



Completed mesocolic excision for right colon cancer: comparison between single-port laparoscopy and conventional laparoscopy

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Abstract: Complete mesocolic excision is believed to play an important role in the treatment for colon cancer. While evidence has shown that laparoscopic surgery is not a technique barrier for CME, the feasibility of single-port laparoscopy is still controversial. In this article we discussed the difference between the single-port and conventional laparoscopic CME surgery for right colon cancer and summarize the key techniques and tips for operation.

Keywords: Complete mesocolic excision; laparoscopy; right colon cancer; single-port surgery

Received: 02 September 2016; Accepted: 19 October 2016; Published: 08 December 2016.

doi: 10.21037/ales.2016.11.09

View this article at: <http://dx.doi.org/10.21037/ales.2016.11.09>

As an increasingly sophisticated procedure, laparoscopic colorectal surgery has been widely applied in clinical settings (1-3). Along with technical development and innovation, some laparoscopy-based novel techniques such as robotic surgery, natural orifice transluminal endoscopic surgery (NOTES), and single-port laparoscopic technique have emerged.

The robotic surgical systems have many advantages including decreased hand vibration, increased operational freedom, shortened living curve, and feasibility of remote operation. However, their high cost and prolonged surgical duration have restricted their applications in China. NOTES requires further innovations before it can be widely applied in clinical settings. In contrast, the single-port laparoscopy has shorter learning curve than NOTES (4); furthermore, by using the conventional laparoscopic devices, it can also achieve cosmetic and minimally invasive effects by hiding the scars. Therefore, single-port laparoscopy may be a more promising minimally invasive technique for Chinese patients.

In 2009, the German scholar Hohenberger *et al.* (5) for the first time proposed the concept of completed mesocolic excision (CME). CME shares the similar principles of embryology and anatomy with total mesorectal excision (TME). In fact, the mesocolon is also covered by two layers of visceral fascia, which are somehow like an “envelope”. Just based on this anatomic basis, Hohenberger proposed the concept of CME, which includes the sharp separation of parietal fascia from visceral fascia and meanwhile avoids any visceral fascia breakage that may cause tumor spread; furthermore, the beginning portion of colon vessel must be thoroughly exposed and ligated at its root, so as to maximize the scope of lymph node dissection and thus increase the survival rate (6,7).

As people become more familiar with the concept of CME, an increasing number of laparoscopic colorectal surgeons have shown interest in this hot topic and began to apply this technique in their clinical practices (8-10). For these ambitious surgeons, CME under single-port laparoscopy has become another target. Then, the

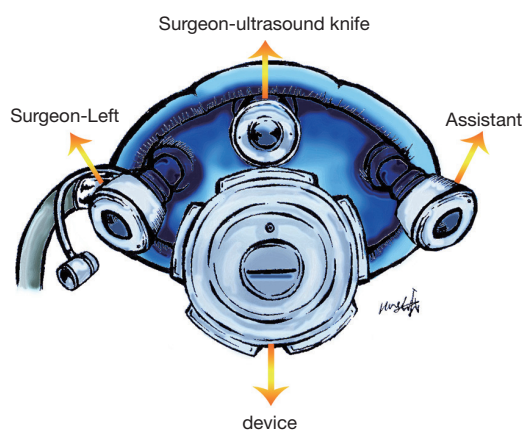


Figure 1 The four-channel single-port device.

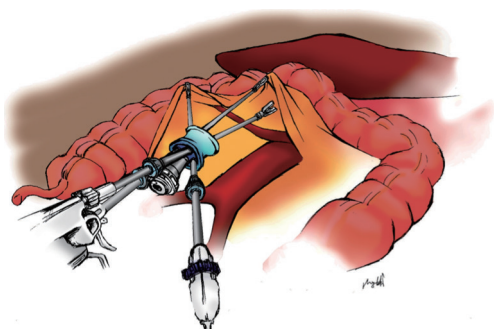


Figure 2 The traction effectiveness after the placement of relevant instruments in the single-port device.

questions are: is CME a feasible technique for the radical resection of colon cancer? What are the key techniques and difficulties of successful surgeries under single-port laparoscopy?

Differences do exist between the single-port laparoscopy and conventional laparoscopy. Compared with the conventional laparoscopy, the single-port laparoscopy is restricted by the “single port”, i.e., all the devices need to enter the abdominal cavity via one single port. As a result, the surgical operations lack adequate angles and the devices may collide and interfere with each other. Counter-traction may be particularly difficult, and sometime the operator needs to cross their hands during operation. In addition, most single-port devices only provide 3–4 operating channels, which are 1–2 less than the conventional laparoscopic colorectal surgery, in which 5 ports are often used. Thus, the traction and exposure can be more difficult if these single-port devices are used (11).

Therefore, compared with the conventional laparoscopic

surgeries, the main challenge of the single-port laparoscopic radical resection of right colon cancer is how to take advantage of a variety of conditions to create good operating angles; meanwhile, the operator must be skillful enough to perform CME.

Single-port devices and trocar design

Placement of the single-port device

Similar to the location of the trocar for camera port during a conventional laparoscopic surgery, the single-port device (SILS™ Port) is placed on the midline 2 cm below the umbilicus after opening the abdominal cavity layer-by-layer.

By using the insufflation channel in the SILS™ Port, a 5-mm device is also placed, so that the initially 3-channel device becomes a 4-channel device; thus, an additional Trocar and an additional auxiliary device (used by the assistant) can be applied for traction, if necessary.

In a conventional laparoscopic surgery, the locations of Trocars need to be reasonably designed; similarly, in a single-port laparoscopic surgery, which instruments should be placed in the 3–4 channels in the SILS™ Port should also be carefully considered, so as to increase the convenience of surgical operation and the effectiveness of space exposure. According to our experience, when these channels are placed as in *Figures 1* and *2*, a good operation triangle can be obtained, which can facilitate the exposure of surgical field, increase the convenience of operation, and reduce the interferences among devices.

Selection of surgical approaches

Similar to the surgical approaches used in the conventional laparoscopic multi-port radical surgery for right colon surgery, the single-port laparoscopic right colon surgery also follows the principle of medial approach, during which a strategy of “making breakthrough in central area after encircling the lateral areas” and a tactic of “upwards, outwards, and combination of downwards and upwards” were adopted (12).

Surgical skills

We divide the radical treatment of right colon cancer by conventional 5-port laparoscopy or single-port laparoscopy into several key operational scenarios to compare these two surgeries; furthermore, based on the similarities and

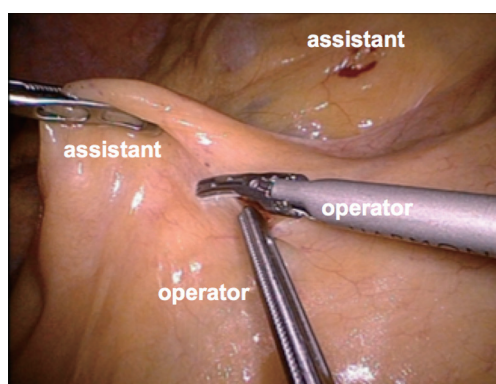


Figure 3 Opening a window in the mesentery using a conventional 5-port method.



Figure 4 Opening a window in the mesentery using single-port laparoscopy.

differences between these two operations, we try to explore whether the single-port laparoscopy could also achieve the effectiveness of 5-port laparoscopy during the CME in right colon.

Scenario 1: handle ileocolic vessels—open a window at the mesentery

The conventional 5-port laparoscopy

Beginning from the lower margin of ileocolic vascular pedicle, the operator cut open the mesocolon to open the “window”, so as to search for and enter the space behind the right colon.

The assistant lifts the mesocolon at the middle of middle colic vascular pedicle towards the head and abdominal sides with left hand and lifted the ileocolic vascular pedicle outwards and downwards using his/her right hand, so

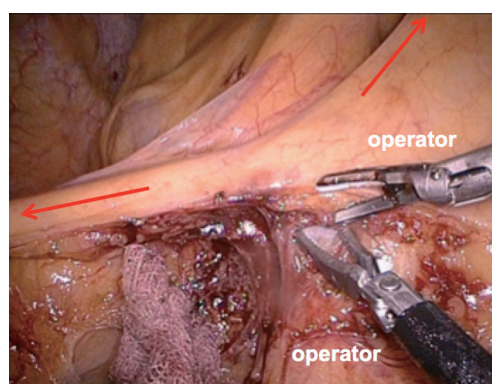


Figure 5 Opening the SMV sheath using a conventional 5-port method.

as to produce sufficient tension and thus achieve exposure (*Figure 3*).

Single-port laparoscopy

The operator pulls the ileocolic vasculature pedicle with his/her own left hand, which replaces the role played by the assistant during a conventional 5-port laparoscopic surgery; meanwhile, the operation by the right hand begins from the lower margin of ileocolic vascular pedicle, so as to open a window on the mesocolon and identify the space behind the right colon.

The assistant then can take a break. If the operation can be completed using a small number of devices, the smallest number of devices should be used as possible, so as to avoid unnecessary interference among devices in a single port (*Figure 4*).

Scenario 2: handle ileocolic vessels—open the SMV sheath

The conventional 5-port laparoscopy

The operator uses a separating forceps in left hand to open the vascular sheath on SMV surface and uses the high intensity focused ultrasound (HIFU) in right hand to cut open the vascular sheath.

The assistant lifts the mesocolon at the middle of middle colic vascular pedicle towards the head and abdominal sides with left hand and lifts the ileocolic vascular pedicle outwards and downwards with right hand, so as to produce sufficient tension and thus achieve exposure (*Figure 5*).

Single-port laparoscopy

The operator lifts the vascular sheath on SMV surface with

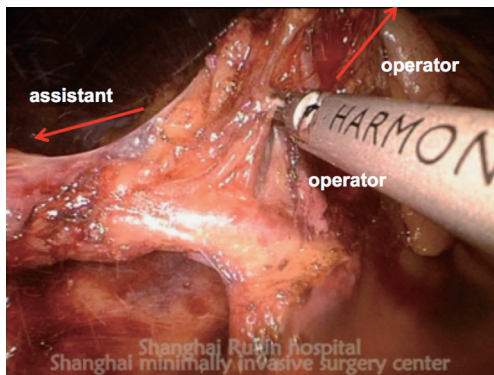


Figure 6 Opening the SMV sheath using single-port laparoscopy.

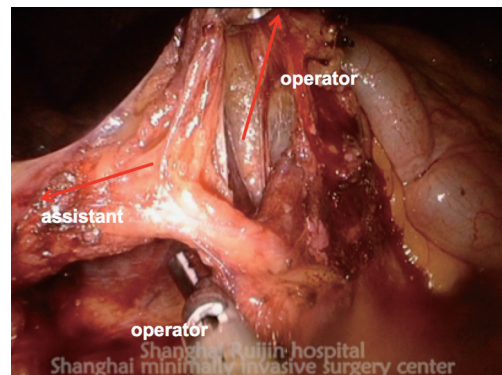


Figure 8 Exposing the vascular root using single-port laparoscopy.

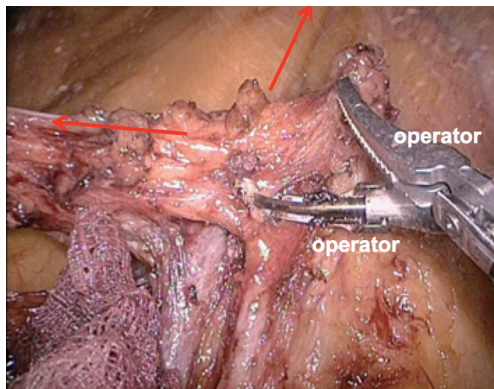


Figure 7 Exposing the vascular root using a conventional 5-port method.

left hand and cuts open the vascular sheath using HIFU in right hand.

The assistant pulls the ileocolic vasculature pedicle (*Figure 6*).

Scenario 3: handle ileocolic vessels—expose the vascular root

The conventional 5-port laparoscopy

The operator lifts the mesocolon in front of SMV with left hand and then exposes the vascular root with a separating forceps or HIFU in right hand.

The assistant lifts the mesocolon at the middle of middle colic vascular pedicle towards the head and abdominal sides with left hand and lifts the ileocolic vascular pedicle with right hand (*Figure 7*).

Single-port laparoscopy

The operator uses left hand to lift the mesocolon in front of

SMV, which partially replaces actions initially performed by the assistant. The right hand, in most cases, still goes alone: it uses a separating forceps or HIFU to complete technical actions such as picking, pulling, isolating, and separating, so as to expose the vascular root.

The assistant's actions are relatively simple: he/she pulls the ileocolic vascular pedicle outwards with right hand to maintain appropriate tension (*Figure 8*).

Scenario 4: extend the space behind right colon

The conventional 5-port laparoscopy

In this scenario, the operator's left hand and right hand cooperate with each other; by using both blunt and sharp methods, the operator extends the whole space behind the right colon upwards and outwards.

The assistant inserts a non-invasive forceps with left hand into the space behind the right colon and lifts the mesocolon towards the left upper side; the right hand also enters this space to lift the mesentery towards the right upper side, so as to provide appropriate tension and space for the operator to perform extension (*Figure 9*).

Single-port laparoscopy

The operator uses left hand to replace the assistant's role in the 5-port method; the left hand enters the space behind the right colon to lift the mesocolon towards the left upper side.

The right hand alone can completely extend the space behind right colon by using both blunt and sharp methods.

The assistant uses a non-traumatic forceps with right hand to enter the space behind the right colon and then lift the mesentery towards the right upper side (*Figure 10*).

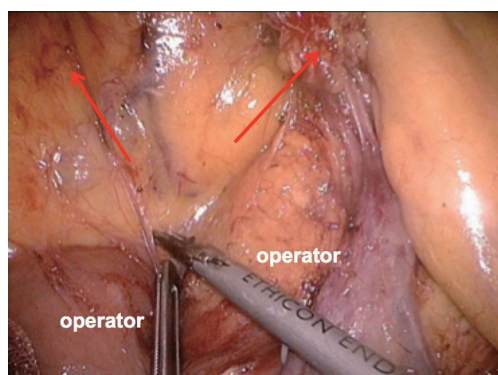


Figure 9 Extending the space behind right colon using a conventional 5-port method.

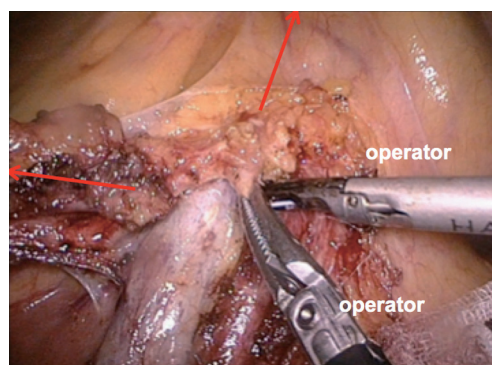


Figure 11 Dissecting the surgical trunk using a conventional 5-port method.

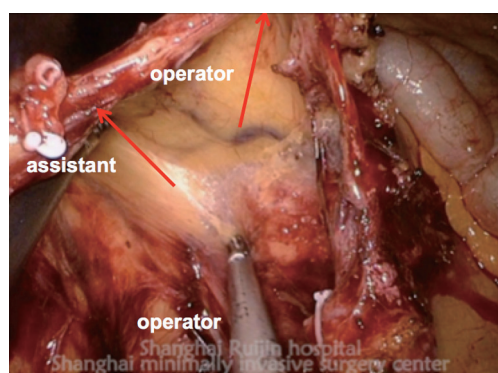


Figure 10 Extending the space behind right colon using single-port laparoscopy.

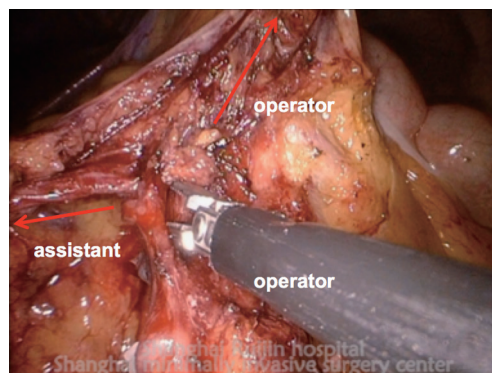


Figure 12 Dissecting the surgical trunk using single-port laparoscopy.

Scenario 5: dissect the surgical trunk

The conventional 5-port laparoscopy

The operator uses a separating forceps or a non-traumatic forceps with left hand to open the vascular sheath along the SMV surface and expose and handle the vascular root using HIFU in right hand.

The assistant pulls the mesocolon at the middle of middle colon vascular pedicle with left hand and pulls the mesocolon towards the right side with right hand (Figure 11).

Single-port laparoscopy

The operator uses left hand to lift the mesocolon in front of SMV and exposes and handles the vascular root using a separating forceps and HIFU in right hand.

The assistant still uses a forceps with right hand to pull the mesocolon rightwards (Figure 12).

Scenario 6: dissect the Henle's trunk

The conventional 5-port laparoscopy

The operator uses a separating forceps with left hand to divide and separate the mesentery on SMV surface to expose the root of the common trunk; then, using the HIFU in right hand, the operator continues to open the mesentery on the surfaces of SMV, common trunk, and its branches, so as to gradually expose the common trunk and its branches.

The assistant pulls the transverse mesocolon with left hand towards the left upper side and pull the mesocolon towards the right upper side with right hand (Figure 13).

Single-port laparoscopy

The operator uses the left hand to replace the role of the assistant in the conventional 5-port method (pulling the middle colic vascular pedicle towards the left upper side) and uses HIFU and a separating forceps in right hand

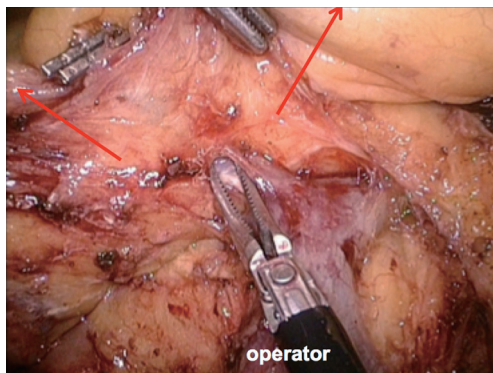


Figure 13 Dissecting the Henle's trunk using a conventional 5-port method.

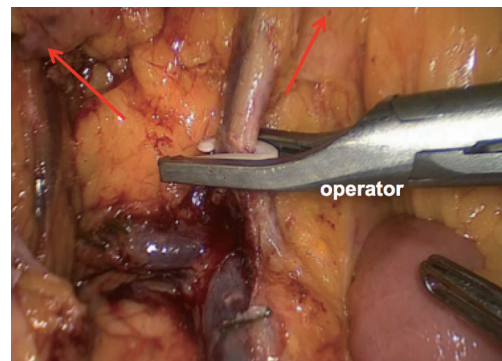


Figure 15 Handling the middle colon vessels using a conventional 5-port method.

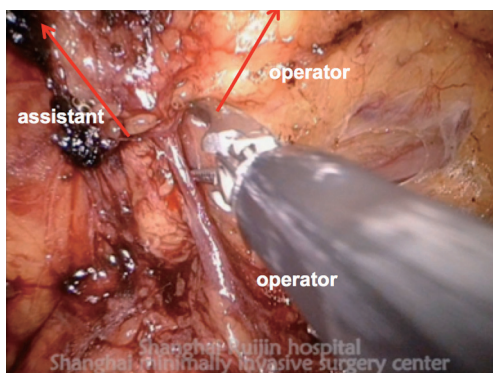


Figure 14 Dissecting the Henle's trunk using single-port laparoscopy.

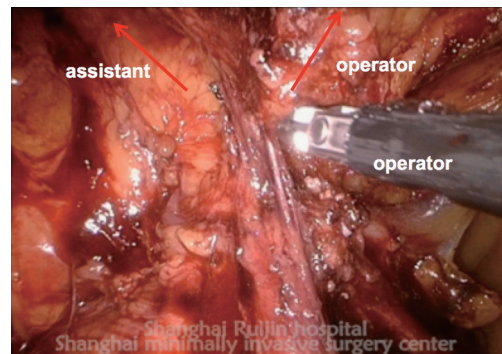


Figure 16 Handling the middle colon vessels using single-port laparoscopy.

to open, separate, and expose the common trunk and its branches.

The assistant only uses the right hand to pull the mesocolon towards the right upper side (*Figure 14*).

Scenario 7: handle the middle colic vessels

The conventional 5-port laparoscopy

The operator uses left hand to dissociate and divide the middle colic vessels and uses right hand to expose and handle the vascular root.

The assistant uses left hand to pull the middle colic vascular pedicle towards the left upper side and uses right hand to pull the transverse mesocolon towards the right upper side (*Figure 15*).

Single-port laparoscopy

The operator uses the left hand to replace the role of the assistant in the 5-port method (i.e., pulling the middle colic vascular pedicle towards the left upper side) and uses the right hand alone to expose and handle the vascular root.

The assistant still uses right hand to pull the transverse mesocolon towards the right upper side, as done in the 5-port method (*Figure 16*).

Scenario 8: enter the lesser omental bursa via the lower edge of pancreas

The conventional 5-port laparoscopy

The operator uses both left and right hands to cut open the lesser omental bursa to expose the posterior gastric wall.

The assistant uses left hand to pull the middle colic

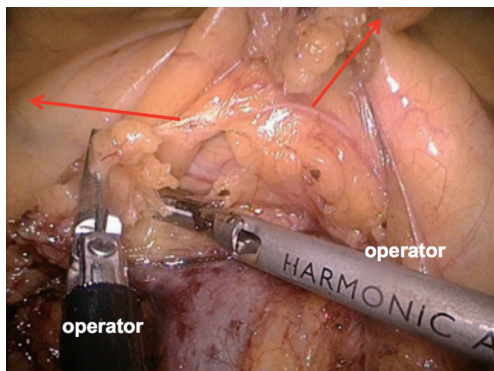


Figure 17 Entering the lesser omental bursa via the lower edge of pancreas using a conventional 5-port method.

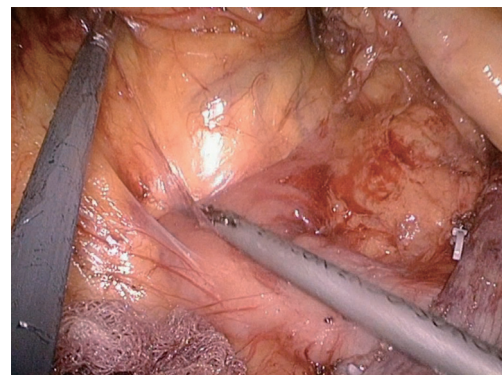


Figure 19 Extending the space behind the transverse colon using a conventional 5-port method.

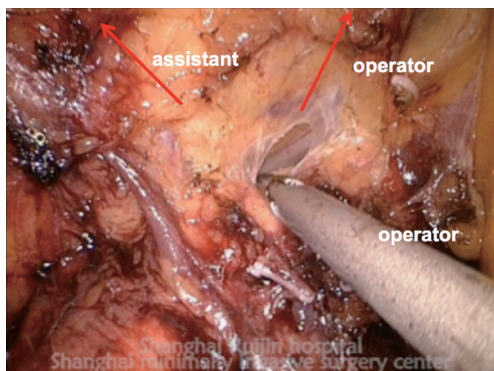


Figure 18 Entering the lesser omental bursa via the lower edge of pancreas using single-port laparoscopy.

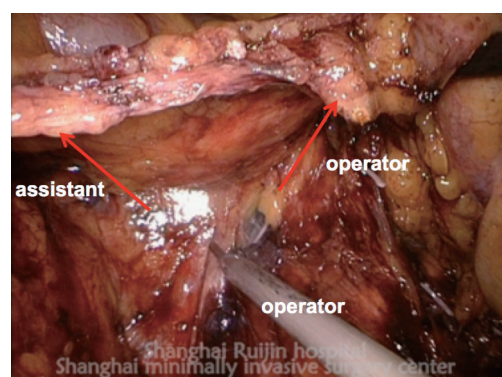


Figure 20 Extending the space behind the transverse colon using single-port laparoscopy.

vascular pedicle or transverse mesocolon towards the left upper side and uses right hand to pull the transverse mesocolon towards the right upper side (*Figure 17*).

Single-port laparoscopy

The operator uses the left hand to replace the role of the assistant in the 5-port method (i.e., pulling the middle colic vascular pedicle or transverse mesocolon towards the left upper side) and uses the right hand to cut open the lesser omental bursa to expose the posterior gastric wall.

The assistant uses the right hand to pull the transverse mesocolon towards the right upper side (*Figure 18*).

Scenario 9: extend the space behind transverse colon

The operative strategy used in this scenario is similar to that for the extension of the space behind right colon (*Figures 19 and 20*).

Scenario 10: cut open the gastrocolic ligament

The conventional 5-port laparoscopy

The operator pulls the greater omentum downwards with left hand and divides the gastrocolic ligament with left hand.

The assistant uses the left hand to lift the anterior wall of stomach and uses the right hand to pull the anterior wall of the gastric antrum (the traction direction is consistent with the left hand of the operator); thus, the gastrocolic ligament is pulled into a fan-shaped or triangular stretching, which not only provides sufficient tension but also offers a clear and reliable visual field (*Figure 21*).

Single-port laparoscopy

The operator pulls the greater omentum downwards with left hand and divides the gastrocolic ligament with left hand, as done in the conventional 5-port method.

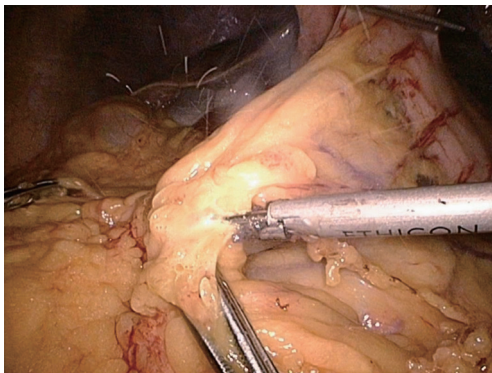


Figure 21 Dividing the gastrocolic ligament using a conventional 5-port method.

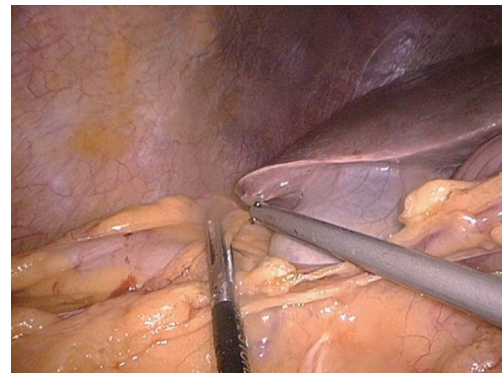


Figure 23 Dissociating the hepatic flexure using a conventional 5-port method.

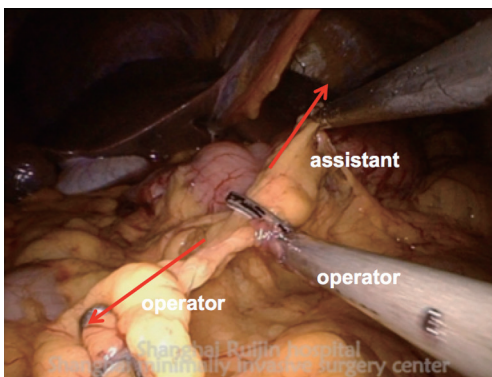


Figure 22 Dividing the gastrocolic ligament using single-port laparoscopy.

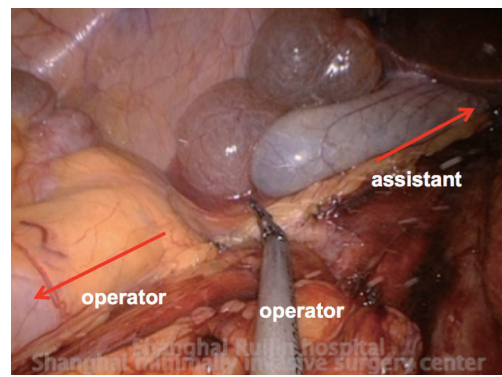


Figure 24 Dissociating the hepatic flexure using single-port laparoscopy.

The assistant can only use right hand to counter-tract the anterior wall of gastric body; meanwhile, he/she can also provide sufficient tension for dividing the gastrocolic ligament. However, since the whole gastrocolic ligament is not stretched in a fan shape, the exposure of the visual field behind the HIFU cutting point is not as adequate as in the 5-port method (Figure 22).

Scenario 11: dissociate the hepatic flexure of the colon

The conventional 5-port laparoscopy

The operator uses left hand to pull the mesocolon downwards and uses right hand to divide both the fusion between mesocolon and mesogastrium and open the transverse mesocolon; then, they meet at the gap that has already divided via the lower approach.

The assistant uses left hand to pull the mesentery of gastric antrum towards the left upper side and uses right

hand to counter-tract the hepatic flexure of colon and the mesocolon (Figure 23).

Single-port laparoscopy

The operator uses left hand to pull the mesocolon downwards and uses right hand to divide both the fusion between mesocolon and mesogastrium and open the transverse mesocolon; then, they meet at the gap that has already divided via the lower approach.

The assistant only uses right hand to counter-tract the mesentery of gastric antrum (Figure 24).

Scenario 12: cut open the lateral peritoneum

The conventional 5-port laparoscopy

The operator uses left hand to lift the lateral peritoneum or parry the small intestine (if it appears); then, the operator uses right hand to cut open the lateral peritoneum.



Figure 25 Opening the lateral peritoneum using a conventional 5-port method.



Figure 26 Opening the lateral peritoneum using single-port laparoscopy.

The assistant uses left hand to lift the ascending colon towards the left and upper side and uses right hand to lift the ileocecal region or appendix towards the left upper side (Figure 25).

Single-port laparoscopy

The operator uses left hand to pull the ileocecal region towards the left and left upper sides and uses right hand to cut open the lateral peritoneum upwards to finalize the “surrounding”, and meanwhile finalize the endoscopic dissociation of the right colon.

The assistant can take a break, so as to avoid any unnecessary interference to the operations of the operator (Figure 26).

Along with the maturing of surgical techniques, optimization of surgical instruments, and deeper understanding of the concept of “single-port” by surgeons involved in minimally invasive surgery, single-port

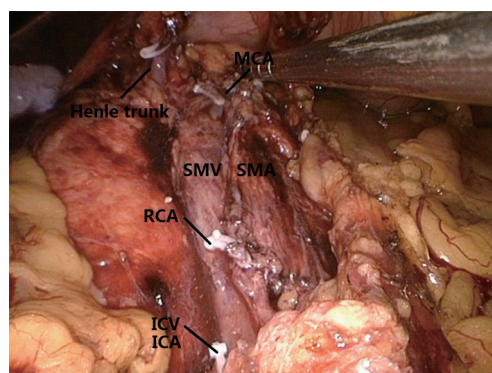


Figure 27 Effectiveness after lymph node dissection.

laparoscopy now allows high-quality radical resection of colorectal cancer. The use of “auxiliary-port” or the use of four-channel single-port devices such as SILS Port somehow resolves the problems such as few inserted instruments and lacking of operation triangles. As a result, key techniques such as intraoperative traction and exposure, division of vascular sheath, blunt/sharp separation of the Toldt's membrane, complete resection of mesocolon, and high ligation of vascular root can be performed. Therefore, when performed by a surgeon with rich experience in minimally invasive colorectal surgery, the single-port laparoscopy can also successfully complete the CME of colorectal cancer or D3 lymph node dissection, suggesting that single-port laparoscopy is not a technical obstacle for high-quality lymph node dissection. It is believed that the single-port laparoscopy will play an increasingly important role in the radical treatment of colorectal cancer (Figure 27).

Acknowledgments

Funding: Supported by National Natural Science Foundation of China (NSFC: 815728).

Footnote

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at <http://dx.doi.org/10.21037/ales.2016.11.09>). Ma J serves as the Managing Editor of *Annals of Laparoscopic and Endoscopic Surgery*. Zheng M serves as the Editor-in-Chief of *Annals of Laparoscopic and Endoscopic Surgery*. The other authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all

aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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doi: 10.21037/ales.2016.11.09

Cite this article as: Ma J, Zhang L, Zang L, Dong F, Feng B, He Z, Hong H, Xue P, Zheng M. Completed mesocolic excision for right colon cancer: comparison between single-port laparoscopy and conventional laparoscopy. *Ann Laparosc Endosc Surg* 2016;1:43.