



Original research

Usefulness of intraoperative ultrasonography in liver resections due to colon cancer metastasis



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HIGHLIGHTS

- We assess IOUS utility and identify factors predicting intraoperative detection of new lesions.
- IOUS remains the only way to evaluate anatomical relationships intraoperatively.
- IOUS sensitivity in detecting occult CRLM is highly dependent on the number of detected tumors.
- There may be additional influential factors.

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ABSTRACT

Introduction: Intraoperative ultrasonography (IOUS) of the liver has been used both as an aid for intraoperative anatomical definition and for the detection of new lesions. The present study aimed to evaluate the impact of IOUS and to identify factors that can predict the detection of new lesions intraoperatively. **Methods:** In this observational and prospective study, with a cross-sectional design, patients with colorectal cancer metastases who underwent hepatectomy were selected. Abdominal computed tomography, magnetic resonance imaging, and positron emission tomography were the preoperative evaluation tests. All patients underwent IOUS performed by the same surgeon. The intraoperative findings were compared with the preoperative tests results.

Results: In total, 56 hepatectomies were evaluated. Half of the patients were men, with a mean age of 57 (30–85) years. New lesions were found intraoperatively in 12 patients (21.4% of cases) and were detected on both palpation and ultrasonography in 11 of these patients. Ultrasonography helped to revise the surgical plans by providing additional information in 35.7% of cases. On multivariate analysis, the presence of more than 4 preoperative nodules was predictive of the intraoperative occurrence of new lesions.

Conclusions: IOUS remains the only way to evaluate the relationships between tumors, liver vascular structures, and bile ducts intraoperatively. Alone, IOUS was not useful for identifying new lesions intraoperatively, as all new lesions were also detected on palpation. The number of lesions diagnosed on preoperative tests influenced the probability of identifying new lesions intraoperatively. There may be additional influential factors.

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1. Introduction

Colon cancer is one of the most common neoplasias in Brazil and worldwide, with 32,600 new cases of colorectal cancer in Brazil in 2014 [1]. The liver is often the first location for metastatic disease and may be the only site in up to 30–40% of patients with advanced disease. Hepatic resection, when feasible, is the only treatment associated with long-term survival [2].

In many institutions, abdominal computed tomography (CT) is the preferred imaging modality for preoperative evaluation of colorectal liver metastases due to ease of image acquisition and patient tolerability. For difficult to characterize nodules or significant liver steatosis, CT is complemented by magnetic resonance imaging (MRI) [3–5].

The first studies comparing preoperative imaging results with ultrasonography performed intraoperatively date from the 1980s [6]. Intraoperative ultrasonography (IOUS) has been used as a guide during liver resections and for complementing cancer staging [7]. Continued improvements in preoperative imaging techniques justify studies comparing modern methodologies. Recently, researchers have been attempting to identify factors that can influence IOUS findings, with studies evaluating echogenicity, chemotherapy, and the number of lesions [8–11].

The present study aimed to assess the value of IOUS for patients who underwent resection of liver metastases due to colorectal cancer, to assess the utility of IOUS in cancer staging, and in anatomical evaluation. We also aimed to identify factors that could predict the detection of new lesions in this group of patients, who underwent surgery at the Santa Rita Hospital, Hospital Complex of the Brotherhood of the Santa Casa de Misericórdia of Porto Alegre, where IOUS is used routinely.

The value of IOUS for tumor staging in patients who undergo hepatic resection due to metastasis from colorectal neoplasia is an active area of investigation, with a greater consensus for the usefulness of IOUS in defining anatomical boundaries [6,7,12–20].

In the 1990s, Soyer et al. [21] recommended that in addition to IOUS being used for tumor staging, IOUS was extremely useful in assessing anatomy and added safety to liver resection.

Recently, identifying the patients in whom there are higher chances of discovering new lesions during surgery has been investigated. *Few studies show predisposing factors in patients with liver metastasis from colorectal cancer [13,17]. Different characteristics influencing preoperative tumor detection could cause discrepancies in detecting new lesions during liver resection.* The sensitivity of preoperative tests detecting liver nodules is inversely proportional to the time between imaging and surgery [22].

The number of patients who undergo metastatic liver surgery after receiving preoperative chemotherapy is increasing. Neoadjuvant chemotherapy may increase the difficulty in staging tumors owing to changes in the structure of liver tissue [12,13,17].

2. Patients and methods

In this observational and prospective study with a cross-sectional design, all patients who underwent hepatectomy through laparotomy due to metastasis of colorectal adenocarcinoma and who were operated on between October 2011 and August 2013 were included.

All patients were examined with at least one of the following imaging modalities: contrast-enhanced abdominal CT, contrast-enhanced MRI, or positron emission tomography (PET-CT). The results of preoperative imaging examinations were regularly discussed in a weekly multidisciplinary meeting, where surgical planning was defined.

Two radiologists, who are abdomen imaging experts, reviewed

all images without prior knowledge of the intraoperative findings. The size, number, and segment locations of the lesions involved were recorded. If there were any discrepancies between evaluations, we included the larger number of lesions in the analysis, intending to identify false-negative nodules.

Imaging examinations were not standardized because some of them were brought from others institutions.

The same surgeon performed all IOUS examinations by using an ultrasound machine with curvilinear transducer operating at 1.4–5 MHz (Siemens CH5-2).

Intraoperative findings were documented during or immediately after surgery, including the size, number, and location of all lesions; the liver segments involved; and whether the lesion was only palpable, only visible on IOUS, or both. The surgeon's opinion regarding the utility of ultrasonography was recorded. IOUS was considered to provide additional information when it helped to accurately locate the lesion, define the anatomy, aid in performing radiofrequency ablation, discard suspicious lesions identified in preoperative examinations, and identify a new lesion.

Any new lesion identified on ultrasonography that had not been previously palpated would be considered as identified on IOUS only. Similarly, any new lesion identified on palpation and not found on IOUS would be recorded as detected on palpation only. New lesions that were initially palpated and observed on IOUS would be considered as identified on both. Therefore, additional lesions detected only on IOUS were defined as those not detected on preoperative imaging or on operative inspection/palpation.

Data from preoperative imaging examinations were compared with intraoperative results.

When complete resection with negative margins was considered impossible, local destruction of the tumor with radiofrequency ablation was performed. In this technique, ultrasonography is used as a guide to appropriately position the equipment, and in these cases, IOUS was considered essential. To estimate the false-negative rate of preoperative imaging tests with 8% maximum error at a 95% confidence level, it was calculated that at least 55 patients would be needed. Statistical analysis was performed using STATA 11.2 (Copyright 1985–2009 Stata Corp LP, Texas, 77845, USA).

Quantitative data were described as the mean or median, according to the distribution of values. Comparisons between groups were performed by using the Student *t*-test or its nonparametric equivalent, when Gaussian assumptions were not met. Comparisons of categorical data were performed by using the chi-squared test or Fisher exact test. A value of $p < 0.05$ was considered significant.

The study protocol (no. 3619/11 dated 12/8/2011) was submitted to and approved by the Ethics and Research Committee of the Hospital Santa Rita, do Complexo Hospitalar da Irmandade Santa Casa de Misericórdia de Porto Alegre.

3. Results

During the study period, 56 hepatectomies performed for 49 patients were assessed. Of these patients, 15 had undergone a previous hepatectomy, with 7 having been performed before initiation of the present study. The mean age of the patients was 57 years, and 28 of the patients were men (50%). Table 1 lists the patient characteristics.

Two patients underwent hepatectomy in two stages, and in the first surgical stage, the portal vein was ligated in both patients. Two patients were subjected to radiofrequency ablation with resection.

In the 56 hepatectomies, 87.5% of patients underwent preoperative CT, 10.7% underwent MRI, and 3.5% underwent PET-CT. The mean period between the preoperative imaging examination and

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