
Optimizing Clinical and Economic Outcomes of Surgical Therapy for Patients with Colorectal Cancer and Synchronous Liver Metastases

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- BACKGROUND:** Traditionally, for patients with colorectal cancer with resectable synchronous liver metastases, resections were performed separately. However, the safety and efficacy of simultaneous resection have been demonstrated in selected patients. The purpose of this study was to evaluate outcomes and economic implications of simultaneous and staged resections.
- STUDY DESIGN:** We conducted a retrospective cohort study of consecutive colorectal cancer patients with resectable synchronous liver metastases treated between 1993 and 2010, constructing a decision tree comparing simultaneous and staged resections. For generalizability, the analysis was conducted from a payer perspective, using costs derived from 2010 Medicare reimbursement. Decision models incorporated the severity-refined DRG complications (complicating condition/major complicating condition) modifiers. Sensitivity analyses used alternative models of DRG reimbursement.
- RESULTS:** There were 144 patients analyzed. Sixty (41.7%) underwent simultaneous resection and 84 (58.3%) underwent staged resection. Median overall survival did not differ between the simultaneous and the staged cohorts (66.3 vs 65.6 months, respectively), nor did the overall complication rate (38.3% vs 40.5%, respectively). Median total length of hospitalization was significantly shorter in the simultaneous cohort (8 vs 14 days; $p = 0.001$). In the base model, the simultaneous strategy cost less than the staged strategy (\$20,983 vs \$25,298 per case)—a savings of 17.1%. Sensitivity analyses examining alternative severity-refined DRG reimbursements demonstrated potential cost savings, in all but 1 extreme sensitivity analysis, ranging from 9.8% to 27.3% favoring simultaneous resection.
- CONCLUSIONS:** The simultaneous resection strategy was oncologically equivalent and more cost efficient for patients with primary colorectal cancer presenting with resectable liver metastases. A reduction in overall length of hospital stay was an associated benefit. Future studies should explore the feasibility and clinical implications of policies to maximize the potential for simultaneous resection in this cohort of patients. (*J Am Coll Surg* 2012;215:262–270. © 2012 by the American College of Surgeons)
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Colorectal cancer presenting with metastasis to the liver is a challenging clinical scenario. Traditionally, colorectal cancer patients with resectable synchronous liver metastases have undergone 2 separate operations: 1 to extirpate the primary tumor and 1 to resect the liver metastasis or metastases. More recently, several institutions have established the safety and feasibility of simultaneous colorectal and hepatic resections.¹⁻¹⁰ In properly selected patients, simultaneous resections and staged resections have comparable oncologic outcomes, and equivalent—or perhaps fewer—overall complications. If accomplished without increasing morbidity or mortality, the potential benefits of 1 surgical procedure over 2 are clear: 1 hospitalization instead of 2; a shorter total duration of inpatient hospital stay; and commitment of fewer financial and human resources.

Abbreviations and Acronyms

BMI	=	body mass index
CC	=	complicating condition
CPT	=	Current Procedural Terminology
CRC	=	colorectal cancer
MCC	=	major complicating condition
OR	=	operating room

However, the appropriateness of simultaneous resection remains controversial, and this approach may not be feasible in all hospital systems. Simultaneous resection requires surgeon experience, appropriate ICU expertise, interventional radiology resources, and inpatient processes to “rescue” patients who experience acute deterioration.¹¹⁻¹⁵ So, appropriate patient selection within a hospital system that is capable of caring for complex and potentially critically ill patients is important to optimizing decisions regarding surgical management of these patients.

In an era of increasing cost consciousness, it is important to examine the fiscal consequences of treating these patients. As health care costs in the US continue to rise, with projection to reach 25% of the gross domestic product in 2025, it is appropriate to consider the economic impact of treating these patients in comparative effectiveness research studies to explore ways to improve the efficiency of health care delivery without compromising patient safety, quality of health care delivery, or long-term outcomes.¹⁶

Keeping the nuances of the simultaneous and staged strategies in mind, we hypothesized that a cost-minimized approach that does not compromise surgical outcomes can be determined for treating patients presenting with colorectal cancer metastases to the liver. Although the cost-effectiveness of different treatment strategies has been studied in patients undergoing hepatic metastasectomy for metachronous colorectal cancer metastases in the liver,¹⁷ a cost analysis of surgical treatments for patients with synchronous colorectal cancer metastases in the liver has not been performed. The purpose of this study was to compare the surgical outcomes and estimated payer costs of simultaneous and staged resections of the primary tumor and liver metastases in patients with synchronous disease using standardized Medicare-based reimbursement.

METHODS**Patient selection**

After Institutional Review Board approval, data on patients undergoing colorectal and hepatic resection for colorectal cancer with synchronous metastases to the liver between 1993 and 2010 were reviewed from a secure institutional database at The University of Texas MD Anderson Cancer

Center. All patients had undergone both the colorectal and the hepatic resections at MD Anderson Cancer Center. All tumors were resected with curative intent; treatment with radiofrequency ablation was defined as an acceptable treatment modality if resection was not technically feasible (ie, if the resultant liver remnant would be too low in volume). Patients were excluded if they presented with colorectal cancer recurrence at the primary site, metachronous hepatic metastases, or if complete resection was not performed.

Cost estimates

Cost data were estimated based on Medicare reimbursements in 2010 US dollars. Dollar amounts for procedures categorized by Current Procedural Terminology (CPT) codes and DRG codes were determined from the Centers for Medicare and Medicaid Services and the Agency for Healthcare Research and Quality, respectively (Table 1).^{18,19} The DRG-based reimbursements were calculated based on cost-to-charge ratios, using national median charges and discharges for specific DRGs. The CPT codes were used to estimate surgeon fees for total proctocolectomy, total abdominal colectomy, partial colectomy, low anterior resection, abdominoperineal resection, minor hepatic resection, hepatic lobectomy, and extended hepatic resection, respectively. Reimbursement for anesthesia services was based on CPT code 840, with increased reimbursement per 15 minutes of anesthesia services. The CPT codes 74170 and 49040 were used for CT and drainage of intra-abdominal abscess, respectively. When applicable, CPT codes included modifiers for technical and professional fees. For DRG coding, a severity-refined DRG system was defined by complicating conditions (CC) and major complicating conditions (MCC) as modifiers for various reimbursements. The DRG codes 329, 330, and 331 were used for major large bowel procedures with MCC, CC, and no complications, respectively. The DRG codes 332, 333, and 334 were used for rectal resections with MCC, CC, and no complications respectively. The DRG codes 405, 406, and 407 were used for hepatic resections with MCC, CC, and no complications, respectively. For DRG reimbursements of simultaneous resections, the model in question determined the appropriate reimbursement.

Treatment models and sensitivity analysis

A model (TreeAge Pro 2011; TreeAge Software, Inc) was created as a decision tree with branching nodes to represent the possibilities of simultaneous vs staged resections, major (≥ 3 segments) vs minor hepatic resections, and 1 or more complications vs no complications (at either operation for staged resections; Fig. 1). The base case model was predicated on all simultaneous resections billed using a hepatic

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