Long splenic flexure carcinoma requiring laparoscopic extended left hemicolectomy with CME and transverse-rectal anastomosis: technique for a modified partial Deloyers in 5 steps to achieve enough reach and preserving middle colic vessels

Salomone Di Saverio1,2 · Kostantinos Stasinos2 · Weronyka Stupalkowska2 · Umberto Bracale3 · Pierpaolo Sileri4 · Antonio Giuliani5 · Giuseppe Nigri6 · Efstratios Kouroumpas2 · James M. D. Wheeler7 · Giovanni Domenico Tebala8 · Francesco Di Marzo9 · Belinda De Simone10 · Carlos Pastor Idote11 · Nicola De Angelis12 · Roberto Cirocchi13 · Antonio Giuliani5 · Giuseppe Nigri6 · Efstratios Kouroumpas2 · James M. D. Wheeler7 · Giovanni Domenico Tebala8 · Francesco Di Marzo9 · Belinda De Simone10 · Carlos Pastor Idote11 · Nicola De Angelis12 · Roberto Cirocchi13 · Patricia Tejedor14

Received: 11 March 2021 / Accepted: 9 June 2021 / Published online: 16 July 2021
© The Author(s) 2021

Abstract
Introduction This How-I-Do-It article presents a modified Deloyers procedure by mean of the case of a 67-year-old female with adenocarcinoma extending for a long segment and involving the splenic flexure and proximal descending colon who underwent a laparoscopic left extended hemicolectomy (LELC) with derotation of the right colon and primary colorectal anastomosis.

Background While laparoscopic extended right colectomy is a well-established procedure, LELC is rarely used (mainly for distal transverse or proximal descending colon carcinomas extending to the area of the splenic flexure). LELC presents several technical challenges which are demonstrated in this How-I-Do-It article.

Technique and methods Firstly, the steps needed to mobilize the left colon and procure a safe approach to the splenic flexure are described, especially when a tumor is closely related to it. This is achieved by mobilization and resection of the descending colon, while maintaining a complete mesocolic excision to the level of the duodenojejunal ligament for the inferior mesenteric vein and flush to the aorta for the inferior mesenteric artery. Subsequently, we depict the adjuvant steps required to enable a primary anastomosis by trying to mobilize the transverse colon and release as much of the mesocolic attachments at the splenic flexure area. Finally, we present the rare instance when a laparoscopic derotation of the ascending colon is required to provide a tension-free anastomosis. The resection is completed by delivery of the fully derotated ascending colon and hepatic flexure through a suprapubic mini-Pfannenstiel incision. The primary colorectal anastomosis is subsequently fashioned in a tension-free way and provides for a quick postoperative recovery of the patient.

Results This modified Deloyers procedure preserves the middle colic since the fully mobilized mesocolon allows for a tension-free anastomosis while maintaining better blood supply to the mobilized stump. Also, by eliminating the need for a mesenteric window and the transposition of the caecum, we allow the small bowel to rest over the anastomosis and the mobilized transverse colon and reduce the possibility of an internal herniation of the small bowel into the mesentery.

Conclusions Laparoscopic derotation of the right colon and a partial, modified Deloyers procedure preserving the middle colic vessels are feasible techniques in experienced hands to provide primary anastomosis after LELC with improved functional outcome. Nevertheless, it is important to consider anatomical aspects of the left hemicolectomy along with oncological considerations, to provide both a safe oncological resection along with good postoperative bowel function.

A preliminary video was accepted and presented in part in the video (oral dynamic) session of the SAGES annual meeting, Cleveland, USA, August 2020, ID 99,823 https://youtu.be/IUWJHyxUZo

Extended author information available on the last page of the article
Elderly patient (>70 yo), (with severe comorbidities, high ASA score) with locally advanced carcinomas and cN+, located proximal, distal or across the SF

Patients <70 yo, patients with locally advanced carcinomas and cN+, located in the distal third of the TC ± across the SF

Patients <70 yo, patients with locally advanced carcinomas and cN+, located across the SF ± proximal descending colon

Patients <70 yo, with early colon carcinomas and cN-, located in the distal third of the TC ± across the SF

Table 1  Practical algorithm on SF carcinoma intraoperative decision-making

| Patients’ characteristics | Type and extent of surgical resection | Type of reconstruction |
|---------------------------|---------------------------------------|------------------------|
| Elderly patient (>70 yo), (with severe comorbidities, high ASA score) with locally advanced carcinomas and cN+, located proximal, distal or across the SF | Segmental SF resection | Colo-colic anastomosis |
| Patients <70 yo, patients with locally advanced carcinomas and cN+, located in the distal third of the TC ± across the SF | Extended right colectomy with CME and CVL of the middle colic vessels | Ileo-descending or ileo-sigmoid anastomosis |
| Patients <70 yo, patients with locally advanced carcinomas and cN+, located across the SF ± proximal descending colon | Extended left colectomy with CME and high ligation of the IMV and IMA | Colorectal anastomosis (between HF or proximal TC and the upper rectum) (possibility of performing a standard or modified Deloyers procedure) |
| Patients <70 yo, with early colon carcinomas and cN-, located in the distal third of the TC ± across the SF | Segmental SF resection (ICG guided if ICG available) radical lymph node dissection along the middle colic and left colic vessels | Colo-colic anastomosis |

TC, transverse colon; SF, splenic flexure; ICG, indocyanine green; HF, hepatic flexure; yo, years old; IMV, inferior mesenteric vein; IMA, inferior mesenteric artery; CVL, central vascular ligation
completed with full dissection of the transverse mesocolon, identification and dissection of the middle colic vessels, and preservation of the main trunk and of the right branch of the middle colic artery. A full derotation of the right colon was achieved on the embryological planes on a craniocaudal manner from the proximal transverse colon (TC), hepatic flexure, ascending colon, and caecum. Combination of a full release of the fusion fascia of Toldt’s (right retrocolic fascia) and, in the upper medial continuity, release of Fredet’s fascia (fascia preduodenopancreatica) (Fig. 1) allowed for a complete laparoscopic derotation of the remaining right and proximal transverse colon. Then, the specimen (Fig. 2) was delivered through a 5-cm mini-Pfannenstiel incision (muscle-splitting), resection was completed including the left pedicle of middle colics and preserving their right branches, a full mobilization of the right colon and hep flexure was noted (Fig. 3), and a 29ch anvil was inserted and secured in the proximal transverse colon stump. A primary intracorporeal transverse-rectal anastomosis was performed. The small bowel mesentery was gently pulled towards the paramedian and right abdominal quadrants, making sure the proximal colonic conduit was lying just lateral of the D-J flexure (which was mobilized itself and appropriately medialized at the time of IMV taking down), avoiding internal hernias and preventing stricture/compression/ischemia of the SB, simply because the colon is not overlying the small bowel loops but it is going down to the pelvis following a longitudinal arcuate pathway. The colon will therefore follow its pathway to the pelvic brim, remaining on the left side of the D-J flexure and of the small bowel loops and overlying the aorta (Fig. 4). The left quadrant of the abdominal cavity remains empty and free of bowel

Fig. 1 Panel A—Entered lesser sac and dividing the embryologic adhesions of the TC mesentery. Panel B—Divide and open the Fredet’s fascia. Panels C and D—Toldt’s fascia is fully mobilized and the right colon is going up to reach the RUQ (visible the appendix over the duodeno-pancreatic head.

Fig. 2 Specimen with IMV and IMA stump taken at their origin.

Fig. 3 Specimen outside its length is demonstrated and transverse colon is exteriorized up the hepatic flexure, which is visible at the level of the wound protector (suprapubic incision).
loops without risk of internal hernia (Fig. 5). A small lesion on the liver surface of segment 4 was detected intraoperatively and resected with a laparoscopic wedge resection (histology: benign solitary necrotic nodule, with no evidence of malignancy). Surgery lasted for 348 min including the small liver wedge resection. The patient had an uneventful recovery. Postoperative histology showed pT3 N0 (0/38 LNs), Mx, L0, V0, pn0, and R0. Patient underwent adjuvant chemo and is currently alive with NED.

Discussion of the embryology and technical steps

The transverse mesocolon is mobile and not rare, especially in thin patients, which can be redundant if appropriately mobilized. Knowledge of the embryology is of paramount importance: the posterior and superior part of the redundant gastrosplenic ligament fuses to the anterior leaf of the dorsal mesentery of the transverse colon to form the transverse mesocolon. The middle colic vessels mark the location of this structure.

The mesenteric component of each flexure is best described in terms of radial and longitudinal axes. The radial axis of the hepatic flexure extends radially from the middle colic vascular pedicle to the intestinal margin of the mesentery. As it does so, the mesentery changes from attached (to the posterior abdominal wall) to non-attached and thus mobile. The longitudinal axis extends longitudinally from the right mesocolic pole of the longitudinal axis, the mesentery is fully attached across its breadth. At the transverse mesocolic pole of the longitudinal axis, the mesentery is attached centrally but mobile at the intestinal margin. Thus, the mesenteric component of the hepatic flexure undergoes
considerable conformational changes. The transverse mesocolon elongates dramatically at the intestinal margin. In this region, and due to elongation, it folds back on to itself and adopts a conformation considerably variable [1].

The transverse mesocolon and colon overlie the small intestinal mesentery, and the greater omentum overlies the upper surface of the transverse mesocolon. As a result, the lesser sac is frequently obliterated where the transverse mesocolon and greater omentum are attached. This arrangement has surgical implications and this is the theoretical basis for our modified technique of allowing the TC to reach the pelvis without the need of sacrificing the middle colic vessels.

As occurs in the right and left mesocolon, mesenteric fat is increased around the middle colic artery (the middle colic adipovascular pedicle). On either side of this pedicle, the mesentery thins to the point of being translucent in individuals whose body mass index is low (i.e., the avascular interpedicular regions) [1].

A crucial step of this modified Deloyers, aiming to easily achieve a full mobilization of the entire length of the transverse mesentery without the need of sacrificing the middle colic vessels, is to proceed in a stepwise manner with the following manoeuvres: performing the dissection of the colo-epiploic attachment close to the upper border of the TC; entering the lesser sac and then gaining adequate extra length of the transverse mesentery for obtaining enough reach up to the pelvic brim, by combined mobilization of the right colon along the Fredet’s fascia and mobilization of the TC by dissecting the root of its mesentery; opening the adhesions between the superior surface of the mesocolon and the inferior border of the pancreas, up to the origin of the middle colic vessels from the SM vessels (Fig. 6).

By avoiding the creation of a defect in the SB mesentery and delivering the right colon through to meet the rectum, one may raise the criticism that the colon is simply fully mobilized, but brought down to the rectal stump by pulling it over the small bowel, thus exposing to the risk of creating an internal hernia which may cause future problems. However, with this modified Deloyers which avoids the creation of a retro-ileal window, the proximal colon is going down to the pelvic brim, by staying over the aortic line and lying just on the left of D-J flexure, while keeping the small bowel loops medially on the right and median abdominal quadrants. Early adhesions between the proximal colonic conduit and the retroperitoneal surface will prevent any internal hernia of small bowel.

While laparoscopic extended right colectomy is a well-established procedure, LELC is rarely used (mainly for distal transverse or proximal descending colon carcinomas extending to the area of the splenic flexure) [2, 3]. Recent nationwide retrospective studies have shown that segmental colonic resection may be a safe and effective alternative in terms of both postoperative and oncological outcomes and was performed more frequently using a minimally invasive approach than extended procedures [4]. However, in selected cases and especially in locally advanced cancers (e.g., cT4),
several authors do prefer extended right or extended left colectomies [5]. The most recent meta-analysis comparing all surgical techniques has shown similar oncological outcomes following a segmental, extended left, or subtotal colectomy; however, extended resections achieved a higher number of lymph nodes harvested, higher rate of primary anastomosis, and a trend towards lower rates of anastomatic leak that any of the surgical procedures (segmental, extended or subtotal colectomies) for the curative resection of splenic flexure tumors provide similar survival; however, extended resections are associated with higher number of lymph nodes retrieved (despite no differences among techniques were seen in terms of proportion of patients achieving the minimum threshold of 12 LNs), with a higher rate of primary anastomosis and a non-significant trend for lower anastomotic dehiscence when compared with more restrict resections [6]. The authors conclude that an individualized surgical plan considering both short- and long-term outcomes is necessary to select the appropriate operation. For young patients with locally advanced tumors affecting long colonic segments, extended colectomies may be a better option for achieving a good quality specimen, especially in high-volume centers with more experienced laparoscopic colorectal surgeons. As shown in our patient’s CT scan, the tumor was extending for a long segment and a more aggressive and extended approach may be therefore justified and used in tertiary centers with advanced laparoscopic colorectal skills and expertise and in patients relatively young with preoperative or intraoperative features/suspicion of locally advanced cancers, especially if long colonic segments, extended colectomies maybe preferable and achieve better oncological radicality, both in terms of nodal clearance (including the IMA axis as in this case) and in terms of margins of resection (as you can see from CT in this patient, the tumor was extending for a long segment). LELC (Fig. 7a) carries several technical challenges which are demonstrated in this video vignette. Firstly, the steps needed to mobilize the left colon and procure a safe approach to the splenic flexure are described, especially when a tumor is closely related to it. This is achieved by mobilization and resection of the descending colon, while maintaining a complete mesocolic excision [7] to the level of the duodenojejunal ligament for the inferior mesenteric vein and flush to the aorta for the inferior mesenteric artery. Subsequently, we describe the operative steps required to enable a primary anastomosis by fully mobilizing the transverse colon, with a “middle colic vessel sparing” technique (Fig. 7) and release as much of the mesocolic attachments at the splenic flexure area.

In conclusion, we present the rare instance when a laparoscopic derotation of the ascending colon is required to provide a tension-free anastomosis. The resection is completed by delivering of the fully derotated ascending colon and hepatic flexure through a suprapubic mini-Pfannenstiel incision. The primary colorectal anastomosis is subsequently fashioned in a tension-free way and provides for a quick postoperative recovery of the patient. This modified and partial Deloyers procedure preserves the middle colic since the fully mobilized mesocolon allows for a tension-free anastomosis while maintaining better blood supply to the mobilized stump and also by eliminating the need for a mesenteric window and the transposition of the caecum; the modified technique allows for the small bowel to rest over the colon and above the anastomosis and by keeping the mobilized transverse colon on the left of the D-J flexure and over the aortic line.

**Fig. 7** LELC with a primary TC-rectal anastomosis achieved with a partial modified Deloyers by fully mobilizing the transverse colon, with a “middle colic vessel sparing” technique. a Laparoscopic extended left colectomy with CME and CVL. b Primary anastomosis is achieved by fully mobilizing the transverse colon, with a “middle colic vessel sparing” technique. c The fully mobilized mesocolon allows for a tension-free anastomosis while maintaining better blood supply to the mobilized stump and also by eliminating the need for a mesenteric window and the transposition of the caecum; the modified technique allows for the small bowel to rest over the colon and above the anastomosis and by keeping the mobilized transverse colon on the left of the D-J flexure and over the aortic line.
colon on the left of the D-J flexure, and over the aortic pathway, the possibility of an internal herniation of the small bowel into the mesentery is virtually none because the proximal colon conduit is going down to the pelvis, and gets immediately adherent to the retroperitoneal surface, where the left CME has been performed (Fig. 7c).

Laparoscopic derotation of the right colon is a feasible technique in experienced hands to provide primary anastomosis after LELC with improved functional outcome. Nevertheless, it is important to consider anatomical aspects of the left hemicolectomy along with oncological considerations, to provide both a safe oncological resection along with good postoperative bowel function.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00423-021-02240-7.

Acknowledgements Collaborators for PUBMED listing of Collaborators: James MD Wheeler MD, FRCS (Addenbrookes Hospital, Colorectal Unit, Cambridge, UK), Giovanni Domenico Tebala (Oxford University Hospital, Oxford, UK), Nicola De Angelis (Henri Mondor University of Creteil, Paris, France), Roberto Cirocchi (University of Perugia, Italy), Belinda De Simone (university of Paris, France), Carlos Pastor Idoate (Colorectal unit, Clinica Universidad de Navarra, Madrid, Spain)

Funding Open access funding provided by Università degli Studi dell’Insubria within the CRUI-CARE Agreement.

Declarations

Research involving human participants and/or animals All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

Written consent Written consent is obtained and available upon request.

Conflict of interest The authors declare no competing interests.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article’s Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article’s Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/.

References

1. Mesenteric and peritoneal anatomy: basic and applied science—chapter 12. Taylor & Francis. March 2017, https://doi.org/10.1201/9781315381565-2, In book: Mesenteric principles of gastrointestinal surgery
2. de’Angelis N, Martínez-Pérez A, Winter DC et al (2020) Extended right colectomy, left colectomy, or segmental left colectomy for splenic flexure carcinomas: a European multicenter propensity score matching analysis. Surg Endosc. https://doi.org/10.1007/s00464-020-07431-9
3. Bracale U, Merola G, Pignata G et al (2019) Laparoscopic resection with complete mesocolic excision for splenic flexure cancer: long-term follow-up data from a multicenter retrospective study. Surg Endosc. https://doi.org/10.1007/s00464-019-07078-1
4. Degiuli M, Reddavid R, Ricceri F, Di Candido F, Ortenzi M, Elmore U, Belluco C, Rosati R, Guerrieri M, Spinelli A, Members of the Italian Society of Surgical Oncology Colorectal Cancer Network (SICO-CCN) Collaborative Group (2020) Segmental colonic resection is a safe and effective treatment option for colon cancer of the splenic flexure: a nationwide retrospective study of the Italian Society of Surgical Oncology-Colorectal Cancer Network Collaborative Group. Dis Colon Rectum 63(10):1372–1382. https://doi.org/10.1097/DCR.0000000000001743
5. Rega D, Pace U, Scala D, Chiodini P, Granata V, Fares Bucci A, Pecori B, Delrio P (2019 Jul 29) Treatment of splenic flexure colon cancer: a comparison of three different surgical procedures: Experience of a high volume cancer center. Sci Rep 9(1):10953. https://doi.org/10.1038/s41598-019-47548-z
6. Wang X, Zheng Z, Chen M, Lu X, Huang S, Huang Y, Chi P (2021 Feb) Subtotal colectomy, extended right hemicolectomy, left hemicolectomy, or splenic flexure colectomy for splenic flexure tumors: a network meta-analysis. Int J Colorectal Dis 36(2):311–322. https://doi.org/10.1007/s00384-020-03763-z (Epub 2020 Sep 25)
7. Bertelsen CA, Neuenschwander AU, Jansen JE et al (2015) Disease-free survival after complete mesocolic excision compared with conventional colon cancer surgery: a retrospective, population-based study. Lancet Oncol 16(2):161–168. https://doi.org/10.1016/S1470-2045(14)71168-4

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.
Authors and Affiliations

Salomone Di Saverio1,2 · Kostantinos Stasinos2 · Weronyka Stupalkowska2 · Umberto Bracale3 · Pierpaolo Sileri4 · Antonio Giuliani5 · Giuseppe Nigri6 · Efstratios Kouroumpas2 · James M. D. Wheeler7 · Giovanni Domenico Tebala8 · Francesco Di Marzo9 · Belinda De Simone10 · Carlos Pastor Idoate11 · Nicola De Angelis12 · Roberto Cirocchi13 · Patricia Tejedor14

1 Department of General Surgery, University Hospital of Varese, University of Insubria, Varese, Italy
2 Cambridge Colorectal Unit, Cambridge University Hospitals NHS Foundation Trust, Addenbrooke’s Hospital, Cambridge Biomedical Campus, Hills Road, Box 201, Cambridge CB2 0QQ, UK
3 University of Naples, Naples, Italy
4 University Vita Salute San Raffaele, Milan, Italy
5 San Carlo Hospital, Potenza, Italy
6 La Sapienza University of Rome, Rome, Italy
7 Colorectal Unit, Addenbrookes Hospital, Cambridge, UK
8 Oxford University Hospital, Oxford, UK
9 Estar Toscan, San Sepolcro Hospital, Florence, Italy
10 University of Paris, Paris, France
11 Colorectal Unit, Clinica Universidad de Navarra, Madrid, Spain
12 Henri Mondor University of Creteil, Paris, France
13 University of Perugia, Perugia, Italy
14 University Hospital ‘Gregorio Marañón’, Madrid, Spain