**Robotic intersphincteric resection and coloanal anastomosis: technical detail**

R Mathew*, SH Kim*

**Abstract**

**Introduction**

Minimally invasive surgery for colorectal diseases has dramatically changed since the introduction of laparoscopic surgery. The frontline for minimally invasive surgery has further progressed since the advent of robotic surgery, with developments more pronounced for rectal cancers especially considering the perceived technological advantages of robotic surgery over the laparoscopic method. The intersphincteric resection for low rectal cancers provides a challenge for open approach and also for laparoscopic method. This paper discusses the method used for a robotic intersphincteric resection and coloanal anastomosis.

**Methodology**

Here, we report a detailed operative technique for performing a robotic intersphincteric resection and coloanal anastomosis.

**Discussion**

Surgical intersphincteric resection is a realistic option for surgical treatment of low rectal cancers.

**Introduction**

The low rectal tumours (<5 cm from anal verge), including those that were close to anal sphincter complex, have been traditionally surgically treated by an abdominoperineal resection, with resultant permanent colostomy and with perineum closed off. In 1994, Schiessel described an alternative approach of intersphincteric resections (ISRs) for these low rectal tumours, with acceptable short-term to medium-term results from oncological and functional perspectives. Subsequently, studies have reported the safety, efficacy and satisfactory outcomes of this ISR approach.

Since the advent of minimally invasive surgery, there has been increasing use of laparoscopic surgery for treatment of rectal cancers. For low rectal cancers, there have been proponents for undertaking ISR laparoscopically, with evidence showing that it is safe, feasible and with acceptable outcomes, and that outcomes were comparable with open approach.

Since the first robot-assisted colectomy was reported a decade ago, robotic surgical systems have been utilised for undertaking colorectal resections. There has been particular interest on robotic total mesorectal excision (TME) for rectal cancer surgery. Since mid-2007, we have developed a single-stage totally robotic surgery without the need to re-dock the patient cart needs to be re-docked. The three-stage technique and two-stage technique were initially developed to aid the ease of dissection for various operative stages – colonic mobilisation, vascular pedicle ligation and pelvic dissection. However, since mid-2007, we have developed a single-stage totally robotic surgery without the need to re-dock the patient cart. We use the da Vinci robotic system (Intuitive Surgical, Sunnyvale, CA).

**Patient position and port placement**

Once general anaesthesia is induced, patient is positioned over beanbags to use as anti-sliding restraints and placed in the Lloyd-Davies position. Prior to the start of the operation, we use standard preoperative measures of antibiotics prophylaxis, urethral catheterisation, anti-embolic compression stockings and pneumatic calf pumps. We use six ports as standard for our robotic procedures: 12-mm optical port, four 8-mm robotic working ports and a 12-mm robotic cart at the patient’s side. The robotic system includes three robotic arms and a master console, which is placed at the patient’s head for the surgeon to control the robotic arms using a 7° optical view. We have developed a single-stage robotic intersphincteric resection and coloanal anastomosis technique, with a combination of laparoscopic surgery for the abdominal part and robotic approach for pelvic dissection.

**Methodology**

The authors have referenced some of their own studies in this methodology. These referenced studies have been conducted in accordance with the Declaration of Helsinki (1964) and the protocols of these studies have been approved by the relevant ethics committees related to the institution in which they were performed. All human subjects, in these referenced studies, gave informed consent to participate in these studies.
and a 5-mm assistant port (Figure 1). The initial approximate port positions are pen-marked on the abdomen prior to creation of pneumoperitoneum. The first port to be marked is the right-iliac fossa (RIF) port near Mc-Burney’s point, which should ideally be at the eventual stoma site. The second port marking is at the right-upper quadrant (RUQ) just inferior to coastal margin at mid-clavicle (MC) line. The optical port site is marked at the umbilical region, but it is to be noted that this optical port placement is not necessarily at umbilicus itself, but can be either the superior/inferior side of umbilicus depending on the apex of the triangle, with RIF and RUQ port markings forming the base of the triangle. The next port is to be placed at the left upper quadrant, just medial to MC and another port at left-iliac fossa (LIF), which would be at the corresponding level to RIF port site. Finally, an assistant port is placed at mid-point between the RUQ and RIF ports. After the pen markings are made, all the ports are inserted, starting with the optical port using an open ‘Hassan’ technique. Pneumoperitoneum is initially set at 12 mm Hg. The patient is now placed in a 30° Trendelenburg tilt and a 15° left-side tilt upwards. Visual inspection of abdominal cavity and pelvis is done to assess any obvious evidence of distant metastatic disease. The greater omentum is retracted over and above the transverse colon, which is then subsequently pushed upwardly. The small bowel (SB) is retracted medially and superiorly. A 10 × 10 cm gauze is used to help retain medial SB retraction. These manoeuvres help visualisation of the root of the IMA pedicle. In addition, patient’s tilt helps keep SB and transverse colon retracted away using the help of gravity. Finally, pneumoperitoneum is reduced to 8 mm Hg.

**Further tips/pointers**

- The upper level of beanbags should not exceed the patient level, as this could hamper the robotic arms or even the assistant instrumentation. Also, it is advisable to place some cotton roll/gel padding between the right shoulder of the patient and beanbag to prevent undue pressure on the patient shoulder from the vacuum-hardened beanbags. The right shoulder is the area of maximum dependant pressure with patient tilt during operation.
- The knees should be slightly flexed in the Lloyd-Davies position, and then the whole leg positioned for the thigh to be flat with the patient’s abdomen level. This again helps with ease of instrumentation. In addition, the left leg should be less abducted, to provide more room for the robotic patient-side cart coming parallel to the left thigh of the patient.
- Although the port positions are pen-marked initially, following pneumoperitoneum creation that stretches the abdominal wall, the final port positions could be placed more outwards, if needed, especially in a thin patient to create more space between the ports. The placement site of the RUQ port should be carefully chosen in a way that it is not very close to the falciform ligament to prevent hindrance from this during instrument changes.
- LUQ and LIF ports should ideally be just medial and just lateral to the MC line respectively.
- Balloon port for optical port site is preferable, especially for obese patients.
- Assistant 5-mm port should be placed medial to the MC line, as a too lateral port can cause SB injury during instrumentation changes, as SB is usually dependant to the right side of the abdomen. The assistant port can be used to connect to a smoke extractor.

**Patient cart placement and robot docking**

The patient cart is brought to patient’s left side parallel to the left thigh. The central shaft of the patient cart is aligned in an imaginary straight line with the umbilicus and left anterior superior iliac spine (ASIS) (Figure 2). The ports are then docked to the robot (Figure 3), including-optical zero degree robotic camera at the umbilical port and RIF port (robotic arm 1) for the surgeon’s right arm using monopolar curved scissors. The RUQ port is docked for the surgeon’s left arm and Maryland bipolar forceps are introduced here. A Cadiere grasper is used as the surgeon’s second left arm is used via the LUQ port.
arm movement required would be much greater than when the port is not too deep in order to create a similar angle of instrument tip movement inside the abdominal cavity. Second, an extra deep port placement may cause excessive traction on the abdominal wall.

- The full insertion of the three working instruments is to be done under direct vision, and eventually directed closed enough to the start of the dissection area, which is at the inferior mesenteric artery (IMA) pedicle.
- Diathermy settings: bipolar settings – 30 (standard), and monopolar settings – 25 cutting (pure) and 25 coagulation (fulgurate).
- Before the start of the next stage of operation of undertaking robotic surgery, it is important to ensure that there is adequate space between all the robotic arms, particularly the shoulders and elbows. Also, once docked, the patient positions should not be changed without undocking completely.

Operative part, abdominal–colonic mobilisation, vascular pedicle ligation

The IMA pedicle is identified and the sigmoid mesocolon over IMA is lifted upwards using Cadiere forceps. The peritoneum at the base of the IMA is incised and dissected with monopolar scissors. Particular care is taken here to preserve the hypogastric nerve plexus. Dissection around origin of the IMA pedicle is completed. The IMA is then divided near its origin, after application of 10-mm robotic Hemo-O-Lok clips (Weck Closure System, Research Triangle Park, NC), with two clips applied proximally on the patient’s side (Figure 4). Following this, Cadiere forceps are changed to hold the divided IMA pedicle of the mesocolic side. Dissection is then continued superiorly towards the ligament of Treitz, and then...
the inferior mesenteric vein (IMV) is identified and divided near the inferior pancreatic border (Figure 5). Medial to lateral dissection is completed, including dissection of the mesocolon away from the retroperitoneum and Gerota’s fascia. The left ureter and gonadal vessels are identified and preserved (Figure 6). The dissection is continued superiorly over the pancreas until the lesser sac is entered. Completion of lateral dissection is commenced at the pelvic brim, at the ‘white line’, and working cephalad towards the splenic flexure. During this part of dissection, the assistant maintains an active retraction of sigmoid colon medially. Once the proximal descending colon area is reached, the second left arm with Cadiere forceps is undocked to prevent external collision of the first and second left arm. Safe counter-traction is maintained by the first left hand Maryland forceps. The splenic flexure is then completely mobilised after division of reno-colic and spleno-colic ligaments. The transverse mesocolon is opened just above the body of the pancreas to enter the lesser sac. Dissection is then completed after dividing the greater omentum, in the avascular plane, from the mid to distal part of the transverse colon.

Further tips/pointers
- Once the lesser sac is entered, during completion of medial to superior/lateral mobilisation, the 10 × 10 cm gauze is placed at the lesser sac above the superior-lateral border of the pancreas. This gauze placement aids completion of splenic flexure mobilisation and dissection of the lesser sac from the superior side.
- In our opinion, splenic flexure complete mobilisation is necessary for obtaining adequate length for a tension free coloanal anastomosis. Likewise, the high ligation of IMA and IMV also helps in ensuring adequate length for a tension free anastomosis.

Operative part – pelvic TME dissection and intersphincteric dissection
Before the start of pelvic dissection and TME, the two left-sided robotic arms from RUQ and LUQ are undocked. These are then re-docked to the LUQ port (left arm, with Maryland grasper) and LIF port (second left arm, with Cadiere forceps) (Figure 7). The position of the patient cart itself remains unchanged. This change of ports also allows the assistant to utilise the two upper right-sided ports, with the RUQ port used for cephalad retraction of rectosigmoid and right flank port with a sucker for both the suction/retraction purpose.

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The first step in pelvic TME dissection starts with division of pelvic peritoneum on the right side of the mesorectum. Following this, dissection is started posteriorly in the TME plane. The Cadiere forceps retract the upper mesorectum anteriorly, whilst the Maryland forceps give counter-traction to aid the sharp dissection, using right arm scissors, along the avascular plane between the mesorectum and presacral fascia. Care is taken to preserve both the right and left bundles of hypogastric nerves (Figure 8). The dissection is continued up to the Waldeyer’s fascia (rectosacral fascia), and is then continued on the right lateral side with the Cadiere forceps moved to the right lateral side wall for counter-traction. The dissection is then moved to the left side, with Cadiere forceps retracting the mesorectum medially and the first left arm Maryland forceps providing lateral countertraction (Figure 9). At this stage, the assistant’s left hand cephalad traction on rectosigmoid is enhanced by changing traction to a cotton tape tie on rectosigmoid. Subsequently, the anterior plane is dissected after dividing peritoneal reflection and then continued through the Denovillier’s fascia in males/rectovaginal septal fascia in females (Figure 10). During anterior dissection (Figure 11), Cadiere forceps may be used to give anterior traction on the prostate/vagina, whilst Maryland forceps may give posterior traction on the rectum. The posterior TME dissection is then completed through the Waldeyer’s fascia, and likewise the lateral attachments are divided, taking particular care to preserve the pelvic plexus in the lateral sidewalls. If the middle rectal artery is encountered during the lateral dissection, these are divided after applying Hem-O-Lok clips (Figure 12). The posterior dissection is then continued, angled upwards to follow the sacral curve. It is to be noted that as the SB would obscure the right lateral plane, further posterior dissection down to the levator ani muscle is approached from the left lateral plane, while the rectum is lifted up by the Cadiere graspers. The final part of TME dissection is completed circumferentially, to reach the pelvic floor muscle sling.

For the intersphincteric dissection, the puborectalis muscle sling is exposed laterally. The posterior anococcygeal ligament is divided (Figure 13). The Cadiere forceps are used to maintain lateral pelvic wall traction, whilst the Maryland forceps are used...
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• Majority of the posterior TME dissection is done from the left side, partly due to the reason that two out of three robotic working arms are angling in from the left side.
• To not injure the bowel or breach the mesorectal envelope – note that traction on bowel/mesorectal fascia propria should primarily be maintained by not pinching/holding the tissues, but by maintaining retraction using the convexity of Maryland forceps or the endowristed flexed part of Cadiere forceps.
• In our opinion, progress during TME dissection is better enabled by sequential circumferential dissection rather than undertaking complete segments one at a time, such as during the laparoscopic approach (e.g. complete posterior dissection, then lateral part and finally anterior part in a laparoscopic approach)
• The ideal places to start the intersphincteric dissection is between 9–11 o'clock and corresponding 1–3 o'clock positions to quickly and easily get into the blood-less intersphincteric plane.

Perineal part – completion of intersphincteric dissection, coloanal anastomosis
Both legs are now put in the steep lithotomy position. The anal canal is opened up with stay sutures, starting at the 12, 3, 6 and 9 o'clock positions. Further, stay sutures are placed along the clock positions. Moist gauze is inserted into the anal canal lumen after identifying the distal level of tumour. The intersphincteric plane is injected with 20 ml of diluted adrenaline (1:200,000) in normal saline (Figure 15). The level of dissection, 1 cm distal to the tumour, is marked circumferentially (Figure 16). The dissection is started posteriorly, after dividing the anal mucosa and internal anal sphincter (IAS) at this level to reach the intersphincteric plane (Figure 17). This plane is then dissected circumferentially through...

Further tips/pointers
• Take great care to preserve the pelvic nerves, with particular areas to note – the bilateral hypogastric nerves during the initial part of posterior TME dissection, pelvic sidewall lateral nerve plexus at S2-4 level area, and also nerve complexes near the seminal vesicle area at 10 and 2 o’clock positions.

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Methodology

via the abdominal wall. Although extraction through anus is possible when the tumour is very small, this is not advisable for big tumours or bulky mesorectum as this can damage the residual anal sphincter complex. In these situations, the specimen extraction is normally done via a small incision at the LIF site (at site of LIF port). The proximal area of intended colon division is then stapled, and the resected specimen is sent for histology. Two long stay-sutures are placed on both corners of the stapled end (so as to help in correct orientation of the bowel and not to have it twisted) and reinserted back into the peritoneal cavity. The stay sutures are held by long grasppers and the stapled end of the colon brought out via anal canal. In case of per anal specimen extraction, the specimen is gently pulled out from the anus (Figure 19), and proximal colon’s transection site is stapled. The orientation of proximal colon is ensured to avoid any mesenteric twist. The pelvis is washed and haemostasis is ensured, and a drain is placed in the pelvis, which is brought out through the LIF site. A loop of terminal ileum is identified and brought out through the RIF port site incision. The abdominal wounds are then closed, and finally, loop ileostomy is matured using vicryl stitches.

The anal canal cavity is washed again from the perineal side. Then, a side (colon)-end (anal canal) anastomosis is fashioned using interrupted 2/0 vicryl stitches that is placed circumferentially at regular intervals (Figure 20). Prior to tying these stitches, the anal canal stay sutures that were inserted at the start of the perineal procedure are cut to reduce the tension on anastomotic stitches. Haemostasis is ensured.

Further tips/pointers

• Lone-star retractor can alternately be used instead of anal verge stay sutures.
• Gauze placed per anus at the start of the procedure helps prevent

both lateral sides and then anteriorly (Figure 18). The anal canal mucosa, on the rectal side, is closed with vicryl stitches, after removing the previously inserted per anal gauze. The ISR dissection is then completed all round to reach the peritoneal cavity.

The rectal end is pushed back into peritoneal cavity and anal canal area irrigated with warm water. The anal canal is packed with gauze to prevent any leak when the subsequent pneumoperitoneum is recreated prior to specimen extraction.

Figure 10: Rectovaginal septal dissection.

Figure 11: Anterior TME view.
Intersphincteric dissection, as we believe this may lead to increased fibrosis thereby reducing functional outcome.

• During the colorectal anastomosis, to try and incorporate part of the EAS into the anastomosis, as this may reduce subsequent possible anal mucosal prolapse.

• Try and excise, if possible, any obvious external haemorrhoids noted at the end of the procedure. These, if left in-situ, can usually become engorged and painful (maybe due to decreased venous drainage after an ISR), with symptoms possibly lasting several days.

Discussion

The first robot-assisted colectomy was reported by Weber et al. in 200210. In addition to this, robotic colorectal surgery had garnered interest, with several reported studies showing acceptable results for both colon and rectal robotic resections11–15. The perceived benefits of robotic surgery include the ability to undertake surgery in confined spaces such as the pelvis. Three-dimensional views offer better visualisation and any hand tremor effects are decreased. Despite these benefits, the use of robotic colorectal surgery has not been widespread, which has been a slightly different scenario from that of laparoscopic surgery. The possible explanations might be the increased operating costs, lack of training and experience associated with robotic surgery.

Studies evaluating robotic surgery for rectal cancer had reported early promising results 16–20, and in addition, results of comparative studies with laparoscopic surgery have also shown that robotic surgery is not inferior to the laparoscopic approach23–27. However, it is important to note that, these are only case series or comparative studies, and no randomised, controlled trials have been completed to-date for rectal cancer surgery.

Figure 12: Left middle rectal artery clipping.

Figure 13: Division of anococcygeal ligament.

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Methodology

The low rectal cancers provide a surgical challenge with ISR as a way of sphincter saving approach compared to an abdominoperineal resection. Although the open method\(^1\)–\(^5\) and subsequently laparoscopic surgery\(^6\)–\(^9\) is well reported in undertaking ISR, a robotic approach to undertake ISR may be the next logical progression from laparoscopic surgery for these very low rectal cancers. There have been only few recent case series\(^2\)\(^8\)–\(^3\)\(^0\) on robotic ISR, reporting acceptable early results, and a single comparative cases series\(^3\)\(^1\) showing comparable short-term results with a laparoscopic approach. However, the reported techniques are different from each other with variations, including using a hybrid technique with laparoscopic approach for the abdominal part and robotically for pelvic dissection\(^2\)\(^8\), and undertaking ISR with perineal dissection first followed by robotic approach for the pelvis\(^3\)\(^0\). These varying techniques reveal that robotic ISR is still unique and is at a very early stage of its development. There is limited literature on undertaking totally robotic ISR. We describe here in detail various technical aspects of performing a robotic ISR and coloanal anastomosis. Robotic ISR technique is still in its early stages of development, and further randomised, controlled studies are required to prove the short-, medium- and long-term results, particularly from both the functional and oncological perspectives.

Conclusion

With the above caveat, we believe the robotic ISR may be a realistic and feasible option for surgically treating low rectal cancers. In addition, the operative approach mentioned here offers a possible standardised approach in undertaking a robotic ISR and coloanal anastomosis.

Abbreviations

ASIS, anterior superior iliac spine; EAS, external anal sphincter; IMA, inferior mesentery artery; IMV, inferior mesenteric vein; ISR, intersphincteric resection; LIF, left-iliac fossa; MC, mid-clavicle; MIS, minimally invasive surgery; RIF, right-iliac fossa; RUQ, right-upper quadrant; SB, small bowel; TME, total mesorectal excision.

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References

Methodology


Figure 18: Intersphincteric plane – during perineal approach.

Figure 19: Specimen extraction per anus.
Methodology


Figure 20: Coloanal anastomosis being undertaken.