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Original Article

Study on the application of the Trendelenburg modified supine position in the surgery of ovarian cancer with rectal metastasis

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Abstract: Aims: To compare the effects of ovarian cancer cytoreductive surgery + Dixon surgery on ovarian cancer patients with rectal metastasis using either the Trendelenburg modified supine position or the Trendelenburg modified lithotomy position for surgery. Background: Trendelenburg modified lithotomy position, the most common surgical position for ovarian cancer cytoreductive surgery + Dixon surgery, might cause severe complications in patients who underwent surgery. As reported, Trendelenburg modified supine position is a safer surgical position to reduce the risks of surgical position complications and to increase the work efficiency. Design: This was a prospective study design. A total of 100 cases of late-stage ovarian cancer patients with metastasis in the sigmoid colon or rectum who underwent ovarian cancer cytoreductive surgery + Dixon surgery in Sun Yat-sen University Cancer Center between March 2013 and April 2015 were included in this study. The patients in the experimental group underwent surgery using the Trendelenburg modified supine position, and the patients in the control group underwent surgery using the Trendelenburg modified lithotomy position. Results: The time required for placement and recovery of the surgical position in the experimental group was shorter than that in the control group. The incidence of sacrococcygeal skin damage after surgery in the experimental group was lower than that in the control group. Conclusion: The placement and recovery of the Trendelenburg modified supine position was simple and quick, which was conducive to maintain the intraoperative stability of the hemodynamics and helpful for reducing the incidence of postoperative complications.

Keywords: Ovarian cancer, rectal metastasis, surgical position

Introduction

Ovarian cancer remains the most lethal gynecologic tumor in the world. Aggressive cytoreductive surgery, the effective treatment, has been shown to induce a clinical response in the majority of ovarian cancer patients. Colorectal metastasis in late-stage ovarian cancer is more common in the sigmoid colon and rectum [1]. Due to the complex operation, the operation duration is always too long to avoid postoperation complication as the result of the surgical position. The surgical position for ovarian cancer cytoreductive surgery + Dixon surgery on ovarian cancer with rectal metastasis commonly adopts the Trendelenburg modified lithotomy position [2].

A large number of domestic and international studies have indicated that the Trendelenburg modified lithotomy position might cause severe complications in patients who underwent surgery, such as lower extremity peripheral neuropathy, obturator and femoral neuropathy (LFC), sciatic nerve and peroneal nerve injury [3-7], deep venous thrombosis of the lower limb, and acute lower extremity compartment syndrome [8, 9]. During the placement and recovery of the surgical position, the rapid decrease and increase of blood reserves in the lower limbs causes rapid changes in returned blood volume, thus causing unstable hemodynamics; if severe, it can even cause acute myocardial infarction or sudden cardiac arrest [10-13]. Based on the principle of human body

mechanics, this study was combined with clinical experiences and data from the literature to investigate a more convenient, feasible, and safer surgical position in order to reduce the risks of surgical position complications in patients and to increase the work efficiency and reduce the work intensity of medical care personnel.

The study

To compare the effects of ovarian cancer cytoreductive surgery + Dixon surgery on ovarian cancer patients with rectal metastasis using either the Trendelenburg modified supine position or the Trendelenburg modified lithotomy position for surgery. This was a prospective study design. A total of 100 cases of late-stage ovarian cancer patients with metastasis in the sigmoid colon or rectum who underwent ovarian cancer cytoreductive surgery + Dixon surgery in the Department of Gynecology of Sun Yat-sen University Cancer Center between March 2013 and April 2015 were selected and randomly divided using the random number table method and the random number remainder grouping method [18]. These 100 patients were randomly divided into the experimental and control groups, with 50 cases in each group. The patients in the experimental group underwent surgery using the Trendelenburg modified supine position, and the patients in the control group underwent surgery using the Trendelenburg modified lithotomy position.

Participants

The inclusion criteria of the subjects were as follows: (1) patients who were first diagnosed with ovarian cancer with metastasis in the sigmoid colon or rectum; (2) patients who planned to receive ovarian cancer cytoreductive surgery + Dixon surgery; and (3) patients with a clear conscience who could normally communicate using words in Mandarin or Cantonese with the researchers. The exclusion criteria were as follows: (1) patients with other types of cancer; (2) patients with severe heart, lung, brain, and kidney function disorders; (3) patients with alcohol or drug addictions or patients with mental illness; (4) patients with a high risk of pressure ulcers with a Norton score < 14 points; and (5) patients with edema in both lower limbs, abnormal dorsalis pedis pulse, abnormal color or severe damage of the skin, abnormal pain sensation in the lower limbs, and motor dysfunction of the lower limbs.

Data collection

Through a review of the domestic and international literature, an information questionnaire related to the positions of patients during ovarian cancer with rectal metastasis surgery was designed. The content included a general information questionnaire, an implementation of the surgical position information questionnaire, a surgical position complication condition questionnaire, and a questionnaire assessing the satisfaction of the surgeons regarding the surgical position of the patients. There were 4 sections of data collection in this study.

General information questionnaire

The general information questionnaire was divided into 3 sections: sociology of population data, preoperative physical condition data, and disease-related data. The basic information of the patients contained 11 items regarding the sociology of population data including name, in-patient number, in-patient ward area, gender, age, height, body weight, marital status, profession, education, family per capita income, and medical payment method. There were 5 items regarding basic physical conditions including blood pressure after admission, heart rate, body mass index (BMI), Norton score, and chronic underlying diseases. The disease-related data included diagnosis after admission, tumor discovery method, tumor diameter, whether there was peritoneal dissemination implantation, whether there were other preoperative treatments, whether the lower limb motor sensory function was normal, whether there was lower limb edema, name of the planned surgery, planned surgery date, white blood cell count, red blood cell count, platelet count, hemoglobin content, albumin content, and prothrombin time [23]. The basic physical condition data and the disease treatment related data were completed by investigators after interviewing the patients and reviewing medical records.

Implementation of the surgical position information questionnaire

After reviewing the literature, referencing data from the literature, and consulting experts, the data collection during the implementation process of the surgical position included the name of the implemented surgery, the surgical position, the blood pressure and heart rate of the patient before and after position placement,

Figure 1. Surgical position during the handling anastomosis in the Dixon surgery.

the blood pressure and heart rate of the patient before and after recovery of position [10-13], the time required for surgical position placement, the time required for recovery of the surgical position [20], the skin condition in the sacrococcygeal region and the compressed location in the lower limb after surgery, whether there was lower limb edema after surgery, the surgery duration, intraoperative blood loss, and whether an analgesia pump was used after surgery. This table was completed by the individual who implemented the surgical positions on the day of surgery. The analgesia pump removal time data were completed at postoperative follow-up.

Satisfaction of surgeons regarding the patients' surgical position questionnaire

This survey was used to investigate the satisfaction of the surgeons regarding the surgical position of the patients. It was completed by the surgeons on the day of surgery. This survey was divided into 3 items. Each item used a 3-grade evaluation method: satisfied, neutral, or dissatisfied. The perception of the surgical position of the patients by surgeons was directly associated with whether the surgical position was proper; this perception was important for the evaluation and measurement of surgical positions.

Measurements and instruments

Experimental group

Formulation of the standards for placement of the Trendelenburg modified supine position: After searching for literature related to the current application status of the placement of the surgical position using the Trendelenburg modified supine position [19-21] and consulting with experts in this field, the position placement standards were formulated. The specific operation process is described below. ① The large operation bed sheet at the end of the bed was folded down evenly at the sitting bed under the mattress. One large drape was placed on each bilateral leg board. ② Assistance was provided for the patient to lie down on the operation bed. The lower edge of the buttocks was aligned with the lower edge of the backboard. The patient's palms faced the body, and both upper limbs were fixed and protected at both sides of the body using a medium drape. The patient's pants were removed, and leg sleeves were placed on the patient. The privacy of the patient must be protected. ③ Prior to anesthesia, a 3-cm thick gel pad was placed under the sacrococcygeal region, and 5-cm thick soft pads were placed under the knee joints of both legs using the comfort of the patient as the reference; the most comfortable locations perceived by the patient under the premise of meeting the surgical requirement were the following conditions: the knee joint was bent at 130°, the abduction angle of the hip joint was 40°, the external extension angle of the lower limbs was 45°, and a lower limb bandage was placed 5 cm above the knee joint. The patient was placed in the most comfortable position that met the surgical requirements and ensured the safety of the patient. Heel and ankle stress points were placed on soft gel pads for protection. ④ After the body was positioned, the 2 leg boards were brought together (**Figure 1**). After general anesthesia and during disinfection by the doctors, the leg boards of the operating bed were opened. After disinfection, a waterproof aseptic large sheet was placed under the hips. Aseptic leg sleeves were independently applied to both lower limbs. After draping, both legs were closed again. After the start of the surgery, the Trendelenburg position was adopted, and the head of the bed was lowered by 15°. After surgery on the pelvic area was completed, the bilateral leg boards were separated again during intestinal anastomosis in the Dixon surgery. The hip joint was abducted at approximately 80° (**Figure 2**). After the anastomosis process was competed, both legs were closed again for the second time. ⑤ The patient was returned to the Trendelenburg position during

Figure 2. Surgical position during intestinal of the pelvis.

Figure 3. Trendelenburg modified lithotomy position.

the abdominal wash, and the modified supine position was ceased at the end of the surgery. During the surgical process, the patient was maintained at a physiological function position as much as possible.

Intervention process

The patients were visited the day before the surgery. General information including each patient's name, age, height, and body weight, as well as disease-related information such as tumor size, metastasis, postoperative blood pressure, heart rate, normality of lower limbs, diabetes mellitus, Norton score, and laboratory examinations, were collected. On the day of the surgery, data on the time required for the placement and recovery of the body position of the patients, changes in hemodynamics before and after placement and recovery of the body position, surgery duration, intraoperative blood loss, satisfaction of the doctors regarding the surgical position, sacrococcygeal skin damage of the patients after surgery, and edema in both lower limbs were collected. On postoperative days 2 and 4, the study subjects were followed up. The presence of postoperative body position complications was identified through inquiry, patient examination, and a review of the medical records and examination results.

Control group

The patients were placed using the conventional placement position of the Trendelenburg modified lithotomy position [18]. Compared to the traditional lithotomy position, the Trendelenburg modified lithotomy position tilts the leg supports to the end of the bed, increases the angle between the trunk and thigh from 90° in the traditional lithotomy position to 150°, and lowers the head of the bed by approximately 15-30°. The Trendelenburg modified lithotomy position is mainly used for surgery in the rectum, bladder, prostate, urethra, and vagina [5] (**Figure 3**). The intervention process in the control group was the same as that in the experimental group.

Ethical considerations

The study was approved by the Institutional Research Ethics Committee of the Sun Yat-sen University Cancer Center. Participants indicated their willingness to participate by returning the completed surveys.

Data analysis

The data were input into SPSS 20.0 software. During the input process, the integrity and rationality of the data were examined again. The data input was performed by the researcher and the group leader of the Department of Gynecology. The researcher was responsible for the data input, and the group leader of the Department of Gynecology was in charge of ensuring the accuracy and reliability of the data input. After data input, the survey data were statistically analyzed to describe the general characteristics of ovarian cancer patients with rectal metastasis who received the ovarian cancer cytoreductive surgery + Dixon surgery, the implementation conditions of the surgical position, changes in hemodynamics during placement and recovery of body position, the time required for the placement and recovery of body position, and the occurrence of complica-

Table 1. General information of the study subjects (n = 100)

		Experimental group (n = 50)		Control group (n = 50)		χ^2	*P*
		Frequency	Percentage	Frequency	Percentage		
Age (years)	≤ 40	6	12.0	9	18.0	0.734	0.693
	41-59	35	70.0	32	64.0		
	≥ 60	9	18.0	9	18.0		
BMI (kg/m^2)*	≤ 18.5	3	6.00	5	10.0	3.866	1.450
	18.6-24.9	43	86.0	42	84.0		
	≥ 24.9	4	8.00	3	6.00		
Marital status	No	0	0.00	1	2.00	1.200	0.549
	Yes	47	100	47	94.0		
	Divorced	3	6.00	2	4.00		
Education	Primary school	20	40.0	21	42.0	1.495	0.472
	Middle school	15	30.0	19	38.0		
	College	15	30.0	10	20.0		
Profession	Employed	32	64.0	28	56.0	5.702	0.575
	Retire	5	10.0	4	8.00		
	Unemployed	13	26.0	18	36.0		
Per family capita income (Yuan/Month)	≤ 1999	23	46.0	19	38.0	1.800	0.407
	2000-2999	11	22.0	17	34.0		
	≥ 3000	16	32.0	14	28.0		
Medical payment method	Self-paying	13	26.0	16	32.0	1.503	0.682
	Health insurance	32	64	29	58		
	National support	5	10.0	5	10.0		

*BMI: Body Mass Index.

tions. General information of the surgery patients in these 2 groups was described using frequencies and percentages. The categorical variables were presented as percentages. The continuous variables that conformed to the normal distribution are presented as the "mean ± standard deviation"; variables that did not conform to the normal distribution are presented using mean, median, maximum, and minimum values. The differences of count data between these 2 groups were examined using the χ^2 test. Based on whether the data conformed to the normal distribution, the differences of measurement data between these 2 groups were examined using either the t-test or the rank sum test. $P < 0.05$ indicated that the difference was statistically significant.

Results

General information of the study subjects

Demographic data and the balance comparison: Female patients who required ovarian cancer cytoreductive surgery + Dixon surgery were recruited for both groups in this study. The patients ranged in age from 24-78 years, the mean age was 49.2 ± 10.3 years, and the largest proportion of patients was in the 41-59 year age group. Most of the patients were married. Most of the patients had a high school or lower education level. The primary professions were unemployed, farmers, and migrant laborers. The family per capita income was generally less than 3,000 RMB. Most of the patients paid for their medical expenses on their own or with village cooperative medical care. The χ^2 test results showed that the demographic characteristics between the 2 groups of patients were not significantly different (P > 0.05) (**Table 1**).

Disease related information and homogeneous comparison

These 2 groups were comprised of in-patients who planned to receive ovarian cancer cytoreductive surgery. Tumors were discovered in both the experimental group and the control group primarily through patients seeking treatment from existing symptoms or a palpable abdominal mass. The primary tumors generally ranged from 5 to 10 cm in diameter. In total, 24 and 30% of the tumors in the experimental and control groups had a diameter larger than 10 cm, respectively. The tumors in the majority of patients already displayed peritoneal dissemi-

Table 2. Disease related information of the study subjects (n = 100)

		Experimental group (n = 50)		Control group (n = 50)		χ^2	*P*
		Frequency	Percentage	Frequency	Percentage		
Diagnose	Self-discovery	46	92.0	47	94.0	0.154	0.695
	Medical examination	4	8.00	3	6.00		
Diameter (cm)	≤ 5	9	18.0	4	8.00	2.323	0.313
	5-10	29	58.0	31	62.0		
	≥ 10	12	24.0	15	30.0		
Peritoneum metastasis	Yes	44	88.0	45	90.0	0.102	0.749
	No	6	12.0	5	10.0		
Preoperative chemotherapy	Yes	20	40.0	19	38.0	0.042	0.838
	No	30	60.0	31	62.0		
WBC①	Normal	34	68.0	35	70.0	0.721	0.697
	Lower	4	8.00	2	4.00		
	Higher	12	24.0	13	26.0		
RBC②	Normal	27	54.0	29	58.0	0.167	0.920
	Lower	22	44.0	20	40.0		
	Higher	1	2.00	1	2.00		
PLT③	Normal	41	82.0	37	74.0	1.854	0.396
	Lower	2	4.00	1	2.00		
	Higher	7	14.0	12	24.0		
Hb④	Normal	15	30.0	11	22.0	1.739	0.419
	Lower	35	70.0	38	76.0		
	Higher	0	0.00	1	2.00		
Alb (g/L)⑤*	Normal	27	54.0	26	52.0	0.04	0.841
	Lower	23	46.0	24	48.0		
PT (min)⑥	Normal	45	90.0	40	80.0	3.866	1.450
	Lower	1	2.00	6	12.0		
	Higher	4	8.00	4	8.00		
Stretch socks	Yes	37	74.0	35	70.0	0.198	0.656
	No	13	26.0	15	30.0		
Lower limb edema	Yes	5	10.0	3	6.00	0.543	0.461
	No	45	90.0	47	94.0		
Chronic disease**	Yes	9	18.0	5	10.0	1.329	0.249
	No	41	82.0	45	90.0		

①WBC: White Blood Cell; ②RBC: Red blood cell; ③PLT: Platelets; ④Hb: Hemoglobin; ⑤ALB: Albumin; ⑥PT: Prothrombin Time.

nation implantation. Patients in both the experimental and control groups had previously received radiotherapy and chemotherapy. Few of the patients had chronic diseases before surgery; the white blood cell count, the red blood cell count, the platelet count, the coagulation function, and the lower limb edema conditions were mostly normal, and there were equal numbers of patients with normal albumin levels and low albumin levels. Before surgery, most of the patients in these groups placed elastic stockings under the popliteal fossa. The χ^2 test results showed that the composition of disease related information between the patients in these 2 groups was not significantly different ($P > 0.05$). The basic physical conditions of all of the patients were evaluated 1 day before the surgery. The t-test results showed that there were no significant differences ($P > 0.05$) in the preoperative BMI, Norton score, cardiovascular system diseases, and diabetes mellitus [22] between the patients in these 2 groups (**Table 2**).

Information related to the implementation of the surgical position in ovarian cancer cytoreductive surgery + Dixon surgery

Comparison of time required for placement and recovery of surgical position between the 2 groups: All of the patients in both the experimental and control groups successfully re-

Table 3. Comparison of the time required for the placement and recovery of the surgery position between these two groups (n = 100)

	Experimental group (n = 50)		Control group (n = 50)		*t*	*P*
	Mean	Standard deviation	Mean	Standard deviation		
Placement time (min)	2.52	0.18	4.46	0.14	-60.93	< 0.001
Recovery time (min)	0.47	0.06	4.39	0.15	-176.83	< 0.001

ceived the ovarian cancer cytoreductive surgery + Dixon surgery. A comparison of the patients between these 2 groups showed that the mean time required for placement of the surgical position in the experimental group was 2.52 ± 0.18 min, and the mean time required for recovery of the surgical position was 0.47 ± 0.06. In the control group, the mean time required for placement of the surgical position was 4.46 ± 0.14 min, and the mean time required for recovery of the surgical position was 4.39 ± 0.15 min. The times required for the placement and recovery of the surgical position in the experimental group were both shorter than those in the control group, and the differences were statistically significant ($P < 0.01$) (**Table 3**).

Comparison of the surgeons' satisfaction regarding surgical positions between these 2 groups: The questionnaire results of the surgeons' satisfaction regarding the surgical positions of the study subjects showed that surgeons in both groups were satisfied with the surgical positions. According to the results of the statistical analysis, the satisfaction of the surgeons in the experimental group was higher than that in the control group, and the difference was statistically significant ($P < 0.05$). However, there was no significant difference between these 2 groups regarding whether the exposure field was clear ($P > 0.05$) (**Table 4**).

Comparison of changes in hemodynamics before and after placement and recovery of the surgical position between these 2 groups: In the experimental group before and after position placement, the mean value of systolic pressure changes was 2.11 ± 1.73 mmHg, and the mean value of diastolic pressure changes was 1.23 ± 0.97 mmHg; moreover, the mean value of arterial pressure changes was 1.14 ± 1.10 mmHg, and the mean value of heart rate changes was 5 ± 3 beats/min. In the control group before and after position placement, the mean value of systolic pressure changes was 11.12 ± 3.43 mmHg, and the mean value of diastolic pressure changes was 8.61 ± 2.74 mmHg; moreover, the mean value of arterial pressure changes was 6.41 ± 2.31 mmHg, and the mean value of heart rate changes was 13 ± 6 beats/min. The changes in hemodynamics between these 2 groups were statistically significant (all $P < 0.05$) (**Table 5**).

In the experimental group before and after recovery of the surgical position, the mean value of systolic pressure changes was 12.35 ± 8.15 mmHg, and the mean value of diastolic pressure changes was 10.74 ± 6.34 mmHg; moreover, the mean value of arterial pressure changes was 11.28 ± 6.49 mmHg, and the mean value of heart rate changes was 2 ± 3 beats/min. In the control group before and after recovery of the surgical position, the mean value of systolic pressure changes was 18.15 ± 23.49 mmHg, and the mean value of diastolic pressure changes was 16.14 ± 10.30 mmHg; moreover, the mean value of arterial pressure changes was -8.12 ± 22.71 mmHg, and the mean value of heart rate changes was 2 ± 3.334 beats/min. The changes in hemodynamics between these 2 groups were statistically significant ($P < 0.05$) (**Table 6**).

Comparison of incidence rate of sacrococcygeal skin damage and lower limb edema at the end of surgery between these 2 groups: At the end of surgery, there was no sacrococcygeal skin damage, and 2 lower limb edema in the experimental group; however, there were 6 cases with sacrococcygeal skin damage, but no lower limb edema in the control group. The result of the χ^2 test showed that the difference in sacrococcygeal skin damage at the end of surgery between patients in these 2 groups was statistically significant ($P < 0.05$), nevertheless, the lower limb edema was not statistically significant ($P < 0.05$) (**Table 7**).

Discussion

General information of ovarian cancer surgery patients with rectal metastasis

Demographic characteristics of ovarian cancer surgery patients with rectal metastasis: All 100

Table 4. Comparison of the surgeons' satisfaction on body positions between these 2 groups (n = 100)

	Experimental group (n = 50)		Control group (n = 50)		χ^2	*P*
	Frequency	Percentage	Frequency	Percentage		
Overall evaluation					15.33	0.020
Satisfied	43	86.0	25	50.0		
Neutral	6	12.0	20	40.0		
Dissatisfied	1	2.0	5	10.0		
Standing operation					39.78	0.001
Very satisfied	50	35	17	70.0		
Neutral	0	0.00	4	8.00		
Dissatisfied	0	0.00	11	22.0		
Surgical field					7.179	0.066
Very satisfied	42	84.00	43	86.0		
Neutral	5	10.0	6	12.0		
Dissatisfied	2	4.00	1	2.00		

Table 5. Comparison of the changes in hemodynamics before and after placement of the surgical position between these 2 groups (n = 100)

	Experimental group (n = 50)		Control group (n = 50)		*t*	*P*
	Mean	Standard deviation	Mean	Standard deviation		
SBP (mmHg)	2.11	1.73	11.12	3.43	2.002	0.046
DBP (mmHg)	1.23	0.97	8.61	2.74	2.614	0.009
MBP (mmHg)	1.14	1.10	6.41	2.31	24.803	0.001
HR (bpm)	5	3	13	6	12.589	0.001

Table 6. Comparison of changes in hemodynamics before and after recovery of the surgical position between these 2 groups (n = 100)

	Experimental group (n = 50)		Control group (n = 50)		*t*	*P*
	Mean	Standard deviation	Mean	Standard deviation		
SBP (mmHg)	12.35	8.15	18.15	23.49	2.906	0.004
DBP (mmHg)	10.74	6.34	16.14	10.30	5.620	0.001
MBP (mmHg)	11.28	6.49	-8.12	22.71	10.207	0.001
HR (bpm)	2	3	5	2	3.334	0.038

cases in this study were females who ranged in age from 24-78 years with a mean age of 49.42 ± 10.23 years. The age distribution was consistent with results in literature reports and met the epidemiological features of the high incidence age period of ovarian cancer [24-27]. The differences of patients from two groups were not statistically significant.

Disease related information of ovarian cancer surgery patients with rectal metastasis: Both groups in this study included patients who were first diagnosed with late-stage ovarian cancer with rectal metastasis. Most of the patients discovered the disease because of the presence of symptoms or physical signs (palpable abdominal mass discovered by the patients). At the discovery of this disease, 89% of the patients already had peritoneal implantation metastasis. The treatment methods for the patients included comprehensive treatment using chemotherapy, radiotherapy, and surgery, of which the main emphasis is placed on surgery. Surgical treatment is a critical measure for the radical treatment of ovarian cancer [1]. Twenty patients in the experimental group and 19 patients in the control group had already received different treatment courses of chemotherapy, which was essentially consistent with the results in literature [28, 29]. The majority of the patients had normal blood cell counts and coagulation functions before surgery, which was a prerequisite to ensure that the surgery could be performed smoothly and surgical blood loss could be reduced. Most of the patients had low hemoglobin levels, nearly half of the study population had low albumin levels,

Table 7. Comparison of the incidence rate of sacrococcygeal skin damage after surgery between these 2 groups (n = 100)

	Experimental group (n = 50)		Control group (n = 50)		χ^2	*P*
	Frequency	Percentage	Frequency	Percentage		
Sacrococcygeal damage					6.383	0.035
Yes	0	0.00	6	12.0		
No	50	100.0	44	88.0		

and patients with late-stage malignant tumors all had different levels of malnutrition [16], which might be associated with rapid tumor growth at the late stage consuming too much nutritious substance. In addition, because of vomiting and loss of appetite, the patients who received chemotherapy had a reduced intake of nutrients, thus aggravating the deficiency of nutrients in the body. The total protein turnover rate in the late-stage tumor patients increased; however, the overall protein decomposition was higher than the protein synthesis rate, which was also an important cause of the low levels of hemoglobin and albumin in the body of patients with late-stage ovarian cancer metastatic to the rectum. The low protein level caused tissue edema in the body and the reduction of skin defense abilities; therefore, long-term compression easily caused skin damage [23].

The basic physical conditions of the patients were evaluated one day before surgery. No significant differences were observed in the mean age, height, body weight, blood pressure, heart rate, BMI, and Norton score between the experimental group and the control group. The blood pressure, heart rate, and BMI of most of the patients in these 2 groups were within the normal ranges. Patients with high blood pressure all received antihypertensive drugs in the morning on the day of surgery to control their blood pressure. The patients' Norton scores were all ≥ 14 points; therefore, these patients had low risks for pressure ulcers, and special preventive measures were not required. The majority of the patients in this study wore elastic stockings below the popliteal fossa to prevent the formation of deep venous thrombosis of the lower limb caused by a long surgery time and passive immobilization of the body position [12]. Few of the patients had lower limb edema before surgery, whereas all of the patients had excellent lower limb skin conditions and did not have skin ulceration and damage or motor sensory dysfunction. Few of the patients had preoperative chronic underlying diseases and few had abnormal sensations and skin damage in the lumbosacral region. All observation indicators were within the normal range.

Analysis of the implementation of the surgical position in the operation of ovarian cancer with rectal metastasis

Comparison of the time required for placement and recovery of the surgical position: The supplies required for surgical position placement were fully prepared in advance before the placement of the surgical position for the patients in these 2 groups. Timing began at the initiation of the body position placement. The process of body position placement and recovery of the patients in these 2 groups was very smooth. The results showed that the time required for body position placement and recovery in the control group was statistically significantly longer ($P < 0.01$) than that in the experimental group, which was consistent with the results in relevant literature [20]. The Trendelenburg modified supine position in the experimental group had some modifications based on the minimally invasive supine surgical position. Compared to the traditional lithotomy position, the Trendelenburg modified lithotomy position in the control group tilts the leg supports to the end of the bed to increase the angle between the trunk and thigh from 90 in the traditional lithotomy position to 150 and lowers the head of the bed by approximately 15-30 [5]. The Trendelenburg modified supine position clearly has a better degree of ease for placement than the Trendelenburg modified lithotomy position. In the experimental group, the body position placement was performed when the patient was awake; the manipulation could be performed with the cooperation of the patient using the comfort of the patient as a reference; therefore, the body position could both meet the surgical requirements and main-

tain the functional body position of the patient to ensure the comfort of the patient and reduce the placement time. In addition, supplies required for body position placement in the experimental group were light, simple and easy for nurses to place, which resulted in low costs and time-saving as well as reducing the work intensity of the nurses [23].

Comparison of surgeon satisfaction regarding these 2 body positions: The overall evaluation of the surgical positions and the evaluation of the surgeons' convenience for operating at the standing position between these 2 groups were significantly different ($P < 0.05$). However, the evaluation on the exposure of the surgical field between these 2 groups was not significantly different ($P > 0.05$). The overall results showed that the surgeons' satisfaction was higher in the experimental group than in the control group. The survey showed that the leg supports used for body position placement in the control group bumped the thigh and waist of the doctors, which hindered their standing position; when the doctors were operating, they often developed leg bruises. In addition, in the control group, the nurses were forced to stand near the patient's head with the instruments, which affected the instrument delivery by the nurses and was an important reason affecting the evaluation of surgeons on the control group.

Comparison of changes in hemodynamics before and after placement and recovery of patient body position in these 2 groups: The mean blood pressure and mean heart rate prior to body position placement did not statistically differ between the experimental group and the control group ($P > 0.05$). Furthermore, the statistical analyses of the mean values of changes in systolic pressure, diastolic pressure, and arterial pressure before and after body position placement and recovery in the experimental group showed that the changes in blood pressure and heart rate before and after body position change of patients in the experimental group were not significantly different ($P > 0.05$). In the control group, the statistical analysis results showed that the mean values of changes in systolic pressure, diastolic pressure, and mean arterial pressure before and after body position placement and recovery were significantly different ($P < 0.05$). The results of this study showed that both legs of the patients in the Trendelenburg modified lithotomy position were higher than the cardiac plane; therefore, a large amount of lower limb blood returned to the heart to increase the burden of the heart [18]. In addition, the inhibitory effects of intraoperative anesthetics and muscle relaxants on sympathetic nerves and muscles caused dilation of the peripheral blood vessels and relaxation of the muscles in the entire body, which caused a significant decrease in the regulation ability of the cardiovascular system in the body, thus affecting blood flow. The phenomenon was even more obvious during the transition between the lithotomy position and the supine position of patients. When the position changed from the lithotomy position to the supine position, the regulatory function in the body of the patients had not yet recovered; in addition, flat placement of both lower limbs caused the large amount of blood flowing to the lower limbs to instantly decrease the effective circulating blood volume, reduce the blood pressure, and increase the heart rate reflex [5, 9-13]. During the placement and recovery of the Trendelenburg modified supine position, both lower limbs extend naturally, the longitudinal axes of both lower limbs and the trunk are on the same horizontal line, and the difference of height in the lower abdominal wall is far smaller than that in the lithotomy position; therefore, during intraoperative body position changes, the variation of blood pressure changes in the patients is smaller than that in the lithotomy position. These results were consistent with the study results in the literature.

Comparison of the incidence of sacrococcygeal skin damage at the end of surgery between these 2 groups: In this study, the patients in the experimental group did not have sacrococcygeal skin damage at the end of surgery whereas 6 patients in the control group did have acrococcygeal skin damage at the end of surgery. The statistical analysis showed that the incidence of sacrococcygeal skin damage at the end of surgery in patients between these 2 groups was significantly different ($P < 0.05$). The study results showed that the required intraoperative passive body position of the patients, the loss of systemic motor sensation of the patients under general anesthesia, the disappearance of the protective reflex, the lack of protective reaction in the muscles, and changes in body position might cause surgical

position complications such as peripheral nerve injury, soft tissue injury, cervical spine injury, and pressure ulcer. Because of the differences in surgical positions, body gravity support points also had significant differences. According to the principles of human body mechanisms, the Trendelenburg modified lithotomy position places the focus points of the patients at the sacrococcygeal region, the outer thigh and crus, and the popliteal fossa. The Trendelenburg modified supine position places the focus points of the patients at both shoulders, the back, the sacrococcygeal region, the buttocks, and the outer thigh and crus [7], thus, patients in a supine position can maintain the normal physiological function position. Therefore, the Trendelenburg modified supine position does not cause long compression on nerves and the blood supply in popliteal fossa, has less compression on blood vessels and nerves, and does not cause local blood reflux disorder [14-17].

Conclusion

In summary, for ovarian cancer patients with rectal metastasis who received ovarian cancer cytoreductive surgery + Dixon surgery, the adoption of the Trendelenburg modified supine position in surgery has the following advantages: it requires a shorter time for placement and recovery, it is simpler and faster and can maintain the stability of intraoperative hemodynamics of the patients, and it can significantly reduce the risk of postoperative complications in patients with ovarian cancer metastatic to the rectum. It is conducive to ensure the safety of patients and deserves promotion and application.

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Disclosure of conflict of interest

None.

Authors' contribution

HYQ, YLL, FJL and MTL were responsible for the study conception and design and supervised the study. FJL and MTL performed the data analysis and drafted the manuscript, and made critical revisions to the paper for important intellectual content. FJL, YFB, YZ, MLL and SZL performed the surgical operation and operation position.

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