

## Original Article

# A comparative study on the use of different connectors in tube sealing in elderly tumor patients with PICC

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**Abstract:** Objective: To compare the therapeutic efficacy of heparin cap and clave connector in tube sealing of PICC in elderly patients with tumor. Methods: One hundred and sixty cases of elderly patients with PICC placement were selected and randomly divided into control group and experimental group with 80 cases respectively. The catheters in control group were sealed with heparin cap while the catheters in experimental group were sealed with clave connector. The tube-plugging rate, phlebitis, catheter indwelling time, infection rate and so on were respectively compared between these two groups. Results: Compared with the control group, the application of clave connector significantly reduced the rate of tube-plugging ( $P=0.0035$ ), phlebitis ( $P=0.0027$ ) and infection ( $P=0.0041$ ), and prolonged catheter indwelling time ( $P<0.01$ ). Conclusion: The efficacy of clave connector in tube sealing was significantly better than heparin cap for patients with PICC placement. And clave connector, with simple, safe and convenient operational procedure, was worthy of promotion in clinical application.

**Keywords:** Heparin cap, clave connector, PICC, elderly patients with tumor, tube sealing

## Introduction

At present, tumor has become a global issue which endangers physical and mental health of human. Elderly patients with tumor account for a large proportion [1, 2]. There are a variety of treatments for tumor, including surgery, radiotherapy and chemotherapy. And elderly patients have the characteristics of low immune function, poor constitution and a lack of self-care ability, which are prone to various complications during treatment, especially in chemotherapy.

Peripherally Inserted Central Catheter (PICC) is a method to provide long-term intravenous access by sending the catheter to the vena cava near the heart through the peripheral venous puncture. It has been widely used in chemotherapy for elderly patients with tumor, which has the advantages of safe and convenient operation, less complications, high success rate, long indwelling time and so on [3, 4]. However, in the process of PICC sealing with routine used heparin cap, the high incidence of complications, such as catheter occlusion, phlebitis and infection, seriously affects the original advantages of PICC and reduces the

patients' life quality [5, 6]. Clave needleless connector is a newly introduced part for PICC sealing in our department. It does not need heparin solution for tube sealing, and this feature significantly reduces the accumulation of heparin in patients. It can directly draw blood and lessen the pain of patients; moreover, the regurgitation of blood is not easy to happen when injecting liquid, reducing the formation of thrombosis. In theory, the efficacy of clave needleless connector is significantly better than heparin cap.

Therefore, this study mainly discussed and compared the curative effect of heparin cap and clave connector in tube sealing of PICC for elderly patients with tumor, in order to promote the clinical application of clave connector, reduce the incidence of related complications, improve patients' trust in PICC, and promote the clinical application of PICC. The specific report was as follows.

## Materials and methods

### Basic data

One hundred and sixty cases were selected from elderly patients who were diagnosed with

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**Table 1.** The contrast of general information of the patients in two groups

Group	Cases	Gender		Age (year)	Course of disease (year)	Coagulation time (min)	White blood cell count ( $10^9/L$ )	Lymphocyte count ( $10^9/L$ )
		Male	Female					
Control group	80	53	27	71.00±7.67	2.10±0.23	10.02±0.77	6.50±0.43	2.63±0.26
Experimental group	80	55	25	68.80±7.90	2.04±0.21	10.11±0.68	6.43±0.51	2.65±0.43
Statistical value		$\chi^2=0.11$		t=1.79	t=1.72	t=0.78	t=0.94	t=0.36
P		0.7357	0.0758	0.0868	0.4344	0.3494	0.7223	

tumor and treated in our hospital from December 2011 to December 2015, including 108 males and 52 females. Inclusion criteria: Patients and their families had signed the informed consents and voluntarily participated in the trial; patients had been definitely diagnosed with tumor and required chemotherapy; all patients underwent PICC puncture successfully; no contraindications to chemotherapy; no other important organ diseases (such as hypertension, coronary heart disease, diabetes, renal insufficiency and so on); there was no statistical difference in irritation and grain size between chemotherapeutic agents of two groups (mainly including calcium folinate and fluorouracil). Exclusion criteria: Patients who had coagulation disorders and other hematological diseases; patients who had cognitive impairment and other mental illnesses; patients' condition took a sharp turn for the worse; patients with serious complications. According to the random number table, patients were divided into the control group (tube sealing with heparin cap) and the experimental group (tube sealing with clave connector) with 80 cases for each. The basic information of two groups, such as age, gender, course, coagulation time (CT), the number of leucocytes, lymphocyte count, etc., was compared and analyzed, and there was no statistical difference, as shown in **Table 1**.

### Materials

The same type of PICC catheters (7617405), produced by Bard Company in U.S.A, were employed in two groups and the puncture sites of patients were all basilic veins. The heparin caps (54384423) used in the control group were the products of BD Company, United states, while the clave connectors (01C-CLC-2000) used in the experimental group were produced by ICU medical Inc.. A clave connector is mainly made up of a positive side and a negative side. The positive side is connected with an indwelling needle, and it's not easy to

slip off with the nut fixed. At the negative side, the infusion tube is firmly fixed by a white and elastic silicon cap, which can avoid being repeatedly punctured by the needle. The heparin sodium solution used in sealing was configured as below: 12,500 u heparin sodium was added into 250 ml normal saline to configure 50 u/ml heparin sodium solution.

### Methods

All puncture-related operations of patients were completed by the same professional. Aseptic manipulations were strictly followed. All the punctures were successful and the operations went well.

Heparin caps were employed to seal up the catheter in the control group. The main operations were as follows: Heparin caps were promptly inserted after successful PICC catheter placement. Heparin caps were disinfected before every infusion and replaced once a week. Before every infusion, 10 ml sterilized saline water was used to wash pipe. Then heparin caps were fixed and conventional infusions were conducted. After infusions, 10 ml heparin sodium solution, which was diluted in advance, was collected to seal up. Steel needles were inserted into heparin caps to perform pulse-type injections. When only 2 ml solution was left in the needle, the bolus and retracement of the needle were performed simultaneously to make sure that no space was left in heparin caps. Finally, heparin caps were bound up after operations.

Clave connectors were employed in the experimental group. The main operations were as follows: Clave connectors were picked out after checking the packing. A dermajet was employed to extract 3 ml sterilized saline water and was connected with the negative side of clave connector. The positive side was up to exhaust. Having removed its protective cap, the positive

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**Table 2.** Catheter blockage grade

Grade	Reference index
Grade 0	There is blood after withdrawing, Liquid injection is smooth.
Grade I	There is no blood reflux after withdrawing, there was resistance in liquid injection, resistance disappears after using urokinase thrombolysis.
Grade II	There is no blood reflux after withdrawing, there is resistance in liquid injection, and resistance still remains after using urokinase thrombolysis, extubation.

**Table 3.** The clinical grade of phlebitis

Grade	Reference index
Grade I	Local pain, reddened and swollen or hydrops, no funicular change in vein, no hard tubercle
Grade II	Local pain, reddened and swollen or hydrops, local funicular change appears, no hard tubercle
Grade III	Local pain, reddened and swollen or hydrops, funicular change appears in vein, hit hard tubercle

**Table 4.** The comparison of tube-plugging rate of the patients in two groups

	Cases	Grade 0	Grade I	Grade II	Tube-plugging rate (%)	$\chi^2$	P
Control group	80	52	16	12	35.00	8.53	0.0035
Experimental group	80	68	8	4	15.00		

side was connected with an indwelling needle. The air between the clave connector and indwelling needle was eliminated by withdrawing the plunger of injector. Then the negative side of the clave connector was connected with an infusion apparatus for conventional infusion. Before every infusion, clave connectors were disinfected conventionally. After infusion, the infusion apparatus was separated from the clave connector. 10 ml normal saline was used to wash pipe, which could make the white silicon cap pop up. The condition of positive pressure and asepsis was ensured. Clave connectors were replaced every 12 days and were disinfected conventionally before use.

### Testing index

The conditions of two groups were compared in tube-plugging rate, phlebitis rate, catheter indwelling time, infection rate and so on. According to clinical criterion of judgment, the severity of tube plugging was divided into 3 grades, as shown in **Table 2**. Grade I and II indicated the occurrence of tube plugging [7, 8]. The evaluation of phlebitis was made in accordance with the criterion of judgment of infusion nurses society, USA, and its severity was also divided into 3 grades [9, 10], as shown in **Table 3**. Catheter indwelling time is affected by various factors, such as skin rash, tube falling off, tube plugging, solution exosmosis and infections. All these factors can lead to extubation.

Therefore, the length of catheter indwelling time is a comprehensive evaluation index of catheter placement effect. During the catheter indwelling period, the operations of nursing and disinfection should be strengthened. The patients should be observed carefully. And it is vital to check whether the part of catheter placement is reddened and swollen and whether tenderness and purulent secretion exist. If any unknown fever is happened, the catheter should be extubated promptly, then the cultivation and observation of the peripheral blood and catheter tip should be performed to test whether there has bacterial infection in these two places.

### Statistical analysis

Software SPSS16.0 was adopted for statistical analysis. The measurement data was expressed as mean  $\pm$  standard deviation ( $\bar{X} \pm S$ ) and examined by t test. The enumeration data was expressed as percentages (%) and examined by  $\chi^2$  test.  $P < 0.05$  was considered that the difference had statistical significance.

## Results

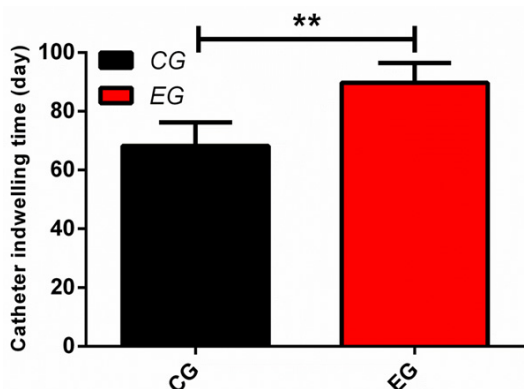
### Comparison of tube-plugging rate between two groups

Among these senior patients with tumor, who treated with chemotherapy, the general tube-

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**Table 5.** The comparison of incidence of phlebitis of the patients in two groups

	Cases	Grade I	Grade II	Grade III	Incidence (%)	$\chi^2$	P
Control group	80	12	6	2	25.00	9.00	0.0027
Experimental group	80	4	2	0	7.50		



**Figure 1.** The comparison of catheter indwelling time in two groups. CG, control group; EG, experimental group. \*\*P<0.01.

plugging rate and degree of each stage of the control group were higher than those of the experimental group. The comparison between two groups was statistically significant ( $P=0.0035$ ), as shown in **Table 4**.

### Comparison of the incidence of phlebitis between two groups

Due to the stimulation of chemotherapy drugs, the number of patients in each stage of phlebitis, whose tubes were sealed up with heparin cap and clave connector, was 12/6/2 and 4/2/0. There was significant difference between the two groups ( $P=0.0027$ ), as shown in **Table 5**.

### Comparison of catheter indwelling time

The catheter indwelling time of experimental group was longer. And there was significant difference compared with the control group ( $P<0.01$ , **Figure 1**).

### Comparison of infection rate

Eight cases were infected in the control group and 2 cases in the experimental group. The infection rate of the control group was significantly higher than that of the experimental

group ( $P<0.0041$ ), see **Table 6**.

### Discussion

Elderly patients with tumor require long-term chemotherapy as well as parenteral nutrition therapy, which requires an ideal vein passage [11]. PICC, as a safe, convenient and effective catheter implanting technique, is currently prevalent in clinical tumor chemotherapy [12, 13]. Under normal conditions, we choose the heparin cap for PICC sealing. And heparin cap sealing needs heparin sodium to wash pipe, resulting in the accumulation of heparin in vivo; each infusion needs the scalp acupuncture to puncture, leading to an increased risk of injury of nurses and patients; repeated punctures in heparin cap can lead bacterial particles to get into patients' body and cause infection [14, 15]. And the final stage of the heparin cap sealing also needs to withdraw the needle at a constant rate to maintain a certain pressure inside the catheter, which significantly increases the difficulty of operation. Therefore, there is an urgent need for an optimized product to replace the heparin cap for PICC sealing. It has been reported that the clave connector may be more suitable for PICC sealing, but the results are not clear and there exist different opinions. Hence, we measured the incidence of catheter occlusion, phlebitis, the length of catheter indwelling time and the rate of infection of the two sealing methods to comprehensively assess their pros and cons when applied to PICC.

In this study, the incidence of phlebitis of control group and experimental group were 25% and 7.5%. As the heparin cap sealing increased the chance of infection, the incidence of phlebitis was significantly higher than the clave connector group.

During the indwelling period of PICC, catheter occlusion and infection are the two main causes of extubation. By observing the results of this study, we found that clave connector, which was used for elderly PICC sealing in patients with tumor, significantly reduced the tube-plugging rate, prolonged catheter indwelling time, alleviated the pain of patient and eased the work burden of nursing staff. When sealing with the heparin cap, the final positive

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**Table 6.** The comparison of infection rate of the patients in two groups

	Control group	Experimental group	$\chi^2$	<i>P</i>
Cases	80	80	8.23	0.0041
Infection cases (%)	16 (20%)	4 (5%)		

pressure sealing is needed. If the operator is not proficient, blood reflux can be caused by the instantaneous negative pressure at the moment of withdrawing needle, leading to the catheter occlusion. The clave connector has a specially designed instantaneous barotropic system, which can reduce the occurrence of blood reflux and catheter occlusion and prolong the catheter indwelling time [16, 17]. In the case of clave connector sealing, the steel needle is not required in the infusion, resulting in the reduction of the occurrence of infection, and the prolongation of the indwelling time of catheter [18, 19].

As for the patients with tumor, the long-term chemotherapy destructs their immune system and reduces their body immunity. The occurrence of infection also can be exacerbated because the catheter has been indwelt in these patients' body for a long time [20, 21]. In this study, it was found that the infection rate (20%) in the control group was significantly higher than that of the experimental group (5%) and clave connector for PICC sealing could significantly reduce the infection rate. When using the heparin cap to seal up the catheter, long-term and repeated use of steel needle in the puncture of heparin cap further increases the likelihood of bacterial infection. When sealing with clave connector, there is no need for needle puncture in each infusion. Therefore, it only needs to disinfect the interface with alcohol, and the incidence of infection is significantly reduced [6]. Besides, clave connector has anti-leakage device at the same time, which can effectively avoid the leakage of chemotherapy drugs and nutrient solution and reduce the incidence of infection [22-25].

Clave connector is a type of needleless closed positive pressure connector. It can play a protective role for both doctors and patients at the same time, and the operation is simple and convenient.

However, this research also has some defects. First of all, the data collection of the participants is not detailed enough; besides, as for the operation with infection risk, the regular follow-up study is not conducted and the long-term impact of this approach on patients is uncertain. As for the medical equipment of PICC sealing with high safety and convenient operation, such as clave connector, will be the favorable choice for future medical treatment, and it will bring great convenience to doctors and patients.

In summary, during PICC catheter placement, clave connection sealing can significantly reduce the occurrence of catheter blockage and phlebitis, prolong the indwelling time and reduce the incidence of infection of elderly patients with tumor. Compared with heparin cap sealing, clave connector sealing is beneficial to alleviate the pain of elderly tumor patients and reduce the work burden of nursing staff. Therefore, clave connector sealing, as a kind of PICC sealing technology, is worthy of clinical promotion.

### Disclosure of conflict of interest

None.

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