“En bloc” caudate lobe and inferior vena cava resection following cytoreductive surgery and hyperthermic intraperitoneal chemotherapy for peritoneal and liver metastasis of colorectal cancer

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Abstract

There are diverse protocols to manage patients with recurrent disease after primary cytoreductive surgery (CRS) with hyperthermic intraperitoneal chemotherapy (HIPEC) for peritoneal carcinomatosis. We describe a case of metachronous liver metastasis after CRS and HIPEC for colorectal cancer, successfully treated with a selective metastectomy and partial graft of the inferior vena cava. A 35-year-old female presented with a large tumour in the cecum and consequent colonic stenosis. After an emergency right colectomy, the patient received adjuvant chemotherapy. One year later she was diagnosed with peritoneal carcinomatosis, and it was decided to carry out a CRS/HIPEC. After 2 years of total remission, an isolated metachronous liver metastasis was detected by magnetic resonance imaging surveillance. The patient underwent a third procedure including a caudate lobe and partial inferior vena cava resection with a prosthetic graft interposition, achieving an R0 situation. The postoperative course was uneventful and the patient was discharged on postoperative day 17 after the liver resection. At 18-mo follow-up after the liver resection the patient...
remained free of recurrence. In selected patients, the option of re-operation due to recurrent disease should be discussed. Even liver resection of a metachronous metastasis and an extended vascular resection are acceptable after CRS/HIPEC and can be considered as a potential treatment option to remove all macroscopic lesions.

**Key words:** Cytoreductive surgery; Liver resection; Hyperthermic intraperitoneal chemotherapy; Colorectal cancer; Liver metastasis

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**Core tip:** Treatment of liver recurrence after a cytoreductive surgery and hyperthermic intraperitoneal chemotherapy is a great challenge. We report here the case of a young patient with metachronous liver metastases who was treated with a limited resection of segment I of the liver and vascular graft interposition of the inferior vena cava achieving a long-term survival. The surgical approach of these patients is extremely complicated and often requires complex major surgical procedures.

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### INTRODUCTION

Peritoneal carcinomatosis (PC) is the second most common presentation of metastatic colorectal cancer and is diagnosed in up to 4%-6% of these cases. Twenty five percent of these patients have the peritoneum as the only site of disseminated disease. PC was traditionally considered the last stage of the disease and was associated with a poor prognosis so that patients were often relegated to palliative systemic therapies. In recent decades multimodal PC treatment has made great advances; cytoreductive surgery (CRS), hyperthermic intraperitoneal chemotherapy (HIPEC) and systemic chemotherapy have shown promising results and have become standard therapy for PC patients in several countries. Various studies have reported that patients undergoing CRS with total macroscopic cytoreduction and HIPEC may achieve prolonged overall survival and potentially even a complete cure in selected patients [4,8,9].

Up to 80% of patients with PC of colorectal origin treated with CRS and HIPEC are likely to recur. In selected cases the possibility of a re-operation due to recurrence or even an extensive abdominal surgical procedure can be individually assessed. The data available on this approach show favourable long-term outcomes with similar morbidity and mortality to that of initial CRS/HIPEC [12-15]. Simultaneous or staged combined CRS and liver resections have also been performed with comparable morbidity and long-term results. In this report we describe the case of a young female patient with metachronous liver metastasis after CRS and HIPEC for colorectal cancer successfully treated by a selective liver and vascular resection.

### CASE REPORT

A 35-year-old female was referred to our emergency unit in February 2011, presenting with abdominal distension, pain, and vomiting for 3 d. Her medical history was only remarkable for asthma. Abdominal computed tomography (CT) was performed and revealed a large tumor in the cecum with consecutive colonic stenosis. The patient underwent an emergency right colectomy, and an R0 situation was achieved. Pathologic examination showed pT4a pN2a (4/22) cM0 poorly differentiated adenocarcinoma. Between March and August 2011 she received 12 cycles of adjuvant FOLFOX (folinic acid, 5-fluorouracil, and oxaliplatin). In February 2012 a CT scan identified lesions in the peritoneum with suspicions of peritoneal carcinomatosis. Our multidisciplinary tumour board decided on pursuing CRS with HIPEC. Abdominal exploration revealed widespread peritoneal carcinomatosis, especially in the pelvis and a large tumor mass in the left sub-diaphragmatic region with a peritoneal cancer index (PCI) of 14. Total parietal and diaphragmatic peritomectomy, protocoloectomy with an end ileostomy, terminal ileum resection, splenectomy, omentectomy, hysterectomy and bilateral salpingo-oophorectomy (CCR-0) were performed to remove the macroscopic tumor. HIPEC was carried out to treat the microscopic residual with mitomycin C, according to the closed-abdomen technique. The postoperative course was uneventful and the patient was duly discharged from hospital. At this time, no further chemotherapy was recommended as the patient had completed adjuvant chemotherapy after the first operation and a R0 situation was achieved. Adjuvant systemic chemotherapy, according to our institution protocols, is performed only in chemo naïve patients. From February 2012 until June 2014 the patient stayed free from recurrence. In July 2014 abdominal magnetic resonance imaging (MRI) surveillance revealed a solid tumor in segment I of the liver (Figure 1) so the patient underwent explorative laparotomy. During the procedure no evidence of a peritoneal recurrence was shown but many adhesions were found from the previous operations. A 4 cm tumor was identified in the caudate hepatic lobe infiltrating the inferior vena cava (IVC). The distal cava was mobilized towards the left renal vein and was divided at a level free of tumor.
Liver segment 1 was transected following the clamp-crushing technique and ICV cranial to the tumor was dissected and divided under the major suprahepatic trunks. Vascular continuity was restored using a prosthetic graft interposition sutured with a running suture of prolene 5/0 onto the proximal and distal IVC (Figure 2B). The postoperative course was mainly uncomplicated except for right pleural effusion, initially managed conservatively with diuretic therapy, and later by thoracocentesis. The patient was finally discharged on the 17th postoperative day. Pathological examination revealed a poorly differentiated adenocarcinoma with identical immunohistochemical phenotype as previously. At this point it was decided not to continue with chemotherapy, as a CCR-0 situation had been surgically achieved and the patient had completed the 12-cycle adjuvant treatment in the past (Table 1). Eighteen months after metastasis resection of the liver and 4 years after CRS and HIPEC, the patient shows no evidence of neoplastic disease.

**DISCUSSION**

After initial CRS and HIPEC, recurrences are mostly intra-abdominal, even if complete cytoreduction is achieved\(^{[17]}\). Protocols differ among the different institutions, thus a number of different treatments are applied in high-volume centres, including chemotherapy, tumour debulking or re-do surgery for intraabdominal metastasis.

The presence of synchronous liver metastases (LM) and PC was traditionally a contraindication for cytoreductive surgery. However, it has been shown that selected patients with low PCI and three or fewer LM can achieve prolonged survival if a liver resection is performed simultaneously\(^{[16,18]}\). A recent meta-analysis by Cuba et al\(^{[19]}\) shows improved overall survival (OS) in patients who were treated with CRS and HIPEC and curative treatment of LM as compared to patients treated with modern systemic chemotherapy alone.

Nevertheless, it remains unclear which approach should be used in patients with isolated metachronous LM, as in our case report. Iterative cytoreductive surgery is feasible in cases of recurrence and appears to be worthwhile in terms of long-term outcomes\(^{[20]}\). The study by Sugarbaker and colleagues was on one of the largest series and included 70 patients with PC of colorectal origin\(^{[15]}\). This study showed that 53% of the patients had at least one reoperation after the initial cytoreduction. The overall survival of patients with repeated surgery approach was significantly longer (39 mo vs 20 mo). Brouquet et al\(^{[13]}\) reported on a cohort of 20 patients with repeat CRS + intraperitoneal chemotherapy (IPC) for isolated peritoneal tumour recurrence of all origins. Five- and 10-year overall survival (OS) rates were 72.5% and 58.1% respectively.

Even though they studied selected groups of patients, the studies by Sugarbaker and Brouquet underline the possibility of highly favourable outcomes and even long-term survival in palliative patients with recurrence of peritoneal carcinomatosis.

In this context, the study by Kianmanesh et al\(^{[12]}\) included 43 patients with PC of colorectal cancer origin who underwent CRS/HIPEC and specifically evaluated the role of simultaneous liver resection. They concluded that patients with colorectal PC, iterative CRS and HIPEC achieved appreciable long-term survival and that liver metastasis resection did not negatively influence the postoperative outcomes. However, they...
Sánchez-Velázquez P et al. Caudate lobe resection after CRS and HIPEC

Table 1  History and detail surgical treatment of our patient’s disease

| Time point | Diagnosis | Procedure |
|------------|-----------|-----------|
| 2011       | Stenotic tumour of the cecum | Right Colectomy |
|            |          | Adjuvant chemotherapy (12 cycles with folinic acid, 5-fluorouracil, and oxaliplatin) |
| 2012       | Peritoneal carcinomatosis PCI = 14 | CRS (CCR-0) |
|            | Peritoneal carcinomatosis PCI = 14 | Total parietal and diaphragmatic Peritoneectomy |
|            | Peritoneal carcinomatosis PCI = 14 | Proctocolectomy with end ileostomy |
|            | Peritoneal carcinomatosis PCI = 14 | Terminal ileum resection |
|            | Peritoneal carcinomatosis PCI = 14 | Splenectomy |
|            | Peritoneal carcinomatosis PCI = 14 | Omentectomy |
|            | Peritoneal carcinomatosis PCI = 14 | Hysterectomy |
|            | Peritoneal carcinomatosis PCI = 14 | Bilateral salpingo-oophorectomy |
|            | Peritoneal carcinomatosis PCI = 14 | HIPEC |
| 2014       | Liver metastases segment Ⅰ with IV/C infiltration | Resection of liver segment Ⅰ |
|            | Liver metastases segment Ⅰ with IV/C infiltration | Partial resection of IV/C with prosthetic graft interposition |
|            | liver metastases segment Ⅰ with IV/C infiltration | Cholecystectomy |
|            | liver metastases segment Ⅰ with IV/C infiltration | Partial adrenalectomy |
| 2016       | No evidence of neoplastic disease |                     |

PCI: Peritoneal cancer index; CRS: Cytoreductive surgery; HIPEC: Hyperthermic intraperitoneal chemotherapy.

did not specify whether an extended vascular resection was performed or if liver resections were performed in cases of metachronous LM.

Achieving complete cytoreduction in most cases is challenging and implies an aggressive approach combining major surgical procedures not exempt from complications. In selected cases, as in the one presented here, the option of re-do surgery for liver metastasis is feasible. Even extended vascular resection is acceptable after CRS/HIPEC and can be considered as a potentially curative treatment option. Early detection of tumour recurrence through a close follow-up is essential, as well as a multidisciplinary assessment of patient selection. The patients should then be referred to a centre specialized in the treatment of peritoneal and liver metastases. In the present case, staged resection of both metastatic sites achieved long-term survival for a young female patient. To our knowledge, this is this first report on liver resection due to metachronous liver metastases following CRS and HIPEC.

Imaging diagnosis
MRI showed a solid tumor in segment 1 of the liver.

Pathological diagnosis
pT4a pN2a (4/22) cM0 poorly differentiated adenocarcinoma.

Treatment
Complete surgical excision of lesion.

Related reports
There are currently no other reports of surgical excision of a liver metastasis in the caudate lobe two years after a cytoreductive surgery.

Experiences and lessons
The report is good example of patient tailored treatment in cases where guidelines are missing or suggest only palliative or best supportive care. It is also novel to perform such an extensive surgery after cytoreductive surgery and HIPEC.

Peer-review
The paper is well written.

REFERENCES
1 Lemmens VE, Klaver YL, Verwaal VJ, Rutten HJ, Coebergh JW, de Hingh IH. Predictors and survival of synchronous peritoneal carcinomatosis of colorectal origin: a population-based study. Int J Cancer 2011; 128: 2717-2725 [PMID: 20715167 DOI: 10.1002/ijc.25596]
2 Esquivel J. Cytoreductive surgery and hyperthermic intraperitoneal chemotherapy for colorectal cancer: survival outcomes and patient selection. J Gastrointest Oncol 2016; 7: 72-78 [PMID: 26941985]
3 Esquivel J, Sticca R, Sugarbaker P, Levine E, Yan TD, Alexander R, Baratti D, Bartlett D, Barone R, Barrios P, Bieilig S, Bretcha-Boix P, Chang CK, Chu F, Chu Q, Daniel S, de Bree E, Deraco M, Dominguez-Parra L, Elias D, Flynn R, Foster J, Garofalo A, Gilly FN, Glehen O, Gomez-Portilla A, Gonzalez-Bayon L, Gonzalez-Moreno S, Goodman M, Gushchin V, Hanna N, Hartmann J, Harrison L, Hoefer R, Kane J, Kecmanovic D, Kelley S, Kuhn J, Lamont J, Lange J, Li B, Loggie B, Mahteme H, Mann G, Martin R, Mish RA, Moran B, Morris D, Onate-Ocana L, Petrelli N, Philippe G, Pingnan J, Pitroff A, Pizzo P, Quinones M, Riley L,
Rustein L, Saha S, Alrawi S, Sardi A, Schneebaum S, Shen P, Shibata D, Spellman J, Stojadinovic A, Stewart J, Torres-Melero J, Tuttle T, Verwaal V, Villar J, Wilkinson N, Younan R, Zeh H, Zoetmulder F, Sebag G. Cytoreductive surgery and hyperthermic intraperitoneal chemotherapy in the management of peritoneal surface malignancies of colonic origin: a consensus statement. Society of Surgical Oncology. Ann Surg Oncol 2007; 14: 128-133 [PMID: 17072675 DOI: 10.1245/s10434-006-9185-7]

4 Verwaal VJ, van Rutten S, de Bree E, van Sloothen GW, van Tinteren H, Boot H, Zoetmulder FA. Randomized trial of cytoreduction and hyperthermic intraperitoneal chemotherapy versus systemic chemotherapy and palliative surgery in patients with peritoneal carcinomatosis of colorectal cancer. J Clin Oncol 2003; 21: 3737-3743 [PMID: 14551293 DOI: 10.1200/JCO.2003.04.187]

5 Franko J, Iriamth Z, Gusani NJ, Holtzman MP, Bartlett DL, Ibrahim Z, Gusani NJ, Holtzman MP, Bartlett DL, Ibrahim Z. The second procedure combining complete cytoreductive surgery and intraperitoneal chemotherapy for isolated peritoneal recurrence: postoperative course and long-term outcome. Ann Surg Oncol 2009; 16: 2744-2751 [PMID: 19626375 DOI: 10.1245/s10434-009-0611-5]

6 Piso P, Arnold D. Multimodal treatment approaches for peritoneal carcinosis. Dtsch Ärzteblatt Int 2011; 108: 802-808

7 Elias D, Gilly F, Boutitie F, Quenet F, Bereder JM, Mansvelt B, Lormier G, Dubè P, Glehen O. Peritoneal colorectal carcinomatosis: incidence and current treatment strategies. J Clin Oncol 2010; 28: 63-68 [PMID: 19917863 DOI: 10.1200/JCO.2009.23.9285]

8 Piso P, Arnold D. Multimodal treatment approaches for peritoneal carcinosis in colorectal cancer. Dtsch Ärzteblatt Int 2011; 108: 802-808

9 Elias D, Gilly F, Boutitie F, Quenet F, Bereder JM, Mansvelt B, Lormier G, Dubé P, Glehen O. Peritoneal colorectal carcinomatosis treated with surgery and perioperative intraperitoneal chemotherapy: retrospective analysis of 523 patients from a multicentric French study. J Clin Oncol 2010; 28: 63-68 [PMID: 19917863 DOI: 10.1200/JCO.2009.23.9285]

10 Koppe MJ, Boerman OC, Oyen WJ, Bleichrodt RP. Peritoneal carcinomatosis of colorectal origin: incidence and current treatment strategies. Ann Surg 2006; 243: 212-222 [PMID: 16432354 DOI: 10.1097/01.sla.0000197702.46394.16]

11 Cavaliere F, De Simone M, Virzi S, Deraco M, Rossi CR, Garofalo A, Di Filippo F, Gianarelli D, Vaira M, Valle M, Pilati P, Perri P, La Pinta M, Monsellato I, Guadagni F. Prognostic factors and oncologic outcome in 146 patients with colorectal peritoneal carcinomatosis treated with cytoreductive surgery combined with hyperthermic intraperitoneal chemotherapy: Italian multicenter study. S.T.I.T.L.O. Eur J Surg Oncol 2011; 37: 148-154 [PMID: 21093205 DOI: 10.1016/j.ejso.2010.10.014]

12 Mirnezami R, Moran BJ, Harvey K, Cecil T, Chandrakumaran K, Carr N, Mohamed F, Mirnezami AH. Cytoreductive surgery and intraperitoneal chemotherapy for colorectal peritoneal metastases. World J Gastroenterol 2014; 20: 14018-14032 [PMID: 25320542 DOI: 10.3748/wjg.v20.i38.14018]

13 Kianmanesh R, Scaringi S, Sabate JM, Castel B, Pons-Kerjean N, Coffin B, Hay JM, Flament Y, Msika S. Iterative cytoreductive surgery associated with hyperthermic intraperitoneal chemotherapy for treatment of peritoneal carcinomatosis of colorectal origin with or without liver metastases. Ann Surg 2007; 245: 597-603 [PMID: 17414609 DOI: 10.1097/01.sla.0000255561.87771.11]

14 Brouquet A, Goéré D, LeFèvre JH, Bonnet S, Dumont F, Raynard B, Elias D. The second procedure combining complete cytoreductive surgery and intraperitoneal chemotherapy for isolated peritoneal recurrence: postoperative course and long-term outcome. Ann Surg Oncol 2009; 16: 2744-2751 [PMID: 19626375 DOI: 10.1245/s10434-009-0611-5]

15 Vassos N, Förtisch T, Aladashvili A, Hohenberger W, Croner RS. Repeated cytoreductive surgery (CRS) with hyperthermic intraperitoneal chemotherapy (HIPEC) in patients with recurrent peritoneal carcinomatosis. World J Surg Oncol 2016; 14: 42 [PMID: 26912149 DOI: 10.1186/s12957-016-0804-x]

16 Bijelic L, Yan TD, Sugarbaker PH. Treatment failure following complete cytoreductive surgery and perioperative intraperitoneal chemotherapy for peritoneal dissemination from colorectal or appendiceal mucinous neoplasms. J Surg Oncol 2008; 98: 295-299 [PMID: 18726900 DOI: 10.1002/jso.21108]

17 Maggioli L, Goéré D, Viana B, Tzanis D, Dumont F, Honoré C, Eveno C, Elias D. Should patients with peritoneal carcinomatosis of colorectal origin with synchronous liver metastases be treated with a curative intent? A case-control study. Ann Surg 2013; 258: 116-121 [PMID: 23207243 DOI: 10.1097/SLA.0b013e3182778089]

18 Verwaal VJ, Boot H, Alemán BM, van Tinteren H, Zoetmulder FA. Recurrences after peritoneal carcinomatosis of colorectal origin treated by cytoreduction and hyperthermic intraperitoneal chemotherapy: location, treatment, and outcome. Ann Surg Oncol 2004; 11: 375-379 [PMID: 15070596 DOI: 10.1245/ASO.2004.08.014]

19 Elias D, Faron M, Iuga BS, Honoré C, Dumont F, Bourgain JL, Dartigues P, Ducreux M, Goéré D. Prognostic similarities and differences in optimally resected liver metastases and peritoneal metastases from colorectal cancers. Ann Surg 2015; 261: 157-163 [PMID: 24509197 DOI: 10.1097/SLA.0000000000000582]

20 de Cuba EM, Kwakman R, Knol DL, Bonjer HJ, Meijer GA, Te Velde EA. Cytoreductive surgery and HIPEC for peritoneal metastases combined with curative treatment of colorectal liver metastases: Systematic review of all literature and meta-analysis of observational studies. Cancer Treat Rev 2013; 39: 321-327 [PMID: 23244778 DOI: 10.1016/j.ctrv.2012.11.003]

21 Esquivel J, Sugarbaker PH. Second-look surgery in patients with peritoneal dissemination from appendiceal malignancy: analysis of prognostic factors in 98 patients. Ann Surg 2001; 234: 198-205 [PMID: 11505065 DOI: 10.1097/01.sla.00000658-20010800-00009]

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