

World Journal of *Gastrointestinal Oncology*

World J Gastrointest Oncol 2021 May 15; 13(5): 312-461



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INDEXING/ABSTRACTING

The WJGO is now indexed in Science Citation Index Expanded (also known as SciSearch®), PubMed, PubMed Central, and Scopus. The 2020 edition of Journal Citation Reports® cites the 2019 impact factor (IF) for WJGO as 2.898; IF without journal self cites: 2.880; 5-year IF: 3.316; Ranking: 143 among 244 journals in oncology; Quartile category: Q3; Ranking: 55 among 88 journals in gastroenterology and hepatology; and Quartile category: Q3. The WJGO's CiteScore for 2019 is 2.0 and Scopus CiteScore rank 2019: Gastroenterology is 86/137.

RESPONSIBLE EDITORS FOR THIS ISSUE

Production Editor: *Jia-Hui Li*; Production Department Director: *Xiang Li*; Editorial Office Director: *Ya-Juan Ma*.

NAME OF JOURNAL

World Journal of Gastrointestinal Oncology

ISSN

ISSN 1948-5204 (online)

LAUNCH DATE

February 15, 2009

FREQUENCY

Monthly

EDITORS-IN-CHIEF

Rosa M Jimenez Rodriguez, Pashtoon Kasi, Monjur Ahmed, Florin Burada

EDITORIAL BOARD MEMBERS

<https://www.wjgnet.com/1948-5204/editorialboard.htm>

PUBLICATION DATE

May 15, 2021

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PUBLICATION ETHICS

<https://www.wjgnet.com/bpg/GerInfo/288>

PUBLICATION MISCONDUCT

<https://www.wjgnet.com/bpg/gerinfo/208>

ARTICLE PROCESSING CHARGE

<https://www.wjgnet.com/bpg/gerinfo/242>

STEPS FOR SUBMITTING MANUSCRIPTS

<https://www.wjgnet.com/bpg/GerInfo/239>

ONLINE SUBMISSION

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What is the best surgical procedure of transverse colon cancer? An evidence map and minireview

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Author contributions: Li C contributed to the research design and wrote the paper; Wang Q contributed to the supervised the manuscript and design the evidence and gap map; Jiang KW contributed to the research design and supervised the manuscript.

Conflict-of-interest statement:

There is no conflict of interest associated with any of the senior author or other coauthors contributed their efforts in this manuscript.

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Manuscript source: Invited

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Abstract

Colorectal cancers comprise a large percentage of tumors worldwide, and transverse colon cancer (TCC) is defined as tumors located between hepatic and splenic flexures. Due to the anatomy and embryology complexity, and lack of large randomized controlled trials, it is a challenge to standardize TCC surgery. In this study, the current situation of transverse/extended colectomy, robotic/laparoscopic/open surgery and complete mesocolic excision (CME) concept in TCC operations is discussed and a heatmap is conducted to show the evidence level and gap. In summary, transverse colectomy challenges the dogma of traditional extended colectomy, with similar oncological and prognostic outcomes. Compared with conventional open resection, laparoscopic and robotic surgery plays a more important role in both transverse colectomy and extended colectomy. The CME concept may contribute to the radical resection of TCC and adequate harvested lymph nodes. According to published studies, laparoscopic or robotic transverse colectomy based on the CME concept was the appropriate surgical procedure for TCC patients.

Key Words: Evidence map; Extended colectomy; Review; Surgical procedures; Transverse colectomy; Transverse colon cancer

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Core Tip: Due to the anatomy and embryology complexity, and the lack of large randomized controlled trials, it is difficult to standardize surgery of transverse colon cancer (TCC). This study discusses the possible appropriate surgical procedures of TCC patients and a heatmap was conducted to show the evidence level and gap. In summary, transverse colectomy challenges the dogma of traditional extended

manuscript

Specialty type: Oncology**Country/Territory of origin:** China**Peer-review report's scientific quality classification**

Grade A (Excellent): 0

Grade B (Very good): 0

Grade C (Good): C, C

Grade D (Fair): 0

Grade E (Poor): 0

Received: January 15, 2021**Peer-review started:** January 15, 2021**First decision:** February 14, 2021**Revised:** February 25, 2021**Accepted:** March 31, 2021**Article in press:** March 31, 2021**Published online:** May 15, 2021**P-Reviewer:** Bains L,
Christodoulou KC**S-Editor:** Gao CC**L-Editor:** A**P-Editor:** Li JH

colectomy, with similar oncological and prognostic outcomes.

Citation: Li C, Wang Q, Jiang KW. What is the best surgical procedure of transverse colon cancer? An evidence map and minireview. *World J Gastrointest Oncol* 2021; 13(5): 391-399**URL:** <https://www.wjgnet.com/1948-5204/full/v13/i5/391.htm>**DOI:** <https://dx.doi.org/10.4251/wjgo.v13.i5.391>

INTRODUCTION

On a global scale, colorectal cancer is the second most common cancer in females and ranks third among males[1]. Generally, transverse colon cancer (TCC) is defined as tumors located between hepatic and splenic flexure[2], and is relatively rare, accounting for 10% of all colon cancers[3,4].

On the one hand, from an embryological standpoint, the proximal two-thirds of the transverse colon are derived from the midgut and the distal one-third is derived from the hindgut, and they are supplied by the middle and left colic artery, respectively[5]. On the other hand, from an anatomical point of view, the transverse colon is in close proximity to upper abdominal vital structures, and is not fixed to the retroperitoneal structures[6,7]. Due to the anatomy and embryology complexity, it is a challenging and daunting mission to mobilize and resect the transverse colon.

In clinical practice, symptoms and signs of TCC are not specific. Abdominal discomfort, which is difficult to locate might be the first complaint and is generally found in an advanced stage. Notably, the transverse colon of some patients has great mobility, and is located at the appendix plane even in the pelvic cavity[5]. Thus, gastritis, appendicitis, oophoritis, and other genitourinary diseases were often confused with TCC.

According to published studies, the 5-year survival rate was 28%-50%, which is obviously poorer than that of other colorectal tumor[8,9]. There are two main reasons: First, lymph node metastasis will occur in TCC patients at both the superior and inferior mesenteric arterial branches, especially the splenic flexure cancers. Second, peripheral important organs might create more surgical danger[8].

Consequently, all these factors contribute to the belief that transverse colic surgery was difficult to standardize and was naturally excluded from several randomized controlled trials (RCTs)[10-13]. The aim of this study was to review the indications, merits and demerits of different surgical procedures for transverse colic *via* the evidence and gap map.

Excel (2019, Microsoft, Redmond, WA, United States) was used for plotting the heatmap. The following electronic databases were searched: PubMed, EMBASE, and the Cochrane library, and the search was completed on December 12, 2020. All published studies were searched without any language and data restriction. The search items were as follows: TCC, surgical procedures and we also used Medical Subject Headings terms combined with free text terms. We also performed a supplementary literature search using Google Scholar. Endnote software (version 20, Thomson Reuters, Philadelphia, PA, United States) was used for removing duplicate publications and to facilitate the screening progress. Patients were included if: (1) The patients' tumors strictly followed the definition of TCC (colon cancer located between hepatic and splenic flexure); and (2) Detailed surgical information. And patients were excluded if the study used informal surgical terms, which were hard to be classified.

SURGICAL PROCEDURE

En-bloc resection of the tumor is the radical therapy of TCC as it is for other colorectal cancers. Because of a low incidence and excluded by RCTs, there is no consensus on the standard transverse colic operation, and the surgical approach for this tumor is frequently based on the surgeon's preference. The common surgical procedures are extended left or right colectomy and transverse colectomy, by laparoscopy or conventional open resection.

Extended colectomy

For better oncological outcomes, and according to the tumor location, extended right or left colectomy was the preference of several surgeons[5].

Extended right hemicolectomy was applicable for tumors located less than distal 10 cm of the hepatic flexure, and lymph node dissection, and included ligation of the ileocolic, right colic and middle colic arteries[14]. Correspondingly, extended left hemicolectomy was applied for tumors located less than 10 cm of the splenic flexure proximally, for which lymph node dissection included ligation of the left and middle colic arteries[14].

Identification of the middle colic arteries was important for extended surgery and transverse colectomy[14], including the medial approach described by Fujita *et al*[15] and Hasegawa *et al*[16], the “window technique” by Bača *et al*[17], and rotating transverse mesocolon by Ichihara *et al*[18]. Due to the specific anatomical position, division of the middle colic vessels and finding the correct surgical plane from complex adjacent organs (such as the duodenum, pancreas or spleen) is challenging in extended colectomy and transverse colectomy[5].

The number of harvested lymph nodes (generally, at least 15) is considered a vital symbol of surgical quality and prognosis[19-21]. Because of the higher number of harvested lymph nodes in extended colectomy, in previous studies, it was believed that patients with advanced TCC who underwent extended colectomy would have a better prognosis[6,22].

Localization of transverse colic carcinoma is especially difficult during surgery, both the attachment to omentum and fixed flexures altogether increases the difficulty. In addition, intraoperative colonoscopy is not applicable because the stimulation may increase hyperinflation of the bowel[5]. Therefore, it has been suggested that four quadrant preoperative tattooing was necessary for transverse colic carcinoma unless the tumor was large enough to be located[23,24].

Transverse colectomy

Transverse colectomy has often been used for tumors located between the hepatic and splenic flexure, and lymph node dissection was performed, including ligation of the middle colic arteries[14]. Transverse colectomy has shown a descending trend from the early 20th century[8]. On the one hand, segmental resection was usually considered a less radical surgical procedures because of low number of harvested lymph nodes. On the other hand, the prevalence of laparoscopy made extended colectomy easier than transverse colectomy.

The most significant technical issue in transverse colectomy was the division of tumor-supplying arteries and drainage veins, especially, the wide variation of middle colic vessels and thorough appreciation of Henle trunk[25-28]. Based on a previous study[29], resection length did not correlate with a better postoperative outcome. Chong *et al*[8] suggested that appropriate central vessel ligation, a minimum distance of 5 cm from each margin, was more critical than extended bowel length resection. Notably, Stracci *et al*[30] demonstrated that a length of less than 20 cm was associated with an inadequate lymph node number and unnecessary chemotherapy. Moreover, there is some discussion about lymphadenectomy of the middle colon artery by laparoscopic transverse colectomy, because of the challenging surgical difficulty[3,7,31,32]. Thus, attention needs to be paid to an appropriate resection length and an adequate number of lymph nodes of at least 12 according to previous studies and guidelines[6].

In previous studies, it was described that less extensive surgeries were safe in TCC patients, but some focused on the distal transverse colon and descending colon[31,33-36]. Chong *et al*[8] conducted a large cohort study and showed that the disease-free survival and overall survival rate were similar in the transverse colectomy and extended resection group. van Rongen *et al*[37] and Leijssen *et al*[6] compared the transverse colectomy and extended colectomy, respectively, and suggested that the former was an appropriate option for patients with TCC.

Laparoscopic, robotic, and open resection

Laparoscopic colorectal surgery was first applied in benign diseases, such as inflammatory bowel disease. However, last decades have witnessed a trend of increasing laparoscopic surgery, and its application has expanded to colorectal cancer[14]. Laparoscopic resection has been accepted and applied in nearly all types of colorectal cancer, because of the better short outcomes and less surgical trauma[38], and because it played an increasingly important role in TCC patients both in extended resection or transverse colectomy[6].

Although several RCTs demonstrated that laparoscopic resection had an equal safety profile compared with open resection in left and right colic carcinoma, the similar result has not yet been verified for TCC[2,10-12,39-41]. Previous retrospective studies have reported that laparoscopic transverse colon resection showed better short-term outcomes and similar oncological outcomes compared with open surgery[2,14,28,42,43]. Although some studies describe that the surgical time was longer and surgical skills were more difficult, laparoscopic transverse colon resection, including extended colectomy and transverse colectomy did not show a significant trend of higher complications, conversion, or poor long-term prognosis[2,5,44]. Moreover, Yamaguchi *et al*[42] demonstrated that the laparoscopic group had a lower overall morbidity rate and wound infection rate. Notably, in some studies, it was incorrectly assumed that laparoscopic surgery was related to a low number of harvested lymph nodes, because of a lack of a review of the colorectal cancer literature[43,45,46].

In the field of robotic surgery, left and right colon resections were predominantly performed, and transverse colectomy has rarely been described[47]. Robotic surgery, which showed favorable outcomes in colorectal surgery, had also gained increasing acceptance in transverse surgery[48-52]. In previous studies, it was shown that robotic transverse colon surgery had the same number of harvested lymph nodes, clearer surgical vision, a lower conversion rate, and better short-term outcomes compared with laparoscopic surgery[3].

Regarding the learning curve, surgeons need a longer time compared to open resection and patients need to be selected for laparoscopic or robotic surgery in order to maximize safety and the best oncological outcomes, however, robotic surgery has a shorter learning curve compared to traditional laparoscopy[53,54].

Complete mesocolic excision

Hohenberger *et al*[55] introduced the concept of complete mesocolic excision (CME) in radical colic resection. CME, as total mesorectal excision in rectal cancer patients, focuses on achieving *en-bloc* resection of the entire enveloped mesocolon, has been shown to produce a higher degree of lymphadenectomy, fewer local recurrences, and a better long-term oncological and clinical safety profile compared to non-CME resection[32].

Storli and Eide[7] published the first studies comparing open and laparoscopic CME in TCC patients, and no obvious differences were observed between these two methods. Although previous studies demonstrated that the feasibility of laparoscopic CME for TCC was appropriate[7,32,56,57], the evidence remained limited. Only three published studies demonstrated the safety and feasibility of robotic transverse colectomy, including two studies[3,58] that performed non-CME and only one study[47] that performed CME.

Evidence and gap map

Among the included studies, a heatmap was constructed to demonstrate the current evidence and gap in three aspects: Transverse colectomy *vs* extended colectomy, robotic *vs* laparoscopic *vs* open surgery, and the CME concept in surgery.

As shown in Figure 1, we used the percentage from included studies to show the application of transverse colectomy in total post-operative TCC patients (including transverse colectomy, extended right/left colectomy). From the heatmap, transverse colectomy comprised a lower percentage compared with extended colectomy, in other words, extended colectomy was the preferential choice in the past decades. Compared with traditional open resection, robotic and laparoscopic surgery was applied more frequently because of better short-term outcomes and similar long-term outcomes. Regarding the CME concept in TCC patients, we defined that if the study demonstrated that all surgeries performed followed the concept of CME and we used "100%" to represent the data; if the study demonstrated none of the surgeries followed CME, or no detailed information about this, we used "0%" to present the data. Thus, the CME concept was rarely applied in both the transverse colectomy and extended colectomy, although it was an adequately safe and effective approach.

LIMITATION

This study has several limitations. First, it was difficult to draw a convincing conclusion with limited data of TCC patients, such as detailed oncological features, surgical quality, and long-term outcomes. Second, based on published studies and



Figure 1 Heatmap of evidence and gap[2,3,5-8,14,25,31,36,59]. Transverse colectomy group: The percentage of transverse colectomy in all post-operative transverse colon cancer patients; Rob/lap surgery group: The percentage of robotic and laparoscopic surgery in all post-operative transverse colon cancer patients; complete mesocolic excision (CME) concept group: (1) 100%: All operation followed the concept of CME; (2) 0%: All operation was not followed CME, or published earlier than the CME; and (3) 50%: Apart from above two conditions, all other unclear description about application of CME. CME: Complete mesocolic excision.

clinical practice, transverse colectomy was a less commonly surgical procedure compared with extended right/ left colectomy. Third, the conclusion does not give robust evidence for standard treatment but reflected the current status of TCC patients.

CONCLUSION

As the surgical technology drives forward, so do the changes in surgical techniques of transverse cancer resection. Transverse colectomy challenges the dogma of traditional extended colectomy, with similar oncological and prognostic outcomes. Compared with conventional open resection, laparoscopic and robotic surgery plays a more important role in both transverse colectomy and extended colectomy. The CME concept may contribute to the radical resection of TCC and adequate number of harvested lymph nodes. In summary, according to published studies, laparoscopic or robotic transverse colectomy based upon the CME concept was the appropriate surgical procedure for most TCC patients.

However, large, multicenter, and prospective RCTs are needed to standardize surgical procedures of TCC patients. Perioperative management of different tumor stages, resection range, and anastomosis method of different transverse colic length, and long-term outcomes also need to be discussed.

ACKNOWLEDGEMENTS

We would like to thank Li Y, Zhang MM, Yu ZL of Peking University People's Hospital for clinical advices, and Zhang RC for providing the help of language supervision. Finally, we showed our respect to all authors of included studies involved

in the study.

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