The Feasibility of Laparoscopic TSME Preserving Left Colic Artery and Superior Rectal Artery for Upper Rectal Cancer

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Research

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Abstract

Background Laparoscopic TSME preserving left colic artery and superior rectal artery is still a technical challenging procedure. To show the feasibility of this procedure for upper rectal cancer, we conducted this study.

Methods A total of 184 patients with upper rectal cancer were retrospectively collected in our cancer center between Apr 2010 and Apr 2017. These patients were treated by either laparoscopic TSME (n=46) or laparoscopic TME (n=138). In the group of TSME, left colonic artery and superior rectal artery were preserved while they were not in TME group.

Results The operation time in TSME group was longer than that in TME group (218.56 ± 35.85 vs. 201.13 ± 42.65, P=0.004). Further, the resected lymph nodes in TSME group is more than that in TME group (19.43 ± 9.46 vs. 18.03 ± 7.43, P= 0.024). The blood loss between TSME and TME groups achieved no significance. There was no mortality occured in either TSME or TME group. One patient in TME group was converted to laparotomy. Total postoperative complication rate in TSME and TME groups were 8.7% and 17.4%, respectively. For severe complication between the two groups (anastomotic leakage and stenosis), they showed no difference.

Conclusions Laparoscopic TSME preserving left colic artery and superior rectal artery can be safely conducted for upper rectal cancer.

Introduction

Total mesorectal excision (TME) is an important surgical technique to prevent local recurrence of rectal cancer [1]. On the other hand, TME may not be suitable for every case of rectal cancer, such as the rectosigmoid junction cancer and upper rectal cancer. Resection range reached to 5 cm mesorectal below the inferior border of the tumor can acquire adequately cure rate reported in previous studies by this method for the patients of the rectosigmoid junction cancer and upper rectal cancer [2]. This tumor specific resection according to the tumor site, or T staging is called tumor-specific mesorectal excision(TSME)[3].

Sudeck's critical point at the rectosigmoid junction is described as the point of origin of the last sigmoid arterial branch, originating from the inferior mesenteric artery (IMA) [4]. The anastomosis between the last sigmoidal artery and superior rectal artery(SRA) are absent in few people. To avoid the risk of postoperative ischemic necrosis, anastomotic leakage, colitis, and delayed stricture, it is desirable to ligate proximal to Sudeck's point, for those cases with anastomosis might be absent or present insufficiently [5].

Therefore, according to tumor location; T staging (invasion); tumor size, function reserve, according to security factors and the type of vascular surgery after consideration of the development of tumor resection with science. Laparoscopic TSME preserving left colic artery and superior rectal artery is still a technical challenging procedure. To show the feasibility of this procedure for upper rectal cancer, we conducted this study.

Methods

Patients

Laparoscopic TSME preserving left colic artery and superior rectal artery using this technique was performed on 46 patients with upper rectal cancer from Apr 2010 to Apr 2017. In the same period, 138 patients with upper rectal cancer underwent standard TME operation. This study was conducted in accordance with the approved guidelines. This study was approved by the institutional review board of The First Affiliated Hospital of Dalian Medical University. Written informed consent was obtained from all patients.

Equipment

Angled (30°) 10 mm diameter 3D laparoscope and insufflation equipment (Aesculap German). Bipolar electrosurgical device (Aesculap German). Harmonic vascular closure system (Johnson USA). 10 mm port, 5 mm ports trocar (Teleflex Medical, USA). Laparoscopic linear staplers (60-mm length, COVIDIEN USA). Hem-o-lock polymer locking surgical clips (Teleflex Medical, USA). Circular stapler (ETHICON Endo-surgery, USA)

Preoperative preparation

Inferior mesenteric artery (IMA) 3D CT-A examination should be performed before operation for assessment of the mesenteric vascular vessel types (Fig. 1). The intestinal preparation was performed 2 days before the operation, and prophylactic intravenous antibiotics were used before the operation 30 minutes. Central venous catheterization was completed after general anesthesia. The surgical posture is starboard lithotomy position with lower head and higher feet.

The operating surgeon and camera assistant stand to the patient’s right side,the first assistant stand to the patient’s left side. The laparoscopic monitor is placed at the patient’s right foot side. The trocar for laparoscope is inserted from right parumbilical side; and four ports are used as working ports showed in Fig. 2.

Surgical techniques

We used a direct open technique in the position of umbilical right position to make approximately 1 cm incision as our visual port, and thought this trocar put into the 30° 3D camera into the abdominal cavity. After camera port and working trocar were established, we performed thoroughly examination of the abdomen for metastatic disease, including the surface of the liver and peritoneum.

This surgical technique was characterized by thorough lymph node dissection based on the preservation of the neurovascular and dissection of the left colon, the sigmoid vessels and the upper rectal vessels along the inferior mesenteric vessels. The region of operation was the superficial layer of the nerve sheath on the vascular surface. The left colonic vessels and the superior rectal vessels needed to be preserved, and the vascular branch from the sigmoid vessels and the blood vessels from the superior rectal vessels to the intestinal wall were selected and severed according to the position of the tumor.

First, we adopted the lateral approach by opening the monks' white line along the descending colon and sigmoid colon reaching the splenic flexure as cephalad dissection point. The correct plane of dissection was achieved Toldt's fascia between the Gerota's fascia and the mesocolon. We usually used bipolar electrosurgical device and bipolar scissors for separate this correct plane with gentle blunt and sharp dissection. The ureter and other retroperitoneal structures would be protected safely by staying in this plane. We continued to dissect along the plane to the root of the IMA. The hypogastric nerves were apparently visible with 3D laparoscope. And these nerves should be carefully protected.

Then, the dissection begins at the position of the sacral promontory, the junction of the sigmoid mesentery and retroperitoneum from the previous dissection plane at the first step. Ideally, we dissected the presacral space below the superior rectal artery (SRA) approached from the left side across the midline to the right side attentively protected hypogastric nerves while using bipolar electrosurgical device (Fig. 3A). The distal dissection end point was approximately 4–5 cm below the tumor. We needed to open the peritoneal reflection and dissect the lateral ligament of rectum with protecting neurovascular bundle (NVB) by Harmonic vascular closure system in some patients. We placed the dissected colon and mesocolon to the right celiac side and thoroughly reveal the left side of the mesocolon. We carefully employed dissection in the correct plane on the vessels to avoid tissue damage for realization of en-bloc resection. The technique in this step is identification of the relationship between left colic artery/ inferior mesenteric vein (IMV) to the IMA and SRA and the branch of the arteriae sigmoideae (Fig. 3B). This vascular bundle can be traced from the origin of the IMA to the rectal segment approximately 4–5 cm below the inferior border of the tumor (Fig. 3C).

Second step was performed at medial approach. Technique of this step was thorough lymph node dissection based on the preservation of the neurovascular. The left colonic vessels and the superior rectal vessels were need to be preserve, and sigmoid vessels and the vessel branch from the superior rectal vessels to the intestinal wall were selected and severed according to the position of the tumor. Employing traction by the assistant by the left side port, the rectosigmoid mesentery was pulled sufficiently so that we could identify the relationship of neurovascular and plane of the lymph node dissection.

Dissection at the correct presacral space and cephalad dissection to the IMA could be employed. Our general medial approach was to begin at the presacral space and obtain connection with the plane of lateral approach. The pelvic dissection was performed from the entrance of the pelvic cavity down to the pelvic floor. We could identify both the hypogastric nerve fibers and the pelvic nerve by the high definition 3D laparoscopy and preserve them. The IMV/left colic artery bundle was then carefully traced to junction position from IMA and No.253 lymph node was completed dissection. Pelvic nerves and ureter were already carefully insulated of the IMA and the circumference of IMA could be revealed. The mesocolon could be freed from retroperitoneal position by anterior dissection. Applying gently forwarded with bipolar electrosurgical device, we dissected the SRA and the blood vessels from SRA to the intestinal wall and perform No.252 and No.251 lymph node dissection. At this point, we had finished lymph node dissection and completely clear the relationship between LCA, IMV, IMA, SRA and arteriae sigmoideae. Finally, we ligated arteriae sigmoideae and vascular branch from SRA into the intestinal wall (Fig. 3D) while preserving left colonic vascular (Fig. 3E). Energy devices and hem-o-locks were used widely in this step.

After the above procedure was completed, we employed separation of the rectal wall from the mesorectum with an adequate distance from the tumor in accordance with T-stage and position of the tumor by Harmonic vascular closure system. In order to provide enough space to insert endoscopic linear stapler, we excised the mesorectum just underneath the rectal wall about 3-5cm (Fig. 3F). Careful operation should be taken to avoid injury rectal wall and SRA, then fixed the endoscopic linear stapler and transected the rectum and showed satisfactory TSME preserved left colic artery and superior rectal artery (Fig. 3G).

Lastly, a small incision of 5 cm was made at left lower abdomen, and the specimen was taken outside of the abdomen and transected. Intraabdominal presacral anastomosis was performed by double stapling techniques after inserting the anvil head of a 28 mm size circular stapler into the oral side of sigmoid colon. Double drains were placed, and no diverting stoma was performed.

In TME group, the inferior mesenteric artery was severed at the root, colon was severed 5 cm away, digestive tract reconstruction methods were similar to group TSME.

Statistics

SPSS19.0 version was used for statistical analysis. Comparison of categorical variables was performed with χ^2 test. Continuous variables were presented as means (standard deviation) or median values (range). These variables were compared with Mann-Whitney U test. P values of less than 0.05 were considered statistically significant.

Results

The general characteristics of included patients were listed in Table 1. There were 31 men (67.4%) and 15 women (32.6%) in TSME, and 81 men (58.7%) and 57 women (41.3%) in TME. The mean age was 64.05 ± 9.59 years in TSME, and 63.50 ± 11.6 years in TME. There was no significant difference in preoperative comorbidity, tumor size, depth of invasion, and lymph node metastasis between the two groups.

Table 1
Clinicopathological features between TSME and TME groups

Factors	TSME n = 46	TME n = 138	P value
Age(year)	64.05 ± 9.59	63.50 ± 11.6	0.598
Gender			0.297
Male	31(67.4%)	81(58.7%)	
Female	15(32.6%)	57(41.3%)	
BMI((kg/m^2)	22.59 ± 3.81	20.88 ± 4.33	0.588
Comorbidity			
Cardiovascular disease	10(21.7%)	25(18.2%)	0.603
Respiratory disease	3(5.5%)	8(5.8%)	0.858
Diabetes mellitus	9(19.6%)	26(18.2%)	0.930
Histological type			0.546
Differentiated type	32(69.6%)	100(72.5%)	
Undifferentiated type	14(30.4%)	38(27.5%)	
Tumor size(mm)	37.26 ± 14.75	36.62 ± 12.70	0.150
T category			0.482
T1	2(4.3%)	19(13.8%)	
T2	18(39.1%)	50(36.2%)	
T3	14(30.4%)	39(28.3%)	
T4	12(26.1%)	30(21.7%)	
N category			0.381
N0	9(19.6%)	35(25.4%)	
N1	30(65.2%)	78(56.5%)	
N2	7(15.2%)	25(18.1%)	
Conversion to open surgery	0	1(0.7%)	0.559
Operation time (min)	218.56 ± 35.85	201.13 ± 42.65	0.004
Blood loss (ml)	25.76 ± 27.87	18.00 ± 24.91	0.997

Factors	TSME n = 46	TME n = 138	P value
Lymph node dissection	19.43 ± 9.46	18.03 ± 7.43	0.024

The operation time in TSME group was longer than that in TME group (218.56 ± 35.85 vs. 201.13 ± 42.65, P = 0.004) (Table 1). Further, the resected lymph nodes in TSME group is more than that in TME group (19.43 ± 9.46 vs. 18.03 ± 7.43, P = 0.024) (Table 1). The blood loss between TSME and TME groups achieved no significance (Table 1). Average hospital stay in TSME was a little shorter than that in TME (9.47 ± 2.02 vs. 11.06 ± 7.61days) (Table 2).

Table 2
Postoperative complications

Factors	TSME N = 46	TME N = 138	P value
Postoperative hospital stay (d)	9.47 ± 2.02	11.06 ± 7.61	0.854
Mortality	0	0	1.000
Morbidity			0.128
Absent	42(91.3%)	114(82.6%)	
Present	4(8.7%)	24(17.4%)	
Anastomotic leakage	0	0	
Bleeding	0	1(0.7%)	
Abdominal abscess	0	1(0.7%)	
Ileus	0	1(0.7%)	
Wound infection	2(4.3%)	10(7%)	
Anastomotic stenosis	0	0	
urinary tract infection	1(2.2%)	2(1.4%)	
Ascites	1(2.2%)	4(2.8%)	
Urinary retention	0	2(1.4%)	
pneumonia	0	1(0.7%)	
Cardiac related complications	0	2(1.4%)	

There was no mortality occured in either TSME or TME group. One patient in TME group was converted to laparotomy due to bowel ischemia at the distal colon.(Table 2). Total postoperative complication rate in

TSME and TME groups were 8.7% and 17.4%, respectively (Table 2). For severe complication between the two groups (anastomotic leakage and stenosis), they showed no difference.

Discussion

In 1982 British surgeon Heald proposed the TME for rectum cancer, pointed out that anatomical level of TME was clear, so that the operative quality can be assessed [6]. The main concerns were a higher anastomotic leakage rate, longer operative time, and higher blood loss after TME [7]. Lopez-Kostner et al pointed that TME was the standard operation performed for lower rectal cancers. TME was not necessary for cancers of the upper rectum [2]. Therefore, the TSME technique was introduced to perform satisfactory local control and low morbidity. Partial mesorectal excision is applied in TSME [8].

Oncologic outcomes after surgery can be divided into two aspects, such as long-term survival and local recurrence rate. Law et al[9] reviewed 622 patients respectively. In this study, 5-year local recurrence rate about TME and partial mesorectal excision (PME) for proximal cancer was 10.7% and 7.4% respectively. The stage of the disease was associated with higher risk of local recurrence. And there was no difference in the local recurrence rate TME and PME. The 5-year cancer-specific survival rates with and without TME were similar 74.0% compare with 76.1%. Kim et al[10] reported that 5-year cancer-specific survival rate was 77.5% and local recurrence rate was 9.2% with 782 cases of rectal cancer after TSME with pathologic stage I to III. The results of the risk factors affecting of cancer-specific survival rate were pT stage, pN stage, positive distal resection margin, and positive circumferential resection margin. The risk factors affecting local recurrence were pN stage, positive distal resection margin, and positive circumferential resection margin. Another study from Korean reviewed experience in 1276 patients with rectal cancer, This study showed that the overall local recurrence rate was 5.4%. The 5-year local recurrence rates were 3.8% in stage I, 4.7% in stage II, and 8.4% in stage III. The 5-year cancer-specific survival rates were 93.8% in stage I, 84.5% in stage II, and 64.5% in stage III. The risk factors were pN stage and circumferential resection margin [11]. Zakir et al [12] performed an analysis with 11 years of experience for 1063 rectal cancer patients who received laparoscopic and open operation of TSME. The 5-year local recurrence rate was 7.1%. The overall 5-year survival and cancer-specific survival were 66.8 and 76.0%, respectively in this analysis. There is no difference in the local recurrence rate between laparoscopic or open resection. The overall and cancer-specific survival were 72.8% and 80.1% in laparoscopic operation group, were 62.9% 73.1% in open operation group. The results showed that laparoscopic operation group was better than open operation group in overall and cancer-specific survival rate. There was no difference in survival in patients with stage I. However, the survival rate in patients with stage II and stage III among the laparoscopic operation group is better than open operation group, which shows the superiority of laparoscopic TSME operation in the long-term prognosis of rectal cancer.

TSME surgery based on TME is now accepted as a standard for rectal cancer surgery and laparoscopic rectal cancer resection is accepted widely in the world even though it is a challenging procedure to surgery. Blood loss in the laparoscopic group is well shown with an average of 90 to 320 ml [13]. Average Blood loss in our study is 25 ml lower than the reported literature. We can identify neurovascular by the high definition 3D laparoscopy to preserve them and we use bipolar electrosurgical device to reduce injury, which is benefit to accurate operation.

The overall complication rate in laparoscopic TSME operation is lower than open operation group. The rate of anastomotic leak shows no statistical difference between the two operation methods. The leak rate published for rectal cancers was average of 10% [13].

Zakir et al[12] reported the overall complication rate was 29.8% in TSME for rectum cancer patients. The rate of anastomotic leak was 3.87% in the open TSME group and 2.97% in the laparoscopic TSME group, there was no statistical difference between these two groups. In our study incident rate of postoperative anastomotic leakage was 0%. Three patients had complications after operation and overall complication rate was 6.5%. Three complications are wound infection,fluid collections and urinary retention with Clavien-Dindo grading 1–2. Yoo et al [14] evaluated the optimal duration of urinary catheterization after TSME for rectal cancer. The logistic regression analysis was performed to determine the risk factors of urinary retention. The variables including age, sex, ASA grade, surgical procedure, TNM stage, tumor position, preoperative radiotherapy, duration of urinary catheterization, and the time of surgery were not significant risk factors for urinary retention.

Laparoscopic TSME has been used for rectal cancer, and can obtain satisfactory functional results compared with open resection and TME. Our surgical technique is characterized thorough lymph node dissection based on the preservation of IMA and the left colonic vessels and the superior rectal vessels, so that anastomotic leak risk decreased.

Conclusions

Laparoscopic TSME preserved left colic artery and superior rectal artery is a technically challenging procedure. Intact visceral pelvic fibro has been protected with even greater accuracy than other technique by 3D laparoscopy offers an optimal vision. Anastomotic leak risk has been reduced by left colic artery and superior rectal artery being preserved so that postoperative ischemic necrosis is avoided. So laparoscopic TSME preserved left colic artery and superior rectal artery can be safely performed for rectal cancer patients.

Declarations

Acknowledgments

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Data Availability

All experimental data used to support this findings are included within the article.

Conflicts of interest

The authors declare that they have no conflict of interest.

Ethics approval and consent to participate

This study was approved by the institutional review board of The First Affiliated Hospital of Dalian Medical University. Written informed consent for publication was obtained from all patients.

Abbreviations

TME total mesorectal excision

TSME tumor-specific mesorectal excision

IMA inferior mesenteric artery

IMV inferior mesenteric vein

SRA superior rectal artery

NVB neurovascular bundle

PME partial mesorectal excision

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Figures

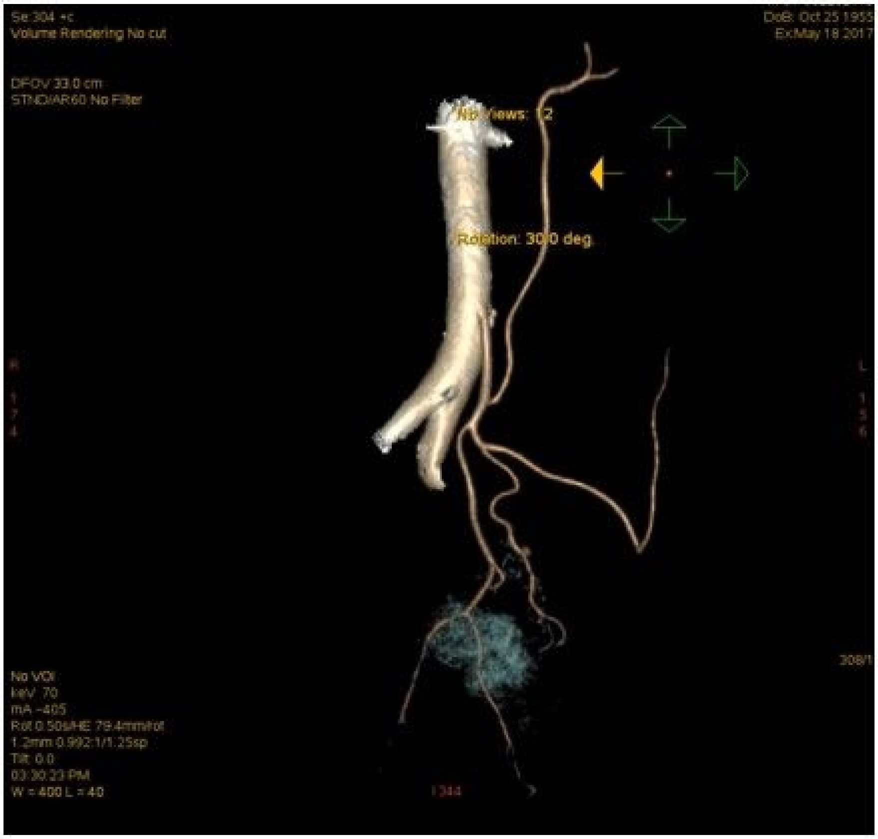

Figure 1

Figure 1

IMA 3D CT-A

Figure 2

Figure 2

Position of troca

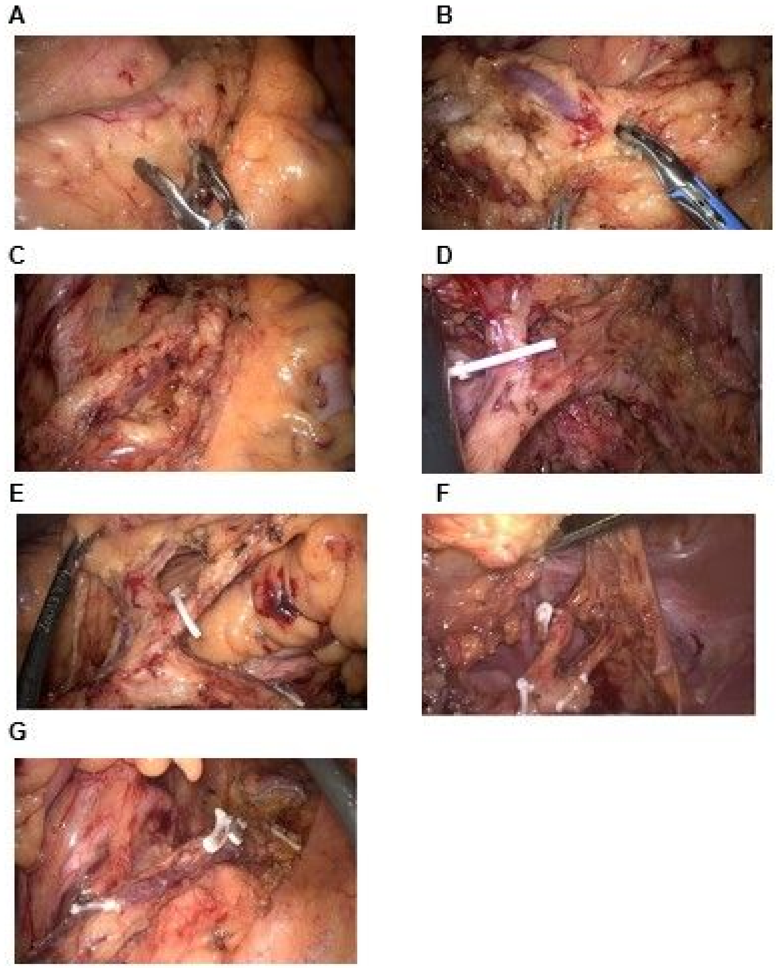

Figure 3

Figure 3

A) Dissection the presacral space below the superior rectal artery (SRA) approached from the left side across the midline to the right side attentively protected hypogastric nerves while using bipolar electrosurgical device. B) Identification of the relationship between left colic artery/IMV to the IMA and SRA and the branch of the arteriae sigmoideae. C) Tracing this vascular bundle from the origin of the IMA to the rectum segment approximately 4-5cm below the inferior border of the tumor. D) Ligation of arteriae sigmoideae and vascular branch from SRA. E) Ligation of arteriae sigmoideae and preserving left colonic vascular. F) Excision the mesorectum just underneath the rectal wall about 3-5cm and being avoid of injury rectal wall and SRA. G) TSME preserving left colic artery and superior rectal artery.