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Research on the Clinical Application Value of Peripherally Inserted Central Catheter (PICC) after Radical Gastrectomy

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Abstract: *Objective*: Patients after radical gastrectomy often require medium- to long-term intravenous therapy. However, traditional central venous catheters (CVCs) have issues such as high infection risk and poor comfort. This study aims to deeply explore the clinical application value of peripherally inserted central catheters (PICCs) after radical gastrectomy, providing a scientific basis for optimizing intravenous access selection. *Methods*: Fifty patients requiring catheterization after radical gastrectomy at the Friendship Hospital of Ili Kazak Autonomous Prefecture from December 2022 to May 2024 were selected. Catheterization site selection was based on patients' preferences, dividing them into two groups: the experimental group receiving PICCs and the control group receiving CVCs, with 25 patients in each group. Multi-dimensional comparative analysis was conducted, including catheterization operation time, catheter indwelling time, success rates of first and second catheterizations, and complication rates. Statistical methods such as t-tests and chi-square tests were used for in-depth analysis. *Results*: Compared to the control group, the experimental group had longer catheterization operations and catheter indwelling times, and a higher success rate of first catheterization ($P < 0.05$). The incidence of catheterization complications in the experimental group was 12.00%, lower than the 40.00% in the control group ($P < 0.05$). *Conclusion*: Although PICC catheterization after radical gastrectomy has relatively longer catheterization operation and indwelling times, it has a high success rate of first catheterization and a low complication rate, demonstrating high clinical application value and worth promoting in clinical practice.

Keywords: Peripherally inserted central catheter (PICC); Central venous catheter (CVC); Post-radical gastrectomy

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1. Introduction

Gastric cancer is one of the common malignancies worldwide, and its incidence rate has ranked fifth globally according to surveys [1, 2]. Currently, radical gastrectomy is the primary treatment for gastric cancer, but long-term nutritional support, chemotherapy, and other treatments are required after surgery, which demands a high standard for intravenous access [2]. Although traditional peripheral intravenous indwelling needles are easy to operate, they

have limitations such as short indwelling time and inability to withstand the infusion of hyperosmolar or irritating drugs, making them difficult to meet the medium and long-term intravenous treatment needs of patients after radical gastrectomy. Central venous catheterization technology provides an effective way to solve this problem. According to surveys, PICC and CVC have similar frequencies of use in intravenous treatment vascular access devices, which are 5.31% and 4.34%, respectively, and both are common intravenous puncture methods for malignant tumor chemotherapy [3]. CVC involves inserting a catheter into the central vein through skin puncture and is suitable for central venous pressure measurement, short-term infusion, drug therapy, and interventional therapy [4]. PICC, on the other hand, is a technique that involves puncturing through the arm vein, with the catheter extending directly to the large vein. The advantage of this method is that it can effectively prevent chemotherapy drugs from damaging the arm veins while promoting rapid drug dilution [5]. To clarify the advantages and disadvantages of the two methods, this study will analyze the catheterization situation in our department from aspects such as catheterization success rate, indwelling time, and related complications after catheterization, in order to determine the best catheterization approach to serve tumor patients.

2. Materials and methods

2.1. General information

Fifty patients requiring post-gastric cancer radical surgery with catheterization for chemotherapy in the hospital from June 2022 to June 2024 were selected. Detailed education was provided to each patient, explaining the purposes, precautions, and economic burdens of PICC and CVC catheterization. Based on the patients' own preferences, they were divided into an experimental group (PICC) and a control group (CVC). Each group consisted of 25 patients. The experimental group's age ranged from 30 to 70 years, with an average of (48.52 ± 2.01); the male-to-female ratio was 16/9. The control group's age ranged from 31 to 69 years, with an average of (48.65 ± 1.98); the male-to-female ratio was 17/8. There were no statistically significant differences in the general information between the two groups ($P > 0.05$).

2.2. Inclusion and exclusion criteria

2.2.1. Inclusion criteria

(1) Patients who underwent gastric cancer radical surgery in our hospital and had a need for central venous catheterization after surgery [6].

(2) Age over 18 years.

(3) All patients provided informed consent.

2.2.2. Exclusion criteria

(1) Patients with coagulation disorders.

(2) Patients with skin damage or infection at the puncture site.

(3) Patients with venous thrombosis at the catheterization site.

2.3. Methods

2.3.1. Control group

CVC catheterization was performed. The operating procedure was as follows: The patient was placed in a supine

position, with the head turned to the contralateral side and lowered by approximately 20° to 30°. The puncture site (i.e., the apex of the sternocleidomastoid muscle triangle) was carefully cleaned and disinfected, and 1% lidocaine was injected for anesthesia. A 16G puncture needle (produced by Zhuhai Fonia Medical Equipment Co., Ltd. (Sino-US joint venture)) was then inserted at an angle of 30° to 45° relative to the skin, with the needle tip pointing towards the ipsilateral nipple or the intersection of the middle and inner 1/3 of the clavicle. The needle was advanced while aspirating, and venous return of blood indicated that the internal jugular vein had been entered. A pressure measurement needle was placed. If no pulsatile blood return was observed, a guidewire was inserted, and the puncture needle was then withdrawn. A dilator was used to expand the subcutaneous tissue, and after dilation, the dilator was withdrawn. The central venous catheter was placed along the guidewire, and after confirming that the catheter was unobstructed, normal saline was injected to seal the tube, which was then connected to a heparin cap for future use. Finally, the puncture site was covered with sterile gauze and fixed with adhesive tape.

2.3.2. Experimental group

PICC catheterization was performed. The operating procedure was as follows: The patient was placed in a supine position and kept relaxed. The arm on the puncture side was abducted at 90°. Based on the length of the catheter and the patient's body type, an appropriate location on the upper arm (preferably the medial basilic vein) was selected as the puncture site. The puncture site was carefully cleaned and disinfected. Sterile drapes were routinely placed, and the operator wore sterile gloves to ensure that the entire procedure was performed in a sterile environment. The PICC catheter was manufactured by Bard Access System, Inc. (National Medical Device Registration No. 20173771671). A 14-G puncture needle was used for the routine puncture operation. When blood return was observed, the angle of the puncture needle was lowered, and it was advanced into the vessel by 1–2 cm. The PICC catheter was gradually inserted into the vein along the guidewire. The catheter was inserted with uniform and slow force, avoiding violent insertion. The catheter was left in place outside the body for 6–8 cm. Finally, the puncture site was covered with a sterile transparent film, and an elastic bandage was used for dressing.

2.4. Observation indicators

Compare the catheterization operation time, catheter indwelling duration, and the success rate of one-time and second-time catheterization between the two groups of patients. At the same time, record the number of cases of catheterization complications in each group.

2.5. Statistical analysis

SPSS 20.0 statistical software was used to process the data. The count data was presented in the form of a percentage (%), and the chi-square test method was used. The measurement data were expressed as ($\bar{x} \pm s$) and analyzed using the t-test. $P < 0.05$ was considered statistically significant.

3. Results

3.1. Catheterization operation time and catheter indwelling time

As shown in **Table 1**, compared with the control group, the experimental group had a significantly longer catheterization operation time and a longer catheter indwelling time ($P < 0.05$).

Table 1. Comparison of catheterization operation time and catheter indwelling time between the two groups ($\bar{x} \pm s$)

Group	Number of cases	Catheterization operation time (min)	Catheter indwelling time (d)
Experimental group	25	12.14 ± 2.14	179.15 ± 3.65
Control group	25	8.04 ± 2.28	5.54 ± 1.89
t-value		6.556	28.268
p-value		< 0.001	< 0.001

3.2. Success rate of catheterization

As shown in **Table 2**, the success rate of one-time catheterization in the experimental group (96.00%) was higher than that of the control group (76.00%) ($P < 0.05$).

Table 2. Comparison of success rate of catheterization between the two groups [n(%)]

Group	Number of cases	First attempt success	Second attempt success
Experimental group	25	24 (96.00)	1 (4.00)
Control group	25	19 (76.00)	6 (24.00)
χ^2 (Chi-square)		4.153	4.153
p-value		0.042	0.042

3.3. Catheter-related complications

As shown in **Table 3**, the incidence rate in the experimental group was 12.00%, which was lower than that in the control group (40.00%) ($P < 0.05$).

Table 3. Comparison of the incidence of catheter-related complications between the two groups [n(%)]

Group	Number of cases	Local tissue injury	Phlebitis	Others	Total incidence
Experimental group	25	1	0	2	12.00%
Control group	25	3	3	4	40.00%
χ^2 (Chi-square)					5.094
p-value					0.024

4. Discussion

Gastric cancer is a highly prevalent malignant lesion of the digestive tract, originating from the gastric mucosal epithelium. It particularly occurs in the gastric antrum region and may spread to the anterior and posterior walls as well as the greater and lesser curvatures of the stomach. Currently, radical gastrectomy is the core treatment method for this disease, and post-surgical patient management and care are equally crucial [7]. Central venous catheterization is a crucial approach for post-surgical monitoring, treatment, and nutritional support. Its selection and application directly affect the recovery effectiveness and prognosis quality of patients. Studies have shown that patients using PICC have a significantly lower risk of catheter-related infections compared to CVC patients [8].

However, another study revealed that in parenteral nutrition support for colorectal cancer patients, CVC puncture operation time is superior to PICC [9]. Both PICC and CVC are catheter techniques that directly enter the central veins. They can effectively reduce the suffering of chemotherapy patients, improve their quality of life, and enhance the acceptance of catheter use.

In this study, the catheterization operation time of the experimental group (12.14 ± 2.14) minutes was longer than that of the control group (8.04 ± 2.28) minutes ($P < 0.05$). The reason for this is analyzed as follows: The longer operation time for PICC is mainly due to the need for detailed vascular assessment, accurate external measurements, catheter tip positioning, and other steps. Compared to CVC, the puncture process of PICC is more delicate and requires operators to have rich experience and skilled techniques. Additionally, although ultrasound-guided PICC catheterization can improve the success rate and accuracy of puncture, it also requires some time to adjust the position of the ultrasound probe and puncture needle. To improve the operational efficiency of PICC, it is possible to strengthen the training of medical staff, enhance their operational skills, and proficiency. Meanwhile, the introduction of advanced auxiliary equipment and technology, such as blood vessel visualization equipment and magnetic navigation positioning systems, can help operators more accurately locate blood vessels and catheter tips, thereby reducing operation time. Furthermore, optimizing the operational process and reasonably arranging the time for each link can also improve the overall operational efficiency.

Patients who have undergone radical surgery for gastric cancer typically require long-term nutritional support, chemotherapy, and other treatments. Extended catheter indwelling time can reduce the pain and fear associated with repeated punctures, enhancing patient comfort and quality of life. Simultaneously, it diminishes the risk of infection and medical expenses arising from repeated catheter placements, which is beneficial for patient recovery and treatment. This study revealed that the catheter indwelling time in the experimental group (179.15 ± 30.65 minutes) was longer than that in the control group (5.54 ± 1.89 minutes) ($P < 0.05$). Furthermore, the success rate of single-attempt catheter placement was significantly higher in the experimental group (96.00%) compared to the control group (76.00%) ($P < 0.05$), aligning with the findings reported by Zhang [10]. The analysis attributed this to the selection of the basilic vein in the experimental group, which is located in the upper extremity, relatively superficial, and easy to observe and palpate. This facilitated more accurate blood vessel localization and puncture by the operator, thereby increasing the success rate of catheter placement.

Conversely, the internal jugular vein chosen in the control group, although also a central vein, has a more complex anatomical structure in the neck region with surrounding crucial nerves and arteries. The need to precisely avoid these structures during puncture increases the difficulty and contributes to a lower success rate of single-attempt catheter placement. For instance, improper needle insertion angle or depth during internal jugular vein puncture can easily damage the adjacent vagus nerve, triggering a vagal reflex that may cause adverse reactions such as decreased heart rate and blood pressure, while also potentially affecting the success rate of catheter placement. Additionally, the basilic vein, as one of the main veins in the upper extremity, has a relatively large diameter and moderate blood flow velocity, favoring smooth catheter insertion. Although the internal jugular vein is also a large blood vessel, due to its special location, fast blood flow velocity, and the influence of neck movement, it may cause instability during catheter placement, thereby reducing the success rate of catheterization. Patients after radical gastrectomy may experience instability in physical condition and poor vascular filling due to surgical trauma, the use of anesthetic drugs, and postoperative pain.

During CVC catheterization, the proximity of the puncture site to the neck may cause patients to turn their heads or experience rapid breathing due to tension or pain, increasing the difficulty of the procedure. In contrast,

during PICC catheterization, the patient's arm on the puncture side is abducted at 90 degrees, and the body remains relatively relaxed, facilitating the operation. Additionally, after PICC placement, patients can resume daily activities with minimal disruption to their lives, making them more likely to accept and comply with the procedure, thereby helping to prolong catheter retention. Regarding post-catheterization complications, this study found that the incidence rate in the experimental group (12.00%) was significantly lower than that in the control group (40.00%) ($P < 0.05$). The analysis suggests that the PICC catheter, which extends from a peripheral vein directly into large vessels such as the superior vena cava, is soft and has good biocompatibility, minimizing mechanical irritation to the vascular wall. Moreover, its external segment of 6–8 cm allows for easy observation of the catheter position, and the sterile transparent film effectively isolates the puncture site from the external environment, reducing infection risks. In contrast, the CVC catheter is located in the neck, close to contaminated areas such as the oral and nasal cavities, and the sterile gauze covering the puncture site provides poor fixation. This increases the likelihood of catheter displacement or dressing loosening due to patient movement, raising the risk of phlebitis and local tissue damage.

5. Conclusion

In summary, the application of PICC catheterization after radical gastrectomy, although the catheterization operation and indwelling time are relatively long, has a high success rate of one-time catheterization, a low incidence of complications, and high clinical application value, which is worthy of promotion and application in clinical practice.

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Disclosure statement

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