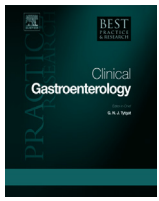
Best Practice & Research Clinical Gastroenterology 28 (2014) 29–39

Contents lists available at ScienceDirect

Best Practice & Research Clinical Gastroenterology



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# Laparoscopy for colorectal cancer

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*Keywords:*
Laparoscopy
Minimally invasive surgery
Colon cancer
Rectal cancer
Recovery
Survival

A B S T R A C T

The laparoscopic approach for colorectal cancer resection has been evolved from an experimental procedure with oncological concerns to routine daily practice within a period of two decades. Numerous randomized controlled trials and meta-analyses have shown that laparoscopic resection results in faster recovery with similar oncological outcome compared to an open approach, both for colon and rectal cancer. Besides improved cosmesis, other long-term advantages seem to be less adhesion related small bowel obstruction and reduced incisional hernia rate. Adequate patient selection and surgical experience are of crucial importance. Experience can be gradually expanded step by step, by increasing the complexity of the procedure. A decision to convert should be made early in the procedure, because the outcome after a reactive conversion is worse than initial open resection or strategic conversion. The additive value of new techniques such as robotic surgery has to be proven in randomized studies including a cost-effectiveness assessment.



## Introduction

In the years following the first description of laparoscopic colon surgery in 1991 [1], the minimally invasive approach for colorectal cancer (CRC) was considered a highly complex procedure with concerns about the oncological safety. It was suggested that laparoscopy for CRC would result in a

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http://dx.doi.org/10.1016/j.bpg.2013.11.017

suboptimal oncological resection with a higher risk of positive margins and lower lymph node yield. Especially the fear of port site metastases was considered to be a major drawback and led to a worldwide temporary moratorium outside clinical trials [2]. The first randomized trial on laparoscopic resection for colon cancer even showed an improved survival for the experimental arm [3–5]. Although this finding was not confirmed in similar trials thereafter, it became clear that the surgical approach did not influence the oncological outcome. This landmark paper caused an enormous progress in laparoscopy for CRC during the last decade, in which it has been incorporated in routine daily practice. However, the application of laparoscopy for CRC still varies hugely among different parts of the world, within continents and also within individual countries [6,7].

The present review will describe the highest level of evidence derived from randomized controlled trials on both short and long-term outcome of laparoscopic surgery for CRC compared to conventional open resection. Furthermore, related topics will be addressed like pathophysiological background, patient selection, learning curve, quality control, costs and technical developments in the field of minimally invasive surgery for CRC.

## Pathophysiological changes related to tumour growth and recovery

Parallel to the clinical studies of laparoscopy for CRC, animal studies on laparoscopy in relation to tumour biology were carried out during the 1990s. Abdominal surgery stimulates tumour growth in general. Animal studies pointed out that the manner in which access is gained to the abdominal cavity influences the capabilities of malignant cells to implant, survive and grow in the postoperative period [8]. Laparotomy results in a significantly higher degree of immunosuppression and increase of tumour growth than $CO_2$ pneumoperitoneum does in an animal model. It was hypothesized that laparoscopy could probably improve oncological outcome based on these experimental data [9]. On the other hand, changes in $CO_2$ concentration have been associated with an invasive capacity of human-derived peritoneal metastases [10]. Animal studies comparing different gases revealed significantly smaller tumour volumes using helium compared to $CO_2$, room air or xenon, but without changes in tumour cell proliferation or apoptosis [11]. Subsequent experiments suggested that this decreased tumour volume could be explained by higher immune activation by helium pneumoperitoneum [12]. Other experimental studies have focused on the hypoxic laparoscopic environment, demonstrating that this can modulate cell adherence by observing down regulation of adhesion molecules such as E-cadherin and CD44 [13]. The clinical value of these findings are not clear yet.

Physiological changes after minimally invasive surgery have also been correlated to postoperative morbidity and recovery in comparison with open resection. In a subset of patients included in a randomized study comparing both laparoscopy to open surgery and fast track care to conventional perioperative care using a $2 \times 2$ factorial design (LAFA trial), human leukocyte antigen (HLA)-DR expression, C-reactive protein (CRP) and IL-6 levels were determined [14]. These parameters were used to determine patient's immune status and stress response in each of the four randomized groups. HLA-DR as a measure for immune competence showed the highest levels after laparoscopy with fast track care, while IL-6 and CRP levels were highest in the open surgery group with standard perioperative care, reflecting a high inflammatory response. A similar Chinese study confirmed the lowest inflammatory response for laparoscopy embedded in fast track perioperative care [15]. This group had also the lowest rate of postoperative complications compared to the other three treatment groups. By determining lymphocyte subpopulations using flow cytometry, no differences in specific immunity (CD3+ and CD4+ counts; CD4+/CD8+ ratio) could be detected.

## Patient selection for laparoscopic resection of colorectal cancer

Despite increasing level of expertise, not every patient with colorectal cancer will be a good candidate for minimally invasive surgery. One of the limiting factors is previous abdominal surgery. Prior laparotomy is not an absolute contraindication, and the possibilities of getting safe access to the abdominal cavity and obtaining exposure with laparoscopic adhesiolysis should be determined on an individual basis. Other risk factors for a laparoscopic approach that have been suggested in literature are obesity, high patient age, high ASA score, advanced tumour stage and emergency setting. Clinical T4