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ORIGINAL ARTICLE

Robot-assisted radical hysterectomy—perioperative and survival outcomes in patients with cervical cancer compared to laparoscopic and open radical surgery

Grigor Gortchev · Slavcho Tomov · Latchesar Tantchev · Angelika Velkova · Zdravka Radionova

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Abstract In this study, perioperative outcomes and survival data in patients with early cervical cancer operated with three surgical methods: robot-assisted, laparoscopic and open, are to be analyzed. From January 2006 to May 2010, 294 patients with T1в1 cervical cancer were studied retrospectively. Robot-assisted radical hysterectomy (RARH) was performed in 73 (24.8%) of them, laparoscopic-assisted radical vaginal hysterectomy (LARVH) in 46 (15.6%) and, in 175, (59.5%), abdominal radical hysterectomy (ARH). Mean hospital stay of patients with RARH and LARVH was 4.1± 0.7 and 4.8±0.5, respectively, and of those with ARH, 9.6± 1.0 days (p=0.001). Mean operative time was 152.2± 26.5 min for the robotic group as it was significantly shorter in comparison with the laparoscopic group (232.1±61.7 min) and laparotomy group (168.2±31.1 min) (p=0.001). The application of Cox regression analysis found that the regional lymph node metastases were of significant value for disease-free survival (DSF), and the nodal status and recurrence presence—for overall survival (OS). Type of surgical procedure did not influence DSF, as well as OS. RARH has been established to be a safe procedure with proven advantages in regard to operative time and hospital stay. The absence of significant differences in DSF and OS is a substantial reason to continue, from an oncologic point of view, the application of this method on patients with T1в1 cervical cancer.

G. Gortchev (✉) · S. Tomov · L. Tantchev · A. Velkova · Z. Radionova
Gynecologic Oncology Clinic, Medical University,
8A, Georgi Kochev Blvd,
Pleven 5800, Bulgaria
e-mail: oncogynec@yahoo.com

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Background

After the first attempts of Nezhat et al. and Canis et al. in the radical laparoscopic hysterectomy, the beginning of the minimally invasive surgery for treatment of cervical carcinoma had been initiated [1, 2].

Conventional laparoscopy has some shortcomings, which premise that the method is mastered with difficulty for a longer period of time, and requires the development of specific coordination skills. The nature of the laparoscopic instruments proposes decreased tactile sensation and paradoxical movements. Hand tremor increases toward the distal end. The effector end of the instruments is with limited motions. The monitor reproduces the operative field in two dimensions, which is connected with a change in the coordination of the "eye–hand" feedback. In most cases, the surgeon works in insufficiently ergonomic position and environment. All these circumstances shape a barrier difficult to be surmounted by a beginning laparoscopist, especially in the cases when a radical laparoscopic surgery is needed [3].

Robotic surgical systems overcome a great part of the disadvantages of the classic laparoscopy. Robotic instruments have seven degrees of freedom, similar to those of the human arm, as the computer interphase eliminates the natural tremor. Sitting behind the console, the surgeon works comfortably in an ergonomic environment, and the image is three-dimensional. In 2006, Sert and Abeler describe the technique of the first robot-assisted laparoscopic radical hysterectomy (Piver type III) [4]. Data about

more than 300 radical robotic hysterectomies for cervical cancer have been published from 2006 to 2009 [4–12]. Literature data concern basically the perioperative results because of the short period of incorporation of the robotic technology in the gynecologic oncology practice [6, 7, 13]. There are a few publications, which assess the survival outcomes of patients with cervical cancer and compare the three radical surgical methods—robotic, laparoscopic, and open [9, 14].

The goal of this study was to analyze our experience in the robotic radical hysterectomy and to compare the perioperative outcomes and preliminary results of survival of patients with early cervical cancer with those of the laparoscopic and open radical surgery.

Material and methods

From January 2006 to May 2010 in the Gynecologic Oncology Clinic, Medical University Pleven, Bulgaria, 294 patients with T1b1 cervical cancer were operated. Robot-assisted radical hysterectomy (RARH) was accomplished in 73 (24.8%) of them, laparoscopic-assisted radical vaginal hysterectomy (LARVH) in 46 (15.6%), and abdominal radical hysterectomy (ARH) in 175 (59.5%). From January 2006 to December 2007, the LARVH cohort of patients was treated. The program in robot-assisted gynecologic surgery and telemedicine, which major task was the implementation and development of the robotic technology in the gynecologic oncology practice, started in January 2008 at our institution. The operating team, consisting of console surgeon, bed-side assistant and bed-side nurse, was trained on porcine model to work with the robotic system at the European training center in Strasbourg. The console surgeon was trained additionally at the Division of Gynecology Oncology, Department of Obstetrics and Gynecology, University of North Carolina at Chapel Hill, USA. The application of the LARVH was gradually reduced after the installation of the robotic system da Vinci S and the beginning of the robotic program. RARHs included in the analysis were accomplished from May 2008 to May 2010, and the radical abdominal hysterectomies from January 2006 to May 2010. All robotic and laparoscopic procedures were accomplished by one surgeon, and the open procedures by two surgeons using one and the same operative methods.

Patients' data were collected retrospectively from the hospital record (history of present illness) and the Bulgarian National Cancer Registry. The da Vinci S system (Intuitive Surgical, Sunnyvale, CA, USA), located in the operating room for laparoscopic and telesurgery (OR1, Karl Storz, Germany) was used for the robotic surgery. The location of the da Vinci S system components is adapted to the specific conditions in OR1. The surgeon's console is located on the left side of the patient, the patient cart—facing the patient's feet, and the vision cart, bed-side assistant and scrub nurse—on the right side of the patient. Patient is placed on the operating table in dorsal lithotomy and in steep Trendelenburg position. Insufflation of CO_2 is accomplished in the upper left abdominal quadrant with Optical Veress (Karl Storz). RARH, which we perform, corresponds to class III radical hysterectomy according to Piver et al. [15]. A detailed description of the positioning and placement of trocars and the operative technique was presented by us in a publication in *Gynecological Surgery* journal [16].

The laparoscopic-assisted radical vaginal hysterectomy technique applied by us is similar to LARVH type III, described by Koehler et al. [17].

Data were processed with the statistical package SPSS 13.1., as the following methods were applied: descriptive analysis, variation analysis, cross tabulation, ANOVA, and χ^2 tests. Log rank, Breslow, and Tarone–Ware methods were used for the assessment of influence availability of the investigated parameters on survival, and the Cox regression model was applied for quantitative assessment of the influence of these factors on survival.

Findings

The mean age of the patients with RARH was 46.0± 11.2 years, and of those with LARVH and ARH, 42.5± 9.9 years and 49.0±11.0 years, respectively, as it was significantly lowest in the group with LARVH (p=0.001). In the abdominal radical surgery group, the cases between 50 and 59 years of age (49/28.0%) were predominating, and in the minimally invasive surgery, between 40 and 49 years of age (RARH, 24/32.9%; LARVH, 17/37.0%) (p=0.003). The preoperative stage, according to FIGO for the whole group of 294 patients, was assessed as Ib1. Metastases in the regional pelvic lymph nodes were diagnosed after the performance of the operative intervention in 59 (20.1%) patients (pT1b1 pN1 pM0). The distribution of the cases with metastatic lymph nodes according to the operation type was as follows: RARH, 12/16.4%; LARVH, 5/10.9%; and ARH, 42/24.0%, as the differences were insignificant (p= 0.095). The average number of the removed lymph nodes was 11.4±7.0 (range 2–56) for RARH, 11.3±5.2 (range 3–24) for LARVH, and 15.9±7.7 (range 2–46) for ARH. The differences between RARH and ARH, and between LARVH and ARH are significant (p=0.001). The histological study determined that in the robotic cohort 65 (89.0%) of the patients were with squamous cell carcinoma (SCC) and 8 (11.0%) with adenocarcinoma; in the laparoscopic cohort, 41 (89.1%) were with SCC and 5 (10.9%) with adenocarcinoma, and in the laparotomy cohort, they were respectively 167 (95.4%) and 8 (4.6%) (p=0.116).

The values of the preoperative hematocrit, postoperative hematocrit on the first day after the operation, and the difference between the pre- and postoperative hematocrit, were investigated. The average preoperative hematocrit values distinguished significantly (RARH, 0.369±0.039; LARVH, 0.375±0.037; ARH, 0.359±0.042) (p=0.035), and those of the postoperative hematocrit insignificantly (RARH, 0.317±0.035; LARVH, 0.330±0.031; ARH, 0.318±0.045) (p=0.153). The difference between the pre- and postoperative hematocrit was insignificant (RARH, 0.052±0.039; LARVH, 0.045±0.036; ARH, 0.041±0.035) (p=0.253). The main patient and tumor characteristics are summarized in Table 1.

The operative time was determined as the time between the beginning of the skin incision and the last skin stitch placement (incision time—skin closed time). Mean operative time was 152.2±26.5 min for the robotic group and significantly shorter in comparison with the laparoscopic group (232.1±61.7 min) and laparotomy group (168.2±31.1 min) (p=0.001). The RARH and LARVH learning curve is presented in Fig. 1. The robotic radical hysterectomy learning curve was without considerable variations. The mean operative time of the first ten patients in the

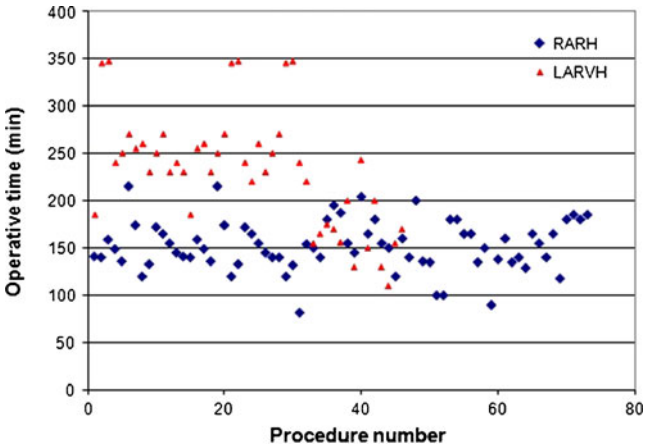

Fig. 1 Learning curve of the robot-assisted radical hysterectomy and laparoscopic-assisted radical vaginal hysterectomy

Table 1 Main patient and tumor characteristics

	RARH (n=73)	LARVH (n=46)	ARH (n=175)	p values
Age (years)				
Mean	46.0	42.5	49.0	0.001
SD	±11.2	±9.9	±11.0	
Range	(24–75)	(20–69)	(20–78)	
Predominating age group	40–49 years	40–49 years	50–59 years	
	24 (32.9%)	17 (30.0%)	49 (28.0%)	0.003
Preoperative Htc				
Mean	0.369	0.375	0.359	0.035
SD	±0.039	±0.037	±0.042	
Range	(0.260–0.460)	(0.280–0.460)	(0.230–0.470)	
Postoperative Htc				
Mean	0.317	0.330	0.318	0.153
SD	±0.035	±0.031	±0.045	
Range	(0.230–0.390)	(0.270–0.390)	(0.230–0.490)	
Htc difference				
Mean	0.052	0.045	0.041	0.253
SD	±0.039	±0.036	±0.035	
Range	(0.043–0.061)	(0.034–0.055)	(0.033–0.049)	
Cancer type				
SCC	65 (89.0%)	41 (89.1%)	167 (95.4%)	0.116
Adenocarcinoma	8 (11.0%)	5 (10.9%)	8 (4.6%)	
Total number of nodes				
Mean	11.4	11.3	15.9	0.001
SD	±7.0	±5.2	±7.7	
Range	(2–56)	(3–24)	(2–46)	
N0	61 (83.6%)	41 (89.1%)	133 (76.0%)	
N1	12 (16.4%)	5 (10.9%)	42 (24.0%)	0.095

robotic cohort was insignificantly higher in comparison with that one of the remaining 63 patients, respectively, 153.9±27.4 and 151.0±26.6 min (p=0.832). Learning curve of the radical laparoscopic hysterectomies shows comparatively high and stable level for the first 20 patients (mean operative time 263.2±49.4) and insignificant tendency toward a reduction for the remaining 26 (mean operative time 223.4±62.5) (p=0.071) (Fig. 1). The frequency of the complications in both groups with different mean operative time appeared statistically insignificant in the robotic (p=0.688), as well as in the laparoscopic cohort (p=0.345). We did not study the learning curve of the abdominal radical hysterectomies as this operative technique is applied according to a standardized method by all surgeons at our institution before 2006.

The average length of hospital stay for the patients with RARH and LARVH was 4.1±0.7 and 4.8±0.5 days, respectively and 9.6±1.0 days for those with ARH as the differences were with high significance in favor of the minimally invasive procedures (p=0.001).

The complications rate for the whole group of 294 patients was 4.4% (n=13). Only in one of them (7.7%) from the laparotomy cohort, an intraoperative ureteral lesion was found. The remaining 12 (92.3%) complications were established in the postoperative period. The complications in the different types of surgical interventions are presented in Table 2. There were no conversions in the robotic and laparoscopy groups.

Adjuvant therapy was conformed to a standard for the treatment of cervical carcinoma, approved by the Guild of the Bulgarian Radiotherapists. The postoperative external beam radiotherapy was carried out on 235 (79.9%) patients at a dose of 50 Gy to the whole pelvis. Chemoradiation was applied to all patients with metastases in the regional lymph nodes (20.1%/59) as the external beam radiotherapy dose was 50 Gy, combined with cisplatin at a dose of 40 mg/m^2.

The mean follow-up period was 316.3±192.0 days in the robotic group, 1,531.6±612.2 days in the laparoscopic group and 808.3±385.3 days in the laparotomy group (p=0.001).

Using the univariate and Cox regression analysis, the disease-free survival (DSF) and overall survival (OS) of the patients, operated with the three types of radical procedures—robotic, laparoscopic and open, were studied. Because of the different time of inclusion in the study and the different follow-up time, the univariate analysis was carried out by the method of Kaplan–Meier; as for determination of DFS, the investigated event was recurrence appearance, and for OS, death, caused by oncologic disease. In 29 (9.9%) of the patients, a recurrence was found, as the mean recurrence time was 2,161.8±57.6 days (95% CI, 2,048.8–2,274.7), and cumulative DFS, 81.8%. Frequency of recurrences, distributed according to the particular types of operative interventions, was as follows: RARH, 1 (1.4%); LARVH, 3 (6.5%); ARH, 25 (14.3%) (p=0.001). With the univariate analysis were analyzed the probable factors, influencing the time for recurrence appearance as follows: metastases in the regional lymph nodes, histological type of tumor, type of operation, complication presence. Significant dependence was established between DFS and the metastases in the lymph nodes (Table 3). DFS was highest in patients with robotic surgery (95.8%±4.1%), lower in the laparoscopic group (91.5%±4.8%), and lowest in the laparotomy group (77.4%±6.5%) as the differences were significant (p=0.019) (Fig. 2). Histological type of tumor and complications appearance did not influence the DFS (p>0.05). After application of the multivariate analysis with Cox regression model, only the regional lymph nodes status from the significant factors preserved its statistical significance, as the presence of metastases in them increased 4.1 times the probability for recurrence appearance (95% CI, 1.35–12.34).

Univariate analysis of the OS established that from the whole group of 294 patients, 23 (7.8%) have died, as 2 (4.3%) of them were with LARVH, 21 (12.0%) were with ARH, and all that have undergone RARH are alive (p=0.004). Cumulative OS was 88.2% at mean survival time of 2,242.5±45.6 days (95% CI, 2,153.0–2,331.9). The following factors with probable influence over the OS were examined: status of the regional lymph nodes, type of operation, histological tumor type, complication presence, and recur-

Table 2 Intra- and postoperative complications in robotic, laparoscopic, and open radical hysterectomy

Complications	RARH (n=73)	LARVH (n=46)	ARH (n=175)	p value
Intraoperative				
Ureteral lesion	–	–	1	
Postoperative				
Ureterovaginal fistula	1	–	1	
Lymphocele	2	–	–	
Pelveocellulitis	–	1	4	
Lung thromboembolia	–	–	1	
Hydronephrosis (unilateral, moderate)	–	–	2	
Total n (%)	3 (4.1)	1 (2.2)	9 (5.1)	0.676

Table 3 Influence of the metastases in the regional lymph nodes on disease-free survival, mean recurrence time, overall survival, and survival mean time

	N1	N0	*p* value		
			Log rank	Breslow	Tarone–Ware
DFS (%)	65.1±10.0	85.3±4.6			
MRT (days)	1,794.5±174.8	2,233.3±57.3	0.001	0.007	0.003
	(95% CI, 1,451.9–2,137.0)	(95% CI, 2,120.9–2,345.7)			
OS (%)	62.3±10.3	93.3±1.9			
SMT (days)	1,769.1±175.7	2,333.1±38.5	0.0001	0.001	0.0001
	(95% CI, 1,427.8–2,113.4)	(95% CI, 2,257.7–2,408.5)			

MRT mean recurrence time, *CI* confidence interval, *SMT* survival mean time

rence appearance. Only the nodal status, the type of operation and recurrence appearance out of all parameters displayed significant dependence with the OS. The influence of the regional lymph node metastases on OS is presented in Table 3. OS in ARH was 84.9%, in LARVH 94.9%, and in RARH 100% (p=0.037) (Fig. 3). Patients with recurrence had 52.5% OS at mean survival time of 1,171.4±170.5 days (95% CI, 837.3–1,505.5), and those without recurrence 90.4% and 2,278.7±42.5 days, respectively (95% CI, 2,195.4–2,362.0) (p=0.001). Histological type of tumor and complication appearance did not influence OS (p>0.05). The nodal status and recurrence presence preserved their significance in the Cox regression analysis. The risk for death of cervical cancer is 6.6 times higher in the presence of metastases in the regional lymph nodes, and 6.3 times higher of recurrences.

Discussion

The predominant part of the literature studies, which investigate the minimally invasive methods (robotic and/or laparoscopic) for treatment of early cervical carcinoma, are retrospective and case matched [6, 7, 9, 14]. Estape et al. have analyzed 32 patients who underwent robotic radical hysterectomy from August 2006 to April 2008. These cases were matched to a historical cohort of patients with total laparoscopic radical hysterectomy (July 2004–July 2006) and radical abdominal hysterectomy (May 2002–July 2006) [9]. Maggioni et al. have collected prospectively data for 40 patients with robotic radical hysterectomy, and compared them with a retrospective group of patients with abdominal radical hysterectomy [12].

Only a few authors compare the three operative approaches–robotic, laparoscopic, and open [6, 9]. Normally, the comparative analyses include either robotic and laparoscopic surgery or robotic and open surgery [4, 7, 11–13, 18, 19].

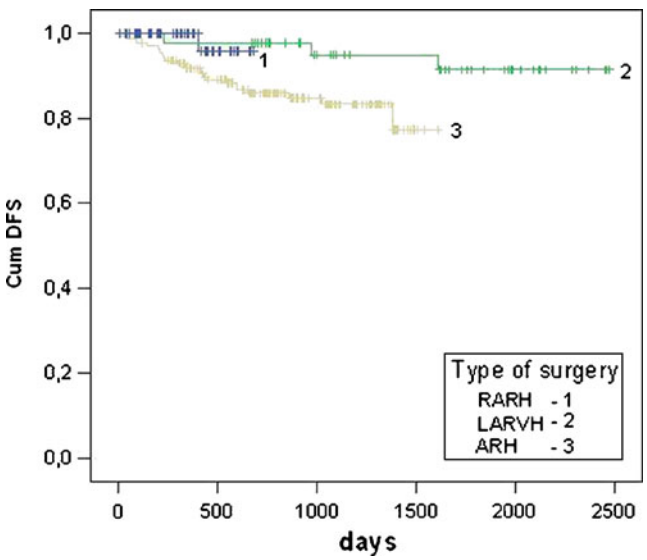

Fig. 2 Disease-free survival and type of surgery

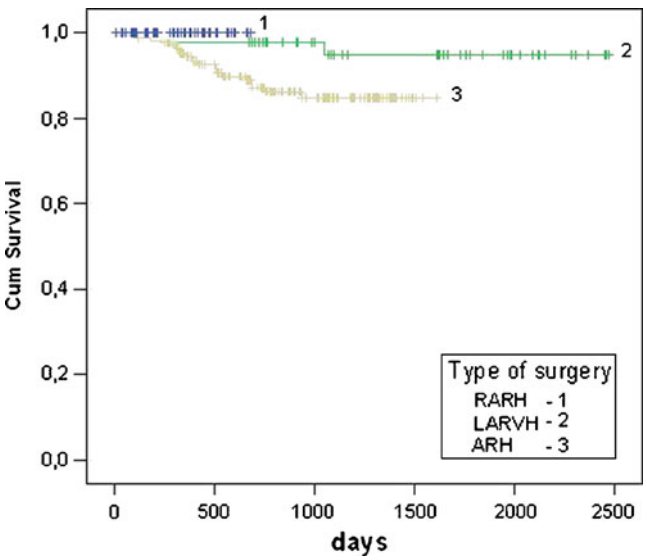

Fig. 3 Influence of type of surgery on the overall survival

Obermair et al. published in 2008 the design of a multicenter prospective randomized controlled trial, which compared laparoscopic or robotic radical hysterectomy with abdominal radical hysterectomy [20].

Our study, like the one of Cantrell et al., is entirely retrospective [14]. We analyze 294 patients with T1b1 cervical cancer, operated by three radical approaches: robotic, laparoscopic, and open. The operative interventions have been accomplished by one and the same team, at one institution, for a period of 4 years and 5 months (January 2006–May 2010). In contrast with Obermair's article, we compare the three methods separately. Although the laparoscopic and robotic surgeries are minimally invasive methods, they require mastering of different surgical skills in order to be applied. For example, LARVH, in contrast to the total laparoscopic radical hysterectomy, has a specific vaginal stage.

The weakness of our study is in its retrospective nature, as well as in the fact that it is not randomized and multicenter. The strength of the study is the comparison of outcome in patients, operated with three different types of radical procedures—robotic, laparoscopic, and open.

In the perioperative parameters, significant differences in favor of the robotic radical surgery were determined in the analysis of the mean age, mean operative time, and mean hospital stay (p=0.001).

Statistically significant lower mean age of the robotic group of patients in comparison with the open approach group was indicated in the studies of Boggess et al., Estape et al., and Maggioni et al. [7, 9, 12]. We attribute the lower mean age of the patients with LARVH and RARH in our series to two fundamental causes: a tendency toward a reduction in the age limit of the diagnosed cases with cervical cancer among the female population on one side, and the preferences of younger women to be operated with minimally invasive methods on the other [21].

Operative time is one of the main parameters, which corresponds with the severity of the operative trauma. Articles with a small number of patients present a longer operative time, because of less initial experience (Ko et al., n=16; mean operative time MOT=0450 hours; Lowe et al., n=7; MOT=260 min; Nezhat et al., n=13; MOT=323 min) [11, 13, 19]. The duration of the first robotic radical hysterectomy performed by us was approximately 4 h (215 min), and of the tenth—3 h (180 min). No significant difference was found in the mean operative time between the group of the first 10 patients and the group of the rest 63 patients. No difference was established in the complication rate between both groups as well. That is why we decided to analyze the operative time of all patients, operated by us, without excluding the first cases.

Our data for the mean operative time for RARH are similar to those of Estape et al. (2.4±0.8 h/144 min), and for LARVH and ARH correspond to the data of Magrina et al. (220.4±37.5 and 166.8±33.2, respectively, p=0.001) [6, 9]. In the multicenter study, presented by Lowe et al., five console surgeons participated, as nobody of them has had any preceding experience in the laparoscopic surgery. This fact and relatively the small number of cases operated by the particular surgeons, explain the longer mean operative time (215 min) in comparison with our data (152.2 min) [22].

The length of hospital stay reflects the differences in the postoperative outcomes of the patients subjected to different operative procedures. Factors that determine the time of discharge from hospital are the possibility of the patient to ambulate independently, recovery of the functions of the gastrointestinal tract, permitting oral ingestion of food, normalization of clinical parameters, as well as adequate pain control with oral drugs. Recovery of urinary bladder function (residual urine <50 ml) is not a determinant. Patients with residual urine >50 ml can be discharged from the hospital with a Foley catheter. Recovery of urinary bladder function is followed up ambulatory.

The differences in the mean hospital stay in our study are with high significance in favor of the minimally invasive procedures (RARH and LARVH, respectively 4.1±0.7 and 4.8±0.5 days) in comparison with the open radical approach (9.6±1.0 days) (p=0.001). Our data about the radical robotic hysterectomy are similar to those of Maggioni et al. (3.7± 1.2 days) and Sert et al. (4 days) [4, 12]. However, there are a lot of studies that present shorter hospital stay, ranging from 1 to 2.6 days [6, 7, 9, 11, 22]. The requirement of the National Health Insurance System for a minimum postoperative hospital stay of 2 days for the minimally invasive procedures was one of the basic reasons for the longer hospital stay of our patients with robotic surgery.

Average number of the removed lymph nodes in radical hysterectomy for cervical carcinoma range widely from 9.2 to 33.8 [7, 18]; as according to the type of the operative approach, the variations are in the following limits: robotic, from 11.5 to 33.8; laparoscopic, from 15 to 31; open, from 9.2 to 27.7 [4, 6, 7, 13, 18]. Our data are close to the lower range for the robotic radical hysterectomies and, in the data of Maggioni et al., are significantly lower in comparison with those of the abdominal radical surgery (p<0.05) [12]. Admitting the fact that in all cases, the zone of dissection visually is without residual lymph tissue, we think that the differences are determined mainly by the individual anatomy of the pelvic lymphatic system and the criteria differences for counting out the lymph nodes by the particular pathologists. Moreover, the size of the lymphatic dissection is not identical with the different authors. Feuer et al. perform dissection from the common iliac artery to the circumflex iliac vein, Persson et al. begin the lymphadenectomy from the common iliac lymph nodes, continue with the external iliac and finish with the obturator lymph nodes, and Magrina et al., in cases with indications, include the

paraaortal lymph nodes in the dissection [6, 10, 18]. The distal margin of our lymph node dissection is determined by the circumflex iliac vessels, and the proximal, by the bifurcation of the common iliac artery. On suspicion of lymph node metastases, we carry out frozen section examination. If metastases are proven, the dissection zone is extended along the common iliac artery.

Hematocrit is a laboratory parameter, which is used for acute and chronic blood loss assessment, as well as for changes in the water–electrolyte balance. In mammals, hematocrit is independent of body size. We used this parameter for indirect assessment of the intraoperative blood loss. No significant differences in the values of the postoperative hematocrit (p=0.153), and the difference between the pre- and postoperative hematocrit in the three operative methods (p=0.253) were established.

Literature data about the complications rate in radical robotic surgery vary in a wide range —from 7.8% to 59% [7, 10]. Different criteria for defining the minor complications and the different patients' follow-up period are the main reasons for that variety. Moreover, differences in the criterion for early and late postoperative complications exist. Magrina accepts, for early complications, those that have occurred to 6 weeks after the operation, while Maggioni, those that have occurred to 1 month after the operation [6, 12]. No significant differences in the frequency of the complications were established in all publications that compare the robotic with the open and/or laparoscopic surgery [9, 12, 13, 18, 19]. The rate of our complications for RARH was 4.1% (n=3) and did not differ significantly from that one of LARVH (2.2%/n=1) and ARH (5.1%/n=9) (p=0.676). Readmission for treatment of complications arising in five patients was necessary—two with ureterovaginal fistulas (RARH and ARH), one with symptomatic lymphocele (RARH), one with severe pelveocellulitis (LARVH), and one with pulmonary thrombembolia, terminated fatally (ARH). Correction of the ureterovaginal fistulas was performed via open surgery, while the patient with the symptomatic lymphocele was subjected to laparoscopy. The remaining cases were treated conservatively.

Data for the follow-up period, recurrences and mortality rate in patients with cervical cancer who have undergone radical robotic hysterectomy are reported in few articles [5, 6, 9, 10, 14]. In a case-matched analysis of robotic radical hysterectomy compared with laparoscopy and laparotomy, Estape et al. present mean patient's follow-up period of 284.2±152.1 days (robotic group), 941.6±273.9 days (laparoscopy group), and 1,382.4±592.7 days (laparotomy group), respectively [9]. In our study, significantly shortest was the mean follow-up period for the robotic group (316.3± 192.0 days), followed by the laparotomy group (808.3± 385.3 days) and laparoscopic group (1,531.6±612.2 days), respectively (p=0.001). Significant differences in favor of the minimally invasive approaches (RARH and LARVH) in comparison with the open surgery, with regard to the frequency of recurrences (p=0.001) and mortality rate (p= 0.004), are observed.

The outlined by the univariate analysis trends in our study for better DFS and OS of patients with robotic surgery in comparison with those with laparoscopic and open radical surgery, were not confirmed by the Cox regression model. The metastases in the regional lymph nodes (for DFS and OS) and the recurrence appearance (for OS) were the only parameters, which preserved their significance. Our results are close to those of Cantrell et al. The authors have studied retrospectively the progression-free survival (PFS) and OS in 71 patients with cervical carcinoma, who have undergone type III robotic radical hysterectomy and compared them with a group of open radical hysterectomies. No significant differences were found in PFS (p=0.27) and OS (p=0.47) between both groups [14].

Conclusion

In conclusion, analysis of the perioperative parameters shows that RARH is a reliable procedure with proven advantages with regard to the mean operative time and hospital stay in patients with early cervical cancer. Data on the survival are preliminary. We recognize that the follow-up period for the patients with robotic hysterectomy is short. After accumulation of sufficient number of cases and sufficient follow-up period from a statistical reliability point of view, it will be clarified in what direction the results will be altered. The absence of significant differences in the DFS and the OS currently, however, is a substantial reason to continue from an oncologic point of view, the application of this method on patients with T1b1 cervical cancer.

Declaration of interest The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

References

1. Nezhat CR, Burrell MO, Nezhat FR, Benigno BB, Welander CE (1992) Laparoscopic radical hysterectomy with paraaortic and pelvic node dissection. Am J Obstet Gynecol 166(3):864–865
2. Canis M, Mage G, Wattiez A, Pouly JL, Manhes H, Bruhat MA (1990) Does endoscopic surgery have a role in radical surgery of cancer of the cervix uteri? J Gynecol Obstet Biol Reprod (Paris) 19:921
3. Ballantyne G, Marescaux J, Giulianotti P (2004) Primer of robotic and telerobotic surgery. Lippincott Williams & Wilkins, Philadelphia
4. Sert B, Abeler V (2007) Robotic radical hysterectomy in early-stage cervical carcinoma patients, comparing results with total

laparoscopic radical hysterectomy cases. The future is now? Int J Med Robot 3(3):224–228
5. Kim YT, Kim SW, Hyung WJ, Lee SJ, Nam EJ, Lee WJ (2008) Robotic radical hysterectomy with pelvic lymphadenectomy for cervical carcinoma: a pilot study. Gynecol Oncol 108(2):312–316
6. Magrina JF, Kho RM, Weaver AL, Montero RP, Magtibay PM (2008) Robotic radical hysterectomy: comparison with laparoscopy and laparotomy. Gynecol Oncol 109(1):86–91
7. Boggess JF, Gehrig PA, Cantrell L, Shafer A, Ridgway M, Skinner EN et al (2008) A case–control study of robot-assisted type III radical hysterectomy with pelvic lymph node dissection compared with open radical hysterectomy. Am J Obstet Gynecol 199(4):357.e1–357.e7
8. Fanning J, Fenton B, Purohit M (2008) Robotic radical hysterectomy. Am J Obstet Gynecol 198:649.e1–649.e4
9. Estape R, Lambrou N, Diaz R, Estape E, Dunkin N, Rivera A (2009) A case matched analysis of robotic radical hysterectomy with lymphadenectomy compared with laparoscopy and laparotomy. Gynecol Oncol 113(3):357–361
10. Persson J, Reynisson P, Borgfeldt C, Kannisto P, Lindahl B, Bossmar T (2009) Robot assisted laparoscopic radical hysterectomy and pelvic lymphadenectomy with short and long term morbidity data. Gynecol Oncol 113(2):185–190
11. Lowe MP, Hoekstra AV, Jairam-Thodla A, Singh DK, Buttin BM, Lurain JR et al (2009) A comparison of robot-assisted and traditional radical hysterectomy for early-stage cervical cancer. J Robot Surg 3(1):19–23
12. Maggioni A, Minig L, Zanagnolo V, Peiretti M, Sanguineti F, Bocciolone L et al (2009) Robotic approach for cervical cancer: comparison with laparotomy: a case control study. Gynecol Oncol 115(1):60–64
13. Nezhat F (2008) Minimally invasive surgery in gynecologic oncology: laparoscopy versus robotics. Gynecol Oncol 111(2 Suppl):S29–S32
14. Cantrell LA, Mendivil A, Gehring PA, Boggess JF (2010) Survival outcomes for women undergoing type III robotic radical hysterectomy for cervical cancer: a 3-year experience. Gynecol Oncol 117(2):260–265
15. Piver MS, Rutledge F, Smith JP (1974) Five classes of extended hysterectomy for women with cervical cancer. Obstet Gynecol 44:265–272
16. Gortchev G, Tomov S, Tanchev L, Velkova A, Radionova Z (2010) Da Vinci S robotic surgery in the treatment of benign and malignant gynecologic tumors. Gynecol Surg 7:153–157
17. Koehler C, Possover M, Klemm P, Tozzi R, Schneider A (2002) Renaissance der Operation nach Schauta. Gynaekologe 35:132–145
18. Feuer G, Benigno B, Krige L, Alvarez P (2009) Comparison of a novel surgical approach for radical hysterectomy: robotic assistance versus open surgery. J Robot Surg 3:179–186
19. Ko EM, Muto MG, Berkowitz RS, Feltmate CM (2008) Robotic versus open radical hysterectomy: a comparative study at a single institution. Gynecol Oncol 111(3):425–430
20. Obermair A, Gebski V, Frumovitz M, Soliman PT, Schmeler KM, Levenback C (2008) A phase III randomized clinical trial comparing laparoscopic or robotic radical hysterectomy with abdominal radical hysterectomy in patients with early stage cervical cancer. J Minim Invasive Gynecol 15(5):584–588
21. Valerianova Z, Vukov M, Dimitrova N (2009) Cancer incidence rates per 100,000 by primary sites and age at diagnosis in Bulgaria 2007 – females. Bulgarian National Cancer Registry 18:48–58
22. Lowe MP, Chamberlain DH, Kamelle SA, Johnson PR, Tillmanns TD (2009) A multi-institutional experience with robotic-assisted radical hysterectomy for early stage cervical cancer. Gynecol Oncol 113(2):191–194