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Original Research Article

Usefulness of a Precursory Small Epigastric Midline Incision during Laparoscopic Right Hemicolectomy

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Abstract

Objectives: During laparoscopic right hemicolectomy, many surgeons make a small incision near the umbilicus after the routine intraperitoneal operation. In this study, we created a precursory small epigastric incision at the center of a line connecting the xiphoid process and umbilicus (the M point, an empirically determined position) at the start of surgery prior to laparoscopic manipulation. This study aimed to determine whether the small incision at the center of the M point was a suitable position through which the right hemicolon is extracted.

Methods: The subjects included 148 patients who underwent laparoscopic right hemicolectomy at our hospital between January 2013 and December 2019. We measured the distance between the M point and the gastrocolic trunk (GCT) root at the base of the transverse mesocolon and the middle colic artery (MCA) root on preoperative contrast-enhanced computed tomography images.

Results: We found that the GCT and MCA roots are located within a radius of 1.5 cm from the M point, suggesting that the base of the transverse mesentery was located almost directly below the M point. Comparisons based on sex differences and body mass index (BMI) also revealed that the transverse mesocolon root is closer to the M point in men and overweight patients.

Conclusions: From these results, the placement of a precursory small epigastric midline incision not only allows for a safe insertion of the first laparoscopic port in a short period of time but also facilitates safe transection and anastomosis due to the proximity of the M point to the transverse mesocolon root.

Keywords

laparoscopic right hemicolectomy, precursory small incision, transverse mesocolon root

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Introduction

Due to the standardization of surgical techniques and development of appropriate instruments, laparoscopic surgery is now used for the treatment of colorectal cancer worldwide. The first laparoscopic port is usually inserted through a 1- to 2-cm-long incision wound. When performing laparoscopic colectomy at our hospital, we create a small precursory incision at the start of the surgical procedure and then insert the first laparoscopic port to further improve the safety of this form of surgery.

Normally, the right hemicolon is first dissected and mobi-

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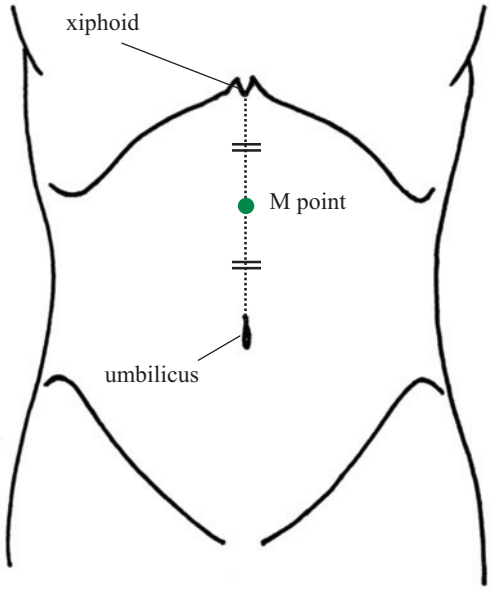


Figure 1. The small epigastric midline incision created during laparoscopic right hemicolectomy at our hospital. At the start of surgery, we identify the center point of a line connecting the xiphoid process and umbilicus (the M point) and create a small incision approximately 5 cm in length across this point to open the abdomen. A wound retractor is inserted into the incision, the first laparoscopic port is inserted, and we initiate insufflation.

lized during laparoscopic right hemicolectomy; then, a small incision is created near the umbilical region, after which transection and anastomosis of the colon are performed *via* extracorporeal manipulation. We first create a small 5-cm long incision across the center point of a line connecting the xiphoid process and umbilicus (which we refer to as the M point) that is used perform laparoscopic manipulation following abdominal insufflation (Figure 1). If cosmetic outcome is of high priority, we believe that the placement of a small incision in the umbilical region is appropriate. It has been reported that the transverse mesocolon is often shortened, making it difficult to pull the mobilized intestinal tract out of the body[1,2], especially in patients with obesity, and bleeding can occur due to excessive traction[3]. We therefore believe that the optimal strategy to ensure that the mobilized colon can be withdrawn from the body efficiently is to place a small epigastric skin incision above the transverse mesocolon root. This is why we create this incision at the M point. However, this position was determined empirically, and it would be practical to verify its validity experimentally. Thus, the objective of this study was to verify the validity of the creation of a small incision at the M point during laparoscopic-assisted right hemicolectomy.

Methods

To verify the positional relationship between the small incision wound and the transverse mesocolon, we first need to define the position of the transverse mesocolon root. Toda et al.[4] reported that the transverse mesocolon root is located in the area from the accessory right colic vein (ARCV) root to its inflow into the inferior mesenteric vein at the inferior pancreatic margin. Contrarily, Fukunaga et al.[5] reported that the inferior pancreatic margin is cranial to the transverse mesocolon root, whereas the middle colic artery (MCA) origin is caudal to it. For this reason, during measurement, the transverse mesocolon root was defined as the root of the gastrocolic trunk (GCT) and MCA. In addition, we considered whether we could verify the positional relationships between the small epigastric incision wound and transverse mesocolon root by measuring the distances between the M point and the GCT and MCA roots, respectively, *via* preoperative contrast-enhanced computed tomography (CT) scans. We thus measured these two distances using these CT images.

Our subjects included 148 patients with preoperative contrast-enhanced CT images who were selected from among 181 patients who underwent laparoscopic-assisted right hemicolectomy at our hospital for the treatment of colon cancer between January 2013 and December 2019. We investigated patient age, sex, and body mass index (BMI) as patient characteristics and then the duration of surgery, volume of blood loss, and length of postoperative hospital stay as surgical outcomes.

We performed the measurements by determining the position of the M point on coronal preoperative contrast-enhanced CT images (Figure 2) and then measuring the distances from the M point to the GCT and MCA roots. As the vascular roots can be located above, below, or to the left or right of the M point, we also defined movement right and cranial to the M point as positive and movement left and caudal to the M point as negative during such measurements (Figure 3).

Furthermore, we simultaneously confirmed how this positional relationship varied according to sex or body type. We used BMI to define body type and defined a BMI of <18.50 kg/m^2 as underweight (n = 16), 18.50 to 24.99 kg/m^2 as normal-weight (n = 96), and ≥25.00 kg/m^2 as overweight (n = 36), in accordance with the World Health Organization criteria.

Significant differences were determined using Student's *t* test and Fisher's exact test. A p-value of less than 0.05 was considered statistically significant.

The study protocol was approved by the Ethics Advisory Committee of St. Marianna University School of Medicine. Written consent was obtained from all patients and relevant persons to publish their information, including photographs.

Surgical procedure[6,7]

The upper limbs are secured to the side of the trunk,

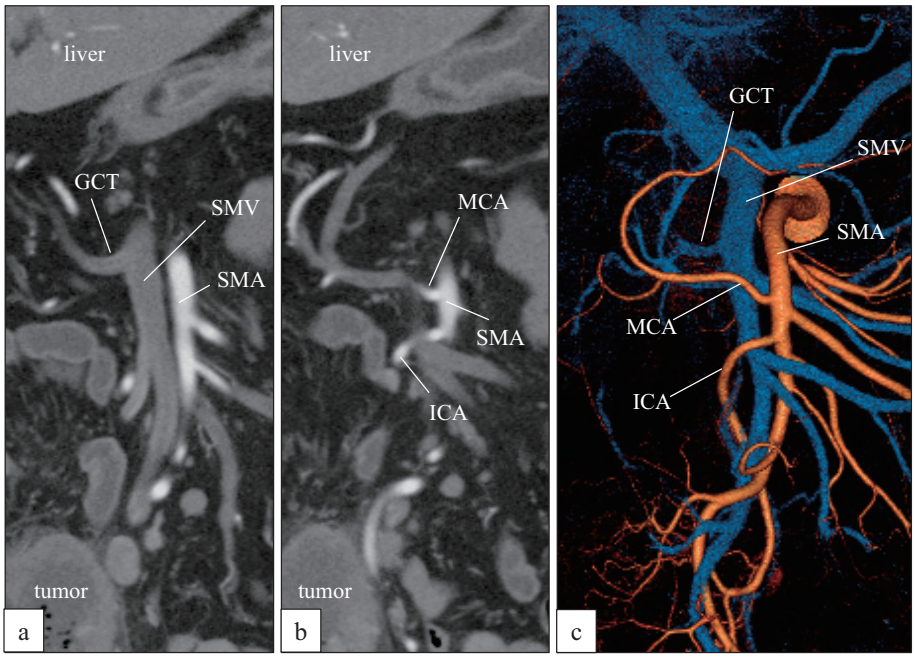


Figure 2. The location of the GCT and MCA on coronal preoperative contrast-enhanced computed tomography scan images. a, b) Coronal images. c) 3D reconstruction. *GCT* gastrocolic trunk, *ICA* ileocolic artery, *MCA* middle colic artery, *SMA* superior mesenteric artery, *SMV* superior mesenteric vein

whereas the lower limbs are placed in the lithotomy position using a Levitator© (MIZUHO Corporation, Tokyo, Japan). An operating surgeon, scopist, and assistant are involved in the procedure. A lateral approach is employed at the start of surgery, and until the ascending colon is mobilized, all parties involved in the procedure are asked to stand on the left-hand side of the patient (Figure 4a). When mobilizing the hepatic flexure, the surgeon moves toward the head of the patient, the scopist stands between the legs of the patient, and the assistant stands on the left-hand side of the surgeon (Figure 4b).

First, a small incision measuring approximately 5 cm is created across the M point to open the abdomen, and a wound retractor (Multi Flap Gate®, Akita Sumitomo Bake, Co., Ltd., Akita, Japan) is placed inside the wound margins and secured. A 12-mm port is then inserted, and the abdomen is insufflated. After performing intraperitoneal examination, we place three additional ports: a 12-mm port placed into the left flank and two 5-mm ports into the umbilicus and the midline of the hypogastrium (Figure 5). A 5-mm flexible scope (Olympus Co., Ltd., Tokyo, Japan) is inserted into the 5-mm umbilical port. The operating surgeon uses his/her right hand to work *via* the left flank port and his/her left hand to work *via* the hypogastric midline port (Figure 4 a). The intraperitoneal part of the laparoscopic intra-abdominal surgery is performed in the following sequence: (1) separation of the anterior surfaces of the duodenum and the pancreatic uncinate process from the dorsal aspect of the ileocolic artery and vein using a lateral approach, (2) dissection around the ileocolic artery and vein, (3) dissection around the surgical trunk (the MCA, MCV, or the right branch of the MCA or the right branch of the MCV and the ARCV is basically divided intracorporeally. But if the feeding artery of the tumor was the ICA, the MCA, MCV, and ARCV are often divided extracorporeally), (4) separation of the perirenal fascia from the dorsal ileum, (5) mobilization of the ascending colon from the ileocecum, and (6) mobilization of the hepatic flexure and medial aspect of the transverse mesocolon, after which the right hemicolon is mobilized from the retroperitoneum. Once the intraperitoneal manipulation is complete, the mobilized right hemicolon is withdrawn through the small incisional wound created in advance (i.e., the M point). Subsequently, the colon is transected and anastomosed.

Results

Table 1 presents the patient characteristics and surgical outcomes. The median patient age was 75 (42 to 91) years, and the median BMI was 21.7 (14.5 to 35.4) kg/m^2. The breakdown of ASA-PS is as follows: 10 cases of PS 1, 124 cases of PS 2, and 14 cases of PS 3. The tumor sites were the cecum (33 cases), ascending colon (94 cases), and transverse colon (21 cases). The median duration of surgery was 190 (97 to 368) min, and the mean volume of blood loss was 24 (0 to 791) mL. We observed hemorrhage close to the

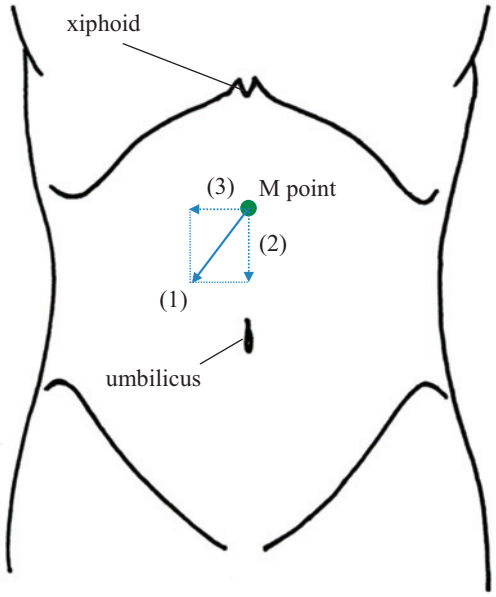
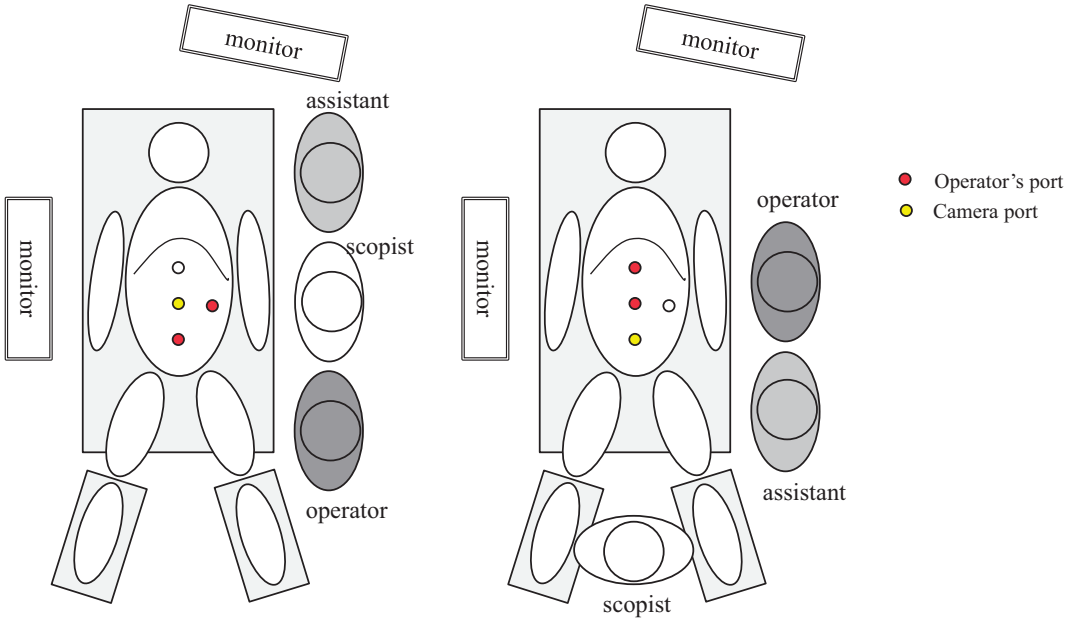


Figure 3. Method for measuring the distance between the GCT and MCA and the M point using coronal contrast-enhanced computed tomography images. The center point of a line connecting the xiphoid process and umbilicus is known as the M point. Different slices can be applied to draw a line connecting the GCT and MCA roots to the M point (1) and then measure the distance between these structures and determine whether these structures are located above, below, or to the left or right of the M point (2)(3). We defined movement right and cranial to the M point as positive and movement left and caudal to the M point as negative. Each measurement was performed on each subject twice, and the mean value was adopted as the measurement value. *GCT* gastrocolic trunk, *MCA* middle colic artery

region where the ARCV flowed into the GCT during extracorporeal manipulation in two patients, but hemostasis was achieved under direct vision *via* the small epigastric incision in both (Figure 6). Thus, none of the operations were converted to laparotomy. The mean length of postoperative hospital stay was 11 (5 to 102) days. Eight patients required additional ports due to the difficulty of securing the surgical field because of a large amount of intra-abdominal fat or because peeling of adhesions had been performed in a previous surgery.

Next, we analyzed the distances from the M point to the GCT and MCA roots, all of which are stated as median values. The M point was located 9.9 mm caudal to and 11.6 mm to the left of the GCT root and 15 mm caudal to and 0.4 mm to the right of the MCA root. On the basis of these findings, we determined that the GCT and MCA roots will be found within a radius of approximately 1.5 cm from the center of the small incision used in this method. We therefore believe that the M point is virtually located directly above the transverse mesocolon root. We also verified the validity of the location of the small incision used in our hospital (Figure 7).

Next, we sought to verify whether the position of the GCT and MCA roots changed based on sex or body type. Figure 8 presents the comparison of results based on sex differences. The GCT root was located 6.5 mm caudal to the M point in men but was significantly more caudal in women (10.9 mm caudal). However, no significant differences were observed between men and women in terms of the location of the GCT root with respect to the M point in the left or right direction (11.7 mm in men vs. 11.5 mm in women). The MCA root was located 14.6 and 17.3 mm caudal to the



a) Inner approach b) Cranial approach

Figure 4. Position of the patient and arrangement of the surgeons involved during surgery.

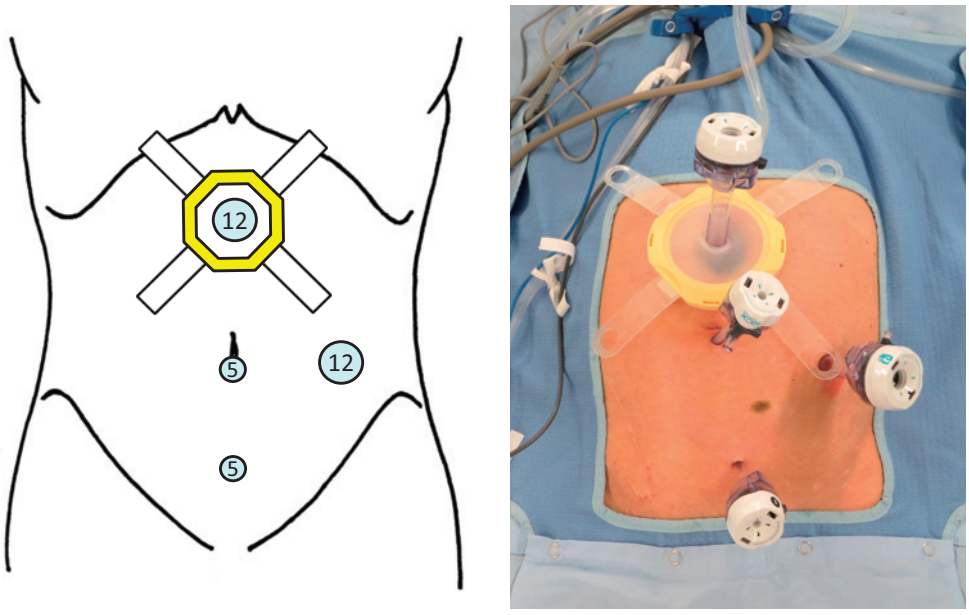


Figure 5. Arrangement of the laparoscopic ports. The encircled numbers indicate port diameter (mm).

Table 1. Patient Characteristics and Surgical Outcomes.

N = 148	Median
Age (years)	75 (42–91)
Sex (Male/Female)	75/73
BMI (kg/m^2)	21.7 (14.5–35.4)
ASA (1/2/3)	10/124/14
Tumor locations (C/A/T)	33/94/21
Length of operation (min)	190 (97–368)
Blood loss (ml)	24 (0–791)
Length of hospital stay (days)	11 (5–102)

BMI body mass index, *ASA-PS* American Society of Anesthesiologists-physical status, *C* Cecum, *A* Ascending colon, *T* Transverse colon

M point in men and women, respectively, and the difference was not significant. The MCA root was located 0.7 mm to the left of the M point in men, whereas there was no left or right deviation in women; moreover, the difference was not significant. Based on the above, the GCT and MCA were both somewhat more caudal and further outside the radius of 1.5 cm around the M point in women compared with men.

Lastly, Figure 9 presents the results based on the BMI. No significant differences were observed in terms of the distance from the M point to the GCT root based on the BMI, with mean distances of 11.8, 10.8, and 4.3 mm caudal to and 8.4, 12.4, and 11.0 mm to the left of the M point in underweight, normal-weight, and overweight individuals, respectively. There were also no significant differences in terms of the distance from the M point to the MCA root, with mean distances of 13.1, 18.5, and 8.1 mm caudal to and 2.9, 0.0, and 3.3 mm to the left of the M point, respectively. However, if we imagined a circle with a radius of 1.5 cm from the M point, we would be able to verify the fact that the GCT and MCA roots were located caudal to this circle in the normal-weight group, on the circle in the underweight group, and within the circle and therefore closer to the M point in the overweight group.

Discussion

The first port is usually inserted through a small incision wound during laparoscopic colectomy; thus, we need to consider the ability to recognize intraperitoneal structures and the potential for injury to organs located immediately beneath this incision. This may be particularly challenging in patients with obesity. During laparoscopic surgery, all diseased bowel is withdrawn from the body and resected, after which the remaining bowel is anastomosed. A small incision wound is required to accomplish these tasks. This incision wound also allows us to insert a single port to reach the intraperitoneal cavity with certainty in a short period of time and ensure the safety of the procedure until abdominal insufflation has been performed, which is why we start the abdominal procedures with this incision. Moreover, we believe that the creation of a small epigastric incision in patients with a history of abdominal surgery who was expected to present with numerous intraperitoneal adhesions helped us prevent and repair intestinal injuries under direct vision. We were also able to dissect a wider extent of intestinal adhe-

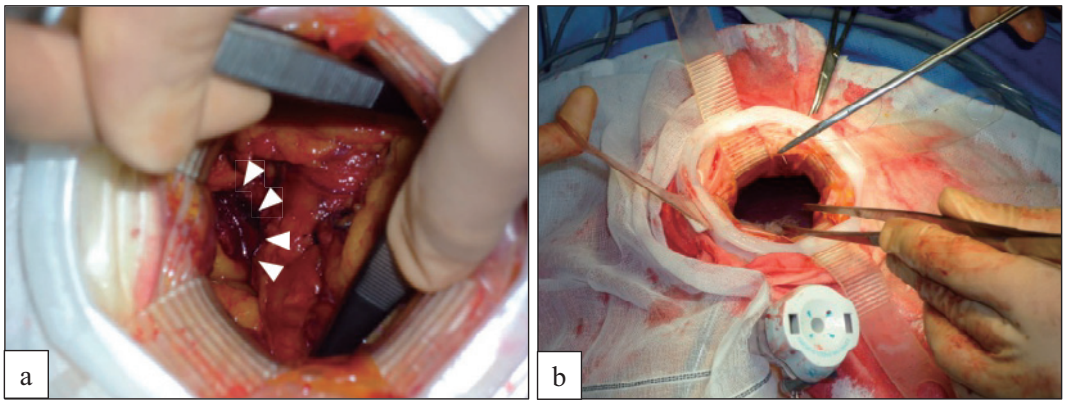
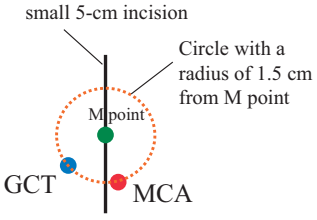


Figure 6. We observed hemorrhage close to the region where the ARCV flowed into the GCT during extracorporeal manipulation, and hemostasis was achieved under direct vision. a) Arrowheads indicate the point of hemorrhage. b) Suture hemostasis was accomplished *via* the small incision. *ARCV* accessory right colic vein, *GCT* gastrocolic trunk

n=148		Median
Distance from the M point to the GCT root (mm)	Up or Down	-9.9 (-66.2- +53)
	Left or Right	-11.6 (-3.9- +13.5)
Distance from the M point to the MCA root (mm)	Up or Down	-15 (-60- +32.5)
	Left or Right	0.4 (-27.1- +30.6)



GCT gastrocolic trunk, *MCA* middle colic artery

Figure 7. Measurement results for the subjects who underwent laparoscopic-assisted right hemicolectomy at our hospital.

		Male (n = 75)	Female (n = 73)	p value
Distance from the M point to the GCT root (mm)	Up or Down	−6.5 (−46.9- +53)	−10.9 (−66.2- +38.8)	0.019
	Left or Right	−11.7 (−36.4- +12.5)	−11.5 (−39- +13.5)	N.S.
Distance from the M point to the MCA root (mm)	Up or Down	−14.6 (−56- +30.9)	−17.3 (−60- +32.5)	N.S.
	Left or Right	0.7 (−19.6- +30.6)	0 (-27.1- +21.6)	N.S.

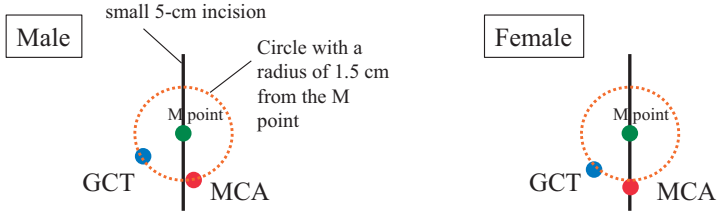


Figure 8. Distances from the M point to the gastrocolic trunk (GCT) and middle colic artery (MCA) based on sex.

		Underweight (n = 16)	Normal range (n = 96)	Overweight (n = 36)	p value
Distance from the M point to the GCT root (mm)	Up or Down	−11.8 (−66.2- +38.8)	−10.8 (−47.4- +53)	−4.3 (−47- +35)	N.S.
	Left or Right	−8.4 (−25.4- 0)	−12.4 (−39- +13.5)	−11 (−29.5- +13)	N.S.
Distance from the M point to the MCA root (mm)	Up or Down	−13.1 (−55.8- +27.5)	−18.5 (−56- +32.5)	−8.1 (−60- +25.1)	N.S.
	Left or Right	2.9 (−12.2- +14.5)	0 (−27.1- +28)	3.3 (−19.7- +30.6)	N.S.

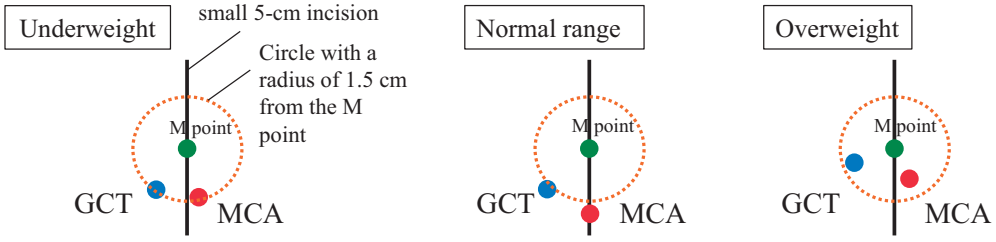


Figure 9. Distances from the M point to the gastrocolic trunk (GCT) and middle colic artery (MCA) based on the BMI.

sions, and we believe that all of these factors were beneficial in reducing the duration of surgery.

However, this incision wound needs to be optimally positioned to facilitate intraperitoneal manipulation, intestinal mobilization, and intestinal resection and anastomosis. The measurement results obtained during this study indicated that the GCT and MCA roots will be found within a radius of approximately 1.5 cm from the center of the small incision (i.e., the M point) used in this method. We therefore believe that the M point is virtually located directly above the transverse mesocolon root. When withdrawing the right hemicolon from the body, it is considered most effective to apply traction that allows the transverse mesocolon to be withdrawn at an angle close to 90° with respect to the ground as possible. For this reason, we can state that the position of the small epigastric incision is extremely useful as it allows us to create the shortest anatomical distance between the skin and transverse mesocolon root, thereby facilitating easy withdrawal of the right hemicolon from the body.

Next, we verified whether the position of the GCT and MCA roots changed based on sex or body type. We found that the GCT route was located significantly more caudal in women than in men. Although there were no significant differences in terms of its position, the MCA root was also somewhat more caudal in women than in men and located somewhat further than the radius of 1.5 cm from the M point in both sexes. In addition, when we compared the results based on the BMI, we found no significant differences, although compared with underweight and overweight subjects, the GCT and MCA roots were located more caudal in normal-weight subjects. The MCA root in particular was 18.5 mm caudal to the M point. The most interesting outcome in this regard was the fact that the distance between the M point and MCA root does not change proportional to the changes in the BMI but that, instead, the only group in which the MCA root was located further away from the M point was the normal-weight group. Another extremely interesting finding, which we have not observed in previous reports to date, was the fact that the position of the MCA root is relatively consistent, irrespective of sex and body type.

The above findings suggest that the small epigastric incision used in this study is particularly effective for patients with obesity and men with abundant visceral fat in whom the GCT and MCA roots are located closer to the M point. Meanwhile, we have to speculate whether it would be more prudent to shift the position of the small epigastric incision to lie approximately 1 cm caudal to the M point in women and normal-weight patients. In addition, when it is difficult to withdraw the mobilized bowel from the body due to increased tumor size or hypertrophic mesocolon, and the M point is the center of the small epigastric incision, we need to bear in mind that this incision will need to be extended in a caudal direction to facilitate the aforementioned withdrawal.

When compared with other forms of colorectal cancer surgery, surgery for the treatment of right colon cancer is a relatively challenging procedure, and it is certainly not considered to be one that allows beginners to shine, making it a particularly formidable procedure. According to the 2015

National Clinical Database Annual Report[8], right hemicolectomy had a higher 30-day mortality rate (1.3%) than low anterior resection (0.3%), esophageal reconstruction (0.8%), hepatectomy (1.2%), and pancreaticoduodenectomy (1.1%). This is probably because the procedure may result in injury to the superior mesenteric vein (SMV) and surrounding veins, which may lead to critical complications that may rapidly progress if these veins are injured, and the fact that the surrounding areas include important organs, such as the duodenum and pancreas[9].

The section of the SMV from the ileocolic vein inflow to the GCT is known as the surgical trunk. The primary structures encountered during dissection in cases of left colon cancer are arteries. Contrarily, in cases of right colon cancer, the primary structures are veins that flow into the surgical trunk[6]. However, previous reports have documented variations in the course of the vessels surrounding the GCT[10-13]. The GCT is a venous trunk that starts at the confluence of the superior right colic vein (SRCV) and right gastroepiploic vein and was first described by Henle in 1868[14]. The SRCV is also known as the accessory middle colic vein and ARCV. Thereafter, Decomps and De Lalaubie reported that the anterior superior pancreatoduodenal vein flows into the GCT. They also recognized the importance of this anatomical structure during epigastric surgery[15]. The GCT is present in 69% of patients and receives venous inflow from the transverse colon in 75%[16]. In addition, there are said to be 0 to 3 veins that flow into the GCT from the colon[17], although it is often difficult to correctly determine their presence preoperatively. Moreover, it is important to bear in mind that the colonic branches that flow into the GCT exhibit numerous variations.

In terms of the pitfalls that occur during laparoscopic-assisted right hemicolectomy, Okuda et al. specifically reported on a short ARCV, which is prone to tear at the point at which it enters the GCT[18]. It is difficult to achieve hemostasis, and the patient may need to be converted to open surgery for this purpose. Furthermore, cases are also encountered in which hemorrhage occurs when the mobilized bowel is withdrawn from the body or when excessive traction is applied during extracorporeal transection and anastomosis. The small epigastric incision that we use for this technique is located almost directly above the transverse mesocolon root. Thus, compared with small umbilical incisions, less tension is applied to the transverse mesocolon, and there is a lower risk of hemorrhage from the root. In addition, when intraoperative hemorrhage occurs from the transverse mesocolon root, in our experience, it is possible to rapidly achieve hemostasis under direct vision *via* the small epigastric incision. We therefore believe that the use of this incision decreases the rate of conversion to open laparotomy for the purpose of hemostasis.

We also conducted a study on 82 patients who underwent laparoscopic right hemicolectomy between 2014 and 2017 and divided the surgeons who performed the operations into three skill levels: beginner, intermediate, and advanced. The surgical outcomes (surgery time, bleeding volume, and postoperative complication rate) remained unchanged, irrespective of the skill level[19]. We therefore consider that this surgical technique is reliable from the perspective of training inexperienced surgeons and for quality and safety reasons.

Based on the above, this technique allows insufflation to be safely performed within a short period of time and facilitates the shortest withdrawal distance after intraperitoneal operation while allowing safe transection and anastomosis. It also prevents the application of excessive tension to the vessels around the GCT, which reduces the risk of vascular injury. Furthermore, it allows rapid achievement of hemostasis under direct vision in the event of hemorrhage, allowing surgery to be performed extremely safely. We therefore believe that it is a useful technique for performing laparoscopic-assisted right hemicolectomy safely and for training inexperienced surgeons.

This study has limitations. It is a retrospective study conducted in a single institution, and the number of cases was small. Furthermore, patients with a history of asthma or renal dysfunction who could not undergo contrast-enhanced CT were excluded.

In conclusion, we determined that the transverse mesocolon root lies beneath the center of a line connecting the xiphoid process and umbilicus. During laparoscopic right hemicolectomy, the use of the small epigastric incision described herein facilitates quick entry into the abdomen and safe abdominal insufflation and is extremely useful when performing extracorporeal procedures as well as for achieving hemostasis. Moreover, this technique is useful for safely training inexperienced surgeons.

Conflicts of Interest

Drs. Ryuichi Oshima, Yukihito Kokuba, Tsukasa Shimamura, Kenta Katsumata, Yasuhito Hisatsune, Hiroyuki Negishi, Nobuyoshi Miyajima, and Takehito Otsubo have no conflicts of interest or financial ties to disclose.

Author Contributions

Ryuichi Oshima: Substantial contributions to the conception or design of the work and the acquisition, analysis, and interpretation of data for the work.

Tsukasa Shimamura, Kenta Katsumata, Yasuhito Hisatsune, Hiroyuki Negishi: Analysis of data for the work.

Yukihito Kokuba, Nobuyoshi Miyajima, Takehito Otsubo: Revising the work critically.

Approval by Institutional Review Board (IRB)

Approval code issued by the institutional review board (IRB): 5046

Name of the institution that granted the approval: St. Marianna University School of Medicine

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