

Core value of laparoscopic colorectal surgery

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Abstract

Since laparoscopy was first used in cholecystectomy in 1987, it has developed quickly and has been used in most fields of traditional surgery. People have now accepted its advantages like small incision, quick recovery, light pain, beauty and short hospital stays. In early times, there are still controversies about the application of laparoscopy in malignant tumor treat-

ments, especially about the problems of oncology efficacy, incision implantation and operation security. However, these concerns have been fully eliminated by evidences on the basis of evidence-basis medicine. In recent years, new minimally invasive technologies are appearing continually, but they still have challenges and may increase the difficulties of radical dissection and the risks of potential complications, so they are confined to benign or early malignant tumors. The core value of the laparoscopic technique is to ensure the high quality of tumor's radical resection and less complications. On the basis of this, it is allowed to pursue more minimally invasive techniques. Since the development of laparoscopic colorectal surgery is rapid and unceasing, we have reasons to believe that laparoscopic surgery will become gold standard for colorectal surgery in the near future.

Key words: Laparoscopy; Minimally invasive surgery; Core value; Laparoscopic colorectal surgery

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Core tip: This article discusses problems of oncology efficacy, incision implantation and operation security in laparoscopy on the basis of evidence-basis medicine, and also analyzes new minimally invasive technologies, their challenges and their range of application. The core value of the laparoscopic technique is studied and concluded.

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HISTORY AND CURRENT STATUS

Since 21st century, minimally invasive surgery has got revolutionary successes in more and more fields of

traditional surgery, and has become mainstream of the global surgery developments. Minimally invasive surgery has been not only the belief and pursuit of modern surgeons, but also the compulsory courses as well.

In March 1987, French surgeon Phillipe Mouret first used laparoscopy in cholecystectomy, which has unveiled a new era in the development of minimally invasive surgery. Compared with small incision in traditional surgery, modern minimally invasive surgery has a deeper and promoted meaning. Small incision, quick recovery, light pain, beauty, and short hospital stays are all advantages of minimally invasive surgery. People begin to realize that postoperative recovery is mainly related with abdominal incision, exposure duration and extent of damage of the abdominal cavity.

In 1990, American surgeon Jacobs completed the world's first laparoscopic right colon resection. Cutting stapling device (Endo-GIA) has greatly improved the operating conditions of laparoscopic surgery, which has made the cut-off of mesenteric vessels and bowel loops inside abdominal cavity and the lower rectal anastomosis possible. In October 1990, Dennis Fowler operated the first laparoscopic sigmoid resection using Endo-GIA. In November of the same year, Patrick Leahy completed the first laparoscopic ultra-low anterior resection (Dixon) with Endo-GIA. In July 1991, Joseph Uddo completed the first laparoscopic right colon resection. Within one year, almost all types of colon surgeries have been attempted under laparoscopy. In 1992, Kokerling completed world's first abdominoperineal resection (Miles) with laparoscopy. In our country, first laparoscopic colorectal surgery was carried out in 1993, and since then, laparoscopy was gradually used in traditional colorectal cancer surgeries. In the past 20 years, with the continuous development of laparoscopic surgical techniques and the invention and perfection of all kinds of laparoscopic equipments, laparoscopic colorectal surgery has achieved encouraging achievements, and its short and long-term effects have been approved.

With the improvement of the technologies and equipments, laparoscopic colorectal surgery is developing constantly. Mainly, laparoscopic colorectal surgery includes three techniques: Laparoscopic colorectal resection, laparoscopic assisted colorectal resection, and hand assisted laparoscopic colorectal resection. Compared with traditional open surgery, laparoscopic colorectal surgery has following advantages: (1) light postoperative pain; (2) shortened wound healing time, the abdominal incision is relatively small and beautiful; (3) faster recovery of gastrointestinal function; (4) fast-returned normal activities and short hospital stays; (5) reduced complications such as ileus, incision infection; (6) improved patient's intraoperative and postoperative immunity; (7) better operative view in narrow space such as pelvic floor; and (8) precise operation under the magnified view, which is beneficial to vascular skeletonization and lymph-node dissection.

Although laparoscopic colorectal surgery has these advantages, in early time, it did not develop fastly as people expected like laparoscopic cholecystectomy. This is mainly because of the complexity and the long "learning curve" of the laparoscopic colorectal surgery. In recent years, with the development of laparoscopic surgical techniques and the invention of ultrasound knife, Ligasure, and all kinds of intracavitary cutting stapling devices, intraoperative bleeding and operation difficulties are greatly reduced, and the operation time is also notably shortened, which has vigorously promoted the development of laparoscopic colorectal surgery. Since then, laparoscopic colorectal surgery has entered into a rapid developing stage. At present, all the colorectal cancer centers in Shanghai have carried out laparoscopic colorectal surgery, and the proportion of laparoscopic surgeries is rising year by year.

EVIDENCE OF LAPAROSCOPIC COLORECTAL CANCER SURGERY

In the early developing period, laparoscopic colorectal surgery has many controversies. This is mainly because people have a lot of concerns about the application of laparoscopic surgery in malignant tumor treatments: First, whether laparoscopic surgery may increase the incidence of implantation metastasis? And whether laparoscopic surgery can achieve radical resection? Second, whether laparoscopic colorectal surgery may increase surgical complications? Third, since in early time, the learning curve and operation time of laparoscopic colorectal surgery is obviously longer, whether laparoscopic surgery can embody minimal invasion? To answer the above questions, it is necessary to resort to evidence-based medicine for help.

Oncology efficacy

At the end of last century, a series of large randomized controlled trial (RCT) studies comparing laparoscopic and open colorectal surgeries were carried out in Europe and United States (Table 1). In 1993, Lacy *et al*^[1] in Spain firstly launched RCT studies comparing laparoscopic and open colon surgeries. From then on, RCT studies such as COST in United States, COLOR in Europe, and CLASICC in United Kingdom were carried out successively^[2-4], Leung *et al*^[5] in Hong Kong also conducted RCT studies on laparoscopic and open colorectal surgeries. In 2002, Lacy *et al*^[1] first published the result of RCT studies on short and long-term effects of laparoscopic colorectal cancer surgery. Since then, the results of RCT studies above have been completed and published one after another. The research contents involve radical resection, long-term curative effects, quality of life and cost effectiveness, etc., which have provided credible clinical evidences for the application of laparoscopic colorectal cancer surgery on the basis of evidence-based medicine.

Since the lack of evidence on laparoscopic rectal

Table 1 Randomized controlled trial studies comparing laparoscopic colorectal surgery and conventional colorectal surgery

Study	No. of patients (laparoscopic vs conventional)	Year
Lacy <i>et al</i> ^[1]	219 (111 vs 108)	1993-1998
Leung <i>et al</i> ^[5]	403 (203 vs 200)	1993-2002
COST	872 (435 vs 437)	1994-2001
COLOR	1248 (627 vs 621)	1997-2003
CLASSIC	794 (526 vs 268)	1996-2002
COLOR II	1103 (739 vs 364)	2004-2010

cancer surgery, Colon Cancer Laparoscopic or Open Resection Study Group in Europe launched COLORII study^[6]. The study began in 2004, a total of 8 countries and 30 centers participated. From January 2004 to May 2010, a total of 1103 cases entered into the group randomly, 59 patients were ruled out for various reasons or incompleting follow-up, 1044 patients were analyzed for statistics finally. In 2013, the study reported the preliminary results. According to the results, the conversion rate of laparoscopic surgery was 17% (91/536). Compared with open surgery, laparoscopic surgery has longer operation time (240 min vs 188 min, $P < 0.001$), but less blood loss (200 mL vs 400 mL, $P < 0.0001$), faster recovery of gastrointestinal function (2 d vs 3 d, $P < 0.036$) and shorter postoperative hospital stays (8 d vs 9 d, $P < 0.036$). Postoperative pathological report shows that tumor stage, tumor size, and pathological type have no significant differences between these two groups. No significant differences were also observed in margin distance, positive margin rate and the number of lymph node dissection. The 28-d postoperative complication and mortality rates were close in these two groups. The researchers concluded that for experienced surgeons, laparoscopic rectal cancer surgery can not only meet the radical standard of open surgery, but also enhance postoperative recovery at the meantime.

Implantation metastasis problems of incision

In early times, there were controversies about whether laparoscopic colorectal cancer surgery may cause incision implantation or tumor dissemination. Once upon a time, it was reported that the rate of incision implantation was higher in laparoscopic surgery, the reason may due to the lack of standardization of the operation. In Lacy *et al*^[1] study, among these 111 cases, only one had implantation metastasis in trocar puncture hole. More and more reports confirmed that as long as the surgery is operated in accordance with disease-free principles, the rate of incision implantation will not increase. After analyzing 2858 laparoscopic colon cancer cases, Stocchi *et al*^[7] reported that the rate of incision implantation is only 0.7% for experienced surgeons. It was also reported, the incision implantation rate is about 0%-1.3% after laparoscopic colon cancer surgery in experienced laparoscopic centers, which has no difference with open surgery^[8-11]. Standardized operation can greatly decrease the rate of incision implantation, including: (1) follow the disease-free principles during the surgery

and avoid cutting tumor directly using ultrasonic knives; (2) do not stretch or squeeze tumor and simply pursue small incision when removing the tumor, take the tumor out gently with an incision protector or specimen bag, and pay attention to incision flushing at the end of surgery; and (3) before taking the Trocars out, exhaust gases from the vent hole slowly first.

Operation security problems

As the laparoscopic vision is 2-dimensional, it is often difficult to distinguish anatomical structure with spatial perception during the surgery. Moreover, laparoscopic surgery is operated by equipments, as a result, there is no hand feeling, so the laparoscopic colorectal surgery is much more difficult than ordinary laparoscopic cholecystectomy. In early time, complications of laparoscopic colorectal surgery is high, generally reported about 10%-17%. But as the advancement of "learning curve" and improvement of surgical techniques and experience, current literature reports that the incidence of complications will be gradually reduced after operating more than 30 cases. The laparoscopic peculiar complications include: Air embolism and subcutaneous emphysema, etc. There are also two Trocar-related complications, one is Trocar infection, but it is very rare, and does not extend hospital stays, and can be treated in outpatient clinics. The other is Trocar hernia, which is also relatively rare, and can be avoided by closing the Trocar holes carefully. Generally, laparoscopic colorectal surgery does not increase mortality, which is usually caused by systemic complications rather than the surgery itself. The life-threatening complications are extremely rare.

Arezzo *et al*^[12] analysed all randomized and prospective controlled studies comparing laparoscopic and open rectal cancer surgeries in the Medline and Embase database from 2000 to 2011. Twenty-three studies including 4539 patients meet the criteria. Among them, there are 8 RCT studies, including 1746 patients. Analysis showed that within 30 d after surgery, mortality in laparoscopic group was 1.0%, while in open group was 2.4% (95%CI: 0.21-0.99, $P = 0.048$). The total complication rate was 31.8% in laparoscopic group, while 35.4% (95%CI: 0.76-0.91, $P < 0.001$) in open group. The results of meta-analysis once again prove that laparoscopic surgery has lower complications and mortality rates than open surgery.

INNOVATIVE OR CONSERVATIVE?

In recent years, new technologies in laparoscopy emerge in endlessly, including traditional laparoscopic surgery, robotic surgery, 3-D laparoscopic surgery, single-port laparoscopic surgery (SPA), natural orifice transluminal endoscopic surgery (NOTES) and transanal minimally invasive surgery (TAMIS).

We take Da Vinci Robot as an example, the system not only inherits advantages of traditional laparoscopic surgery, but has many peculiar advantages as well: (1)

there are 4 mechanical arms with the ability of 7 free degrees, which makes it possible to operate precisely in narrow and small space; (2) the thrill of hand can be filtered by computer, which improves the stability of real-time operation picture, and greatly improves the accuracy of operation; (3) high resolution 3-D image gives the operator clear and real stereo visual feedbacks; (4) the good ergonomic design allows the surgeon to operate without standing, which can significantly alleviate fatigues and is more convenient for surgeons to complete complicated and long-time surgeries; and (5) long-distance operation is possible through the robot arm controlled by remote signal transmission. However, so far, the robot's force feedback components are not perfect, because in colorectal surgery, keeping good tension is very important for the quality of operation. Moreover, robots are extremely expensive, their overall cost performance is not high enough for developing countries. So, there is still a long way to go for the popularization of robots.

3-D laparoscopic surgery has the advantages of traditional laparoscopic surgery, its high resolution 3-D image makes the operation more accurate, so it can shorten the learning curves for surgeons, especially for beginners. In order to pay more attention to minimally invasive surgery, techniques such as SPA, NOTES and TAMIS were developed in recent years, the challenges we face are how to operate safely and effectively with only one hole in the case that the surgical instruments are still deficient and how to design instruments with good handling and flexibility, these challenges decide whether these techniques would be epoch-making innovations like the birth of laparoscopy 24 years ago.

In the era of rapid development of new technologies, should a colorectal surgeon be innovative or conservative? It is hard to decide sometimes. As far as I am concerned, the key point is: the feasibility of technology does not mean the rationality of treatment. When treating colorectal cancer, the reliability of radical resection is always in the first place, the second is to minimize surgical complications, finally we may consider to operate minimally invasively. So, we should not put the cart before the horse. We should not pursue less holes and result in increasing difficulties of radical dissection and decreasing of the quality of surgery. For the new techniques like SPA, NOTES and TAMIS, they are now restricted by the existing equipments, which will undoubtedly increase the difficulties of radical dissection and the risks of potential complications. As a result, such technologies should only be confined to benign or early malignant colorectal tumors presently.

As a colorectal surgeon, we should not get lost in the tide of minimally invasive surgery and simply pursue the maximization of minimally invasion. We are delighted to see that since laparoscopic colorectal surgery was developed in China, high-resolution endoscopic vision, high levels of fine anatomy and the establishment of good training plans have made young surgeons more profound in understanding colorectal surgery, which

have greatly improved the surgical quality of young surgeons. Therefore, patients are getting better quality of the surgical treatments, and gaining a better survival. Based on the above understanding, we think that the core value of the laparoscopic technique is to ensure the high quality of tumor's radical resection and less complications. On the basis of this, it is allowed to pursue more minimally invasive techniques.

After hundred years of development of colorectal cancer surgery, people's concepts have been greatly changed, the early emphasis of radical resection has been substituted by function preservation and life quality improvements on the basis of radical treatment. Minimally invasive surgery meet these requirements, which reveals the irreversible developments of laparoscopic colorectal surgery. We have reasons to believe that laparoscopic surgery will become gold standard for colorectal surgery in the near future.

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