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Clinical features and surgical outcomes of major urological interventions during cytoreductive surgery and hyperthermic intraperitoneal chemotheraphy

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Abstract

Background: Urinary system resections and reconstructions are needed in peritoneal carcinomatosis due to abdominal malignancies. The effect of hyperthermic intraperitoneal chemotherapy on these urological procedures after reconstruction remains uncertain. The aim of the study is to evaluate major urological interventions during cytoreductive surgery and hyperthermic intraperitoneal chemotherapy in complex abdominal malignancies with peritoneal carcinomatosis.

Methods: Forty-four cases underwent surgical intervention related to the urinary system among 208 cases who underwent cytoreductive surgery and hyperthermic intraperitoneal chemotherapy because of peritoneal carcinomatosis. Urinary system procedures performed in these patients (radical-partial cystectomy, partial ureter resection ureteroneocystostomy, ureteroureterostomy, nephrectomy) were evaluated in terms of postoperative morbidity–mortality and survival.

Results: Urinary system resections were performed during cytoreductive surgery in a total of 44 cases. The mean age was 54 years (20–73). Patients were diagnosed with peritoneal carcinomatosis due to colorectal cancer in 21 (47.8%), ovarian cancer in nine (20.4%), sarcomatosis in five (11.4%), cervical cancer in four (9%) and other cancers (mesothelioma, uterus, breast, gastric) in five (11.4%) cases. Total nephrectomy was performed in three cases and partial nephrectomy in one case. Cystectomy was performed in 21 cases; 16 of these were partial and five were total cystectomies. Ureteroureterocystostomy with double J was performed in four cases and ureteroneocystostomy in 12 cases. While Clavian–Dindo grade 3–4 complications were seen in nine cases (20.4%), three cases (6.8%) became exitus during the first 30-day follow-up.

Conclusions: Although urinary system involvements have been regarded as inoperable in the past, we think that with adequate experience radical urinary interventions performed in suitable patients can be carried out with acceptable morbidity and mortality as seen in our series.

Keywords: cytoreductive surgery, nephrosthomy, peritoneal carcinomatosis, ureteroneocystostomy, ureteroureterostomy

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Introduction

In addition to abdominal visceral and parietal involvement, involvement of pelvic organs and pelvic peritoneum also frequently occurs in peritoneal carcinomatosis (PC). While ureter and bladder involvements were considered inoperable

in cytoreductive surgery (CRS) until the last decade, the recent introduction of advanced treatment centers for these end-stage tumors, the presence of surgical teams specialized in this topic, and experience gained due to their increased high volumes have led surgeons to question these resections, and have caused the possibility of performing these urological interventions and a change in this mentality.[1,2]

Leaving tumor-free areas within the abdomen is essential for a complete optimal CRS. Recognition and familiarity of these lesions by radiologists in the interpretation of magnetic resonance imaging (MRI) and computed tomography (CT) images has made an undeniable contribution to surgeons performing CRS. However, recognition of lesions below 0.5 cm and of invasions of ureter and bladder, which are retroperitoneal organs, still brings difficulties in pre-op testing that need to be solved. For successful CRS and hyperthermic intraperitoneal chemotherapy (CRS + HIPEC), it is essential that resection of involved abdominal organs in a tumor-free fashion and peeling of visceral and parietal peritoneum, that is, briefly, the R0 procedure, is successful. Primary and secondary intra-abdominal tumors can occasionally pass this point due to the tumor growth and aggressive course because of close vicinity with each other, especially in the narrow pelvic space, during their primary and secondary surgeries, and invade urologic organs like kidneys, ureters, bladder, seminal vesicles and prostate.

With the concomitant increase in our clinical experience resulting from the high volume of CRS + HIPEC performed in our clinic in the last 4 years, we currently perform major urinary system resections targeting R0 surgery during CRS. We aimed in this study to present the early-stage results of major urological interventions and resections we perform in this subject, which has little information in world literature and no related randomized controlled studies.

Methods

Data of 208 cases who underwent CRS + HIPEC because of PC and whose data were prospectively recorded at Health Sciences University Umraniye Teaching and Research Hospital between May 2016 and May 2020 were retrospectively analyzed. Written informed consent was obtained from the study participants and the ethics committee of Umraniye Teaching and Research Hospital approved the study (numbered 2020/219). Cases that underwent surgery related to the urinary system were separated, and a form was prepared for each patient. Major urological interventions were found to be performed in a total of 44 cases. Other data pertaining to the patients were accessed from the hospital information system. Demographic data of the cases [gender, age, ASA (American Society of Anesthesiologists)] score, ECOG (Eastern Cooperative Oncology Group) score, body surface area (BSA), diagnosis, preoperatively performed surgical interventions (additional organ resections), urinary system interventions performed (radical-partial cystectomy, partial ureter resection, ureteroneocystostomy, ureteroureterostomy, total-partial nephrectomy, primary repair of bladder injury), peroperatively administered chemotherapy protocol, duration of surgery, peritoneal carcinomatosis index (PCI), completeness of cytoreduction (CC) score, duration of intensive care unit (ICU) and hospital stay were evaluated in terms of postoperative morbidity–mortality and short-term survival.

Preoperative diagnoses of the cases were colorectal tumors in 21 (47.8%), ovarian cancer in nine (20.4%), sarcomatosis in five (11.4%), cervical cancer in four (9%) and other cancers (uterus, gastric, breast, mesothelioma) in five (11.4%) cases. Of these 44 patients, 23 (52.3%) were primary patients, while 21 (47.7%) had prior surgical interventions. Seven (16%) had undergone total abdominal hysterectomy + bilateral salpingo-oopherectomy (TAH + BSO), five (11%) redo CRS, four (9%) laparascopic low anterior resection, and five (11%) other surgeries (anterior resection for sigmoid colon cancer, total gastrectomy for gastric cancer, breast-conserving surgery for breast cancer, cadaveric liver transplantation for liver cirrhosis).

The patients with an ECOG score of 0–2 were prepared preoperatively. The patients with malnutrition were seen by a dietitian. All patients underwent thoraco-abdominopelvic triphasic CT scan, and lower, upper abdominal and pelvic dynamic diffusion MRI scan. If the work-up of a patient referred from another center was uncertain and insufficient, it was repeated. Cases with radiologically detected hepatoduodenal ligament, celiac and superior mesenteric vascular involvement, multiple metastases in the liver and distant organ metastases were referred to the medical oncology unit for neoadjuvant or palliative

therapy because of radiologic irresectability. The decision of diagnostic laparoscopy was made in patients at the radiologic limit. All patients were evaluated at a multidisciplinary oncology council. The patients were seen by an enhanced recovery after surgery (ERAS) nurse before, during and after surgery and a strict ERAS program was applied.

Cystoscopic bilateral ureter stent was placed at the operating table before starting surgery in patients planned to re-operate because of redo surgery and with suspicious signs of ureter invasion in radiologic imaging. In order to avoid unnecessary laparotomy, suspicious cases were checked by inserting a camera port through the umbilical region with the aid of open Hasson technique. The extent of the patient's abdominal tumor was calculated with the PCI score described by Sugarbaker.[3] The cut-off values taken into consideration were 13 in gastric cancer, 18 in colorectal cancers, and 20 in ovarian, uterus and cervical cancers. Cut-off values were not taken into consideration in breast cancer, mesothelioma and sarcomatosis. The CRS procedure was performed in the fashion described by Sugarbaker.[3] The same urology specialist attended all surgeries. Every effort was made to conserve the kidney and bladder as much as possible. While partial nephrectomy was performed in cases invading the kidney together with the Gerota fascia in the retroperitoneum and requiring partial removal of renal tissues, total nephrectomy was performed when the tumor invaded the renal hilus and the kidney could not be preserved. Ureter tissues invaded by the tumor, with poor viability following dissection and reduced function, were excised. In cases with ureter involvement, ureteroureterostomy was performed after resection with double J stent. When this procedure could not be performed, the ureters were tied and nephrostomy was applied to the kidneys in the post-op period. In tumors close to the ureterovesical junction, the ureter and bladder were partially excised and after freeing the bladder, a tension-free ureteroneocystostomy was performed with a double J stent. In cases with bladder injury during pelvic dissection and with partial bladder invasion, invasion areas were excised and the bladder was sutured in two layers. In patients who underwent total cystectomy, ureters were matured to the lower right quadrant by forming an ileal conduit after resection of the ileal segment in the terminal ileum. After all the anastomoses were performed, a loop ileostomy and/or an ileal conduit was created. As abdominal closure was performed, colorectal tumors were intravenously treated using 5-fluorouracil (5FU; 400 mg/m^2 BSA) + leucovorin (LOC; 20 mg/m^2 BSA). The skin was closed using stapler or prolene sutures, and intraperitoneal HIPEC procedure was initiated. For colorectal tumors oxaliplatin (OXA; 300 mg/m^2 BSA) in 5% dextrose was administered at 42–43°C for 30 min. The patients with ovarian, cervical, uterus, gastric cancers, sarcomatosis and mesothelioma were intraperitoneally injected with cisplatin (CIS; 75 mg/m^2 BSA) + doxorubicin (DOXO; 15 mg/m^2 BSA) in 0.9% NaCl solution for 60 min. The patient with breast carcinoma was intraperitoneally injected with CIS (75 mg/m^2 BSA) for 60 min. During this procedure, intra-abdominal body temperature was measured using a probe placed in the esophagus. The patients who were administered with OXA were monitored for blood sugar levels using the Belmont Hyperthermia Pump (Belmont Instrument Corporation, Billerica, MA, USA). After the procedure, the patients were transferred to the ICU.

Statistical analyses

The data obtained from raw data were recorded to IBM SPSS Statistics 22 (IBM SPSS, Turkey) software and analyzed. The numerical data obtained were summarized in tables as arithmetic mean, ± standard deviation, minimum, maximum and range values. The nominal and ordinal data were evaluated as frequency and percentages. Finally, overall survival was calculated by using Kaplan–Meier survival analysis available in the same software.

Results

Urinary system interventions (radical-partial cystectomy, ureteroneocystostomy, ureteroureterostomy, total-partial nephrectomy and primary repair of bladder injury) were performed during CRS in a total of 44 cases. When the cases were evaluated regarding age and gender, the mean age of all the cases was 54 years (20–73), whereas the mean age of 30 female patients was 54.2 years (25–73 years) and that of 14 male patients was 53.5 years (20–72 years). Preoperative evaluation revealed colorectal carcinoma in 21 (47.8%), ovarian cancer in nine (20.4%), sarcomatosis in five (11.4%), cervical cancer in four (9%) and other cancers (mesothelioma, uterus, breast, gastric cancer) in five patients (11.4%).

Among the patients, 21 (47.7%) had a history of prior surgery, while 23 (52.3%) were primary surgery patients. Among the patients who had undergone prior surgery, five had been operated on for redo CRS, seven had undergone TAH + BSO because of gynecologic malignancies, and four had undergone laparoscopic anterior resection. Of the remaining five patients, one patient had previously received a cadaveric liver transplant because of liver cirrhosis, while the others were patients who had undergone total gastrectomy for gastric cancer, anterior resection for sigmoid cancer and breast-conserving surgery for breast cancer.

The ECOG scores of the cases were 0 in 37 cases (75.5%), 1 in nine cases (18.3%) and 2 in three cases (6.1%). The mean BSA of the cases was 1.76 (1.3–2.02). The mean duration of surgery was 7.9 h (4–18). The mean PCI score was 14 (3–39). A CC score of 0–1 was achieved in 47 patients (95.7%), while two patients (4%) had a CC score of 2. Mean stay in the ICU was 3 days (0–19 days), and mean hospital stay of all the cases was 8 days (4–31 days) (Table 1). All CRS and urologic procedures were performed by the same four surgeons.

A Foley catheter was placed into the bladder during pelvic dissection of CRS in all the cases. Bladder injury occurred in eight patients because of the difficulty in dissection planes during stripping of the peritoneum over the bladder by inflating the bladder with 200 cc of saline. The defects in these injuries were repaired with primary closure over two layers. Total right nephrectomy was performed in three patients with renal involvement, and partial left nephrectomy was performed in one patient with distal renal involvement. Cystectomy was performed in a total of 21 cases. While 16 of these were carried out as partial cystectomy + two layers of primary repair, total cystectomy was performed in five cases. Ileal conduit was created in three of the five cases who underwent total cystectomy, and in two cases, resection of bilateral ureters had been performed, therefore, ureters could not be technically anastomosed to the ileal conduit, so these ureters were tied at the proximal end and a nephrostomy procedure was performed postoperatively. Partial ureter resection was performed in a total of four patients because of ureter involvement, two on the right and two on the left. The piece was sent to frozen section for proximal and distal borders. Ureteroureterostomy was performed with double J stents. Ureteroneocystostomy was performed in a total of 12 patients because of tumoral implants at the ureterovesical junction, eight on the right and four on the left. In a total of seven patients, ureters were ligated because of involvement of the long segment and loss of function and a nephrostomy was created in the postoperative period (Figure 1a–d). Three of these nephrostomies were bilateral, and one each was performed on the right and left with nephrostomies being performed in a total of seven patients (Table 2). After the gastrointestinal and urologic anastomoses, HIPEC drains and thermal probes were placed in the abdomen. The fascia and the skin were closed and hyperthermic intraperitoneal chemotherapy was administered.

The ureter catheters placed with the aid of cystoscopy were pulled at the operating table postoperatively and the Foley catheter was removed on day 14 in bladder injury and primary repair, and double J catheters 6 weeks later at the urology outpatient clinic by the urology specialist who performed the surgery. Oxaliplatin was used in the cases undergoing nephrectomy because they were of colorectal origin and neither renal failure nor elevated creatinine levels developed in these cases. During the follow-up, one case was reoperated because of intra-abdominal hematoma, one case because of anastomosis leak and one case because of evisceration. Pleural effusion developed in three cases and the fluid was drained with a pleuracan. Transfusion related acute lung injury (TRALI) syndrome developed in one case. Positive results were obtained with supportive therapy in the intermediate ICU and correction of hypoxemia. Creatinine was sent from the abdominal drains of all patients postoperatively. Urinary leakage was considered to be positive in cases with drain creatinine threefold that of serum creatinine. Urinary leakage was detected in three patients with elevated drain creatinine. Interventional radiologic investigations revealed that leakages originated from the right ureteroneocystostomy, left ureteroureterostomy and from the areas of primary repair following partial bladder resection. Improvement was achieved with percutaneous drainage catheter for intra-abdominal urinoma, conservative follow-up and bilateral nephrostomy, respectively. Neurogenic bladder developed in one case in the late stage and follow-up with a permanent Foley catheter was decided. Clavian–Dindo 3A, 3B, 4A

Table 1. Patients' demographics.

Features		Median (SD)
Age (years)	Total	54 (20–73)
	Male	53.5 (20–72)
	Female	54.2 (25–73)
Gender *n*, %	Male	14 (31.8)
	Female	30 (68.2)
Body surface area (BSA) (du Bois) median		1.76 (1.3–2.02)
WHO/ECOG score *n*, %	0	37 (75.5)
	1	9 (18.3)
	2	3 (6.1)
Peritoneal Carcinomatosis Index score (PCI) median		14 (3–39)
Completeness of cytoreduction (CC) score *n*, %	0–1	47 (95.9)
	2	2 (4)
ICU stay (days) median		3 (0–19)
Hospital stay (days) median		8 (4–31)
Diagnosis *n*, %	Colorectal	21 (47.8)
	Ovary	9 (20.4)
	Sarcomatosis	5 (11.4)
	Cervix	4 (9)
	Others (uterus, stomach, breast, mesothelioma)	5 (11.4)
Operation time (hours) median		7.9 (4–18)
Prior surgery *n*, %		21 (47.7)
	TAH + BSO	7
	RedoCRS	5
	Lap.LAR	4
	Others (AR, TG, BSS, OLTx)	5
	None	23 (52.3)

AR, anterior resection; BSS, breast-sparing surgery; ICU, intensive care unit; Lap.LAR, laparoscopic low anterior resection; OLTx, orthotopic liver transplantation; RedoCRS, redo cytoreductive surgery; SD, standard deviation; TAH + BSO, total abdominal hysterectomy + bilateral salphingo-oopherectomy; TG, total gastrectomy; WHO/ECOG, World Health Organization/Eastern Cooperative Oncology Group.

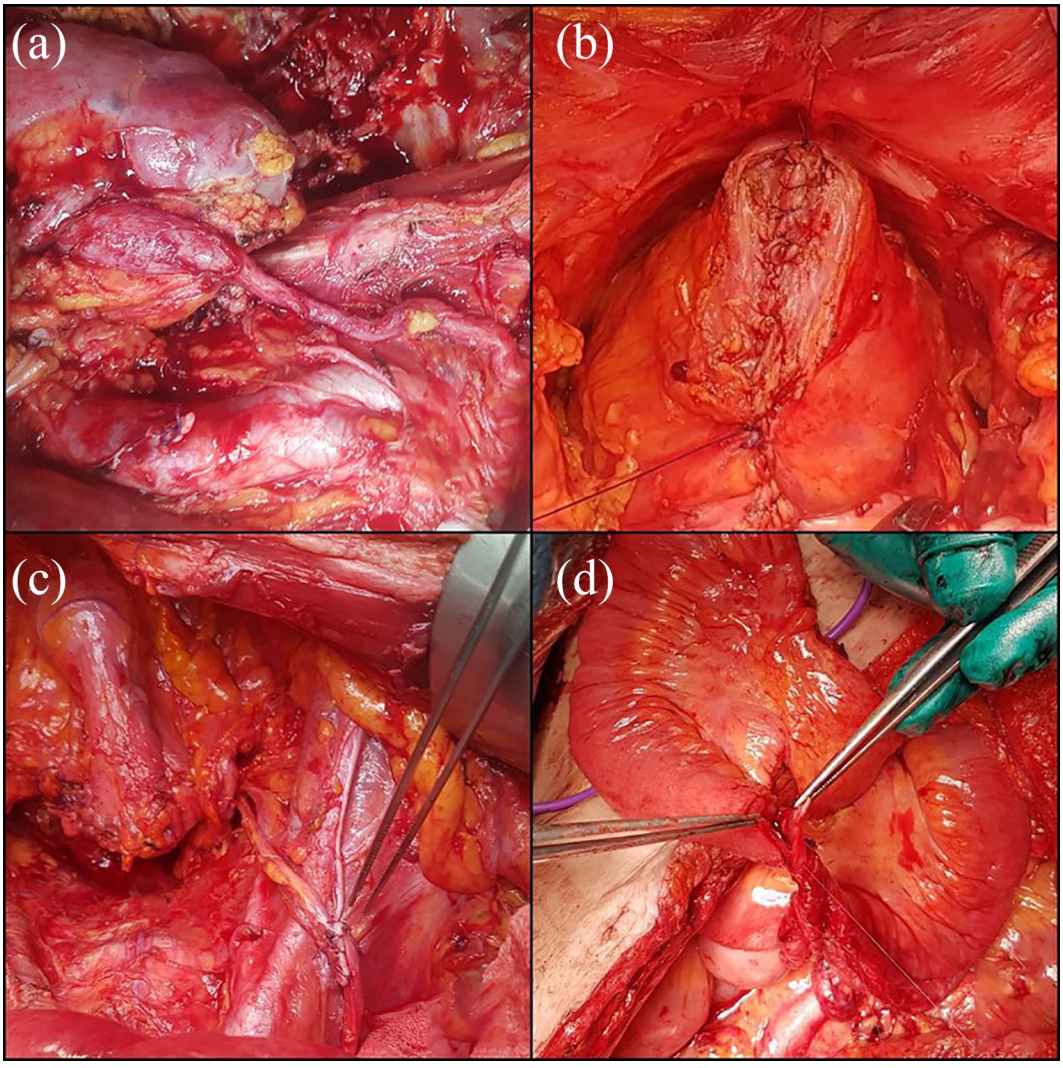

Figure 1. (a) Kidney and ureter dissection during cytoreductive surgery; (b) Partial bladder excision and primary closure; (c) Right ureteroureterostomy after partial ureter resection; and (d) Preparation of ileal conduit.

complications were seen in nine cases (20.4%) in the entire CRS group and three cases (6.8%) became exitus during the first 30-day follow-up (pulmonary embolism, myocardial infarction, pneumonia). Median overall survival was 30 months. The 1-year, 2-year and 3-year survival rates were 71%, 65% and 60%, respectively.

The patients were regularly followed up. The patients who did not show up in the clinic were reached *via* telephone and social communication channels and they presented at the outpatient clinic. The patients were followed every 3 months during the first 2 years, and every 6 months after the second year by the same doctors at the surgical oncology outpatient clinic. In the second month, two patients were lost due to pulmonary embolism and myocardial infarction (MI). Two cases could not be reached after the second month because they live abroad, and were removed from follow-up. One patient each was lost in the third and fourth months due to pneumonia and COVID 19, and two patients were lost in the sixth month and one patient in the 24th month because of re PC (Table 3). The mean follow-up of the cases was 15 months SD 13.57 (3.5 months–3 years 7 months). The median overall survival was 30 months. Figure 2 and Table 4 summarize the survival outcomes of the patients who underwent urologic interventions.

Discussion

While major urologic invasions like ureter, bladder and renal involvements have been accepted as irresectability criteria in cases with PC until the

Table 2. Urological procedures performed.

Procedures (*n*, %)		**Number of cases (SD)**
Nephrectomy *n*, %		4 (100)
	Total	3 (75)
	Partial	1 (25)
Cystectomy *n*, %		21 (100)
	Total	5 (24)
	Partial	16 (76)
Cystoraphy *n*,	8	8
Ureteroureterostomy *n*, %		4 (100)
	Right	2 (50)
	Left	2 (50)
Ureteroneosystostomy *n*, %		12 (100)
	Right	8 (66.6)
	Left	4 (33.4)
Ileal conduit *n*	3	3
Ureter ligation + nephrostomy Total *n*, %		7 (100)
	Right ureter ligation + nephrostomy	1 (14.4)
	Left ureter ligation + nephrostomy	3 (42.8)
	Bilateral ureter ligation + nephrostomy	3 (42.8)

n, number; SD, standard deviation.

Table 3. Morbidity and mortality.

Clavien–Dindo complication score *n*, %	
3A Requiring surgical, endoscopic or radiological intervention not under general anesthesia	5 (11.4) (3 Pleural effusion, 1 bilateral nephrostomy, 1 drainage for urinoma)
3B Requiring surgical, endoscopic or radiological intervention under general anesthesia	3 (6.8) (1 intra-abdominal hematoma, 1 anastomosis leakage, 1 evisceration)
4 Life-threatening complication requiring IC/ICU-management	1 (2.2) (TRALI syndrome)
5 Death of a patient	3 (6.8) (1 MI, 1 Pulmonary embolism, 1 pneumonia)
Follow-up range (days)	30 mo (3.5 mo–3 y 7 mo)

IC, intensive care; ICU, intensive care unit; MI, myocardial infarction; mo, month; *n*, number; TRALI, transfusion related acute lung injury; y, year.

last decade, recently these procedures are performed in high-volume specific centers, and when compared with groups not undergoing this surgery, it is seen that they do not significantly increase morbidity and mortality.[4–10]

CRS + HIPEC has made a major breakthrough in advanced stage cancer therapy in the last 30 years, with morbidity rates reaching nearly 25–41% and mortality rates 0–8% in high-volume centers in selected patient groups (ASA 1–2, ECOG 0–1 and low PCI) in PC.[11] Tan *et al.* have performed urological resection and reconstruction in 21 of 214 CRS cases in their own series and have reported a urological procedure rate of 9.8%.[12] It has also been reported in the literature that there is a need for urological procedures at a mean rate of 7–20%.[7–9]

In the meta-analysis of Seretis *et al.*, CRS + HIPEC was reported to be a revolutionary management and in five studies out of six, genitourinary resection and reconstruction did not negatively impact overall postoperative morbidity and mortality rates.[10] In the meta-analysis by Votanopoulos *et al.*, peritoneal surface disease did not increase overall surgical morbidity, and urological involvement should not be considered a contraindication for CRS + HIPEC in patients with resectable peritoneal surface disease.[6] Cascales *et al.* have operated on seven patients for distal ureter and bladder involvement for primary and recurrent ovarian PC and have shown the feasibility of CRS + HIPEC with acceptable morbidity rates.[13] Braam *et al.* have reported in their study on 267 CRS + HIPEC cases that gastrointestinal leakage and fistula were more frequently encountered in those undergoing urological surgery (24% leakage and 10% fistula), operation time, blood loss, and length of hospital stay were statistically increased, but urologic procedures were needed in CRS + HIPEC candidates at rates between 7% and 20% and these morbidities had no adverse effect on the survival of patients treated with CRS + HIPEC.[8]

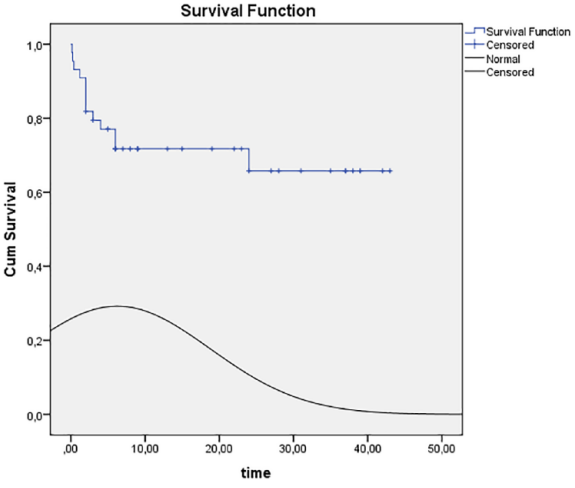

Figure 2. Kaplan–Meier graph.

Leapman *et al.* performed urological reconstruction in 34 of 170 CRS patients (20%); median follow-up was 9.4 months, partial cystectomy was performed in 65% and segmental ureteral resection in 31%, intestinal anastomosis and high number of resected organs were higher in the group with genitourinary resection and these procedures did not increase major morbidity.[5] In their CRS + HIPEC series consisting of 598 cases, Honore *et al.* have performed urologic resections on 48 cases (8%); 57% of these were partial cystectomies and bladder repair, 38% were segmental ureteral resections, and while morbidity was seen at a rate of 41%, urinary fistula developed at a rate of 12%. In addition, they showed that CRS + HIPEC was not contraindicated in genitourinary reconstructions and that preoperative malnutrition and a PCI level of greater than 20 contributed to the formation of fistula.[4] In the retrospective, comparative, case-matched multicenter study of Pinar *et al.*, it was reported that re-implantation should be the preferred technique because the rate of fistula formation was 0% *versus* 28% in 14 cases who underwent end-to-end anastomosis or re-implantation in ureteral

Table 4. Survival in patients who underwent major urological interventions.

	Overall	Survivals, %		
	Median survival months (95% CI)	1-year	2-year	3-year
CRS + HIPEC patients requiring major urological interventions	30 (24–36)	71	65	60

reconstructions.[14] In the 103 CRS + HIPEC cases performed by Trujillo *et al.*, urinary tract injury occurred in 7% of the cases, urinary tract infection in 21%, post-renal failure in 4%, urinary fistula in 4% and acute urinary retention in 1%, reporting that they were not negligible but infrequent.[11]

Again in the article by Tan *et al.* comparing groups with and without urinary resection and reconstruction, it was reported that groups with and without surgery did not vary and that these procedures did not increase complication rates but only prolonged hospital stay.[12] Berger *et al.* have reported that median length of hospital stay and ICU stay are greater in cases who underwent extreme CRS + HIPEC.[15]

Similarly, urological procedures were needed at a rate of 21% in our series. Although this number is in accordance with the world literature, we believe that redo surgeries increased this rate in our series. In addition, we found these morbi-mortalities to be similar to the data of CRS + HIPEC series without urological interventions. We also found morbidity and mortality rates to be 20.4% and 6.8%, respectively, in the cases in our series who underwent urinary system resection and reconstruction. In order to prevent bladder and ureterovesical junction injuries, we think that pre-op bilateral ureteral stent and placement of a Foley catheter in the bladder and performing peritoneal dissection after filling the bladder with saline have a favorable effect. Among the short-term urological complications following CRS + HIPEC, urine leakage from abdominal drains/urinoma, fistula, stenosis, hydronephrosis, renal failure, need for hemodialysis, abscess and urinary tract infection can develop. In our study, we noted urinary fistula in three cases (6.8%). One of these fistulas was from ureteroureterostomy, the other from uterereroneocystostomy and the last one from the site of primary repair of the bladder. We think that two of these three urinary fistulas resulted from suturing areas with poor vascular supply and the other fistula from the tension in the bladder repair, because these cases were the first urologic cases we performed and we had not yet gained sufficient experience. In our study, neurogenic bladder developed in one patient as a result of damage to the detrussor muscles in the bladder and nerve structures during stripping of pelvic peritoneum, and was treated with permanent Foley catheter, whereas in another patient the stenosis in the ureteroureterostomy was treated with a double J stent but a nephrostomy procedure was needed because of hydronephrosis and the patient is still living with the nephrostomy.

In CRS surgeries with a final aim of R0 resection, it is essential to not leave any tumor within the abdomen. Another problem that we see especially in redo surgeries is the occurrence of implants in the ureterovesical junction. We have observed that most of the recurrences in the pelvic region occur in this area and that this area is not sufficiently explored in patients with prior surgery and tumoral tissue or implants are left behind. With the addition of an interested and trained urology specialist in our multidisciplinary team who is familiar with cytoreductive surgery mentality to the CRS team, we have seen once again the importance of a multidisciplinary approach in these areas requiring major urological intervention. In addition, as a result of our own clinical experience, we have observed that partial resection and suturation are easily performed by the CRS team in cases requiring resection because of iatrogenic injury in the bladder or tumoral implants. With the presence of urology surgeons in the operations, we have observed that procedures like ureteroureterostomy, ureteroneocystostomy, total cystectomy, ileal conduit and nephrectomy can both prevent future problems that can develop medicolegally and cause shorter surgery time and fewer urologic complications, and also that cases in the surgeries included perioperatively are more successful both in terms of complications that can develop in the perioperative period and in the post-op follow-up.

In our study, the mean follow-up was 15 months and the mean survival was 30 months. The mean surveillance of different organ carcinomatoses has shown us that interventions toward urinary involvements considered to be irresectable are feasible even though not specific for organs. One of our purposes will be to present late-term survival outcomes of this patient group with better early-stage survival.

The limitations of our study are that it is primarily a retrospective case series study with a heterogeneous group, with a small number of cases and absence of a control group that could be randomized. There are limited cases of HIPEC with ileal conduits in the literature.[16,12] In our study, we showed that ileal conduits can be performed in HIPEC without increasing morbidity. As we

mentioned in our article, we learned that having the same urologist in the same team working with PC is essential for success.

Although the need for prospective and randomized studies with higher number of cases in this subject is well known, its difficulty in practice continues to be an undeniable truth.

Author contributions

Özgül Düzgün - Concepting and design, Drafting of the manuscript
Murat Kalın - Acquisition of data, analysis and interpretation of data
Resul Sobey - Statistical analysis, administrative, technical or material support
Ömer Faruk Özkan - Critical revision of the manuscript, conception and design.

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Conflict of interest statement

The authors declare that there is no conflict of interest.

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References

1. Cotte E, Passot G, Gilly F-N, *et al.* Selection of patients and staging of peritoneal surface malignancies. *World J Gastrointest Oncol* 2010; 2: 31–35.
2. Esquivel J, Elias D, Baratti D, *et al.* Consensus statement on the locoregional treatment of colorectal cancer with peritoneal dissemination. *J Surg Oncol* 2008; 98: 263–267.
3. Sugarbaker PH. Cytoreductive surgery using peritonectomy and visceral resections for peritoneal surface malignancy. *Trans Gastrointest Cancer* 2013; 2: 54–74.
4. Honoré C, Souadka A, Goéré D, *et al.* HIPEC for peritoneal carcinomatosis: does an associated urologic procedure increase morbidity? *Ann Surg Oncol* 2012; 19: 104–109.
5. Leapman MS, Jibara G, Tabrizian P, *et al.* Genitourinary resection at the time of cytoreductive surgery and heated intraperitoneal chemotherapy for peritoneal carcinomatosis is not associated with increased morbidity or worsened oncologic outcomes: a case-matched study. *Ann Surg Oncol* 2014; 21: 1153–1158.
6. Votanopoulos KI, Randle RW, Craven B, *et al.* Significance of urinary tract involvement in patients treated with cytoreductive surgery (CRS) and hyperthermic intraperitoneal chemotherapy (HIPEC). *Ann Surg Oncol* 2014; 21: 868–874.
7. Smeenk RM, Bex A, Verwaal VJ, *et al.* Pseudomyxoma peritonei and the urinary tract: involvent and treatment related complications. *J Surg Oncol* 2006; 93: 20–23.
8. Braam HJ, van Oudheusden TR, de Hingh IH, *et al.* Urological procedures in patients with peritoneal carcinomatosis of colorectal cancer treated with HIPEC: morbidity and survival analysis. *Anticancer Res* 2015; 35: 295–300.
9. Lyon TD, Turner Ii RM, Nikonow TN, *et al.* Effect of a concomitant urologic procedure on outcomes following cytoreductive surgery with hyperthermic intraperitoneal chemotherapy. *J Surg Oncol* 2016; 113: 218–222.
10. Seretis C, Shariff U and Youssef H. Urinary tract involvement in peritoneal metastatic disease: is this a contraindication to cytoreductive surgery and hyperthermic intraperitoneal chemotherapy? *J BUON* 2017; 22: 301–305.
11. Trujillo CG, Domínguez C, Robledo D, *et al.* Urological approach for cytoreductive surgery and hyperthermic intraperitoneal chemotherapy in a clinical care center. *Acta Chir Belg* 2018; 118: 348–353.
12. Tan GHC, Shannon NB, Chia CS, *et al.* The impact of urological resection and reconstruction on patients undergoing cytoreductive surgery (CRS) and hyperthermic intraperitoneal chemotherapy (HIPEC). *Asian J Urol* 2018; 5: 194–198.
13. Cascales PA, Gil J and Alarcón CM. Urinary tract surgery in patients with ovarian peritoneal carcinomatosis treated with cytoreduction and hyperthermic intraoperative intraperitoneal chemotherapy. *Cir Esp* 2012; 90: 162–168.
14. Pinar U, Tremblay JF, Passot G, *et al.* Reconstruction after ureteral resection during HIPEC surgery: re-implantation with ureteroneocystostomy seems safer than end-to-end anastomosis. *J Visc Surg* 2017; 154: 227–230.
15. Berger Y, Aycart S, Mandeli JP, *et al.* Extreme cytoreductive surgery and hyperthermic intraperitoneal chemotherapy: outcomes from a single tertiary center. *Surg Oncol* 2015; 24: 264–269.
16. Sugarbaker PH. Total pelvic exenterative surgery in patients with peritoneal metastases from appendiceal neoplasms. A case series of 2 patients. *Int J Surg Case Rep* 2019; 65: 279– 283.