COMPARATIVE ANALYSIS OF OPERATIVE TIME, LENGTH OF STAY IN ICU AND ESTIMATED BLOOD LOSS IN ROBOT-ASSISTED AND LAPAROSCOPIC SURGERY

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ABSTRACT

INTRODUCTION: Minimally invasive surgical techniques are increasingly utilized in contemporary surgical practice worldwide. Despite the similarities between them, such as minimal tissue trauma, improved visibility of the operative field, etc., there are also a number of differences. The most common of them are related to the operative time and length of stay in the intensive care unit (ICU), as well as the amount of intraoperative blood loss.

AIM: The aim of this study is to compare the length of ICU stay, the need for blood transfusion due to intraoperative bleeding and the mean operative time in accordance with the body mass index among Bulgarian female patients, who have undergone laparoscopic and robot-assisted gynecological surgery.

METHODS: We analyzed 460 women with benign and malignant gynecological diseases who were operated on at the Gynecology Clinic at the University Hospital - Pleven, Bulgaria from 2007 to 2015. Robot-assisted surgery was performed on 223 patients, and laparoscopic surgery – on 247 patients.

RESULTS: We found out that ICU stay (in days) was 1.12 in the group of robot-assisted operations, and 1.05 – in the laparoscopic surgery group. The operative time in laparoscopic operations was significantly shorter, as compared to robot-assisted operations.

CONCLUSION: The need for blood transfusion was determined, considering the estimated intraoperative blood loss and the changes of hemoglobin and hematocrit levels in the postoperative period, compared to their preoperative values. Three prognostic groups were formed.

Keywords: *robotic surgery, length of ICU stay, blood transfusion, operative time*

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INTRODUCTION

At present, robotic surgery with the Da Vinci system is widely used for the treatment of a number of benign and malignant diseases. Originially developed for the needs of NASA as a telesurgery robotic system for remotely performed surgery on war victims on the battlefield, it is now gaining popularity in different areas of on-site minimally invasive surgery (1).

The other most commonly used minimally invasive method is laparoscopic surgery. The two techniques, however, have essential differences. The laparoscopic instruments cause reduced tactile feedback and paradoxical movements. The tremor of the hands is amplified at the distal end, and the effector part of the instruments has limited movements. The monitor reproduces the operative field in two dimensions, which is associated with a change in the“hand-eye“ coordination feedback. In most cases, the surgeon works in insufficiently ergonomic position and environment. Altogether, these circumstances form a hardly surmountable barrier for a beginner in laparoscopic surgery, especially in radical procedures, which in turn is a prerequisite for many obstacles during surgery.

Unlike laparoscopic instruments, the robotic surgical systems overcome many of the disadvantages of classical laparoscopy. The robotic „arms“ have seven degrees of freedom of movement, similar to those of the human hand, and electronic control makes them more precise and eliminates tremor. The human hand is capable of 180° movements. In comparison, each arm of the Da Vinci robot performs 540° movements and provides better mobility of the surgeon. The surgeon works comfortably in an ergonomic environment, sitting behind the console and has a three-dimensional view to the field. This implies less tissue trauma, less blood loss in the intraoperative and postoperative period, and a better quality of life after surgery.

AIM

The aim of this study is to compare the length of ICU stay, the need for blood transfusion due to intraoperative bleeding and the mean operative time in accordance with the body mass index among Bulgarian female patients, who have undergone laparoscopic and robot-assisted gynecological surgery.

MATERIALS AND METHODS

The study involved 470 women with gynecological diseases (both benign and malignant), operated on in the Clinic of Gynecology at University Hospital - Pleven, Bulgaria for a period of 8 years (2007-2015). The average age of the patient was 45.35±8.14 years, age range 30-69 years. Of all the patients, 223 (47.4%) underwent robot-assisted operations for malignant diseases, and 247 (52.6%) underwent laparoscopic operations for benign diseases.

The largest number of patients with robotic operations was from the 40-49-year-old age group (78 patients), followed by the 50-59-year-old group with 65 patients, and the group of 60-69-year-olds (18 patients). In the laparoscopic surgery group, the 40-49-year-old age group included the largest number of patients (126), followed by 30-39-year-olds (63 patients), while the smallest group was of the 60-69-year-olds (5 patients).

Clinical Methods

The clinical methods used included patient history, physical examination, consultation with an anesthesiologist, intensive care specialist, internist, if necessary, a cardiologist, endocrinologist or other specialists.

Laboratory Methods

The following laboratory tests were performed preoperatively and on the first two postoperative days: complete blood count, hemostasis tests - activated partial thromboplastin time (aPTT), prothrombin time (PT), fibrinogen, bleeding time, clotting time; blood sugar; serum electrolytes (Na+, K+, Ca+, Cl+), blood gas analysis, total serum protein (total protein, albumin).

Instrumental Methods

Chest radiographs and ECG were performed.

Operative time was defined as the interval in minutes between the skin incision to the anterior abdominal wall (LH, TAH and RAH) or the incision to the vaginal mucosa (TVH) and the last suture of the abdominal wall skin (LH, TAH and RAH), or the vaginal mucosa (TVH) (skin/mucosa incision time - closure time).

Blood transfusion was carried out at a hemoglobin level <80g/l.

Statistical Methods

The data was processed with the software package for statistical analysis SPSS 13.0. The significance level, rejecting the null hypothesis was set to $p<0.05$

The following statistical methods were used:

1. Descriptive analysis - the frequency-related distribution of the examined signs, divided into study groups, was presented in a tabular form

2. Variation analysis – used to assess the characteristics of central tendency and statistical dispersion

RESULTS

The analysis included only patients with statistically significant diagnoses, namely: uterine fibroids (myoma), ovarian cyst, cervical cancer and endometrial cancer.

The results of our study showed a decrease in the hemoglobin concentration levels in the early postoperative period, compared to the preoperative values in both groups. The hemoglobin level remained stable on the next day in the robot-assisted group, but had a significant decrease in the laparoscopic group. The fact that the average hemoglobin concentration in the laparoscopic group was significantly lower in the preoperative period contributes to the difference between the hemoglobin level changes in the two groups.

Hematocrit in both groups lowered significantly in the early postoperative period and raised statistically significantly on the next day. Still, the level remained significantly lower than the preoperative one. The level of this parameter was significantly higher in the robotic-surgery group at the early postoperative stage (Table 1).

All four groups of patients with statistically significant diagnoses had significantly decreased hemoglobin levels in the early postoperative period. The group with ovarian cyst diagnosis showed statistically significant increase of hemoglobin levels on the day following the surgery, while the level in the other three groups remained the same from a statistical point of view.

Patients in all four groups were found with a significant decrease of hematocrit level in the early postoperative period. The ovarian cyst and cervix cancer patients showed a statistically significant increase of hematocrit levels on the day after the surgery, while patients in the other two groups it remained the same from a statistical point of view (Table 2).

Table 1. Hemoglobin and hematocrit level changes in patients with the two types of surgery

Type of surgery	Number of cases	Hb			Hct		
		Preoperative period	Early postoperative period	The next day	Preoperative period	Early postoperative period	The next day
		$\overline{X}$	$\overline{X}$	$\overline{X}$	$\overline{X}$	$\overline{X}$	$\overline{X}$
Robot-assisted	223	127.48[a]±12.54	112.22[b]±13.45	112.57[b]±12.42	0.363[a]±0.039	0.321[b]±0.040	0.324[c]±0.038
Laparoscopic	247	124.00[a]±12.37	109.76[b]±12.34	111.27[c]±12.50	0.358[a]±0.039	0.314[b]±0.042	0.318[c]±0.042
p		0.003	0.063	0.330	0.109	0.025	0.122

Table 2. Hemoglobin and hematocrit level changes in the different groups of diagnoses

Diagnosis	Number of cases	Hb			Hct		
		Preoperative period	Early postoperative period	The next day	Preoperative period	Early postoperative period	The next day
		$\overline{X}$	$\overline{X}$	$\overline{X}$	$\overline{X}$	$\overline{X}$	$\overline{X}$
Myoma	154	124,21[a]±12.60	109,1[b]±13.28	110,35[b]±13.51	0,362[a]±0.039	0,314[b]±0.045	0,317[b]±0.046
Ovarian cyst	93	123,66[a] ±12.05	110,77[b]±10.57	112,78[c]±10.50	0,352[a]±0.037	0,313[b]±0.037	0,320[c]±0.035
Cervical cancer	155	126,68[a] ±11.87	111,1[b]±13.09	111,97[b]±12.22	0,361[a]±0.038	0,317[b]±0.038	0,322[c]±0.037
Endometrial cancer	58	130,66[a]±12.69	115,9[b]±12.30	114,97[b]±11.79	0,371[a]±0.042	0,333[b]±0.044	0,331[b]±0.039

The only significant difference between the four groups was observed in the hemoglobin levels on the next day after the surgery, compared to preoperative levels. The average value of this change of hemoglobin levels was significantly lower in patients with ovarian cysts, as compared with the other groups.

Significant difference between the four groups was observed in the dynamics of hematocrit in the early postoperative period, compared to preoperative levels and on the day following the surgery, as compared to the preoperative period. The average value of this change was significantly lower in patients with ovarian cancer, as compared to those with uterine fibroids and cervix cancer (Table 3).

Based on these results, an analysis of the correlation between the diagnoses and the need for blood transfusion was made. The number of patients with the diagnoses of ovarian cyst, endometrial cancer and hyperplasia and polyp of the endometrium who did not need blood transfusion were significantly larger. Those with cervix cancer, on the other hand, needed blood transfusion.

Table 3. Comparative analysis of the operations (the diagnoses groups), considering hemoglobin and hematocrit level changes

Diagnosis	Number of cases	Hb			Hct		
		Ratio: Preoperative to early postoperative	Ratio: Preoperative to level on the next day	Ratio: On the next day to early postoperative	Ratio: Preoperative to early postoperative	Ratio: Preoperative to level on the next day	Ratio: On the next day to early postoperative
		$\overline{X}$	$\overline{X}$	$\overline{X}$	$\overline{X}$	$\overline{X}$	$\overline{X}$
Myoma	154	15.06[a]±10.47	13.86[a]±10.60	1.20[a]±9.15	0.049[a]±0.042	0.046[a]±0.049	0.003[a]±0.049
Ovarian cyst	93	12.88[a]±8.55	10.87[b]±8.49	2.01[a]±6.84	0.038[bc]±0.039	0.031[bc]±0.040	0.007[a]±0.028
Cervix cancer	155	15.59[a]±10.29	14.72[a]±9.77	0.87[a]±10.76	0.044[a]± 0.036	0.039[a]±0.035	0.005[a]±0.033
Endometrial cancer	58	14.74[a]±10.53	15.69[a]±11.28	-0.95[a]±8.44	0.038[ac]±0.041	0.040[ac]±0.042	-0.002[a]±0.037

Considering the data from Table 4, three prognostic groups of patients who needed blood transfusion can be formed:

Group No.1 - in cases with diagnoses of ovarian cyst, endometrial cancer, hyperplasia and polyp of the endometrium, it is about 100% likely that a transfusion of blood will not be necessary.

Group No.2 - in cases with uterine fibroids, the probability of occurrence of need for transfusion is 1.3/1 compared to that in cases of no occurrence.

Group No.3 – in cases with cervix cancer the probability of occurrence of the need for transfusion is 1.7/1 compared to that in cases of no occurrence.

Comparison of the parameters: length of stay in the ICU in patients with different diagnoses found no significant difference between them (Table 5).

Analysis of the parameters: operative time and BMI, showed that BMI correlates poorly and proportionally to the operative time only in patients, diagnosed with an ovarian cyst (Table 6).

DISCUSSION

Hematocrit is a laboratory parameter for the ratio of the volume of red blood cells to the total volume of blood. It is a relative indicator, used to evaluate acute and chronic blood loss as well as changes in the fluid-electrolyte balance. In mammals, the hematocrit is independent of body size. This is why we use this parameter along with the postoperative hemoglobin concentration for an indirect assessment of intraoperative blood loss.

The majority of authors evaluate intraoperative blood loss as the amount of blood that the patient has lost in milliliters (Jelovsek et al., 2007; Mahdavi et al., 2006; O'Hanlan et al., 2004; Twignstra et al., 2009). As this is an absolute value, it does not adequately re-

Table 4. Analysis of the correlation between the diagnosis and the need for blood transfusion

Diagnosis	Frequency	Need for blood transfusion		P
		NO	YES	
Uterine fibroids (Myoma)	Number	145	9	
	%	32.4	40.9	n.s.
Ovarian cyst	Number	93	0	
	%	20.8	0	<0.001
Cervical cancer	Number	143	12	
	%	31.9	54.5	<0.05
Endometrial cancer	Number	58	0	
	%	12.9	0	<0.001
Ovarian cancer	Number	3	0	
	%	0.7	0	n.s.
Hyperplasia and polyp of the endometrium	Number	6	0	
	%	1.3	0	<0.05
Uterine sarcoma	Number	0	1	
	%	0	4.5	n.s.
Total	Number	448	22	
	%	100.0	100.0	

Table 5. Comparison of length of stay in the ICU of patients with different diagnoses

Diagnosis	n	$\overline{X}$ (days)	SD
Uterine fibroids (Myoma)	154	1.08[a]	0.33
Ovarian cyst	93	1.01[a]	0.10
Cervical cancer	155	1.14[a]	0.61
Endometrial cancer	58	1.05[a]	0.29
Ovarian cancer	3	1.00	0.00
Hyperplasia and polyp of the endometrium	6	1.00	0.00
Uterine sarcoma	1	2.00	.

**Identical letters on the horizontal lines indicate no statistically significant difference; different letters indicate the existence of such significance (p<0.05)*

***Diagnoses with number of cases under 8 are not included in the analysis, due to a lack of statistical representativeness*

flect the clinical importance which losing a certain amount of blood can have on the patient (2,3,4,5).

The results of our study revealed that the need for blood transfusion was most common in patients, diagnosed with uterine fibroids who have undergone conventional laparoscopic surgery and in patients with cervix cancer who have undergone robot-assisted surgery.

In a study by Payne et al (2008.), robot-assisted operations were an average 27 min. longer than laparoscopic ones. The authors noted, however, that the last 25 out of 100 robot-assisted cases were performed faster than the average time for laparoscopic operations (92.4min compared to 78.7min). They also reported a difference of about 52ml in the blood loss between robotic and laparoscopic surgery in favor of the robot-assisted hysterectomies (6).

Table 6. Analysis of the correlation between BMI and operative time in the different groups, based on the diagnosis

Diagnosis	Parameters	Operative time
Uterine fibroids	BMI	-0.091
Ovarian cyst		0.241*
Cervical cancer		-0.124
Endometrial cancer		0.047

** p<0.05*

Other studies, also reporting longer operative time in robot-assisted operations are those of Shashoua al (2009) and Nezhat et al. (2009). According to them, operative time was increased to 20 min and to 70 min, respectively (7,8).

The research of Seamon et al. (2009) and Boggess et al. (2008), on the other hand, determined a shorter operative time for the robotic surgery group compared to the laparoscopic surgery group of about 45min. in the first study and 22min. in the second one (9,10).

Enrique Soto et al (2011) compared 124 patients, undergoing laparoscopic and robotic hysterectomies: 77 laparoscopic and 47 robotic surgery cases. In the laparoscopic group there were significantly more patients with estimated blood loss greater than 200 mL compared to the robotic group and this difference proved to be statistically significant (p=0.009). The estimated blood loss in the laparoscopic surgery group was 207.7 mL and 131.50 mL in the robotic surgery group. This difference turned out to be statistically significant (p=0.0105) although the 76 mL difference in the groups had no obvious clinical significance and need for blood transfusion (11).

These studies partially support our own results. We associate more frequent transfusions in the group of uterine fibroid diagnosis with chronic blood loss and the development of anemia syndrome in these patients. In the cervical cancer group the need for blood transfusion is associated with the greater volume of surgery.

The same authors demonstrated that the two groups of patients had comparable length of hospital stay - 2.2 days for the laparoscopic surgery group and 1.9 for the robotic surgery one. This again is in support of our results.

Tomov et al. (2012) presented interesting data in their study of body mass index and operative time. The regression analysis they conducted indicated a significant correlation between the two parameters. Increasing BMI with 1 kg/m2 resulted in an average 0.6 minutes increase in the operative time (p=0.026). In our research, we found such dependence only in patients, diagnosed with ovarian cysts.

CONCLUSIONS

High technologies in medicine are being increasingly utilized in the surgical practice worldwide. Their main aim is to achieve greater precision, to reduce pain and complications and to improve the quality of life in the postoperative period. The conventional laparoscopic and the robot-assisted surgical techniques are closest to achieving these goals.

Less tissue trauma and small amount of blood loss are a prerequisite for a short stay in the intensive care unit, higher quality of life in the early postoperative period and a rapid return of the patients to their social activities.

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