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Original Article

Application value of modified skin expansion in PICC catheterization under the guidance of B-ultrasound in gastrointestinal cancer patients with chemotherapy

Lijuan Wan[1], Ling Yin[2], Wenhong Zhang[1], Jiejie Yang[3], Xiuying Yi[1], Lihua Guo[4]

[1]Fifth Department of General Surgery, The First Affiliated Hospital of Gannan Medical College, Ganzhou 341000, Jiangxi, China; [2]Department of Hepatobiliary and Pancreatic Surgery, The First Affiliated Hospital of Gannan Medical College, Ganzhou 341000, Jiangxi, China; [3]Gastrointestinal Endoscopy Room, The First Affiliated Hospital of Gannan Medical College, Ganzhou 341000, Jiangxi, China; [4]First Department of General Surgery, The First Affiliated Hospital of Gannan Medical College, Ganzhou 341000, Jiangxi, China

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Abstract: Objective: To investigate the clinical value of modified skin expansion in peripherally inserted central venous catheter (PICC) catheterization under the guidance of B-ultrasound in gastrointestinal cancer patients with chemotherapy. Methods: In this retrospective study, 60 gastrointestinal cancer patients with chemotherapy were included and divided into an experimental group (treated with modified skin expansion in PICC catheterization under the guidance of B-ultrasound) and a control group (treated with the longitudinal skin expansion in PICC catheterization under the guidance of B-ultrasound). The bleeding volume, pain score, success rate of one-time PICC catheterization and the incidence of complication were compared between the two groups. Results: The modified skin expansion in PICC catheterization under the guidance of B-ultrasound had obvious effect on gastrointestinal cancer patients with chemotherapy. The VAS scores were significantly lower after PICC catheterization in the experimental group compared with the control group ($P < 0.05$). The success rate of one-time PICC catheterization in the experimental group was significantly higher than that in the control group. Moreover, the incidence of complication and massive bleeding during puncture and 24 hours after puncture was significantly lower in the observation group compared with that in the control group. Conclusions: Modified skin expansion in PICC catheterization under the guidance of B-ultrasound in gastrointestinal cancer patients with chemotherapy can improve the success rate of one-time sheath delivery, effectively reduce the amount of blood leakage after catheterization, reduce patients' pain and reduce the incidence of complications.

Keywords: Modified skin expansion, PICC Catheterization, B-ultrasound, gastrointestinal cancer, chemotherapy

Introduction

Gastrointestinal tumors mainly include gastric cancer, rectal cancer and colon cancer [1]. Until 2018, gastrointestinal (GI) cancers are among the top 10 most prevalent and deadliest tumors worldwide, accounting for 26% of global cancer incidence and 35% of all cancer-related deaths [2, 3]. The mortality of gastric cancer and colorectal cancer remains high, ranking the third and fourth of malignant tumor related mortality in China, respectively [4, 5]. It shows that gastrointestinal tumor is one of the most noteworthy malignant tumors after lung cancer [6]. At present, chemotherapy is still the primary choice for the treatment of gastrointestinal tumors [7]. Peripherally inserted central venous catheterization (PICC) is a common catheter implantation, which is used in patients with gastrointestinal tumor chemotherapy [8]. With the increase of tumor chemotherapy, intravenous infusion, the occurrence of complications such as phlebitis and drug extravasation also increase, which not only increases the medical risk and patient pain, but also increases the nursing labor intensity of medical staff. Therefore, to find a painless and safe way of intravenous infusion is particularly important for patients receiving long-term intravenous treatment. PICC can effectively avoid the direct contact between the arm vein and the drug. In addition, the blood flow velocity of the great

vein can quickly dilute the chemotherapy drug, so as to eliminate the stimulation of the drug to the blood vessel.

Blunt separation is a surgical technique. Compared with the traditional scalpel skin breaking method, it can effectively prevent the accidental injury to blood vessels and nerves, reduce the damage to tissue function, and play an important role in preventing the occurrence of blood and fluid leakage after PICC catheterization [9, 10]. The modified Seldinger PICC catheterization under the guidance of B-ultrasound is to puncture the central vein through the peripheral vein [11], which uses the catheter to puncture from the vein of the peripheral arm. The catheter goes directly to the great vein close to the heart to avoid direct contact between chemotherapy drugs and the vein of the arm [12]. In addition, the blood flow rate of the great vein is very fast, which can dilute chemotherapy drugs quickly and prevent the stimulation of drugs to blood vessels. However, the modified Seldinger technique requires skin expansion, which is easy to damage the subcutaneous lymphatic vessels and other tissues, resulting in bleeding and exudation, which seriously affects the quality of catheterization. However, the blunt separation method is a surgical operation technique, which can avoid excessive tissue opening and reduce tissue damage [13]. Therefore, it can effectively protect the upper limb veins during chemotherapy for malignant tumors and reduce the occurrence of local tissue necrosis caused by phlebitis and drug extravasation, reduce the pain of patients and improve their quality of life [14]. However, there is few study assessing clinical value of modified skin expansion in clinical, especially in gastrointestinal cancer patients who required PICC catheterization.

Therefore, the aim of this study was to assess clinical value of modified skin expansion in PICC catheterization under the guidance of B-ultrasound in gastrointestinal cancer patients with chemotherapy.

Materials and methods

Study design

In this retrospective study, a total of 60 gastrointestinal cancer patients who had chemotherapy from March 2021 to November 2021 were included and divided into an experimental group (n = 30 cases) and a control group (n = cases) according to different skin expansion methods during PICC catheterization. This study had been reviewed and approved by the medical ethics committee of the First Affiliated Hospital of Gannan Medical College.

Inclusion criteria

Inclusive criteria: ① Patients met the diagnostic criteria of the 2019 guidelines for gastrointestinal malignancies [15], who need PICC catheterization and met the requirements of PICC catheterization [16]; ② Patients who underwent catheterization with Seldinger technique under the guidance of supracubital B-ultrasound; ③ Patients with an age ≥ 18; ④ Patients with normal coagulation function; ⑤ Patients with complete clinical data.

Exclusion criteria

① Patients with blurred consciousness and mental abnormalities; ② Patients with cancer metastasis; ③ Patient with severe liver, kidney and other organ dysfunction; ④ Patients with scar constitution; ⑤ Patients with crucial data missing.

Interventions

The control group received the longitudinal skin expansion commonly used in clinic with the use of skin expansion knife. After the fine puncture needle was successfully inserted into the guide wire, the operator held the skin expander vertically with the back of the blade close to the guide wire; the tip of the blade was penetrated into the skin at an angle of 20 along the guide wire to expand the skin, with a depth of about 3 mm. After skin dilation, the wound was compressed with non-woven cloth for 30 s, and then the microvascular sheath was completely sent into the blood vessel along the guide wire (**Figure 1A**, **1B**).

The experimental group received blunt separation skin expansion. After the fine puncture needle was successfully inserted into the guide wire, the operator held the skin expanding knife vertically. The guide wire on the back of the knife edge was close to the skin, and the skin expanding direction was parallel to the dermatoglyph. The knife tip was close to the right side

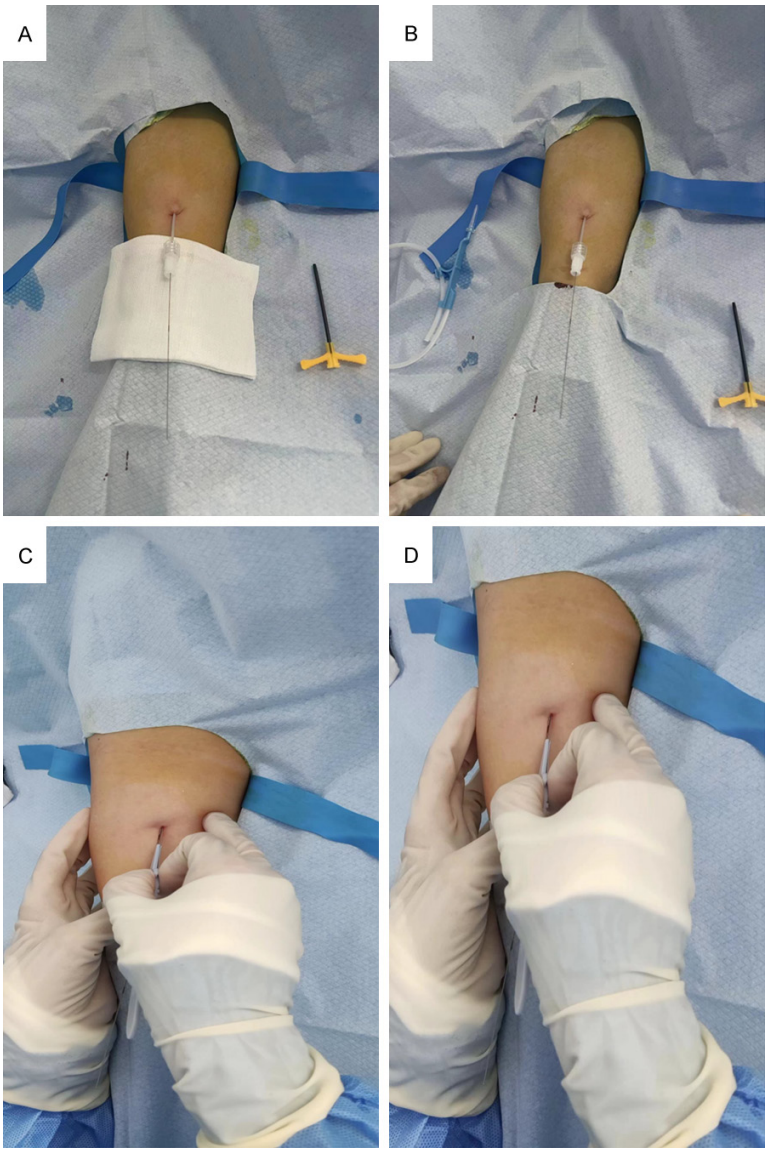

Figure 1. The skin expansion of two groups. A, B: Longitudinal skin expansion; C, D: Blunt separation skin expansion.

of the guide wire, entered the skin horizontally, and then expanded the skin upward by 2 mm. After skin dilation, the wound was compressed with non-woven cloth for 30 s, and then the microvascular sheath was incompletely sent into the blood vessel along the guide wire. The feeding length was increased by 1 cm based on the depth of the target blood vessel located by B-ultrasound (**Figure 1C**, **1D**).

Observational indexes

Bleeding volume: The bleeding volume of the two groups was compared immediately after PICC insertion and 24 h after tube placement (24 h gauze change). Small amount of bleeding: blood seepage can be seen on the surface of gauze with an area less than 0.5 cm^2; Medium amount of bleeding: blood can be seen on the gauze, with an area of 0.5-1.0 cm^2; Large amount of bleeding: blood seepage can be seen on the gauze with an area of > 1.0 cm^2.

Success rate of one-time PICC catheterization: It was considered successful if the sheath was sent into the blood vessel at one time.

The incidence of complication: The incidence of exudation, infection and thrombosis were recorded.

Pain score: Visual analog scale (VAS) [17] was applied to assess the severity of pain. The scale ranges from 0 to 10 with “0” for no pain and “10” for unbearable pain. The pain was divided into three degree: Mild or no pain (VAS score 0-2), moderate pain (VAS score 3-6) and severe pain (VAS score 7-10).

Hematological and gastrointestinal toxicity: We also evaluated haematological and gastrointestinal toxicity according to the National Cancer Institute Common Toxicity Criteria [18]. The gastrointestinal toxicity included changes such as nausea, diarrhoea, anorexia, abdominal pain, vomiting, and fatigue, while the hematological toxicity included changes such as anemia and leukopenia.

Inflammatory factors: The levels of interleukin-8 (IL-8), interleukin-10 (IL-10), interleukin-6 (IL-6) and high-sensitivity C-reactive protein (hsCRP) were evaluated to assess the inflammatory changes in all the participants. 3-5 ml of morning fasting venous blood before and

Table 1. Clinical characteristics of patients

	Experimental group (n = 30)	Control group (n = 30)	t/χ^2	*P*
Age (years)	52.1±7.37	59.85±11.23	9.65	0.47
Sex			11.46	0.79
Male (n%)	21 (70%)	23 (76.7%)		
Female (n%)	9 (30%)	7 (23.3%)		
BMI (kg/m^2)	17.15±2.03	18.25±1.87	6.39	0.09
Marital status			16.85	0.32
Married	13 (43.3%)	19 (63.3%)		
Single	6 (20%)	4 (13.3%)		
Divorced or separated	6 (20%)	3 (10%)		
Widowed	3 (10%)	3 (10%)		
Unknown/missing data	2 (6.7%)	1 (3.3%)		
Puncture site			5.67	0.12
Basilic vein	22 (73.3%)	23 (76.7%)		
Brachial vein	8 (26.7%)	6 (20%)		
Cephalic vein and others	0	1 (3.3%)		
Coagulation function				
Platelet	17.1±7.37	19.85±8.23	0.658	0.52
INR	1.2±0.18	1.22±0.19	0 ≥ 583	0.76

Note: INR: International Normalized Ratio.

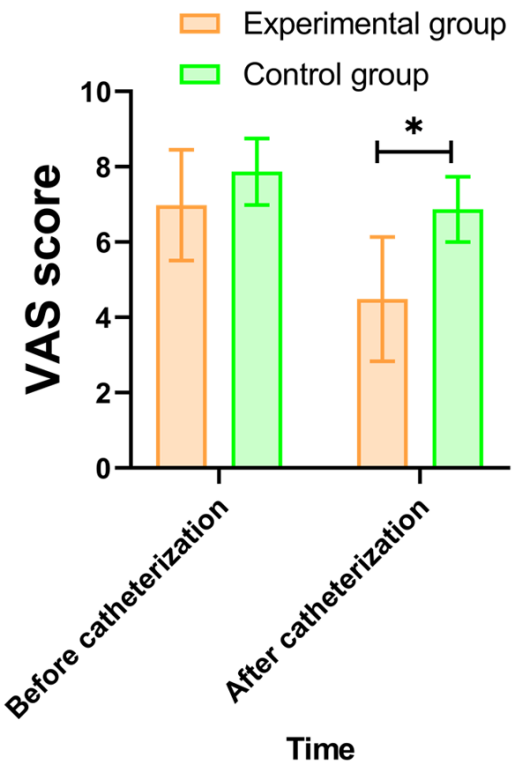

Figure 2. VAS: Visual analogue scale. *P < *0.05*.

after treatment were collected from patients and centrifuged at 3000 R/min for 10 min to obtain the supernatant. The expressions of interleukin-6 (IL-6) (CSB-E04638h, CUSABIO, Wuhan, China), interleukin-8 (IL-8) (CSB-E04641h, CUSABIO, Wuhan, China) and high-sensitivity C-reactive protein (hsCRP) (CSB-E08617h, CUSABIO, Wuhan, China) were detected by enzyme-linked immunosorbent assay. IL-6, IL-8 and hsCRP kits were provided by Everbright Biotechnology Co., Ltd. (CUSABIO, China). The operation was carried out in strict accordance with the operation manual.

Statistical analysis

All the data in this study were processed by SPSS19.0 statistical analysis software. The measurement data were expressed by (x ± s) and analyzed by t test; the count data were expressed by percentage (%) and analyzed by χ^2 test. The influence factors for the success of PICC catheterization was analyzed by multiple linear regression analysis. P < 0.05 was regarded as with statistical difference.

Results

Clinical data

As shown in the **Table 1**, the average age of the patients in the experimental group was (52.1±7.37) years old (ranged from 30 to 83), and that of the control group was (59.85± 11.23) years (31-80). There were no significant differences between two groups in terms of gender, age, body mass index (BMI), marital status, puncture vessel and coagulation function (all P > 0.05).

Comparison of the pain score between two groups

As shown in **Figure 2**, there was no significant difference in VAS score between the two groups before PICC catheterization (P = 0.686). After PICC catheterization, the VAS scores of the two groups were decreased, and the VAS score of the experimental group was signifi-

Table 2. Comparison of the catheterization outcome between the two groups ($\overline{x}$ ± s)

Group	Number of cases	Success rate of catheterization	Satisfaction score	Completion time of catheterization (min)
Experimental group	30	29 (96.7%)	91.47±7.65	19.7±8.2
Control group	30	24 (80%)	83.64±5.24	23.9±9.1
X^2	-	2.763	14.274	6.235
P	-	0.042	0.003	0.024

Table 3. Comparison of complications between the two groups ($\overline{x}$ ± s)

Group	Number of cases	Exudation	Infection	Thrombosis
Experimental group	30	10 (33.3%)	5 (16.7%)	2 (6.7%)
Control group	30	14 (46.7%)	15 (50%)	11 (36.7%)
X^2	-	4.578	11.372	7.165
P	-	0.095	0.012	0.044

Table 4. Comparison of bleeding volume between the two groups (%)

Group	Number of cases	Massive bleeding during puncture	Massive bleeding 24 hours after puncture
Experimental group	30	2 (6.7%)	3 (10%)
Control group	30	10 (33.3%)	13 (43.3%)
X^2	-	3.518	10.312
P	-	0.035	0.021

cantly lower than that of the control group (P = 0.002).

Comparison of the success rate of one-time PICC catheterization between two groups

In the **Table 2**, the success rate of one-time PICC catheterization in the experimental group was 96.7%, and that in the control group was 80%. The mean time of indwelling PICC catheter placement was (19.7±8.2) min in the experimental group, which was shorter than the control group. There were statistical significances between two groups in terms of the satisfaction score, the success rate and mean time of PICC catheter indwelling (all P < 0.05).

Comparison of the incidence of complication between two groups

In our study, the incidence of exudation was 33.3% in the experimental group, and that in the control group was 46.7%; however, there was no significant different between two groups (P > 0.05). Moreover, in terms of the incidence of infection and thrombosis, there were significant differences between two groups (P < 0.05) (**Table 3**).

Comparison of the bleeding volume between two groups

In our study, the events of massive bleeding during puncture and 24 hours after puncture were recorded. The results demonstrated that the incidence of massive bleeding during puncture and 24 hours after puncture was lower in the experimental group compared with control group, and the difference was significant (P < 0.05) (**Table 4**).

Comparison of the inflammatory factors between two groups

As shown in **Figure 3**, the results demonstrated that the level of IL-6 and hsCRP were decreased in the experimental group, and the inflammatory factor (IL-10) was increased in the experimental group (all P < 0.05).

Comparison of haematological and gastrointestinal toxicity between two groups

The haematological and gastrointestinal toxicity between two groups are shown in **Table 5**. The dominant haematological and gastrointestinal toxicities in the experimental group were nausea (16.7%), diarrhea (23.3%), fatigue (26.7%), abdominal pain (40%), anorexia (63.3%), leukopenia (33.3%), and anemia (66.6%), which showed no significance with

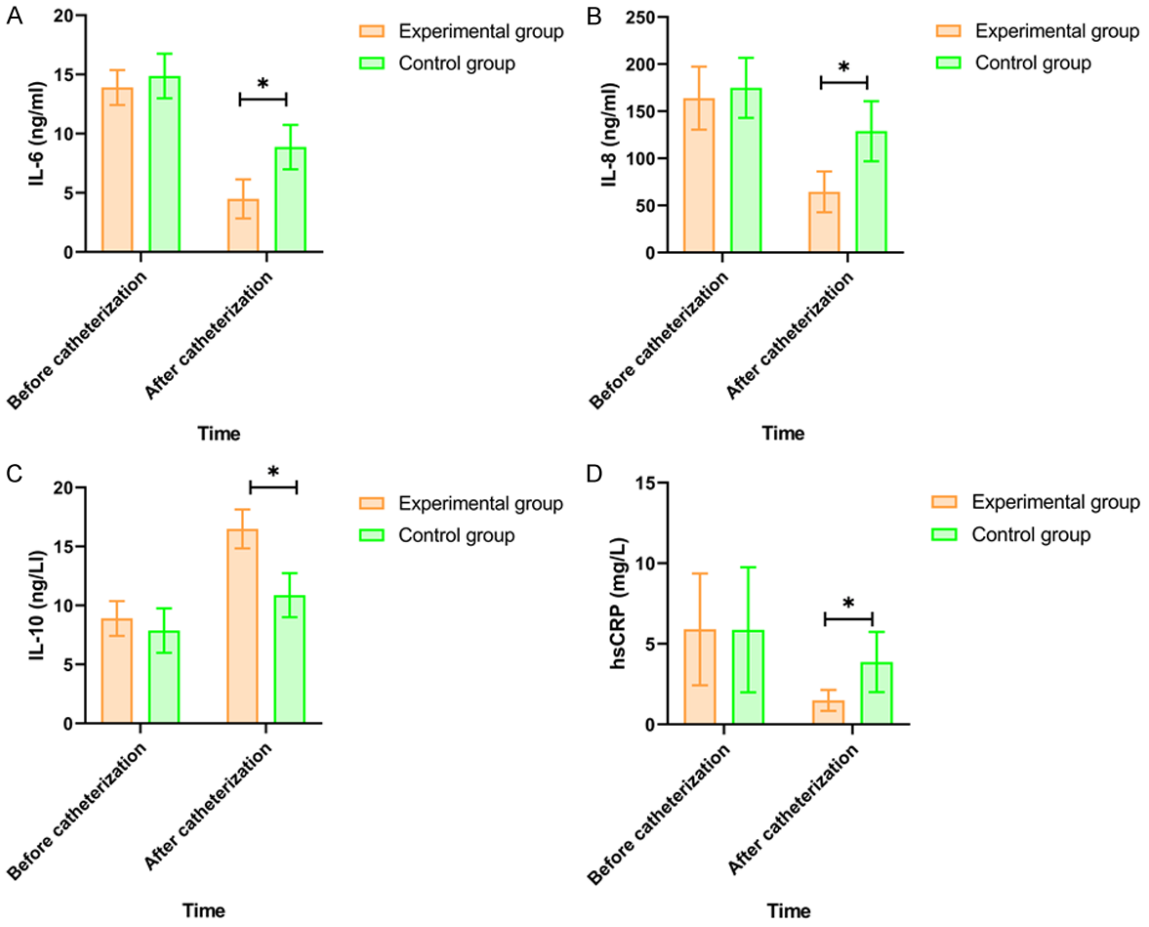

Figure 3. Comparison of inflammatory factors between the two groups before and after intervention. A: IL-6, Interleukin-6; B: IL-8, Interleukin-8; C: IL-10, Interleukin-10; D: Hscrp, High-Sensitivity C-Reactive Protein.

Table 5. Comparison of haematological and gastrointestinal toxicity between the two groups (%)

Group	Number of cases	Nausea	Fatigue	Diarrhea	Abdominal pain	Anorexia	Leukopenia	Anemia
Experimental group	30	5 (16.7%)	8 (26.7%)	7 (23.3%)	12 (40%)	19 (63.3%)	10 (33.3%)	20 (66.6%)
Control group	30	8 (26.7%)	7 (23.3%)	12 (40%)	15 (50%)	18 (60%)	19 (63.3%)	18 (60%)
X^2	-	6.372	7.165	5.596	6.735	9.896	8.889	7.583
P	-	0.052	0.057	0.053	0.067	0.062	0.059	0.061

control group ($P < 0.05$), indicating that modified skin expansion had little effect on the incidence of haematological and gastrointestinal toxicity.

Univariate analysis of the factors affecting the success of PICC catheterization

The modified skin expansion, infection, thrombosis, massive bleeding during puncture, massive bleeding 24 hours after puncture, and completion time of catheterization were correlated with the success of PICC catheterization (all $P < 0.05$); While there was no significant difference between the two groups in age, gender, smoking and marital status (all $P > 0.05$) (**Table 6**).

Multivariate regression analysis of the factors affecting the success of PICC catheterization

The factors showed statistical significance in univariate analysis, such as modified skin expansion, infection, thrombosis, massive bleed-

Table 6. Univariate analysis of the factors affecting the success rate of PICC catheterization

Indexes	rho	*P*
Age	0.061	0.054
BMI (kg/m^2)	-0.074	0.061
Smoking	0.464	0.611
Married (Marital status)	-0.243	0.443
Single (Marital status)	0.357	0.101
Divorced or separated (Marital status)	0.328	0.061
Widowed (Marital status)	-0.058	0.071
Modified skin expansion	0.881	< 0.001
Infection	0.198	0.005
Thrombosis	-0.082	0.001
Massive bleeding during puncture	0.499	< 0.001
Massive bleeding 24 hours after puncture	0.664	0.001
Completion time of catheterization	0.764	< 0.001
Haematological toxicity	-0.329	0.211
Gastrointestinal toxicity	0.664	0.056

Note: BMI: Body Mass Index; PICC: Peripherally Inserted Central Venous Catheterization.

ing during puncture, massive bleeding 24 hours after puncture, and completion time of catheterization, were included into multivariate regression analyses to screen the independent risk factors affecting the success of PICC catheterization, and the result showed that infection (P = 0.009) and modified skin expansion (P = 0.002) were the independent risk factors of success of PICC catheterization (**Table 7**).

Discussion

This study proved that the modified skin expansion in PICC catheterization under the guidance of B-ultrasound had obvious effect on gastrointestinal cancer patients with chemotherapy. The VAS scores were significantly improved after PICC catheterization in the experimental group compared to the control group. The success rate of one-time PICC catheterization in the experimental group was significantly higher than that in the control group.

PICC catheterization is widely used in patients with blood diseases or undergoing chemotherapy and can provide ideal venous access for patients [19]. During catheterization, selection of appropriate puncture vessels, catheterization sites, and correct puncture methods can greatly improve the effect of puncture and lay the foundation for subsequent treatment [20]. Conventional longitudinal skin expansion can easily lead to tissue injury and lymphatic injury, and the risk of bleeding and exudation is relatively high. Therefore, in order to reduce the bleeding at the puncture point, a more effective way of skin expansion should be adopted.

In our study, the PICC catheterization time was significantly shorter than that in the control group, and the success rate of one-time sheath delivery was significantly higher than that in the control group, indicating that modified skin expansion could improve one-time PICC catheterization success rate. The micro intubation sheath method may reduce the bleeding at the puncture point because the blood vessels and epidermis of the dermal papillary layer of human upper arm skin are perpendicular to each other. The thickness of dermis is between 0.4-2.40 mm, and the skin cutting depth reaches 3 mm, breaking through the dermis [21-24]. In addition, the basilic vein is located on the inner side of the limb, the skin is thin, and the expanded mouth is only 2 mm which will not damage the skin epidermis and can effectively reduce the amount of bleeding [25]. The No. 14 trocar used in the micro intubation sheath method does not need to be equipped separately. When expanding the skin, the inclined plane of the needle is exposed by 1/2, and then the needle stops when it touches the skin after expanding the skin. It is convenient to operate, easy to control the strength, easy to send the sheath, and the success rate of one-time sheath feeding is high [26-29].

Moreover, the VAS score was significantly lower than that in the control group, which indicated that modified skin expansion could reduce the pain of patients. The skin expansion incision of the patients in the experimental group was only 2 mm. Only cutting the skin epidermis of the patients will not cause damage to the subcutaneous tissue or dermis. In this way, it is easier to send the sheath without damaging the tissue [30]. The injury is small, the skin heals quickly, and the degree of pain is low. Furthermore, we observed that the improved micro intubation sheath method can effectively reduce the bleeding at the puncture site. Skin wound healing is a continuous process,

Table 7. Multivariable regression analysis of the factors affecting the success rate of PICC catheterization

Dependent variables	Independent variables	Standardized partial regression coefficient	Standard error	95% confidence interval	*P*-value
The success of insertion	Infection	-0.267	0.198	-0.923-0.138	0.009
	Modified skin expansion	-0.209	0.518	-2.631-0.572	0.002
	Completion time of catheterization	0.127	2.279	-1.673-7.373	0.215
	Thrombosis	-0.123	0.095	-0.309-0.688	0.209
	Massive bleeding during puncture	0.008	0.186	-0.354-0.384	0.936
	Massive bleeding 24 hours after puncture	-0.295	0.498	-2.091-0113	0.059

Note: PICC: Peripherally Inserted Central Venous Catheterization.

which starts immediately after the trauma, and the quantity and quality of regenerated granulation tissue starts forming in large quantities until 72 hours after injury [31]. The modified skin expansion and sheath delivery technology has less trauma, fast healing and less blood leakage than the control group.

The results of present study showed that the incidence of complications in the experimental group was significantly lower than that in the control group. The modified skin expansion has more selectable puncture points and reduces the influence of arm flexion and extension on the puncture vessel and the catheter, which can effectively reduce the incidence of mechanical phlebitis [32, 33]. At the same time, it can also prevent frequent and repeated internal and external sliding of the catheter from bringing bacteria into the vessel, so as to effectively avoid the occurrence of catheter-related infection [34-37]. The formation of venous thrombosis is closely related to intimal injury, decreased blood flow velocity of catheterization and hypercoagulable state of blood. The modified skin expansion had a high success rate of one-time puncture, which can reduce intimal injury of blood vessels. When the arm moves, it has little impact on blood vessels and blood flow velocity, thus reducing the possibility of thrombosis.

The levels of serum CRP and IL-6 in experimental groups after treatment were lower than control group, suggesting that the modified skin expansion treatment could decrease inflammatory reactions to a certain extent, which is beneficial to reduce puncture trauma and other complications. Guo et al. demonstrated that the application of PICC could reduce inflammatory reactions [14]. Disappointedly, there are few studies on the relationship between inflammatory factor levels and modified skin expansion in PICC catheterization under the guidance of B-ultrasound, and whether there is a positive correlation between the two requires further research to prove.

It is undeniable that our research has some limitations. Firstly, this study was retrospectively conducted only in the First Affiliated Hospital of Gannan Medical College, which may cause some selection bias. Secondly, the sample size of this study is too small. So, it needs to be verified by further large sample and more rigorous multi center research.

In summary, modified skin expansion in PICC catheterization under the guidance of B-ultrasound can improve the success rate of one-time sheath delivery, effectively reduce the amount of blood leakage after catheterization, reduce the pain and incidence of complications for gastrointestinal cancer patients with chemotherapy. However, due to the small sample size of the study, the research results need to be further verified by large sample and multi-center RCT to explore the effectiveness and superiority of the modified skin expansion applied in PICC catheterization under the guidance of B-ultrasound in gastrointestinal cancer patients with chemotherapy.

Disclosure of conflict of interest

None.

Address correspondence to: Lihua Guo, First Department of General Surgery, The First Affiliated Hospital of Gannan Medical College, No. 26, Qingnian Road, Ganzhou 341000, Jiangxi, China. Tel: +86-15870715179; E-mail: ghb456@126.com

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