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Pelvic exenteration, a surgical treatment option for locally advanced, primary and recurrent neoplasia

ANA-MARIA MUŞINĂ[1,2)], IONUŢ HUŢANU[1,2)], MIHAELA GRIGORE[1,3,4)], IOANA-SHADIYE SCRIPCARIU[1,3)], BOGDAN FILIP[1,2)], MARIA-GABRIELA ANIŢEI[1,2)], DRAGOŞ-VIOREL SCRIPCARIU[1,2)], MIHAELA-MĂDĂLINA GAVRILESCU[1,2)], IULIAN RADU[1,2)], NICOLAE IOANID[2)], ADRIAN NICOLAE PANTAZESCU[2)], MAXIMILIAN HOGEA[2)], ANDRIAN PANUŢA[1,2)], MIHAELA BUNA-ARVINTE[1,2)], GIANINA-VANDA MORARU[1,2)], VIOREL SCRIPCARIU[1,2)]

[1)] *Department of Surgery, "Grigore T. Popa" University of Medicine and Pharmacy, Iaşi, Romania*

[2)] *1st Surgical Oncology Unit, Regional Institute of Oncology, Iaşi, Romania*

[3)] *Department of Obstetrics and Gynecology, "Grigore T. Popa" University of Medicine and Pharmacy, Iaşi, Romania*

[4)] *Medis Medical Centre, Iaşi, Romania*

Abstract

Pelvic exenteration (PE) is an extensive surgical procedure for locally advanced primary neoplasia (LAPN) or recurrent neoplasia (RN) that consists in the *en bloc* removal of the pelvic organs (rectum, internal genital organs and bladder) associated with pelvic lymph nodes. PE is classified into anterior, posterior and total, supra or infralevatorian approaches. Our aim was to evaluate the surgical procedure and the resection margins in correlation with postoperative complications and morbidity rates after PE in patients treated in a single surgical unit. The study group comprised patients diagnosed with different malignancies, surgically treated by using PE procedure, during 2012–2018. The cohort included 121 cases with LAPN (*n*=98, 80.99%) and RN (*n*=23, 19%), mostly female (*n*=114, 94.21%), with a mean age of 61.16 (33–85) years. LAPN had predominantly digestive (*n*=48, 49.98%) and gynecological (*n*=28, 28.57%) origins, while the majority of RN cases were cervical cancers (*n*=9, 39.13%). The univariate analysis showed that the gynecological origin of the tumor (*p*=0.02), urinary stoma (*p*=0.02) and posterior PE (PPE) (*p*=0.004) were significant prognostic factors for postoperative complications. After performing the multivariate analysis, only the gynecological origin (*p*=0.02) of the tumor and PPE (*p*=0.03) remained determining factors for postoperative complications. PE is a disabling surgical procedure associated with high postoperative mortality and morbidity, although it is often the only solution for advanced cases. The judicious selection of patients who can benefit from such extensive surgery is compulsory. Our study suggests that the gynecological origin of the tumor and PPE are key factors in postoperative complications.

Keywords: pelvic exenteration, colorectal neoplasia, gynecological neoplasia, postoperative complications.

Introduction

Pelvic exenteration (PE) was performed by the first time in 1946, by Alexander Brunschwig, to address advanced carcinoma by means of a total, *en bloc* excision of the pelvic viscera, with a bilateral ureter implantation in the colon, above the colostomy [1]. Anterior PE (APE) consists in rectal preservation with mass removal of the bladder, vagina, uterus and adnexa, while in posterior PE (PPE) the bladder and ureter are preserved, while the uterus, adnexa and rectum with the pelvic lymph nodes are removed. Only the obturator and sciatic nerves, iliac vessels and pelvic muscle are left in place [2]. For PPE in women, the vaginal approach for resection was proposed in cases with difficult abdominal dissection [3]. Onco-genetic studies of anatomy allow the radical resection of the meso-viscera, with the benefits of a significantly decreased risk of recurrence and better survival [4].

The original technique was modified and different urinary diversion (incontinent or continent) and reconstruction techniques were attempted and proposed, with varying degrees of physical and psycho-social impact [5]. PE is associated with high morbidity and mortality and although is considered the most destructive surgical approach, it is also the only potential curative treatment for locally invasive gynecological neoplasia [4]. It can be suitable for patients who received radiotherapy [6] or adjuvant chemotherapy [7]. Minimally invasive, total PE (TPE) may be feasible in select cases [8].

PE performed on patients with locally advanced, recurrent colorectal cancer is associated with a 5-year overall survival (OS) of 58.7%, this rate being 11.8% higher in patients with R0 rather than R1/R2 resection (*p*=0.015) [9]. The one-year OS for patients with PE is reported to be 64%, 44% at two years and 34% at 50 months, with a better OS and disease-free survival (DFS) for patients with recurrent disease compared with persistent forms (*p*=0.0003 *versus p*=0.048) [10]. When a curative procedure is performed on gynecological neoplasia, 5-year OS is reported at 30–60% [10–12]. In order to improve the quality of life for patients presenting with severe symptoms, palliative PE is an option [13]. The most frequent indications for palliative PE are pain, clinically manifested fistulas, obstruction, genital or rectal bleeding, and fetor. Palliative PE is associated with a high post-

operative morbidity rate (53.6%) and currently lacks conclusive evidence of improving quality of life [14].

Such elevated mortality and morbidity rates in PE are facilitated by postoperative complications, the most frequent of which being related to urinary diversion (50%), reconstruction techniques (30%), pelvic or systemic infections (20–70%) [15, 16].

In order to facilitate international collaboration and to provide the scientific community with substantial worldwide data, such as necessary to identify the factors associated with the best prognostic for PE patients, the *PelvEx Collaborative Group* was formed, showing that margins status and bone resection were the significant determinants in long-term survival, in locally recurrent rectal cancer [17]. OS rates of up to 36 months after R0 resection, 27 months after R1 resection, and 16 months after R2 (p<0.001) were reported [17]. Minimally invasive PE can be applied in highly selected cases, and it is associated with a reduced morbidity rate (56.7% *versus* 88.5%) compared to open PE, a 6-day shorter length of hospital stay, and reduced intraoperative blood loss [18]. Neoadjuvant therapy was found to increase the risk of 30-day morbidity (p<0.012) and multivariate analyses pointed to the resection margins and nodal status as significant determinants in OS [19]. Quality assessments of surgery procedures at centers performing PE have revealed an increase in bone resections and flap reconstructions at higher-volume centers *versus* more frequent R0 resections in low-volume centers [20].

PE being a disabling surgery also influences the physical activity in the immediate postoperative days. Studies show that in PE physical activity decreased in the first six weeks after surgery, but it improves significantly in the postoperative within six months [21].

Aim

Within this context, our aim was to evaluate the surgical procedure and the resection margins in correlation with postoperative complications and morbidity rates after PE in patients with locally advanced, primary neoplasia (LAPN) and recurrent neoplasia (RN), treated in a single surgical unit.

Patients, Materials and Methods

This is a retrospective study based on a prospectively collected database including patients who underwent PE during 2012–2018 at the 1st Surgical Oncology Unit from the Regional Institute of Oncology, Iaşi, Romania. The surgical procedure was performed on LAPN and RN in the context of gynecological, colorectal, urinary and peritoneal cancers, and even on non-malignant tumors suspected of malignancy upon imagistic assessment. All the patients were subject to complete clinical and biological preoperative evaluations. Computed tomography (CT) and magnetic resonance imaging (MRI) were also used to appraise the possibility of complete tumor resection. Tumor staging was based on the 7th edition of *Tumor, Node, Metastasis (TNM) Classification* of the *American Joint Committee on Cancer* (AJCC) and the *International Union for Cancer Control* (UICC) [22]. Whenever available, a confirmation biopsy was also performed. All the surgical procedures were conducted by the same surgical team, highly experienced in surgical oncology. We divided the patients into two groups: one with LAPN and the other with the recurrent form (RN). The surgical treatment had a radical or a palliative visa in order to improve the quality of life of the patients presenting with clinical manifested fistulas. Follow-up was in accordance with international guidelines [23, 24]. The type of PE, postoperative complications related to the surgical technique, surgical margins and 30-day mortality rate were recorded and analyzed for both groups. Postoperative complications were evaluated according to the Dindo–Clavien classification [25].

For descriptive statistics, we used Excel 2013 (Microsoft Corporation, Redmond, WA, USA). Univariate analysis between categorical covariates was performed using the χ^2 (*chi*-square) or Fisher's exact tests. Any p-values <0.05 were considered significant. For multivariate analysis, performed in Statistical Package for the Social Sciences (SPSS) ver. 21.0 (SPSS, Inc., Chicago, IL, USA), only covariates with p<0.05 were included.

Results

Patients' characteristics

A total of 121 patients were included in the study, entailing both cases with LAPN (n=98, 80.99%), as well as cases of RN (n=23, 19%). Of them, seven were men and 114 women, with a mean age of 61.16 (ranging between 33 and 85) years. Primary neoplasia had mainly digestive origins (n=48), followed by gynecological localization (n=28) (Table 1).

Table 1 – ***Patient characteristics in LAPN and RN***

Characteristics	LAPN (n=98, 80.99%)	RN (n=23, 19%)	Total (n=121, 100%)
Age, mean (range) [years]	61.41 (33–85)	60.13 (38–75)	61.16 (33–85)
Gender			
F	96 (97.96%)	18 (78.26%)	114 (94.21%)
M	2 (2.04%)	5 (21.74%)	7 (5.79%)
Gynecological	28 (28.57%)	13 (56.52%)	41 (33.88%)
Cervical	1 (1.02%)	9 (39.13%)	10 (8.26%)
Endometrial	3 (3.06%)	1 (4.35%)	4 (3.31%)
Fallopian	2 (2.04%)	0	2 (1.65%)
Ovarian	23 (23.47%)	3 (13.04%)	26 (21.49%)
Digestive	48 (48.98%)	9 (39.13%)	57 (47.11%)
Recto-sigmoid junction	4 (4.08%)	2 (8.7%)	6 (4.96%)
Sigmoid colon	7 (7.14%)	1 (4.35%)	8 (6.61%)
Rectum	34 (34.69%)	6 (26.09%)	40 (33.06%)
Peritoneal	3 (3.06%)	0	3 (2.48%)
Urinary	0	1 (4.35%)	1 (0.83%)
Bladder	0	1 (4.35%)	1 (0.83%)
Non-malignant	4 (4.08%)	0	4 (3.31%)
Pelvic actinomycosis	3 (3.06%)	0	3 (2.48%)
Pelvic endometriosis	1 (1.02%)	0	1 (0.83%)

LAPN: Locally advanced primary neoplasia; RN: Recurrent neoplasia; F: Females; M: Males; *n*: No. of cases.

In four cases, the origin was a benign disease, such as actinomycosis (*n*=3) and pelvic endometriosis (*n*=1) (Table 1). For RN, the majority of cases were cervical (*n*=9) and rectal cancers (*n*=6).

Associated preoperative fistulas were present in 14 cases: recto-vaginal (*n*=5), recto-bladder (*n*=2), vaginal-bladder (*n*=5), ureter (*n*=1), and complex fistulas (*n*=4) (Figure 1), with notable differences between primary and RN (nine patients *versus* five patients), surgical treatment being applied in order to improve quality of life (Table 2).

At the time of the surgery, 39 patients had distant metastases with multiple localizations: ovarian (*n*=3), hepatic (*n*=9), pulmonary (*n*=6), and peritoneal (*n*=21). Of them, 34 patients were from the LAPN group and five patients from the RN group (Table 2).

A total of 11 patients reported personal histories of other associated neoplasia: breast (*n*=3), renal (*n*=1), thyroid (*n*=2), prostatic (*n*=1), uterus (*n*=1), cervical (*n*=1), colon (*n*=1), and parathyroid (*n*=1) forms of cancer. The associated malignancies were not synchronous with the pelvic neoplasia and the indication for PE was unrelated to them. In only one case, a patient with locally advanced rectal cancer had undergone surgery for endometrial cancer as part of his medical history.

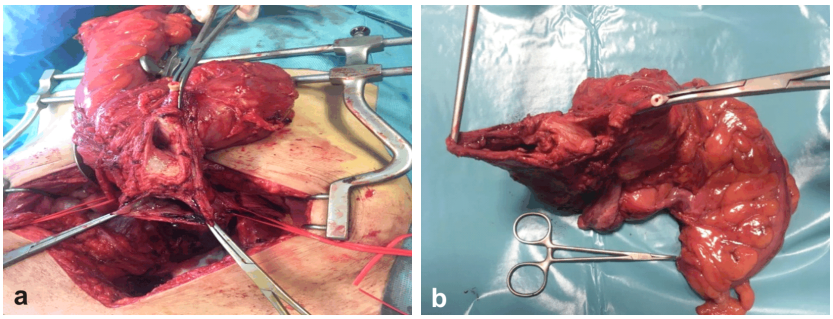

Figure 1 – ***Intraoperative aspects in a patient with locally advanced cervical cancer who underwent total pelvic exenteration with complex recto-vaginal fistula: (a) Tumor dissection; (b) Surgical specimen with the urethral catheter present, the vaginal and the anal canal.***

Table 2 – ***Patient characteristics: associated fistulas and distant metastases***

Characteristics	LAPN (*n*=98, 80.99%)	RN (*n*=23, 19%)	Total (*n*=121, 100%)
Associated fistulas	9 (9.18%)	5 (21.73%)	14 (11.57%)
Bladder-vaginal	4 (4.08%)	1 (4.35%)	5 (4.13%)
Recto-vaginal	3 (3.06%)	2 (8.7%)	5 (4.13%)
Recto-bladder	1 (1.02%)	1 (4.35%)	2 (1.65%)
Colon-bladder	1 (1.02%)	0	1 (0.83%)
Ureter fistula	0	1 (4.35%)	1 (0.83%)
Complex fistulas (recto-vaginal and bladder-vaginal)	2 (2.04%)	2 (8.7%)	4 (3.31%)
Metastasis localization	34 (34.69%)	5 (21.73%)	39 (32.23%)
Hepatic	8 (8.16%)	1 (4.35%)	9 (7.44%)
Peritoneal	18 (18.37%)	3 (13.04%)	21 (17.36%)
Ovarian	3 (3.06%)	0	3 (2.48%)
Pulmonary	5 (5.1%)	1 (4.35%)	6 (4.96%)

LAPN: Locally advanced primary neoplasia; RN: Recurrent neoplasia; *n*: No. of cases.

Surgical treatment

The surgical treatment was performed with a radical visa following oncological principles (97 of cases, 80.17%) and with a palliative visa, in order to improve quality of life (*n*=10, 8.26%). Surgical treatment consisted of APE (*n*=11, 9.09%), PPE (*n*=90, 74.38%), or TPE (*n*=20, 15.53%), with predominantly supralevatorian PE (*n*=107, 88.43%) compared to infralevatorian PE (*n*=14, 11.57%).

Ileal conduit (Bricker) (*n*=12, 9.92%) was applied in 20 (16.53%) cases with TPE, and ureterostomy was performed in patients with TPE and APE (*n*=8, 6.61%) (Figure 2). Colostomy was done for patients with PTE and TPE (*n*=95, 78.51%). Perineal reconstructions after extensive resection was necessary in two cases using gracilis muscle flap and ventral *rectus abdominis* muscle (VRAM) flap (Figure 3).

Pelvic lymphadenectomy was performed in 90 (74.38%) cases. We recorded a mean number of 25.52 lymph nodes (raging 2–82 nodes), with a mean number of 4.48 positive nodes (ranging 0–45 nodes) (Figure 4).

Surgical margins were negative (R0) in 98 (80.17%) patients, with some differences between the two groups (80 cases in LAPN and 17 cases in RN). Positive margins [R1 (microscopically)/R2 (macroscopically)] were present in 24 cases (*n*=14 in LAPN and *n*=10 in RN group), without significant differences between the groups in the multivariate analysis (*p*=0.3) (Table 3).

The pathological report showed that the predominant histopathological type was rectal adenocarcinoma (*n*=41, 33.88%), followed by ovarian serous carcinoma (*n*=30, 24.79%) (Table 4).

Neoadjuvant treatments were prescribed and recorded in 50 (41.32%) patients mainly from the LAPN group (*n*=33, 33.67%), but also from the RN group (*n*=17, 73.91%). These consisted of chemotherapy (*n*=14, 11.57%), radiotherapy (*n*=16, 13.22%), radio-chemotherapy (*n*=16, 13.22%), and brachytherapy (*n*=1, 0.83%) (Table 4).

Postoperative complications and survival

The postoperative complications were classified according to Dindo–Clavien classification, with 32 grade I–II cases and six grade III–IV cases (Table 5).

In the univariate analysis, the gynecological origin of the tumor (*p*=0.02), urinary stoma (*p*=0.02), and PPE (*p*=0.004) proved to be significant prognostic factors for postoperative complications. Also, Bricker ileal conduit (*p*=0.06) and TPE (*p*=0.06) seem to be influence postoperative complications but not in statistically significant degrees, according at least to the univariate analysis of our data (Table 6).

Table 3 – *Surgical treatment performed in the study group*

Type of surgery	LAPN (*n*=98, 80.99%)	RN (*n*=23, 19%)	Total (*n*=121, 100%)
Anterior PE	7 (7.14%)	4 (17.39%)	11 (9.09%)
Posterior PE	84 (85.71%)	6 (26.09%)	90 (74.38%)
Total PE	7 (7.14%)	13 (56.52%)	20 (16.53%)
Supralevatorian	86 (87.76%)	21 (91.3%)	107 (88.43%)
Infralevatorian	12 (12.24%)	2 (8.7%)	14 (11.57%)
Colostomy	77 (78.57%)	18 (78.26%)	95 (78.51%)
Colorectal anastomosis	11 (11.22%)	1 (4.35%)	12 (9.92%)
Brooke lateral ileostomy	9 (9.18%)	0	9 (7.44%)
Pelvic floor reconstruction (gracilis, VRAM)	2 (2.04%)	0	2 (1.65%)
Sacrum resection (S4–S5)	0	2 (8.7%)	2 (1.65%)
Bricker ileal conduit	8 (8.16%)	12 (52.17%)	20 (16.53%)
Cutaneous ureterostomy	5 (5.1%)	3 (13.04%)	8 (6.61%)
Wed colostomy	1 (1.02%)	0	1 (0.83%)
R0	80 (81.63%)	17 (73.91%)	97 (80.17%)
R1	10 (10.2%)	4 (17.39%)	14 (11.57%)
R2	8 (8.16%)	2 (8.7%)	10 (8.26%)

PE: Pelvic exenteration; LAPN: Locally advanced primary neoplasia; RN: Recurrent neoplasia; VRAM: Ventral *rectus abdominis* muscle; R0, R1, R2: Resections; *n*: No. of cases.

Table 4 – *Histopathological characteristics, neoadjuvant treatment and mortality of the study group*

Characteristics	LAPN (*n*=98, 80.99%)	RN (*n*=23, 19%)	Total (*n*=121, 100%)
Histopathological type			
Rectal adenocarcinoma	33 (33.67%)	8 (34.78%)	41 (33.88%)
Colon adenocarcinoma	5 (5.1%)	1 (4.35%)	6 (4.96%)
Ovarian serous carcinoma	27 (27.55%)	3 (13.04%)	30 (24.79%)
Squamous cell carcinoma	9 (9.18%)	8 (34.78%)	17 (14.05%)
Salpingian serous carcinoma	3 (3.06%)	0	3 (2.48%)
Other	14 (14.28%)	1 (4.35%)	15 (12.39%)
Complete resolution of tumor	2 (2.04%)	2 (8.7%)	4 (3.31%)
Neoadjuvant treatment	33 (33.67%)	17 (73.91%)	50 (41.32%)
Radiotherapy	12 (12.24%)	4 (17.39%)	16 (13.22%)
Radio-chemotherapy	11 (11.22%)	5 (21.74%)	16 (13.22%)
Brachytherapy	0	1 (4.35%)	1 (0.83%)
Chemotherapy	7 (7.14%)	7 (30.43%)	14 (11.57%)
HIPEC	3 (3.06%)	0	3 (2.48%)
Total lymph nodes, mean (range)	26.14 (0–82)	17 (3–51)	25.52 (0–82)
Positive lymph nodes, mean (range)	4.77 (0–45)	0.5 (0–2)	4.48 (0–45)
Mortality	20 (20.41%)	9 (39.13%)	29 (23.97%)
<30 days mortality	1 (1.02%)	0	1 (0.83%)

LAPN: Locally advanced primary neoplasia; RN: Recurrent neoplasia; HIPEC: Hyperthermic intraperitoneal chemotherapy; *n*: No. of cases.

Table 5 – *Clavien–Dindo classification of postoperative complications*

Clavien–Dindo classification	LAPN (*n*=98, 80.99%)	RN (*n*=23, 19%)	Total (*n*=121, 100%)
Grade I–II			
Urinary infection	14 (14.28%)	2 (8.69%)	16 (13.22%)
Deep venous thrombosis	1 (1.02%)	1 (4.34%)	2 (1.65%)
Renal failure	4 (4.08%)	1 (4.34%)	5 (4.13%)
Pneumonia	1 (1.02%)	1 (4.34%)	2 (1.65%)
Ureterohydronephrosis	2 (2.04%)	1 (4.34%)	3 (3.48%)
Clostridium difficile colitis	4 (4.08%)	0	4 (3.31%)
Grade III–IV			
Postoperative bleedings	1 (1.02%)	0	1 (0.83%)
Colic necrosis	2 (2.04%)	0	2 (1.65%)
Pelvic abscess	1 (1.02%)	0	1 (0.83%)
Pulmonary embolism	2 (2.04%)	0	2 (1.65%)

LAPN: Locally advanced primary neoplasia; RN: Recurrent neoplasia; *n*: No. of cases.

Table 6 – *Predicting factors for postoperative complications according to univariate and multivariate analysis*

Covariates	Grade II–IV (Dindo–Clavien) morbidity after pelvic exenteration		
	*Univariate**	*Multivariate***	
	p-value	*HR (95% CI)*	*p-value*
Age >60 years (yes *vs.* no)	0.54		
Gender (male *vs.* female)	0.21		
Histological type			
Colorectal vs. non-colorectal	1		
Gynecological vs. non-gynecological	0.02	0.313 (0.118–0.825)	0.02
Preoperative chemotherapy (yes vs. no)	0.11		
Preoperative radiotherapy (yes vs. no)	0.83		
Urinary stoma (yes *vs.* no)	0.02		NS
Bricker conduit (yes *vs.* no)	0.06		NS
Ureterostomy (yes *vs.* no)	0.21		
Colostomy (yes *vs.* no)	0.45		
Ileostomy (yes *vs.* no)	0.44		
Colorectal anastomosis (yes *vs.* no)	0.51		
Type of exenteration			
Anterior vs. others	0.68		
Posterior vs. others	0.004	0.259 (0.105–0.64)	0.03
Total vs. others	0.06		
Supralevatorian vs. infralevatorian	1		
Type of resection (R0 *vs.* R1–2)	0.61		
Primary tumor *vs.* recurrence	0.3		

**Chi*-square test or Fisher's exact test, when appropriate; **Logistic regression analysis; HR: Hazard ratio; CI: Confidence interval; R0, R1, R2: Resections; NS: Not significant.

Furthermore, the multivariate analysis confirmed the gynecological origin of the tumor (p=0.02) and PPE (p=0.03) as determinant factors in postoperative complications.

After a follow-up of up to 84 months (ranging between nine to 84 months), overall mortality was at 23.97% (n=29), and 30-day mortality at 1.65% (n=2). In the group with RN, further recurrence occurred between 4–108 months after treatment.

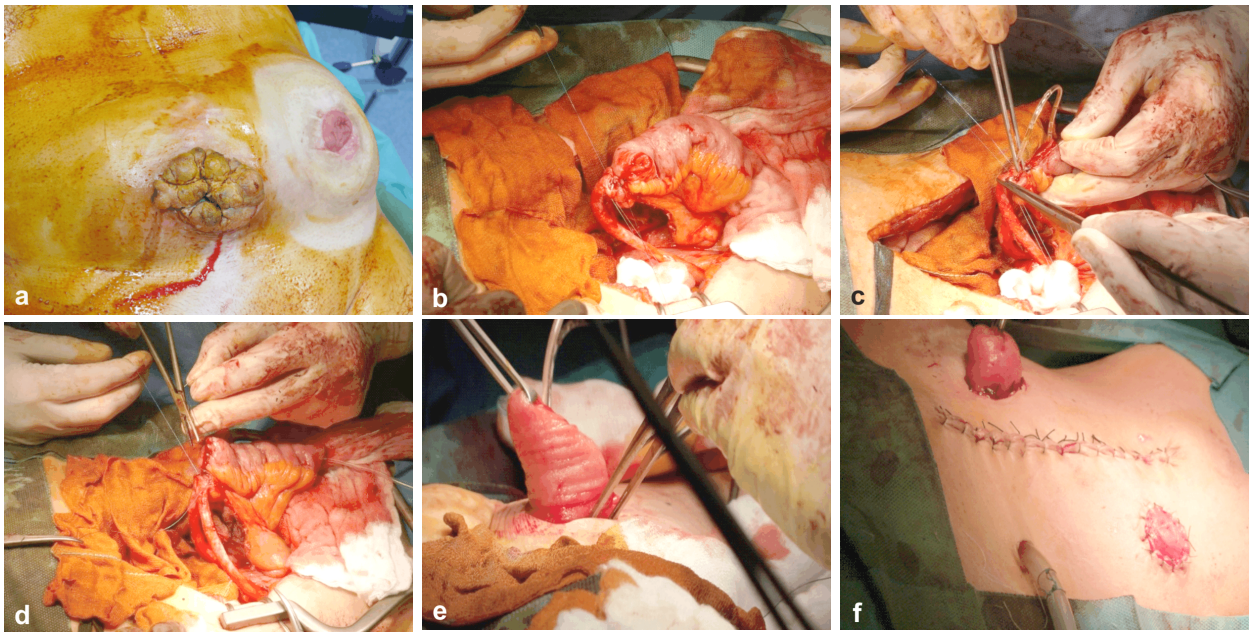

Figure 2 – ***Total pelvic exenteration: (a) Locally advanced tumor invading the abdominal wall of a patient with recurrent rectal cancer; (b) Intraoperative aspects: ileal-ureteral anastomosis; (c) Intraoperative aspects: ureteral stenting with size-8 French catheter; (d) Intraoperative aspects: closure of the ileal ansa after the ureteral anastomosis; (e) Intraoperative aspects: ileal ansa exteriorization with Bricker conduit creation, skin catheter fixation; (f) Intraoperative aspects: Bricker ileal conduit and terminal sigmoid colostomy.***

Figure 3 – ***Posterior infralevatorian pelvic exenteration: (a) Intraoperative aspects: locally advanced rectal cancer treated by posterior pelvic exenteration and perineal reconstruction; (b) Early postoperative aspects: perineal reconstruction with gracilis muscle; (c) Late postoperative aspects: perineal reconstruction with gracilis muscle.***

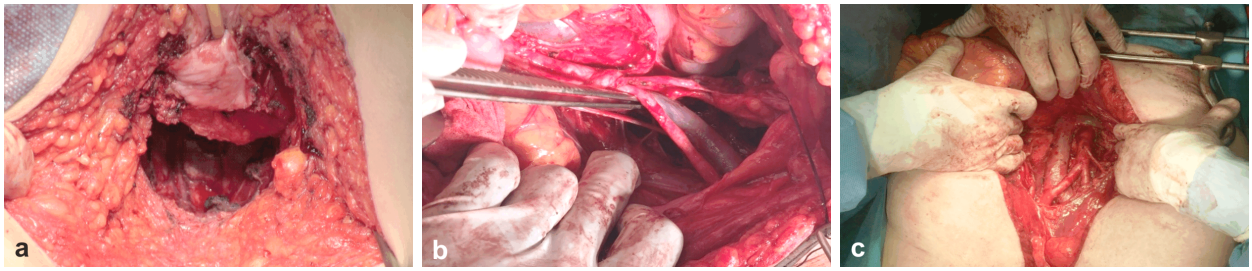

Figure 4 – ***Intraoperative aspects: (a) Perineal defect after posterior infralevatorian pelvic exenteration in a patient with locally advanced cervical cancer; (b) Pelvic lymphadenectomy in a patient with posterior exenteration for cervical cancer; (c) Aortic lymphadenectomy in a patient with posterior exenteration for ovarian cancer.***

Discussions

Advanced, neoplastic pelvic diseases, both newly diagnosed and recurrent, represent a major problem in oncology due to their significant negative impact on quality of life and survival. According to our knowledge, there are no randomized comparative studies assessing survival or quality of life in patients who undergo surgery *versus* patients who prefer non-surgical treatments. Despite innovations in the field of oncology and radiotherapy, such a biological therapy or intensity modulation radiation therapy, surgery remains a major treatment option, and the rationale for choosing it over medical treatment must be weighed carefully in relation to other patient-related factors, such as survival, quality of life and estimated therapeutic benefits in terms of oncological resection margins [26].

In PE for ovarian cancer, literature data show that 30-day postoperative complications are recorded in 82%

of cases, while late postoperative complications occurred in 23% of cases, with predominantly urinary related (5%) and associated rectal incontinence (16%) [27]. In TPE, complete resection is reported in 75% of the cases, R1 resection in 16% and R2 resection in 9%, with good local disease control [28].

In gynecological neoplasia, vaginal reconstruction is performed after PE with reduced complications, using different types of flaps, such as transverse *rectus abdominis* myocutaneous (TRAM) flaps or deep inferior epigastric artery perforator (DIEP) flaps [29, 30].

In colorectal cancer, complication rates are reported to be 86% with a median survival of 21.4 months [31]. For patients with unresectable liver metastasis, neoadjuvant chemotherapy can be prescribed in order to transition towards a resectable disease and PE eligibility [32].

Our cohort of patients was fairly small and relatively heterogeneous. The patients were operated on by the same team specialized in surgical oncology and trained in gynecological and urological surgery. All patients proposed for surgery underwent preoperative investigations, most of which suggested the possibility of complete resection and the absence of extrapelvic localization for non-ovarian tumor pathology. R0 resection was obtained in 80% of the cases in accordance with other reported data [33]; this result could be supported by the lesion underestimation upon imagistic evaluation and the positioning of operated cases on the surgical learning curve.

In our cohort, 27% of the patients developed postoperative complications, which were severe in 5% of the cases (grade III–IV Dindo–Clavien) – a reduced rate comparing to other reported studies [34]. Major complications are reported in primary ovarian cancer and recurrent cervical and endometrial neoplasia [33]. Of all the risk factors included in the univariate and multivariate analyses of complication incidence, only PPE and gynecological pathology maintained statistical significance throughout.

A possible explanation for the more frequent complications in genital tumors in our cohort is the high proportion of stage IIIC ovarian cancers, for which the treatment required extrapelvic surgery. In the case of PPE, we believe that the complication rate was higher due to the involvement of the rectum in the surgical excision, and possibly because a larger cavity in the pelvis was created, thus increasing the odds of septic complications. Our study offers a surgical perspective on PE, which does not include the traditional risk factors as performance status, or nutritional status with preoperative albumin value. It is worth to mention that patients with *Eastern Cooperative Oncology Group* (ECOG) performance status >1 or a Charlson index >4 were not proposed for exenteration, as a result of a rigorous selection process.

Also, in our results, postoperative complications were not statistical correlated with neoadjuvant treatment or surgical resection in cases with RN. At the same time, the urinary diversion was not associated with a high rate of postoperative complications despite the fact that the most frequent complications were the urinary ones.

In locally advanced rectal cancer, the median OS is influenced by the type of neoadjuvant treatment, with values of 37 months for chemoradiotherapy, 33 months for chemotherapy alone and 53 months for radiotherapy alone, with a 3.01 hazard of death for R2 resection margins [19]. In PE for ovarian cancer, the reported survival rates are 14 months for DFS and 21 months for OS [27]. OS after PE varies according to the tumor location: 75% in vulvar, 57.6% in cervical, 55.6% in vaginal and 53.6% in endometrial cancers [35]. In recurrent gynecological neoplasia, PE is associated with long-term survival, but also with fatal postoperative complications [36]. TPE can be performed for synchronous gynecological tumors; however, the prognosis is poorer compared to operating on single neoplasia. In advanced ovarian cancer, exenterative resection is consider to be the most important prognostic factor [37]. For urinary malignancies, the reported 3-year OS rate is 59% in patients following R0 resection, compared to 5.6% in patients with positive resection, and is associated with improved long-term survival in multivariate analysis [hazard ratio (HR) 0.234, 95% confidence interval (CI) 0.146–1.34], other factors like age, neoadjuvant treatment or postoperative morbidity being insignificantly statistic [33].

When performed, PE is not influenced by advanced age or extensive oncological disease [38] and is associated with a significant impact on quality of life in terms of social, psychological and emotional functioning [39]. In terms of quality of surgical technique, surgeon volume in PE seems to be associated with the improvement of intraoperative factors, such as blood loss and implicit transfusion rates, but without further influences on complication and survival rates [40]. After PE, adjacent organ invasion is also considered a significant factor influencing 5-year OS in univariate analysis compared to patients without such invasion (p=0.018) [41].

For our cohort the follow-up was limited for some cases, but the results are in accordance with previous reports. After a follow-up ranging between nine to 84 months, our data revealed the best OS for gynecological cases, similar with the literature data [33]. The statistical differences between postoperative complications and, respectively, survival, in colorectal *versus* gynecological neoplasia, can be explained by the variability of the surgical resection, performed by a heterogeneous team that includes oncology surgeons, gynecologists and urologists. Moreover, a detailed analysis of the results obtained by our team starting with 2012 had shown a positioning of the initial cases on the surgical learning curve.

PE is still considered a type of major surgical resection associated with high morbidity and mortality but useful in attempting to resolve both primary neoplasia and RN with indications for *en bloc* tumor removal. A strict preoperative evaluation of the patients is required in order to achieve complete surgical resection. In carefully selected cases of patients with clinically manifested tumors, even when R2 resection is predicted due to imaging evaluation, PE can be performed in order to improve quality of life. Advances in imaging technology, staging procedures, resection associated with reconstruction techniques, pubic

bone and sacral resection have allowed for a reduction in postoperative complications and superior survival rates.

Conclusions

PE is a disabling surgical procedure associated with high postoperative mortality and morbidity, although it is often the only solution for advanced cases. The judicious selection of patients who can benefit from such extensive surgery is compulsory. Our study sustains the gynecological origin of the tumor and PPE as key factors in postoperative complications.

Conflict of interests

The authors declare that they have no conflict of interests.

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Corresponding authors

Ionuţ Huţanu, Assistant Professor, MD, PhD, Department of Surgery, "Grigore T. Popa" University of Medicine and Pharmacy, Iaşi; 1st Surgical Oncology Unit, Regional Institute of Oncology, 2–4 General Henry Mathias Berthelot Street, 700483 Iaşi, Romania; Phone +40726–349 150, e-mail: hionut65@gmail.com

Mihaela Grigore, Associate Professor, MD, PhD, Department of Obstetrics and Gynecology, "Grigore T. Popa" University of Medicine and Pharmacy, Iaşi; "Cuza Vodă" Hospital of Obstetrics and Gynecology, Iaşi; Medis Medical Centre, 7C Bălţi Street, 700011 Iaşi, Romania; Phone +40744–438 024, e-mail: mihaela.grigore@edr.ro

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