the fascia is incised, the muscles laterally displaced and the peritoneum opened; a plastic lap-disk is inserted and the specimen within the bag is delivered by the grasper outside and gently retrieved, as shown in figure 21.

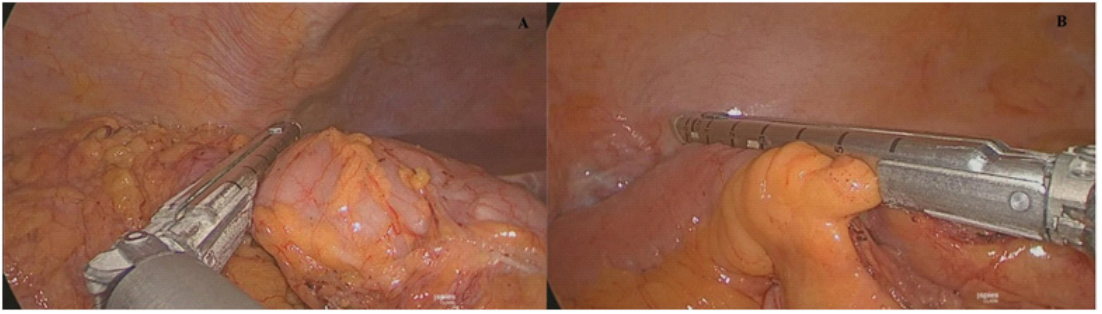


Figure 21: Specimen extraction through a mini Pfannestiel incision of 4-5cm protected by a lap-disk; the specimen (within and endo-bag) is handled to the mini laparotomy by the grasper in the subxifoid region.

The minilaparotomy is closed and the pneumoperitonum reinduced.

Totally intracorporeal anastomosis. The stapled end ileal loop and the transverse colon are approximated in an iso-peristaltic fashion and distally united with a single absorbable stitch so to allow a proper alignment of the two, as shown in figure 22.

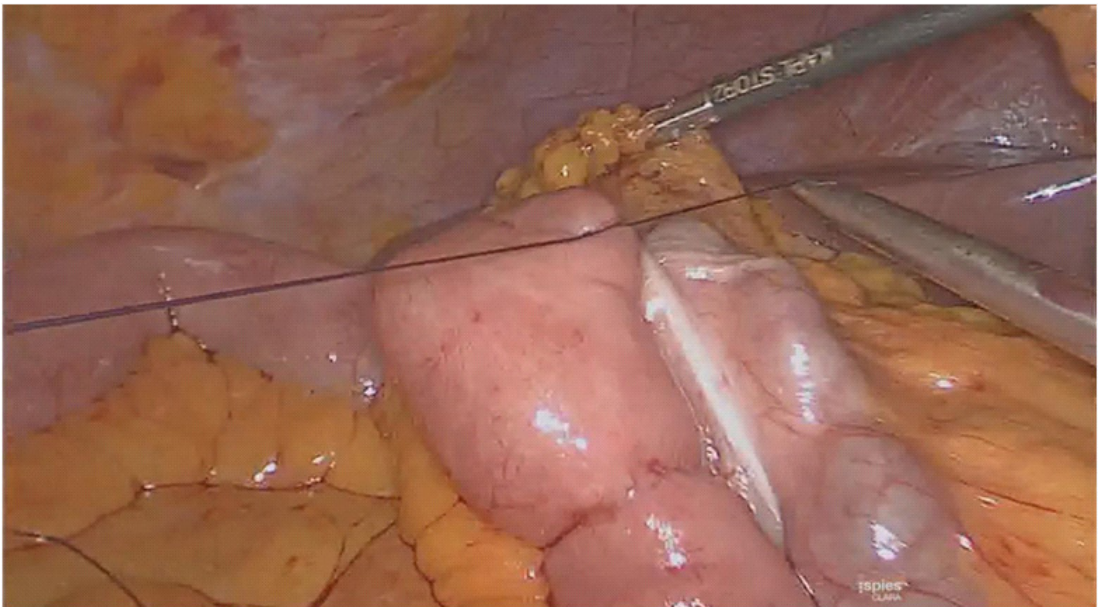


Figure 22: The ileal and colonic branch are aligned in an iso-peristaltic fashion and distally fixed with an absorbable stitch which will be held and stretched laterally by the assistant.

The ileal end is incised on the antimesenteric wall with a small breach, applying tension on the stapled distal end so to stretch the ileal wall and make the incision easier (figure 23a); a similar incision is carried out on the transverse colon on the top of the antimesenteric tenia coli (and not over it), so that the two incisions are placed at the same level (figure 23b).

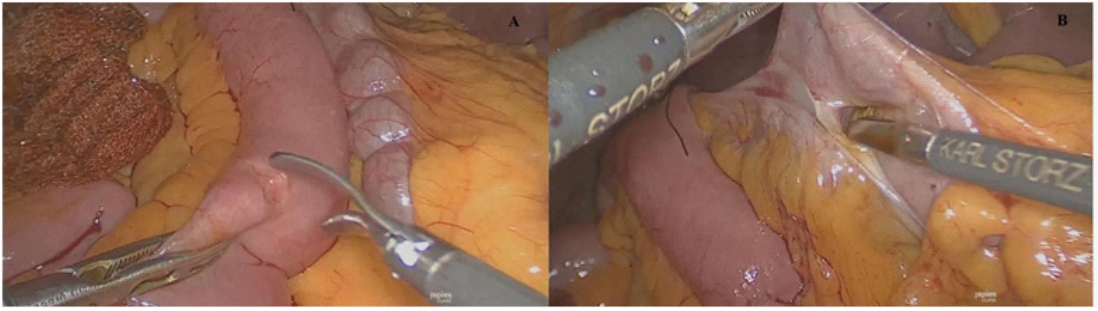


Figure 23: Small subcentrimetric incision of the ileum on the antimesenteric border (A) and colon transversum on the external border of the antimesenteric tenia coli (B). The incisions must be minimal and will be enlarged by the passage of the stapler.

The endo-stapler (loaded with a medium thickness cartridge) is inserted with the thin branch in the ileal loop and with the thick branch in the colon; to make the procedure easier, the assistant stretches the stitch distally and the operator push the stapler to the stitch itself while exerting a counter-traction on the ileal end, as shown in figure 24. Once the stapler is correctly placed, it is closed, fired and retrieved.

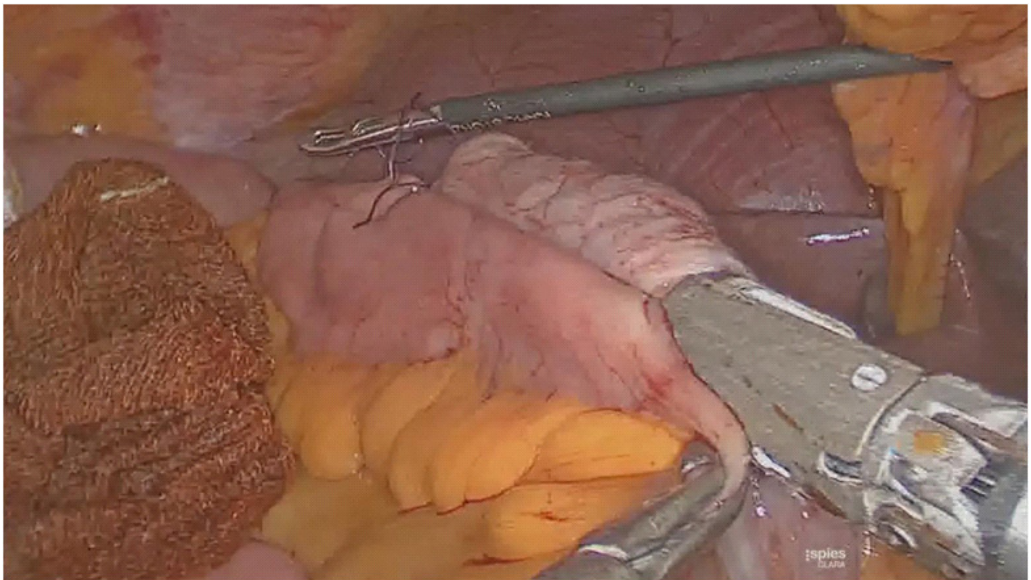


Figure 24: The stapler, loaded with a 45mm medium thickness cartridge, is inserted initially on the ileal branch and than on the colonic one, exerting a countertraction on the ileal end to allow a proper allocation. When the alignment is optimal, the stapler is closed and fired.

The anastomotic hole is closed applying a first absorbable short proximal distal stitch (figure 25a) and a long (for a running suture) distal stitch (figure 25b), both in a Lambert fashion; the running suture is carried out from distal to proximal side and finally secured with the first stitch, sealing the anastomosis (figure 26). One or two tension releasing stitches are placed medially.

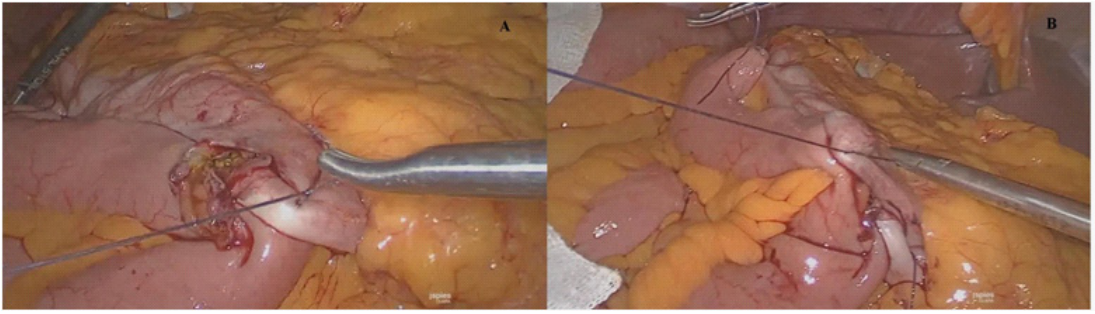


Figure 25: A. The first 3-0 absorbable stitch is placed at the lowermost aspect of the defect in a Lambert fashion, leaving a long end. B. The first stitch of the running suture is then placed at the uppermost aspect of the defect, in the same fashion.

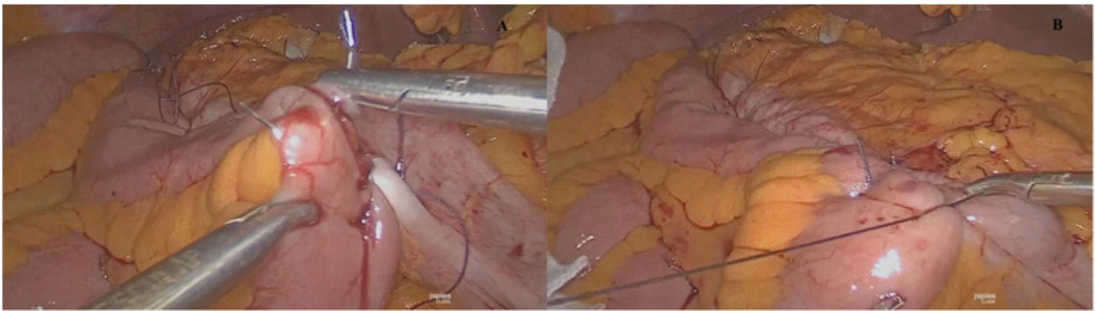


Figure 26: A. The running suture (A) proceeds from up to bottom in an extramucosal fashion with bites 1cm thick every 5mm until the lowermost stitch, with which is secured (B). The anastomosis is now sealed and completed.

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