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Original Paper

Quantitative Methodologies for Selection of Patients with Recurrent Abdominopelvic Sarcoma for Treatment

B. Berthet,[1]* T.A. Sugarbaker,[1] D. Chang[2] and P.H. Sugarbaker[1]

[1]The Washington Cancer Institute, Washington Hospital Center, 110 Irving Street, NW, Washington, DC 20010; and [2]Westat, 1441 W. Montgomery Avenue, Rockville, MD 20850, U.S.A.

Peritoneal sarcomatosis is a major cause of surgical treatment failure in patients with abdominal or pelvic sarcoma. In the past, patients with this condition have had a lethal outcome. In this study, 43 consecutive patients with recurrent sarcomatosis were studied in order to evaluate an aggressive reoperative approach. In all patients, the goal of surgery was to resect all recurrent sarcoma in the abdomen and pelvis. In 30 patients in whom sarcomatosis was demonstrated and in whom a complete cytoreduction could be performed, resection was associated with peri-operative intraperitoneal chemotherapy with doxorubicin or cisplatin plus doxorubicin. Using a standardised and quantitative methodology to assess local-regional recurrence and dissemination on peritoneal surfaces, the clinical features that may affect prognosis were tabulated and analysed statistically. The median survival of these 43 patients was 20 months. Clinical features that had a significant impact on survival were involvement of less than six abdominopelvic regions ($P = 0.0009$), an increase in the involvement of abdominopelvic regions of less than four regions ($P = 0.0007$), involvement of less than 10 anatomic sites ($P = 0.0002$), complete cytoreduction with tumour reduced to nodules < 2.5 mm ($P = 0.005$) and a Peritoneal Cancer Index less than 13 ($P = 0.01$). Histological type and grade of recurrent sarcoma were not correlated with prognosis. In the multivariate analysis, an increase in abdominopelvic regions by four or more showed a risk ratio of 18.5. The involvement of 10 or more anatomic sites showed a risk ratio of 5.9. These data suggest that selected patients with recurrent sarcoma should be considered for further treatment and that the results of aggressive reoperative surgery and peri-operative intraperitoneal chemotherapy are greatly dependent on the volume and distribution of disease, determined at the initiation of therapy. Because of the great likelihood of local-regional treatment failure, the use of peri-operative intraperitoneal chemotherapy in a randomised study in patients with primary abdominopelvic sarcoma should be considered.

Key words: sarcoma, sarcomatosis, cytoreduction, intraperitoneal chemotherapy, peri-operative chemotherapy, hyperthermic chemotherapy
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INTRODUCTION

THE PROPORTION of patients with local or regional treatment failure following resection of an abdominopelvic sarcoma is high [1, 2]. Recurrence at the site of resection of the primary malignancy associated with peritoneal seeding has been reported to have been observed in 35–82% of patients [3, 4]. In all reports, recurrence of sarcoma at the operative site and on peritoneal surfaces was a prominent cause of morbidity and mortality in patients with abdominopelvic sarcoma. Therefore, to treat patients with recurrent disease, a strategy that combined aggressive surgery with escalating amounts of peri-operative intraperitoneal chemotherapy was utilised. Cytoreductive surgery with peritonectomy procedures was used in an attempt to achieve a disease free margin of resection. Also, peri-operative intraperitoneal chemotherapy was considered appropriate in 30 patients who had peritoneal sarcomatosis. Doxorubicin and then doxorubicin plus cisplatin were used in an attempt to eradicate microscopic residual disease.

*Present address: Hopital de la Conception, 147 Boulevard Baille, 13385 Marseille Cedex 05, France.
Correspondence to P.H. Sugarbaker.
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The aim of this study was to assess the possible benefit of this new approach, and to identify clinical features that correlated with favourable results of treatment. The data suggested that the volume and distribution of sarcoma at the time treatments were initiated had a great effect upon outcome.

PATIENTS AND METHODS

Patient data

Between 1989 and 1996 a total of 43 consecutive patients with histologically proven recurrence from abdominopelvic sarcoma were treated. These patients were referred from other institutions by physicians familiar with the treatment plan. A selection bias of patients appropriate for this treatment plan is likely. All patients had at least one resection or attempt at resection at another institution. There were 24 men and 19 women, ranging in age from 16 to 77 years (median 50 years). The mean free interval between primary resection and reoperation was 57 months (range 1–252 months). The median follow-up was 20 months (range 4–84 months). No patients were lost to follow-up. The mean hospital stay was 32 days (range 12–150 days). The mean intervention time was 10 h (range 4–19 h). The mean blood replacement was 6 units of packed red blood cells (range 0–35 units).

Pathology

The histological type of sarcoma was determined from a review of both the surgical pathology obtained from the referring institution and from the repeat resection. No changes were observed over time. The most common pathology was leiomyosarcoma (22 patients, 51%), followed by liposarcoma (9 patients, 21%), fibrosarcoma (4 patients, 9%), small round cell sarcoma (4 patients, 9%), spindle cell carcinoma (2 patients, 5%), schwannoma (1 patient, 2%) and haemangiopericytoma (1 patient, 2%).

Also, specimens were divided into three grades based on established pathology criteria using atypia, morphology, mitotic activity and extent of necrosis [5]. The tumour was grade I in 10 cases, grade II in 11 cases and grade III in 22 cases.

The primary sites of disease were retroperitoneal in 16, small bowel in 10, an unknown site in 5, uterine in 4, an extremity in 3, the pelvic side wall in 3 and the abdominal wall in 2.

The largest recurrent sarcoma deposit was more than 5 cm in 42 patients, and between 0.5 and 5.0 cm in 1 patient. 9 of the patients had parenchymal liver metastases (as opposed to serosal implants) from sarcoma, whilst 34 did not.

Cytoreductive surgery

The goal of surgical treatment in these patients with recurrent abdominopelvic sarcoma was to remove, if possible, all clinical evidence of disease. Electrosurgical dissection was used for tissue transection and electroevaporation for the removal of as much disease as possible. The resection of sarcomatosis required the use of peritonectomy procedures described in detail elsewhere [6].

In order to resect the sarcoma recurrence in these 43 patients, there were 14 abdominal colectomies, 16 right colectomies, four total colectomies, four segmental colectomies, two colostomies, 26 small bowel resections, four ileostomies, two jejunostomies, two gastrojejunostomies, two pyloroplasties, one gastrostomy, 10 splenectomies, 13 cholecystectomies, 11 liver resections, one hepatic infusion pump insertion, one Whipple procedure, two hysterectomies, four salpingo-oophorectomies, two nephrectomies, four partial cystectomies, three ureteroureterostomies and three ureteral stent placements. No bypass procedures were performed because complete resection was the goal in these patients.

Peri-operative intraperitoneal chemotherapy

The rationale for peri-operative intraperitoneal drug administration in patients with peritoneal sarcomatosis was established by pharmacological studies [2, 7, 8]. No rationale for delayed intraperitoneal chemotherapy was evident; consequently, the only chemotherapy regularly employed was associated with surgery. For chemotherapy administration, four separate protocols were utilised for the treatment of sequential groups of patients with increasingly aggressive strategies (Table 1). For all patients, closed suction catheters (Zimmer, Warsaw, Indiana, U.S.A.) were placed through the abdominal wall to lie beneath the right and left hemidiaphragms and within the pelvis, and were used for drainage of chemotherapy containing fluid [9]. A curled Tenckhoff catheter with the tip occluded by a ligature (Quinton, Seattle, Washington, U.S.A.) was placed similarly through the abdominal wall and functioned as an in-flow line to the peritoneal cavity. It was positioned near the area that the surgeon considered to be at greatest risk for recurrence.

If heated intra-operative intraperitoneal chemotherapy was used, two temperature probes (Respiratory Support Products Inc., Irvine, California, U.S.A.) were secured within the peritoneal cavity over the edge of the abdominal incision [10, 11]. One temperature probe was secured to the in-flow portion of the Tenckhoff catheter. All transabdominal tubes were secured to the skin with purse string sutures to prevent fluid leakage. The abdomen was partially covered with a plastic sheet to allow access of the surgeon's hand to all peritoneal surfaces. The skin edges were suspended to the Thompson retractor (Thompson Surgical Instruments, Traverse City, Michigan, U.S.A.) with a number 2 running Nylon suture to create a reservoir for the chemotherapy solution. The hyperthermic perfusion with cisplatin (50 mg/m^2) or

Table 1. *Evolution of increasingly aggressive intraperitoneal chemotherapy regimens in patients treated for recurrent abdominopelvic sarcoma*

Treatment plan	No. patients	Cytoreductive surgery	EPIC	HIIC	Mortality
1	7	Yes	Doxorubicin	None	0
2	7	Yes	Doxorubicin and cisplatin	None	0
3	13	Yes	Doxorubicin	Cisplatin	1
4	3	Yes	None	Cisplatin and doxorubicin	0
5	13	Yes	None	None	2

EPIC, early postoperative intraperitoneal chemotherapy; HIIC, heated intra-operative intraperitoneal chemotherapy.

cisplatin and doxorubicin (15 mg/m^2) was carried out for 2 h at 42°C heat with continuous manual manipulation of the abdominal contents. After perfusion, bowel anastomoses and other reconstructive procedures were performed.

For early postoperative intraperitoneal chemotherapy, on postoperative days 1–5, doxorubicin at 0.1 mg/kg in 1000 ml of 1.5% dextrose peritoneal dialysis solution was instilled by gravity [9]. Early postoperative intraperitoneal cisplatin was used similarly at a dose of 10 mg/m^2/day. Doxorubicin or doxorubicin and cisplatin were allowed to remain in place for 23 h and were removed by gravity drainage over a period of 1 h. On the sixth postoperative day, all fluid was drained from the peritoneal cavity, and the Tenckhoff catheter was withdrawn. The closed suction drains were removed as surgically indicated.

In these 43 patients, 30 had sarcomatosis demonstrated at the time of surgical exploration and a CC-0 or CC-1 cytoreduction was possible. These 30 patients received intraperitoneal chemotherapy. There was an increasingly aggressive treatment with intraperitoneal chemotherapy over time. 13 patients had cytoreductive surgery only (Figure 1). 8 patients had intraperitoneal chemotherapy withheld because gross residual disease remained after maximal surgical efforts and this volume of sarcoma was impenetrable to local use of drugs. 3 patients were not candidates for intraperitoneal chemotherapy because 2 had prior total abdominal radiotherapy and 1 had extensive pelvic radiotherapy. 2 patients had no sarcomatosis and, therefore, intraperitoneal chemotherapy was thought unnecessary. The distribution of patients by treatment modalities is illustrated in the clinical pathway shown in Figure 1.

During the 7 years over which this study was performed, there was an evolution of increasingly aggressive intraperitoneal chemotherapy treatment strategies. Originally, the chemotherapy agent doxorubicin was used normothermically in the early postoperative period [8]. At the completion of treatment of these 7 patients, cisplatin was combined with doxorubicin in the early postoperative period in another seven patients. Then, intra-operative heated cisplatin followed by early postoperative intraperitoneal doxorubicin was used in 13 patients [11]. Finally, combined intra-operative heated cisplatin with intra-operative heated doxorubicin was utilised in the last 3 patients [10]. Although differences in therapeutic effect may operate in these groups of patients, because of the small sample size, all patients given intraperitoneal chemotherapy are considered together in this paper.

Lesion size assessment

The surgeon's estimate of lesion size was performed at the time of abdominal and pelvic exploration. Lesion size 1 indicates tumour nodules less than 0.5 cm in diameter; lesion size 2 indicates tumour nodules 0.5–5 cm in diameter; and lesion size 3 indicates tumour nodules greater than 5 cm in diameter, or a confluence of disease, matting structures together [12, 13].

Abdominopelvic regions

The abdominopelvic cavity was divided into 13 regions as illustrated in Figure 2. Two transverse planes and two sagittal planes were used to divide the abdomen into nine abdominopelvic regions (AR-0 to AR-8). Because of the profound implications of cancer involvement of the small bowel, it was assessed as a separate entity and was designated AR-9 to AR-12 [12–14]. For each patient, the number of abdominopelvic regions involved by sarcoma was recorded. This assessment allowed quantification of the distribution of peritoneal sarcomatosis and was performed retrospectively from operative notes and pathology reports for the primary resection of sarcoma. It was prospectively recorded for the reoperative procedure. The increase in abdominopelvic regions from first options to cytoreduction was tabulated [12, 13].

Anatomic sites

Twenty-one anatomic sites were selected for study at reoperation. These anatomic sites were abdominal incision, anterior peritoneal surface, greater omentum, lesser omentum, right hemidiaphragm, left hemidiaphragm, liver surface, spleen, pancreas surface, stomach, small bowel, large bowel, right paracolic gutter, left paracolic gutter, right pelvic side

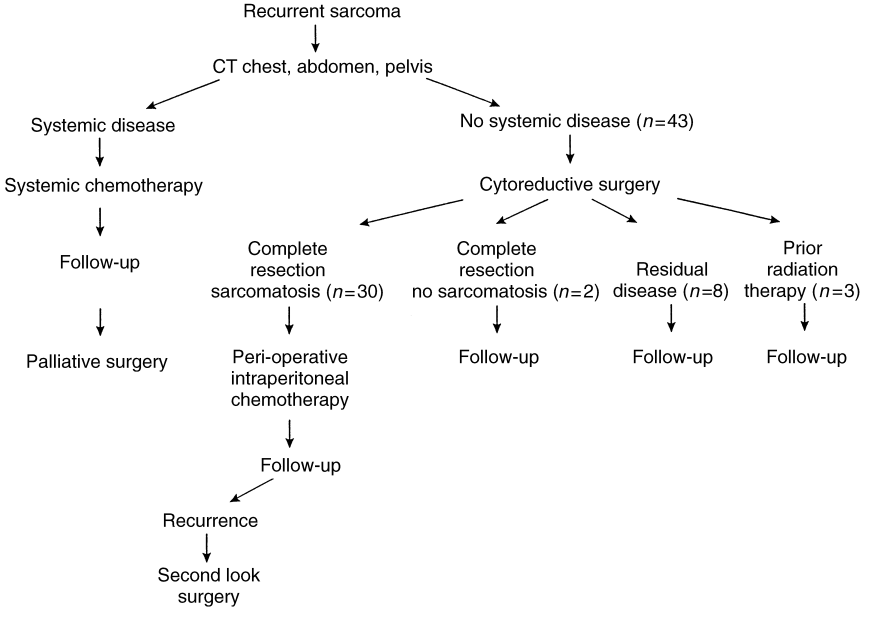

Figure 1. Clinical pathway for 43 patients with recurrent abdominopelvic sarcoma.

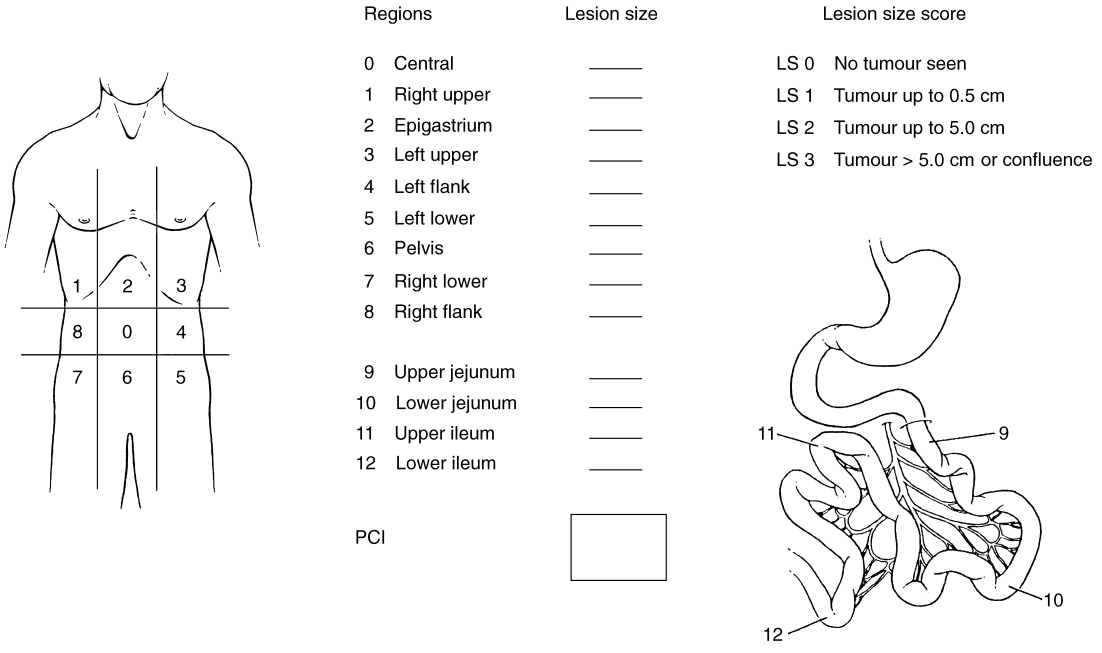

Figure 2. Abdominopelvic regions 0–12.

wall, left pelvic side wall, bladder, vagina and internal genitalia, cul-de-sac of Douglas, retroperitoneum and perirenal space. For each patient, the number of anatomic sites involved by sarcoma was recorded.

Peritoneal Cancer Index

This assessment combined the data gathered from the measurement of lesion size with the abdominopelvic regions assessment [15]. The index was calculated as the sum of the lesion size of the tumour in all the abdominopelvic regions involved by locally recurrent sarcoma and by sarcomatosis. The score of the Peritoneal Cancer Index ranged from 1 to 39 and was calculated for each patient. The largest sarcoma deposit in each abdominopelvic region was used to compute the total score.

Completeness of cytoreduction

The completeness of cytoreductive surgery (CC score) was assessed by the operating surgeon at the conclusion of the cancer resection. A CC-0 resection meant that no visible tumour was seen at the end of the resection. A CC-1 resection meant that visible tumour, left behind in the abdomen or pelvis, was less than 0.25 cm in diameter. A CC-2 resection indicated that after cytoreduction, there were tumour nodules visible between 0.25 and 2.5 cm in greatest diameter. A CC-3 resection category implied residual tumour nodules greater than 2.5 cm [14]. Complete cytoreduction was deferred as a CC-0 or CC-1 resection.

Data analysis

The clinical features selected for analysis by survival were sex, age, free interval, histological type, primary site, grade, pelvic regions involved, increase of abdominopelvic regions involved between primary resection and reoperation, number of anatomic sites involved, Peritoneal Cancer Index and completeness of cytoreduction. In the data presentation of the significant clinical features, the most robust statistic was selected for presentation.

The significance of each of these clinical features was analysed. A Kaplan–Meier survival curve was fitted to the data and tested using a log rank test for difference between curves. The response variable was survival in months for clinical features. A multivariate analysis was performed using a Cox proportional hazard model. The *P* values were calculated for each analysis. The 3 patients who died postoperatively were censored from the data analysis.

RESULTS

Overall survival

The median survival of these 43 patients was 20 months. At the time of preparation of this manuscript, 21% (9/43) of patients were alive with no evidence of disease, 23% (10/43) of patients were alive with disease, 54% (23/43) of patients died of disease, including 3 postoperative deaths, and 2% (1/43) of patients died of other causes. The overall survival of these 43 patients is shown in Figure 3.

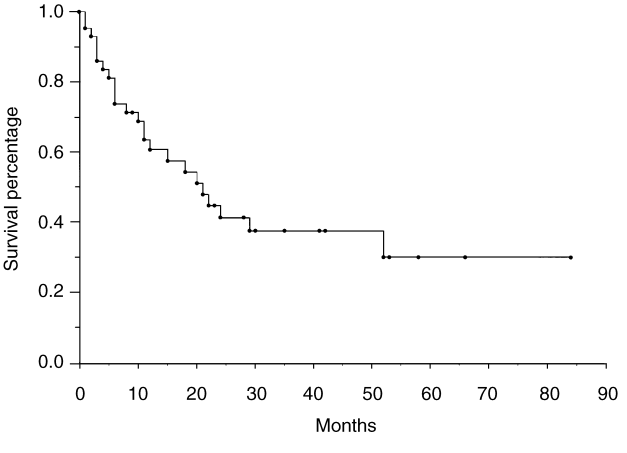

Figure 3. Kaplan–Meier survival curve in 43 patients undergoing reoperation for recurrent sarcoma.

Analysis by involvement of abdominopelvic regions

The effect on prognosis determined by the involvement of abdominopelvic regions was analysed. There was a significant difference ($P = 0.0009$) in survival in the group of patients with less than six abdominopelvic regions involved at the time of surgery (Table 2).

Analysis by increased involvement of abdominopelvic regions

At the primary operation, a total number of 65 regions (mean 1.51; range 1–6) were involved by sarcoma. At the time of reoperation for sarcomatosis, the total number of regions involved was 294 (mean 6.83; range 2–13). The primary operation was reported to resect all visible disease in 40 of these 43 patients. Nevertheless, the involvement of abdominopelvic regions had increased in all 43 patients at the time of reoperation. Figure 4 shows the number of involved regions at the primary operation and at reoperation.

The change in the involvement of abdominopelvic regions between the primary sarcoma resection and reoperation was calculated. This change in involvement was analysed for its impact on survival. The increase was less than four regions in 11 patients with a 5 year survival of 80%. An increase of more than four regions was observed in 32 patients, with a 5 year survival of 0% ($P = 0.0007$, Table 2).

Analysis of anatomic sites involved

There were 25 patients who had less than 10 anatomic sites involved, and 18 patients who had 10 or more sites involved. There was a significant improvement in survival if less than 10 anatomic sites were involved ($P = 0.0002$, Table 2).

Analysis of Peritoneal Cancer Index

The Peritoneal Cancer Index allowed the lesion size of sarcoma deposits to be calculated within the 13 abdominopelvic regions. The lesion size was assessed for each abdominopelvic region, and these scores were summated. The Peritoneal Cancer Index for each of these 43 patients was analysed to determine whether a larger score correlated with a diminished survival. When the Peritoneal Cancer Index was 13 or greater, there was a statistically significant difference in survival ($P = 0.01$, Table 2).

Analysis of completeness of cytoreduction

In 43 resections, 27 were classified as CC-1, six as CC-2, and 10 as CC-3. The 5 year survival rate for the incomplete

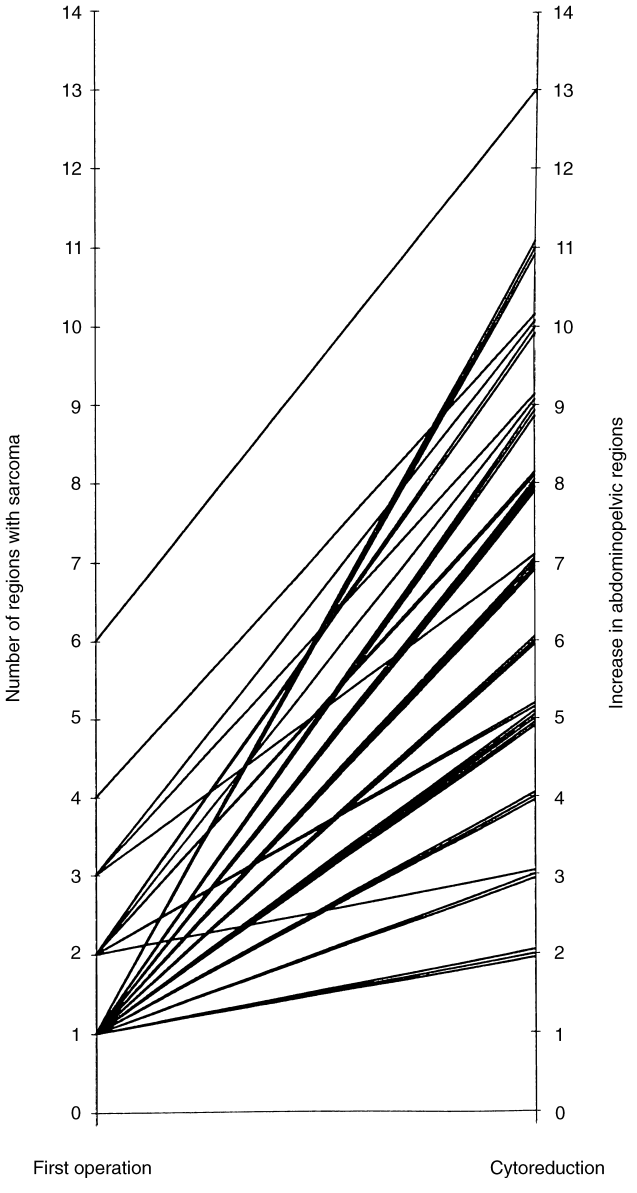

Figure 4. Number of abdominopelvic regions involved at first operation and at definitive cytoreduction in 43 patients. Each line represents 1 patient.

Table 2. Summary of significant clinical features

Clinical feature	No. of patients	5 year survival (%)	*P* value
Number of abdominopelvic regions involved			
Less than six regions	16	67	0.0009
Six or more	27	0	
Increase in abdominopelvic regions			
Less than four	11	80	0.0007
Four or more	32	0	
Anatomic site involved			
Less than 10	25	43	0.0002
More than 10	18	0	
Cytoreduction			
Complete (CC-0 or CC-1)	27	39	0.005
Incomplete (CC-2 or CC-3)	16	13.6	
Peritoneal Cancer Index			
Less than 13	9	75	0.01
More than 13	34	12.8	

cytoreduction group (CC-2 and CC-3) was zero (Table 2). The survival for completeness of cytoreduction for the two groups, CC-1 versus CC-2 plus CC-3 showed a statistically significant difference ($P = 0.005$, Table 2).

Analysis by liver metastases

For 9 (21%) patients, haematogenous metastases within liver parenchyma, but without tumour on the surface of the liver, were identified. In 8 cases, liver metastases were observed on computed tomography before the surgical procedure. There was no statistically significant difference in survival in patients with or without liver metastases.

Analysis of other clinical features

There was no statistically significant difference in survival concerning sex, age, free interval, histological type, grade or size of largest sarcoma deposits.

Multivariate analysis

With a Cox proportional hazard model, which takes into account the time of death, two features were statistically valid. The first feature was the increase in abdominopelvic regions involved and the second was the number of anatomic sites involved. The risk of death from disease in this study for patients with an increase of four or more abdominopelvic regions was 18.5 times higher than for patients with less than four regions involved ($P = 0.0018$). For patients with 10 or more anatomic sites involved, the risk was 5.9 times higher than patients with less than 10 sites involved ($P = 0.0010$).

Complications

8 (19%) patients presented with complications; 2 duodenal perforations, 2 leaks of anastomoses, 1 pneumonia, 3 intra-abdominal infections and 1 acute renal failure. There were 3 postoperative deaths (7%). Because of the regional nature of the chemotherapy, no grade III or IV adverse effects, such as nausea, vomiting, diarrhoea or haematological toxicity, were observed. The perforations, anastomotic leaks and intra-abdominal infections may have been caused, at least in part, by the intraperitoneal chemotherapy.

DISCUSSION

Two innovations that our group developed were utilised in these patients with recurrent abdominopelvic sarcoma. Firstly, all dissections were performed with 'lasermode electrosurgery' [16]. In this surgical technique, high voltage electrosurgery utilising pure cut was used to perform the dissection, especially at the margins of excision. Approximately 1 mm of heat necrosis occurs beyond the visible limits of dissection. This heat necrosis may have been responsible for maintaining a sarcoma free margin in the months and years postoperatively. Lasermode electrosurgery is in great contrast to scissor or knife dissection, which causes less trauma, but does not eradicate tumour cells at the margin of resection.

The second innovation involved the use of peri-operative chemotherapy in patients who had visible peritoneal dissemination of sarcoma on peritoneal surfaces. Recurrent disease manifested as sarcomatosis may result from necrosis and perforation of a primary sarcoma. More frequently, sarcomatosis may be caused by the spillage of cancer cells as a result of disruption of the primary sarcoma mass during its dissection. Intraperitoneal chemotherapy used concomitantly with surgery may eliminate microscopic residual disease that subsequently progresses to sarcomatosis [7]. In all patients with sarcomatosis who had a complete cytoreduction, peri-operative intraperitoneal chemotherapy with doxorubicin or doxorubicin plus cisplatin was utilised. No support for repeated treatments via intraperitoneal port catheters from a theoretical basis or from the oncology literature was identified. The combination of lasermode electrosurgery and peri-operative intraperitoneal chemotherapy may benefit patients with recurrent abdominopelvic sarcoma. In the past, these patients had no treatment options, and uniformly went on to die of their disease. With this new treatment strategy, some patients went on to enjoy long-term disease free survival.

In this study, quantitative assessments of peritoneal sarcomatosis were used to identify patients who were most likely to benefit from aggressive reoperative treatment strategies. These methodologies originate from the peritoneal carcinomatosis models, originally proposed by T.A. Sugarbaker and colleagues [12, 13]. The clinical features traditionally used to assess prognosis presented in Table 1 had no predicative value in these patients. Making a clinical assessment, whether carcinomatosis is present or absent, is no longer adequate. More sophisticated assessments, as utilised in this study, that qualitatively and quantitatively measure sarcoma aggressiveness, abdominopelvic distribution and completeness of cytoreduction, have been shown to be of value in patient selection for treatment of recurrent disease.

Measuring the involvement of abdominopelvic regions, first used in this study to assess prognosis, has been shown to have a significant effect on survival [12, 13]. Patients with an increase of less than four abdominopelvic regions had a strong survival benefit. The biological explanation for this is not readily apparent. This increase in the distribution of sarcoma around the abdomen and pelvis could be determined by the aggressiveness of the malignant process. The fact that the grade of malignancy had shown no trends in this analysis would tend to place this hypothesis in disfavor. Alternatively, an increased involvement of four or more abdominopelvic regions may reflect the extent of the surgical trauma that caused the intraperitoneal dissemination of the primary sarcoma. Those patients in which there was a large tumour spill, and in whom the surgery widely distributed these sarcoma cells, were likely to show reduced survival.

The dissemination of sarcoma by surgical manipulation is suggested in that its distribution increased from a mean of 1.51 regions at primary surgery to a mean of 6.83 regions at reoperation. In these patients with recurrence, resection of the primary sarcoma resulted in dissemination of the disease. Sarcoma recurrence is preferentially located at sites of surgical trauma because of fibrin entrapment of cancer cells [7]. Sarcoma surgery alone resulted in a progressive dissemination of the disease and may not by itself be an adequate treatment for abdominopelvic sarcoma.

Surprisingly, those patients who presented at the time of definitive cytoreduction with liver metastases did not have a significantly decreased survival as compared with those patients free of metastatic disease to the liver. A partial explanation for this finding comes from the fact that all but 3 of these sarcoma patients had complete resection of liver tumours at the time of cytoreduction. Recurrent disease within the abdomen and pelvis was the cause of death in a majority of these patients, rather than progression of disease within the liver.

An important prognostic factor in reoperative surgery for sarcoma was the completeness of cytoreduction. With long-term follow-up, it is likely that patients with an incomplete cytoreduction will not show long-term survival. A CC-0 or CC-1 cytoreduction was possible in approximately 63% (27/43) of the patients. Our results suggest that this treatment strategy is most appropriate in patients in whom it is possible to achieve complete cytoreduction. Combining a complete cytoreduction (CC-0 or CC-1) with peri-operative intraperitoneal chemotherapy may eliminate not only gross sarcoma recurrence, but also microscopic residual disease. A debulking procedure in which gross cancer was left behind after surgery can only be considered a palliative treatment.

The benefits of intraperitoneal chemotherapy in this group of patients are difficult and perhaps impossible to evaluate. In these 43 patients, 30 received intraperitoneal chemotherapy and 13 had cytoreductive surgery only. Also, during the 6 years over which this study was performed, there was an evolution of treatment strategies that began with normothermic early postoperative intraperitoneal doxorubicin alone. Changes in the delivery of chemotherapy over time allowed for the evolution of combined intra-operative heated cisplatin with intra-operative heated doxorubicin. Because of the small numbers of patients treated in each group, differences in therapeutic effect could not be detected in these patients. Other groups using a delayed intraperitoneal cisplatin chemotherapy for recurrent sarcoma found less therapeutic benefit than in these patients [17].

Perhaps the favourable results of treatment of these sarcomatosis patients can be applied not only to patients with recurrent abdominopelvic sarcoma, but also to patients with primary sarcoma resection. Adjuvant peri-operative intraperitoneal chemotherapy treatment should be evaluated in a prospective randomised trial to assess the prevention of sarcoma spread to peritoneal surfaces. The dose and distribution of chemotherapy must provide a cytotoxic response to reliably eliminate microscopic residual disease. The use of 42°C heat and continuous manual distribution of chemotherapy to all abdominal and pelvic surfaces as safely as utilised in the last group of patients may improve survival [10]. These data may provide the rationale for an adjuvant peri-operative intraperitoneal chemotherapy protocol for patients with primary abdominal and pelvic sarcoma.

Although selection factors for surgery to achieve long-term survival are established by this study, one must not rely completely on quantitative sarcomatosis assessments in order to recommend surgical intervention. Patients who require palliation for gastrointestinal bleeding, perforation, or intestinal obstruction may require surgery for short-term benefits. The surgeon needs to be extremely careful in obtaining consent on this group of patients, to be sure that patients and their families do not misconstrue the goal of surgery as curative, when it is only palliative. The surgeons should proceed with great caution in this setting of palliative surgery for recurrent abdominopelvic sarcoma. The cost per life year in this group of patients is likely to be great, and not compatible with cost-effective surgery that results in a reasonable postoperative quality of life.

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