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Original Article

Precision nursing and intermittent pneumatic compression significantly reduce perioperative deep vein thrombosis in post-surgical ovarian cancer patients

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Abstract: Objective: This study investigated the efficacy of precision nursing combined with intermittent pneumatic compression (IPC) devices in preventing perioperative deep vein thrombosis (DVT) in patients with ovarian cancer. Methods: A retrospective analysis was conducted on 136 ovarian cancer surgery patients at Xi'an People's Hospital from February 2019 to April 2023. The patients were divided into two groups: 71 patients received precision nursing with IPC intervention (study group), while the remaining received standard nursing care (control group). Key variables analyzed included operation duration, intraoperative blood loss, postoperative blood transfusion requirements, changes in limb circumference, and variations in coagulation parameters activated partial thromboplastin time (APTT), D-Dimer (D-D), Fibrinogen (FIB), and Prothrombin Time (PT) before and after surgery. The incidence of DVT was recorded in both groups to determine risk factors for deep vein thrombosis. Results: No significant differences were observed between the groups regarding operation duration, intraoperative blood loss, and postoperative blood transfusion rates ($P > 0.05$). Post-intervention, significant improvements were noted in the study group, with reduced FIB and D-D levels and increased PT and APTT levels compared to the control group ($P < 0.05$). Furthermore, the study group exhibited a significantly smaller post-intervention difference in limb circumference and a lower incidence of DVT ($P=0.003$). Precision nursing combined with IPC, pre-intervention D-D < 498.5, and FIGO stages III+IV were identified as independent factors against DVT development. Conclusion: Precision nursing paired with an IPC device significantly reduces the risk of perioperative DVT in ovarian cancer patients compared to conventional care.

Keywords: Ovarian cancer, deep vein thrombosis prophylaxis, precision care, IPC, predictive modeling

Introduction

Ovarian cancer (OC) is the fifth most common cancer among women globally, accounting for 3% of all female cancers [1]. Approximately 70% of patients are diagnosed at advanced stages (III/IV), resulting in a 5-year survival rate of only 20% to 40% [2]. Despite recent advances in ovarian cancer treatment, reducing the associated morbidity and mortality remains challenging.

Surgery plays a pivotal role in the initial management of ovarian cancer, serving as a fundamental therapeutic intervention [3, 4]. It allows for the excision of the tumor and adjacent tissues, significantly reducing postoperative recuperation time and mitigating the risk of infection [5]. Despite its critical importance in treating early-stage ovarian cancer, surgery can lead to various postoperative complications, with deep vein thrombosis (DVT) being a relatively frequent and serious concern [6, 7]. Surgical intervention may lead to reduced circulation and an increased propensity for blood clot formation, predisposing patients to DVT [8]. This complication not only hampers recovery but also poses a serious risk by potentially causing a pulmonary embolism due to the dislodgement of the thrombus, which could be life-threatening.

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Preventing postoperative DVT is crucial for improving the prognosis and quality of life in patients [9]. Nursing interventions are pivotal during the recovery phase following surgery, playing a significant role in this preventative process [10]. Traditional care methods, which primarily focus on essential monitoring and support, may fall short of meeting the complex and diverse needs of patients. The precision care model emerges as a solution, offering a more detailed and patient-centered approach through customized care plans tailored to the unique conditions and risk factors of individuals [11]. This model encompasses a comprehensive assessment and management of not only physical needs but also psychological, social, and emotional support to significantly improve patient care outcomes [12]. By adopting such a proactive stance in nursing care, it is possible to alleviate mental stress, stabilize vital signs during surgery, and minimize the adverse impacts of psychological disorders and other unforeseen factors on surgical results.

Intermittent pneumatic compression (IPC) devices represent a mechanical strategy to encourage venous return via cyclic pneumatic compression of the lower extremity veins, thus effectively lowering the risk of postoperative DVT [13]. Despite the potential benefits of IPC in DVT prevention, there remains a paucity of direct research evidence on its specific effectiveness and safety in patients undergoing radical ovarian cancer surgery.

Therefore, this study aims to explore and validate the effectiveness of this comprehensive prevention strategy. The novelty of this research is primarily reflected in the systematic evaluation and optimization of DVT prevention methods after surgical treatment of ovarian cancer, with the goal of providing more scientific and precise guidance to enhance the quality of patients' postoperative prognosis.

Methods and materials

Ethical statement

This study was conducted with the approval of Xi'an People's Hospital, ethical batch number: 2023077.

Clinical information

A retrospective analysis was conducted to collect clinical data from patients who underwent surgical treatment for ovarian cancer from February 2019 to April 2023 in Xi'an People's Hospital. Inclusion criteria: 1. Age between 18 and 80 years (n=484); 2. Grade I to II according to the American Society of Anesthesiologists (ASA) criteria (n=437) [14]; 3. A complete case history (n=410); 4. A histopathologic diagnosis of ovarian cancer confirmed by pathological examination (n=384); 5. An imaging diagnosis of DVT confirmed by ultrasound or radiology (n=302). Exclusion criteria: 1. Ongoing anticoagulation or antiplatelet therapy (n=288); 2. Severe liver or renal disease (n=258); 3. Other malignancies or hematologic disorders (n=205); 4. Patients who needed to be transferred from laparoscopic to open surgery (n=184); 5. History of DVT (n=169); 6. History of trauma or surgery within the last 6 months, with the presence of severe organic lesions, severe anemia, or coagulation disorders (n= 158); 7. Pregnant or breastfeeding women (n=136). According to the inclusion and exclusion criteria, we obtained a total of 136 patients.

The patients who received precision care combined with IPC intervention were included in a study group (n=71), and the other patients who were given only routine care were in a control group (n=65) (**Figure 1**). The different care models in the study stem from the hospital's innovation. Specifically, until January 2022, the hospital had been utilizing a routine care model. Afterwards, the hospital has begun to implement precision care model.

Models of care

In the control group, perioperative routine care was implemented. Before the operation, patients were given detailed explanation about the surgical method and the expected therapeutic outcomes. During the operation, patients were given rapid assessment and routine care. Patients were moved gently to keep them a comfortable position for anesthesia and surgery. In addition, their vital signs were monitored, the room temperature was maintained at 24-26°C, and double-layer blanket was used for heat preservation. After the operation,

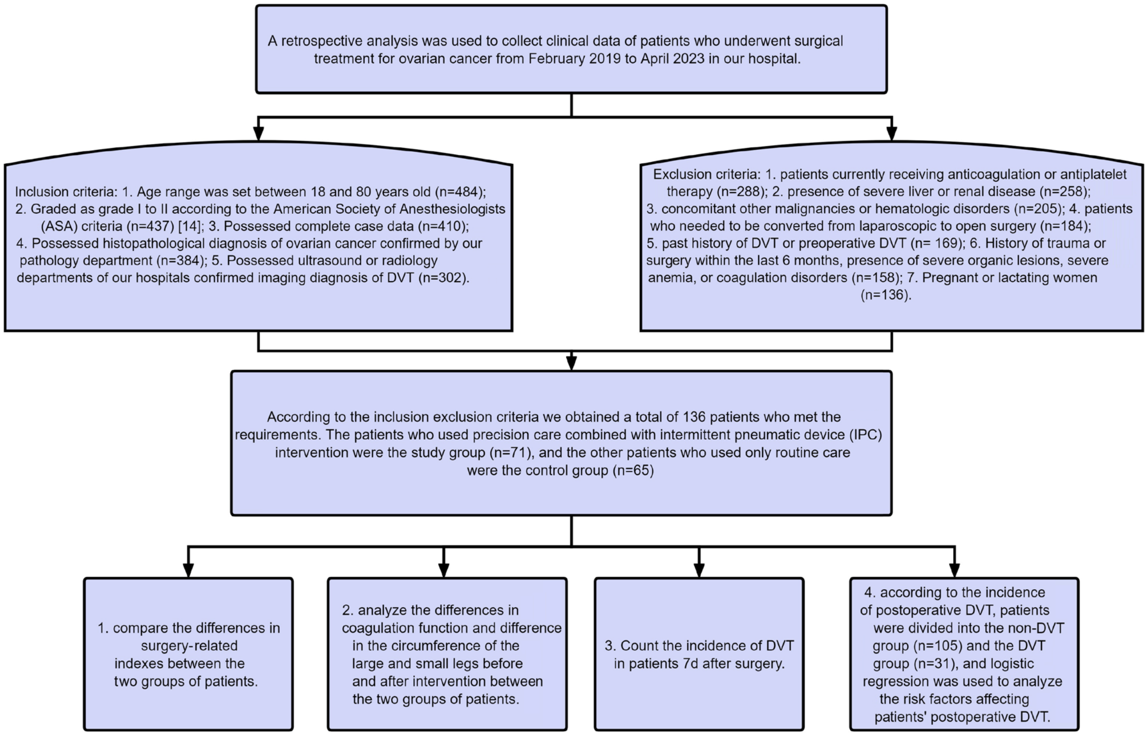

Figure 1. Patient sample inclusion and outcome analysis process.

patients were encouraged to get out of bed early if their body conditions allowed, and their conditions were continuously monitored.

In the study group, intraoperative precision care combined with IPC was implemented. (1) A specialized nursing team was established. (2) A specialized preoperative visit plan was developed, including a teaching manual to explain the causes, formation mechanisms, and preventive measures of DVT to improve patients' understanding of IPC in surgery and nursing compliance. The patients' lower limbs were checked for skin color, swelling, skin temperature, along with gastrocnemius muscle test and Tommy's test. Additionally, their risk level for DVT was assessed according to the Caprini thrombosis risk factor table. (3) Intraoperative precision care: 1) Temperature care: Patients were placed on an inflatable preheated heating blanket (at about 37°C) on the surgical bed. A Ranger infusion thermometer was preset at 39°C to ensure that the temperature of the intravenous fluid was about 37°C. Also, the temperature of surgical rinsing fluid and disinfectant was also warmed up to 37°C. In addition, the skin of the operation field was covered with surgical film to reduce the loss of body temperature. Drager vista xl multifunctional monitor was used to continuously monitor the patients' body temperature, and the room temperature was maintained at 22-28°C according to the changes of the patients' body temperature, and kept at a higher temperature before the end of the operation. 2) Positioning: The patients were positioned in a modified herringbone position, with the buttocks in a hollowed-out area of the operation bed and exceeding the edge by 10 cm. The angle was adjusted to 150° for the two leg frames (i.e. the plane of the thighs and abdomen), ≤ 90° between the two thighs, and about 120° between the calves and the thighs, with both lower limbs were elevated by 15°-20° to reduce the popliteal vein compression and the height of the left leg slightly lower than that of the right leg. A small quilt was used to cover on the leg frames, and fine adjustments can be made before anesthesia until they were comfortable. 3) IPC: DAESUNG MAREF DVT-2600 device was set at conventional therapeutic parameters (i.e., pressure of 40 mmHg). The inflatable band was chosen according to leg circumference and applied to the calf and foot with cloth cover for skin protection. After connecting the inflatable belt to the air pump, the device was powered-on using an automatic mode.

Clinical data collection

Patient clinical information was obtained from admission records and the hospital's electronic medical record system. Baseline information included age, body mass index (BMI), menopausal status, comorbidities (diabetes, hypertension, hyperlipidemia), history of surgery, neoadjuvant chemotherapy, International Federation of Gynecology and Obstetrics (FIGO) staging [15], tumor diameter, histotype, degree of tumor differentiation, and incidence of DVT at 7 days postoperatively. Surgery-related data included operation time, intraoperative bleeding, and postoperative blood transfusions. Laboratory parameters included activated partial thromboplastin time (APTT), D-Dimer (D-D), fibrinogen (FIB), and prothrombin time (PT) before and 7 days after surgery. Routine indices included differences in thigh and calf circumference before and 7 days after surgery.

Laboratory tests

APTT, FIB, and PT were measured using the Mindray C3510 coagulation analyzer (Shenzhen Mindray Company) and its supporting reagents. D-D was determined by enzyme immunoassay.

Observation indexes

Primary indicators included differences in surgery-related indexes, coagulation function, and circumference of the upper and lower legs before and after the intervention between the two groups, as well as the incidence rate of DVT in the 7-day postoperative period.

The secondary indicator was risk factors for DVT, which were analyzed using logistic regression according to the occurrence of DVT, with 105 cases in the non-DVT group and 31 cases in the DVT group.

Statistical analysis

All data were statistically processed using SPSS 26.0 software. The K-S test was performed for data distribution analysis. For normally distributed data, independent samples t test was used for comparison between groups, and paired t test was used for comparison within groups. The Mann-Whitney U rank sum test was used for non-normally distributed data. Chi-square test was used for categorical data to assess differences between groups. Logistic regression was used to analyze the risk factors for postoperative DVT. Statistical significance was determined at P less than 0.05.

Results

Comparison of baseline information

Evaluation of the baseline data revealed no statistical differences between the study group and the control group ($P > 0.05$, **Table 1**).

Comparison of surgical conditions

Statistics on the operation time, intraoperative bleeding, and postoperative blood transfusion were found to be similar between the study group and the control group ($P > 0.05$, **Table 2**).

Comparison of coagulation functions

Comparison of coagulation function revealed no statistical difference in FIB, PT, APTT, and D-D between the two groups before intervention ($P > 0.05$). After intervention, the FIB and D-D significantly decreased, while the PT and APTT significantly increased in both groups ($P < 0.05$). In addition, further comparisons showed that the study group exhibited significantly lower FIB and D-D, as well as significantly higher PT and APTT than the control group after intervention ($P < 0.05$, **Table 3**).

Comparison of calf circumferences

Comparison of the circumferential diameter of the upper and lower legs between the two groups revealed no statistical differences between the two groups before the intervention ($P > 0.05$). After the intervention, the circumferential diameters of the legs were significantly reduced in both groups ($P < 0.05$). In addition, further comparison showed that the circumferential diameters of the legs in the study group were significantly smaller compared to that in the control group after the intervention ($P < 0.05$, **Table 4**).

Comparison of incidence of lower extremity DVT

There were 9 and 22 patients with lower extremity DVT after intervention in the study

Table 1. Comparison of patients' baseline data

Item	Study group (n=71)	Control group (n=65)	X^2 value	*P*-value
Age				
≥ 50 years	38	41	1.273	0.259
< 50 years	33	24		
BMI				
≥ 22 kg/m^2	21	25	1.197	0.274
< 22 kg/m^2	50	40		
Menopausal state				
Yes	32	26	0.357	0.550
No	39	39		
Combined diabetes				
Yes	11	12	0.213	0.645
No	60	53		
Combined high blood pressure				
Yes	28	23	0.238	0.626
No	43	42		
Combined hyperlipidemia				
Yes	11	7	0.659	0.417
No	60	58		
Surgical history				
Yes	28	25	0.014	0.907
No	43	40		
Neoadjuvant chemotherapy				
Yes	21	23	0.523	0.470
No	50	42		
FIGO Stage				
I+II	32	34	0.712	0.399
III+IV	39	31		
Tumor diameter				
≥ 10 cm	23	24	0.308	0.579
< 10 cm	48	41		
Tumor Tissue Typing				
Slurry	26	24	0.729	0.393
Non-slurry	19	25		
Lymphatic node transfer				
Yes	25	29	1.254	0.263
No	46	36		
Degree of tumor differentiation				
Low differentiation	14	10	0.439	0.508
Middle and high differentiation	57	55		

Note: BMI, Body Mass Index.

Table 2. Comparison of surgical indices

Group	Surgical time (h)	Intraoperative bleeding (mL)	Postoperative blood transfusion
Control group (n=65)	293.08±62.96	335.57±101.45	8 (12.30)
Study group (n=71)	282.35±51.53	329.72±136.99	10 (14.08)
t/χ^2 value	1.081	0.285	0.093
P-value	0.282	0.776	0.760

Table 3. Comparison of coagulation function before and after intervention

Group	APTT (s)		D-D (μg/L)		FIB (g/L)		PT (s)	
	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
Control group (n=65)	25.86±3.72	29.34±4.51*	489.68±25.73	286.97±25.40*	7.78±1.43	4.32±0.94*	10.15±3.10	13.06±2.08*
Study group (n=71)	25.25±4.00	37.01±5.49*	485.15±27.67	243.73±23.13*	7.54±1.63	3.11±0.89*	10.48±2.80	15.99±4.07*
t-value	0.918	-8.939	0.988	10.347	0.951	7.717	-0.639	-5.344
P-value	0.36	< 0.001	0.325	< 0.001	0.344	< 0.001	0.524	< 0.001

Note: * indicates P < 0.05 vs. pre-intervention. APTT, Activated Partial Thromboplastin Time; D-D, D-Dimer; FIB, Fibrinogen; PT, Prothrombin Time.

Table 4. Comparison of the difference in leg circumference before and after the intervention

Group	Thigh circumference (cm)		Calf circumference (cm)	
	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
Control group (n=65)	3.02±0.16	1.58±0.09*	1.67±0.11	1.07±0.11*
Study group (n=71)	2.99±0.13	1.24±0.09*	1.66±0.12	0.78±0.06*
t-value	0.922	22.645	0.730	19.886
P-value	0.358	< 0.001	0.467	< 0.001

Note: * indicates P < 0.05 compared to pre-intervention.

group and the control group, respectively, with the incidence being significantly lower in the study group than in the control group (χ^2=8.642, P=0.003).

Analysis of risk factors for postoperative lower extremity DVT

The patients were grouped according to the occurrence of DVT. By comparison, we found that the intervention program, neoadjuvant chemotherapy, FIGO stage, and pre-intervention D-D were risk factors for postoperative DVT (**Table 5**, P < 0.05). Further multivariate logistic regression analysis revealed that precision care combined with IPC, pre-intervention D-D < 498.5, and FIGO stage III+IV were independent risk factors leading to the development of lower limb DVT (**Figure 2**, P < 0.05).

Discussion

In this study, we investigated the multifaceted risk of DVT in patients, attributing it to various elements such as the surgical method, adjustments in positioning, operative procedures, duration of surgery, and procoagulant factors secreted by ovarian cancer cells [16, 17]. Our analysis revealed significant enhancements in patients' coagulation functions and a notable reduction in the difference between thigh and calf circumferences following a regimen of precision nursing care combined with IPC intervention, compared to standard care protocols. Additionally, the incidence of DVT within 7 days post-surgery was diminished. These findings underscore that integrating precision nursing care with IPC intervention can markedly enhance perioperative management for patients and reduce the risk of DVT. This advancement holds profound implications for bolstering the safety and improving the prognosis of patients undergoing laparoscopic radical surgery for ovarian cancer.

PT, D-D, APTT, and FIB are critical markers for assessing thrombosis risk and hypercoagulability in blood [18, 19]. Postoperative arteriovenous damage impairs vascular function, leading to coagulation system activation. The deceleration of blood flow during and after surgery, due to prolonged immobilization, exacerbates hypercoagulability, a pivotal factor in DVT development [20, 21]. This study demonstrated that coagulation indices in the precision care combined with IPC intervention group were maintained at normal levels, significantly outperforming the control group. This indicates that intraoperative precision care alongside IPC can effectively mitigate the impact of surgery on coagulation. Shi et al. [20] highlighted that preoperative hypercoagulability significantly elevated DVT risk in elderly hip fracture patients. Similarly, Ruan et al. [22] observed notable improvements in hemorheology and quality of life in patients with lower limb fractures following rehabilitation nursing interventions. Moreover, Li et al. [23] reported that intraoperative risk management coupled with comfort nursing interventions enhanced coagulation and immunoinflammatory markers post-gynecologic laparoscopic surgery, decreased DVT incidence, and boosted patient satisfaction with nursing care. These findings affirm that targeted nursing interventions can effectively enhance coagulative or hemorheological functions, reducing postoperative DVT risks.

In the present study, we also found that the post-intervention calf circumference difference in patients with precision care combined with IPC was significantly smaller than that in the control group. The main reason is that IPC enhances blood circulation in the lower extremities and reduces venous blood stagnation, thus reducing the risk of DVT [24, 25]. Additionally, the implementation of precision nursing optimized patient care, including personal-

Table 5. Univariate analysis of factor influencing DVT

Variant	Non-DVT group (n=105)	DVT group (n=31)	x^2/t value	*P*-value
Age				
≥ 50 years	59	20	0.681	0.409
< 50 years	46	11		
BMI				
≥ 22 kg/m^2	39	7	2.267	0.132
< 22 kg/m^2	66	24		
Menopausal state				
Yes	43	15	0.541	0.462
No	62	16		
Combined diabetes				
Yes	21	2	3.127	0.077
No	84	29		
Combined high blood pressure				
Yes	41	10	0.471	0.493
No	64	21		
Combined hyperlipidemia				
Yes	17	1	3.503	0.061
No	88	30		
Surgical history				
Yes	40	13	0.148	0.700
No	65	18		
Neoadjuvant chemotherapy				
Yes	29	15	4.717	0.030
No	76	16		
FIGO installments				
Phase I+II	43	4	8.326	0.004
III+IV	62	27		
Tumor diameter				
≥ 10 cm	36	11	0.015	0.902
< 10 cm	69	20		
Tumor Tissue Typing				
Slurry	63	13	3.168	0.075
Non-slurry	42	18		
Lymphatic node transfer				
Yes	41	13	0.083	0.773
No	64	18		
Degree of tumor differentiation				
Low differentiation	22	2	3.463	0.063
Middle and high differentiation	83	29		
Surgical time	282.35±51.53	293.08±62.96	1.081	0.282
Intraoperative bleeding	329.72±136.99	335.57±101.45	0.285	0.776
Postoperative blood transfusion				
Yes	13	5	0.293	0.588
No	92	26		
Pre-intervention APTT (s)	25.25±4.00	25.86±3.72	0.918	0.360
Pre-intervention D-D (μg/L)	513.35±24.92	479.97±23.24	6.653	< 0.001
Pre-intervention FIB (g/L)	7.00 [6.00, 9.00]	8.00 [7.00, 9.00]	1.126	0.252

Pre-intervention PT (s)	10.00 [8.00, 12.00]	10.00 [8.00, 12.00]	-0.756	0.448
Pre-intervention thigh circumference (cm)	2.98 [2.93, 3.07]	2.99 [2.89, 3.11]	0.63	0.530
Pre-intervention calf circumference (cm)	1.66±0.12	1.67±0.11	0.73	0.467

Note: BMI, Body Mass Index; APPTT, Activated Partial Thromboplastin Time; D-D, D-Dimer; FIB, Fibrinogen; PT, Prothrombin Time.

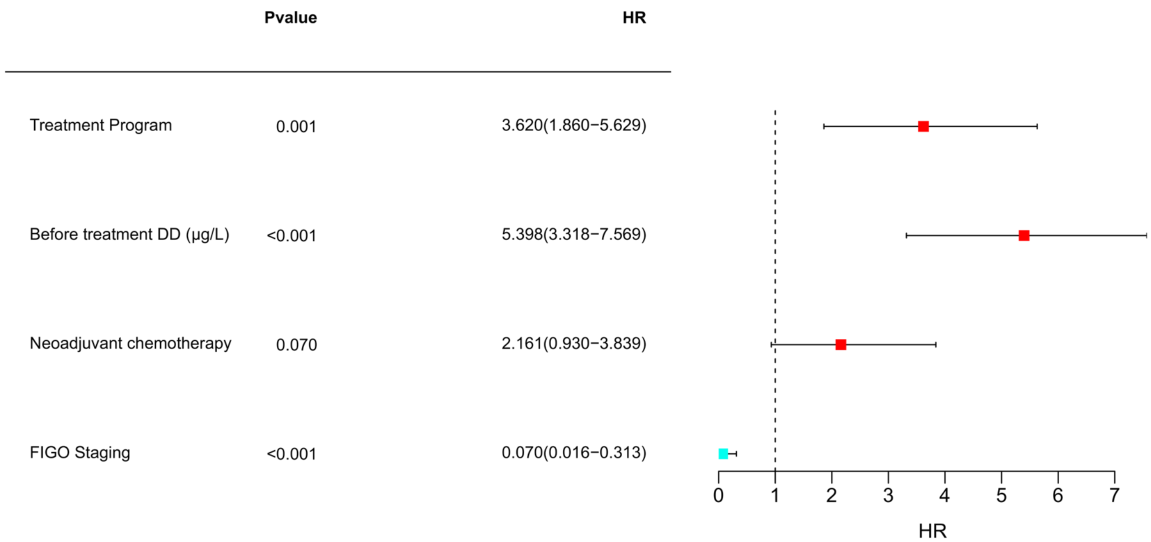

Figure 2. Multivariate logistic regression analysis of risk factors for postoperative lower extremity DVT. Note: D-D, D-Dimer; FIGO staging, Federation of Gynecology and Obstetrics staging.

ized interventions and continuous monitoring of patient conditions, effectively reducing endothelial damage and inflammation and promoting blood circulation [26]. This comprehensive intervention includes patient-specific adjustments, such as leg position optimization and instruction in early postoperative activity, which work together to maintain coagulation homeostasis and reduce thrombosis. These findings emphasize the importance of implementing precision care and IPC interventions in surgical treatment, especially in patients with high-risk DVT, providing an effective strategy for reducing postoperative complications [27].

To identify individuals at elevated risk, we analyzed various factors contributing to the development of DVT. Our research identified intervention regimen, neoadjuvant chemotherapy, FIGO staging, and pre-intervention D-dimer levels as significant influencing factors of postoperative DVT. Conventional care protocols often lack the granularity necessary for effective DVT prevention, primarily due to their omission of individual variances and specific risk factors. In contrast, personalized and detailed interventions, such as IPC, demonstrate superior efficacy in mitigating DVT risks [28]. Particularly, patients with advanced FIGO stage (III-IV) ovarian cancer undergoing neoadjuvant chemotherapy represent a demographic with heightened DVT susceptibility, attributed to increased proclivity for blood clot formation and reduced efficacy of chemotherapeutic agents [8, 29]. Meanwhile, high levels of D-D (≥ 498.5 μg/L), as a marker of thrombogenic and lysogenic activities in the body, indicate a higher state of blood coagulation [30]. Identifying high-risk patients enables targeted interventions, such as IPC, enhancing DVT prevention and improving postoperative outcomes. This approach advocates for precision care, prioritizing individual patient profiles and specific risk factors in surgical treatment plans.

This study is limited by the small sample size, lack of long-term follow-up, and individual differences in intervention effects. Future research should expand the sample size and implement multicenter cooperation to enhance the generalizability of the conclusions. Additionally, introducing long-term follow-up will allow for a comprehensive assessment of the long-term efficacy of treatment and prevention strategies. Addressing individual differences and conducting in-depth research on personalized treatment strategies will promote more accurate and comprehensive research results and provide a solid foundation for improving the prognosis of ovarian cancer patients.

Conclusion

In conclusion, this study demonstrated that for postoperative ovarian cancer patients, precision care combined with IPC can significantly reduce the risk of DVT, proving superior to conventional care.

Disclosure of conflict of interest

None.

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