

The Application of Midline Catheter in Perioperative Period of Patients with Laryngopharyngeal Cancer

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Abstract

Objective: To investigate the application value of midline catheters in patients with larynx cancer during the postoperative period. **Methods:** 150 patients with larynx cancer treated in our hospital from May 2019 to May 2022 were selected as the study objects. According to the random number method, 75 cases were divided into a control group and a study group. The study group used a midline catheter during treatment, and the control group used a Peripheral venous indwelling needle during treatment. The indwelling time, puncture times, complication rate, daily catheter maintenance cost and catheterization satisfaction rate of the two groups were compared. **Result:** The retention time of the study group (11.53 ± 6.91 days) was significantly higher than that of the control group (2.92 ± 1.41 days) ($P < 0.01$). The total puncture times were significantly lower than that of the control group ($P < 0.01$), and the incidence of complications such as catheter blockage, catheter detachment, drug extravasation and phlebitis were lower than those of the control group. The difference was statistically significant ($P < 0.05$), the average daily maintenance cost of the two groups was not statistically significant ($P > 0.05$), and the satisfaction rate of the study group was significantly higher than that of the control group, the difference was statistically significant ($P < 0.01$). **Conclusion:** Compared with the Peripheral venous indwelling needle, postoperative application of a midline catheter in patients with larynx cancer can effectively reduce the number of puncture times and the incidence of catheter-related adverse reactions, and has higher economic benefits and satisfaction rate, which is worthy of clinical application.

Keywords

Larynx Cancer, Postoperative Period, Midline Catheter,

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1. Introduction

Pharyngeal cancer is a highly malignant tumor in the head and neck region, and the main treatment methods include surgery, radiation therapy, and systemic chemotherapy [1]. Among them, surgical intervention is the preferred treatment method, but postoperative complications such as swallowing dysfunction, wound infection, pharyngocutaneous fistula, and secondary lung infections may occur [2]. Antibiotics and nutritional support are often required, and the duration of intravenous fluid therapy is typically 10 - 20 days, thus necessitating the placement of a venous access device to meet the long-term intravenous treatment needs during the perioperative period. Peripheral venous indwelling needles have a short dwell time of only 2 - 6 days and are associated with a higher incidence of complications such as drug extravasation, which severely hinder their usage. Meanwhile, infusion ports and peripherally inserted peripherally inserted central venous catheters (PICCs) are not cost-effective for medium-term intravenous fluid access [3]. In 2016, the Infusion Nurses Society in the United States recommended considering the use of midline catheters (MC) when the infusion duration is 1 - 4 weeks [4]. Therefore, in our department from May 2019 to May 2022, midline catheters were utilized in the perioperative venous treatment of patients with pharyngeal cancer, effectively reducing the need for repeated punctures of peripheral veins and lowering the occurrence rate of catheter-related complications. The findings are reported as follows.

2. Data and Methods

2.1. Clinical Data

A total of 150 patients who underwent surgery for pharyngeal cancer at our hospital from May 2019 to May 2022 were selected as the study subjects. The inclusion criteria were as follows: 1) Patients diagnosed with primary pharyngeal cancer confirmed by pathological examination and receiving surgical treatment; 2) Complete clinical medical records available. The exclusion criteria were: a) Patients with impaired consciousness or communication difficulties; b) Patients with severe cardiac, pulmonary, hepatic, renal dysfunction, or other malignant tumors; c) Pregnant or lactating women. Using a random number table, the 150 eligible patients were divided into a study group and a control group, with 75 cases in each group. In the study group, there were 5 females and 70 males, with an age range of 32 to 74 years and an average age of 57.52 ± 9.21 years. In the control group, there were 6 females and 69 males, with an age range of 30 to 72 years and an average age of 58.46 ± 10.26 years. The baseline data of the two groups showed no significant differences ($P > 0.05$), indicating comparability. Informed consent was obtained from all included patients in this study, and they

signed a catheter placement consent form.

2.2. Catheterization Procedure

2.2.1. Peripheral Venous Puncture for Central Venous Catheterization

In the control group, infusion therapy was performed using a 22 - 24 G closed-ended safety intravenous indwelling needle (Xinma) manufactured by BD Company, with a straight hub and a heparin cap, and an infusion connector (Kellunfu; model: 01C-C3300T). The puncture site was selected as a thick, straight, and elastic blood vessel on the patient's hand or forearm for venous puncture. After a puncture, a 6 cm × 7 cm transparent dressing manufactured by 3 M was used for coverage and fixation. Infusion procedures were performed according to the standards for intravenous indwelling needle infusion, with normal saline used for catheter maintenance.

2.2.2. Midline Catheter

In the study group, patients were catheterized with a disposable peripheral-inserted central venous catheter made of silicone material, with a size of 4 - 5 Fr, manufactured by Bard Company. Before catheter placement, the patient's coagulation function and the skin at the puncture site were assessed and found to be normal. The patient was placed in a supine position, and the blood vessels in the two transverse fingerbreadth regions above the elbow of the healthy limb were carefully examined. The superior vena cava, jugular vein, or median vein at the elbow were available options for catheter placement, with the superior vena cava being the preferred choice. An appropriate vein was selected, and the puncture site was marked. The distance from the puncture site to the midpoint of the ipsilateral clavicle was measured to determine the length of the inserted catheter. The skin was disinfected with a 2% glucose chlorhexidine ethanol solution. Under the guidance of ultrasound, the Seldinger technique was used to insert the catheter to the predetermined length. After confirming no abnormalities, the catheter was properly secured. After each infusion, a pulsatile positive pressure flush with 10 mL of normal saline was performed, followed by sealing with 50 U/mL heparin saline [5].

2.3. Observation Indicators

The duration of catheter retention and total number of punctures were observed and recorded in both groups of patients. The occurrence rate of relevant complications during catheterization treatment, such as catheter occlusion, catheter dislodgement, drug extravasation, venous inflammation, and puncture site bleeding, were also observed and recorded in detail if they occurred. Finally, clinical indicators such as catheter retention time, total number of punctures, and adverse events were statistically analyzed for both groups of patients.

2.4. Economic Benefits of the Two Treatments

The average daily cost of maintaining the catheter for each group of patients was

accurately recorded.

2.5. Satisfaction with Catheter Placement in Two Groups of Patients

A self-designed catheter satisfaction questionnaire was used to survey the patients. The survey results were divided into categories of satisfied, moderate, and dissatisfied. After the survey, the patient satisfaction rate was calculated.

2.6. Statistical Methods

Statistical analysis was performed using SPSS 22.0 statistical analysis software. Count data were expressed as (n, %) and analyzed using the chi-square test. Measurement data were expressed as ($\bar{x} \pm s$) and analyzed using the t-test. A significance level of $P < 0.05$ was considered statistically significant.

3. Results

3.1. Comparison of Catheter Retention Time and Total Number of Punctures between the Two Groups

As shown in **Table 1**, the catheter retention time in the study group was significantly longer than that in the control group ($P < 0.01$), and the total number of punctures was significantly lower than that in the control group ($P < 0.01$).

3.2. Comparison of Complication Rates between the Two Groups with Different Catheter Placement Methods

As shown in **Table 2**, there were statistically significant differences in the occurrence rates of catheter occlusion ($\chi^2 = 13.56$, $P < 0.01$), catheter detachment ($\chi^2 = 6.86$, $P < 0.01$), drug extravasation ($\chi^2 = 8.45$, $P < 0.05$), venous inflammation ($\chi^2 = 12.52$, $P < 0.01$), and puncture site hemorrhage ($\chi^2 = 5.37$, $P < 0.05$) between the two groups. This indicates that the use of midline catheter significantly reduces the occurrence of catheter-related complications.

3.3. Comparison of Treatment Economic Benefits between the Two Groups of Patients

As shown in **Table 3**, there was no significant difference in the average daily maintenance cost between the two groups ($P > 0.05$).

Table 1. Comparison of catheter retention time and total number of punctures between the two groups.

Groups	Control group (n = 75)	Research group (n = 75)	t	P value
Catheter retention time (d)	2.92 ± 1.41	11.53 ± 6.91	10.69	<0.001
Total number of punctures (times)	3.35 ± 1.61	1.07 ± 0.25	12.48	<0.001

Table 2. Comparison of complication rates between the two groups with different catheter placement methods [n(%)].

Adverse events/Groups	Control group (n = 75)	Research group (n = 75)	χ^2	P value
Catheter occlusion	17 (22.67)	2 (2.66)	13.56	<0.001
Catheter detachment	9 (12.00)	1 (1.33)	6.86	0.009
Drug extravasation	8 (10.67)	0 (0)	8.45	0.04
Venous inflammation	14 (18.67)	1 (1.33)	12.52	<0.001
Puncture site hemorrhage	13 (17.33)	4 (5.33)	5.37	0.02

Table 3. Comparison of treatment economic benefits between the two groups of patients.

Groups	Control group (n = 75)	Research group (n = 75)	t	p value
Average daily maintenance cost of the catheter	27.31 ± 4.16	28.17 ± 4.05	1.54	0.128

3.4. Comparison of Catheter Satisfaction between the Two Groups

As shown in **Table 4**, the satisfaction rate ($\chi^2 = 28.95$, $P < 0.01$) and general satisfaction rate ($\chi^2 = 17.13$, $P < 0.01$) of the study group were significantly higher than those of the control group, while the dissatisfaction rate was significantly lower than that of the control group ($\chi^2 = 7.95$, $P < 0.01$). The differences were statistically significant.

4. Discussion

4.1. Vein Access Selection during the Perioperative Period for Patients with Pharyngeal Cancer

Intravenous fluid therapy and parenteral nutrition support are crucial in the perioperative care of patients with pharyngeal cancer. Currently, there are multiple methods for intravenous fluid therapy, including peripherally inserted central venous catheters (PICC), central venous catheters (CVC), midline catheters (MC), peripheral venous indwelling needles, and infusion ports [6]. Due to the anatomical characteristics of the surgical field in pharyngeal cancer patients, central venous catheters located near the head and neck region may interfere with intraoperative and postoperative procedures. Therefore, PICC, midline catheters, and peripheral venous indwelling needles are suitable vein access choices for patients with pharyngeal cancer during the perioperative period. PICC is often the preferred choice for medium to long-term intravenous therapy [7], as it effectively reduces patient discomfort and unpredictable time consumption caused by multiple venous punctures. However, PICC insertion is cumbersome and requires high technical proficiency [8], and it is relatively expensive, making

Table 4. Comparison of catheter satisfaction between the two groups of patients.

Groups	Control group (n = 75)	Research group (n = 75)	χ^2	P value
Satisfied (n, %)	38 (50.67)	68 (90.67)	28.95	P < 0.001
Moderately satisfied (n, %)	27 (36.00)	6 (8.00)	17.13	P < 0.001
Dissatisfied (n, %)	10 (13.33)	1 (1.33)	7.95	0.005

it less cost-effective for patients who require intravenous therapy for only about 2 weeks. Peripheral venous indwelling needles are commonly used for most patients because they are easy to insert [9] and have low single-use costs. However, some patients may experience difficulties in puncture due to factors such as excessive obesity or emaciation, multiple comorbidities, insufficient peripheral vein filling, vascular sclerosis, and small veins. Moreover, the indwelling time of peripheral venous indwelling needles is limited (72 - 96 hours), which often requires frequent site changes, leading to patient's repeated puncture pain and mechanical injuries [10]. The clinical application effect of indwelling needles is therefore less than ideal. A midline catheter (MC) is an infusion device that is inserted through a peripheral vein (such as the basilic vein or the brachial vein) with its tip positioned in the axillary vein or subclavian vein. It can typically be retained for up to 4 weeks [10]. Current research has shown that midline catheters are more effective when used for continuous intravenous drug infusion, reducing the pain caused by repetitive peripheral vein punctures and the occurrence of complications [11]. In addition, midline catheter insertion has a relatively high success rate and requires less time [12].

4.2. Feasibility and Advantages of Midline Catheters in Intravenous Therapy during the Perioperative Period for Patients with Pharyngeal Cancer

Surgery for pharyngeal cancer involves significant trauma and carries high surgical risks. It often results in a large amount of intraoperative bleeding and fluid loss. Postoperatively, antibiotic and nutritional support treatment is commonly required. The pH value of medications used during treatment ranges from 4 to 9, and the median duration of intravenous therapy is 2 weeks. Midline catheters allow for longer indwelling time, and the results of this study also demonstrate that the mean indwelling time of the catheters (11.53 ± 6.91 days) can meet the requirements of intravenous therapy during the perioperative period for patients with pharyngeal cancer. Various high-risk complications, such as wound infection, pharyngeal fistula, and hemorrhage from major neck arteries, often occur within 1 - 10 days after radical surgery for pharyngeal cancer [2] [13]. During this period, rapid fluid resuscitation is frequently needed to effectively replenish blood volume. The tip of the midline catheter is positioned in the subclavian vein, with a blood flow rate of up to 900 ml/min, which can meet the needs of rapid fluid resuscitation [10]. Additionally, the use of midline catheters ensures that

patients have an effective vascular access, alleviating the puncture pressure on healthcare workers during emergency situations. This facilitates timely administration of rapid intravenous fluid and blood transfusions, thus saving valuable rescue time.

The results of this study showed that midline catheters have the following advantages: the number of punctures in the study group was significantly lower than in the control group ($P < 0.01$), and the indwelling time of the catheters was significantly longer than the control group ($P < 0.01$). Moreover, as shown in **Table 2**, the occurrence rate of complications during catheter insertion in the study group was significantly lower than that in the control group receiving indwelling needle treatment ($P < 0.05$). The reason for this can be analyzed as follows: the tip of the midline catheter has a fast blood flow rate, which leads to rapid dilution of medications [10], thereby reducing the stimulation of the vascular endothelium and lowering the occurrence rate of adverse reactions [14]. On the other hand, the soft texture of the midline catheter causes less damage to the venous blood vessels, which contributes to a certain extent in reducing the occurrence rate of adverse reactions. This indicates that the use of midline catheters for intravenous therapy during the perioperative period in patients with pharyngeal cancer is safer. This study also found that the economic benefits in the study group were not significantly different from the control group ($P > 0.05$), indicating that the use of midline catheters does not impose additional economic burden on patients. Furthermore, as the midline catheter is positioned far from the heart, there is no need for ultrasound or X-ray to locate the tip of the catheter, saving additional costs and reducing the medical burden on patients as well as minimizing radiation exposure from X-rays. In addition, the results of this study revealed that the treatment satisfaction rate in the study group was significantly higher than in the control group. This is attributed to the alleviation of patient pain from repeated punctures, ensuring smooth fluid administration, and reducing the occurrence of various complications related to intravenous therapy, providing a better experience for the patients. This suggests the feasibility of promoting the use of midline catheters in patients with pharyngeal cancer.

4.3. Limitations of This Study

Due to the limited research on the application of midline catheters in China, there is still controversy surrounding the accurate analysis of their effectiveness. Therefore, this experiment compared the application value of midline catheters with indwelling needles in patients with pharyngeal cancer through strict inclusion and exclusion criteria. However, due to limitations in the experimental conditions, our study also has certain limitations.

Firstly, there is a lack of specific comparisons with a wider range of infusion tools. Secondly, the sample size of this study is small and further expansion of the sample size is needed for research. Thirdly, the subjects in this study were mainly patients with pharyngeal cancer, and the effects of midline catheters on

other tumor patients were not analyzed in detail. Therefore, in the future, we will expand the sample size of the study population and further explore the application of midline catheters in other tumor patients in order to obtain optimal experimental results.

5. Conclusion

In summary, compared to peripheral venous indwelling needles, the perioperative use of midline catheters in patients with pharyngeal cancer can effectively reduce the number of punctures, decrease the occurrence rate of catheter-related complications, and provide higher medical economic benefits and patient satisfaction rates. Therefore, it is worthy of clinical promotion and application.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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