



Radio-surgical agreement on the inferior mesenteric artery ligation level in left colon and rectal cancer

C. L. A. Ghezzi^{1,2,6} · C. Rahde³ · A. S. Casagrande¹ · M. M. Bianchin^{2,3} · O. C. Corleta^{4,6} · T. L. Ghezzi^{5,6}

Received: 29 May 2019 / Accepted: 17 June 2019 / Published online: 6 July 2019
© Springer Nature Switzerland AG 2019

Dear Sir

Studies on postoperative, functional, and oncological outcomes in left colon cancer (LCC) and rectal cancer (RC) surgery have been based exclusively on the surgeon's judgment of the inferior mesenteric artery (IMA) ligation level [1–3]. However, the accuracy of such an evaluation has been poorly investigated. Contrast-enhanced computed tomography (CT) scanning has proven to be useful for postoperative assessment of the vascular ligation level in patients with colon cancer [4, 5].

We retrospectively analyzed preoperative and postoperative multidetector CT (MDCT) images of patients who underwent LCC and RC resection at Hospital de Clínicas de Porto Alegre, Brazil, between 2015 and 2017. Exclusion criteria were multivisceral resection, contraindication for using intravenous contrast agent, prior colorectal resection, unclear information regarding the IMA ligation level, or IMA thrombosis. All surgical procedures were performed by a fourth-year resident of colorectal surgery or a second-year resident of general surgery supervised by a

senior (> 10 years' experience) colorectal or general surgeon, respectively. The IMA ligation level was decided by the senior surgeon and recorded by the resident in the surgical report. Two independent senior radiologists, blinded to the level of ligation performed, compared preoperative and postoperative MDCT with maximum intensity projection (MDCT-MIP) images to assess the IMA ligation level. Radiological consensus was defined as agreement between both radiologists. To validate the radiological consensus as a reliable method for comparison with the IMA ligation level reported by surgeons, we assessed inter-radiologist agreement regarding the preoperative IMA anatomy.

Overall, 111 patients were included in the study [64 RC and 47 LCC; 69 men, 42 women; mean age, 65.1 years (range 33–91 years)]. Eighty-seven patients (78.4%) were American Society of Anesthesiologists (ASA) class 1 or 2, and 24 patients (21.6%) were ASA 3 or 4. The mean body mass index was 26.4 kg/m². Thirty-nine patients (60.9%) with RC underwent long-term neoadjuvant chemoradiotherapy. Seventy-nine percent of the surgeries were performed by colorectal surgeons. The open approach was chosen in 85 patients (76.6%). Three-phase protocol was used in 73% and 31.5% of the preoperative and postoperative CT scans, respectively. In RC group, a laparoscopic approach was significantly more frequent in patients who had high than in those who had low ligation of the IMA (66.7% vs. 20%; $p = 0.008$). Inter-radiologist agreement regarding the IMA ligation level was 97.4% ($\kappa = 0.945$; $p < 0.0001$). Very good agreement was observed with respect to IMA bifurcation pattern ($\kappa = 0.932$; $p < 0.0001$), intersection pattern of the LCA and IMV ($\kappa = 1.000$; $p < 0.0001$), and relationship between the LCA and IMV at the IMA origin ($\kappa = 1.000$; $p < 0.0001$). The radio-surgical agreement on the IMA ligation level in patients with LCC and RC was 63.9% ($\kappa = 0.457$; $p < 0.001$) and 71.8% ($\kappa = 0.295$; $p = 0.005$), respectively. In both groups, concordance with respect to low IMA ligation was the most common type of radio-surgical agreement, and the overestimation of the IMA ligation

✉ T. L. Ghezzi
tghezzi@hcpa.edu.br

¹ Radiology Service, Hospital de Clínicas de Porto Alegre, Porto Alegre, Rio Grande do Sul, Brazil

² Post-Graduate Program in Medical Sciences, School of Medicine, Federal University of Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil

³ School of Medicine, Federal University of Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil

⁴ Division of General Surgery, Department of Surgery, Hospital de Clínicas de Porto Alegre, Federal University of Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil

⁵ Division of Coloproctology, Hospital de Clínicas de Porto Alegre, 2350 Ramiro Barcelos St 600, Porto Alegre, Rio Grande do Sul 90035-903, Brazil

⁶ Moinhos de Vento Hospital, Porto Alegre, Rio Grande do Sul, Brazil

Table 1 Radio-surgical agreement on the IMA ligation level in patients with left colon and rectal cancer

Surgeon	Radiological consensus							
	Left colon cancer*				Rectal cancer**			
	High ligation	Low ligation	Preservation	Overall	High ligation	Low ligation	Preservation	Overall
High ligation	6 (12.8)	8 (17)	4 (8.5)	18 (38.3)	7 (10.9)	16 (25)	0 (0)	23 (35.9)
Low ligation	3 (6.4)	14 (29.8)	0 (0)	17 (36.2)	2 (3.1)	39 (60.9)	0 (0)	41 (64.1)
Preservation	0 (0)	2 (4.3)	10 (21.3)	12 (25.5)	0 (0)	0 (0)	0 (0)	0 (0)
Overall	9 (19.1)	24 (51.1)	14 (29.8)	47 (100)	9 (14.1)	55 (85.9)	0 (0)	64 (100)

Data presented as number of cases (%)

*Agreement = 63.9%; $\kappa = 0.457$; $P < 0.001$

**Agreement = 71.8%; $\kappa = 0.295$; $P = 0.005$

level by the surgeons was the most common type of radio-surgical disagreement (Table 1). Regarding the association between patient- and surgery-related factors and radio-surgical agreement on the IMA ligation level, there were no differences with respect to age, sex, ethnicity, BMI, ASA score, administration of neoadjuvant chemoradiotherapy, classification of surgery, surgical approach, specialization of surgeon, type of operation, clinical stage, and number of phases of preoperative and postoperative CT scans.

Our study indicated that surgeons correctly identified the IMA ligation level in approximately two-thirds of cases. Maximum intensity projection is a CT rendering method that improves the visualization of high-density structures, such as blood vessels, through contrast media. Given the accurate and simultaneous assessment of the entire anatomy of the IMA by MDCT-MIP, the radiological consensus was considered the gold standard in the present study. Misjudgment of the IMA ligation level by surgeons may be due to anatomical variants (e.g., LCA origin close to the IMA root) and/or incomplete dissection of the proximal segment of this vessel [4]. Dissection from the origin of the IMA to its first branch could be the only way to ensure correct identification of the ligation level. In our hospital, most surgeons adopt low ligation of the IMA as the standard practice. The participating surgeons' vast experience in performing this type of ligation could explain the higher radio-surgical agreement observed in patients who had low ligation of the IMA. The most frequent error was overestimation of the IMA ligation level by the surgeons, as demonstrated previously by Prevot et al. [4]. Our findings raise doubts on scientific evidences of the IMA ligation level in LCC and RC patients published so far. Therefore, we recommend surgeons to consider the radiological preoperative assessment of IMA anatomy during surgical planning and the routine postoperative radiological evaluation of the IMA ligation level in scientific investigations that assess outcomes of patients submitted to LCC and RC resection.

Compliance with ethical standards

Conflict of interest Caroline Lorenzoni Almeida Ghezzi, Carolina Rahde, Aline Spader Casagrande, Marino Muxfeldt Bianchin, Oly Campos Corleta, and Tiago Leal Ghezzi declare no conflict of interest.

Ethical approval The study was conducted in accordance with the ethical standards of the institutional and national research committees, and with the 1964 Helsinki Declaration and its later amendments.

Informed consent All patients provided written informed consent.

References

1. Fujii S, Ishibe A, Ota M et al (2019) Short-term and long-term results of a randomized study comparing high tie and low tie inferior mesenteric artery ligation in laparoscopic rectal anterior resection: subanalysis of the HTLT (High tie vs. low tie) study. *Surg Endosc* 33:1100–1110
2. Mari GM, Crippa J, Coccoza J et al (2018) Low ligation of inferior mesenteric artery in laparoscopic anterior resection for rectal cancer reduces genitourinary dysfunction. *Ann Surg* 269:1018–1024
3. Yang Y, Wang G, He J et al (2018) High tie versus low tie of the inferior mesenteric artery in colorectal cancer: a meta-analysis. *Int J Surg* 52:20–24
4. Prevot F, Sabbagh C, Deguines JB et al (2013) Are there any surgical and radiological correlations to the levels of ligation of the inferior mesenteric artery after sigmoidectomy for cancer. *Ann Anat* 195:467–474
5. Munkedal DLE, Rosenkilde M, West NP, Laurberg S (2019) Routine CT scan one year after surgery can be used to estimate the level of central ligation in colon cancer surgery. *Acta Oncol* 58:469–471

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