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Preventive effect of dexamethasone solution pre-treated catheter on PICC-induced phlebitis.

Xin-juan Wang*

Medical College of Taizhou University, Taizhou, Zhejiang, PR China

Abstract

Objectives: To study the preventive effect of dexamethasone solution pre-treated catheter on Peripherally Inserted Central Catheter (PICC)-induced phlebitis.

Methods: 320 cases of patients undergone PICC in our hospital between Aug., 2013 and Aug., 2016 were selected and randomly divided into control group and observation group with 160 cases respectively. The observation group was in turn separated into high concentration group and low concentration group with 80 cases of each group. To find out the effects and the best concentration of dexamethasone solution in preventing PICC-induced phlebitis, we compared the occurrence of phlebitis and some other complications of these three groups by immersing the catheters of high concentration group, low concentration group and control group in 30 ml of 0.08 mg/ml, 0.04 mg/ml dexamethasone and saline respectively before placing catheters.

Results: There were no statistical significance of the differences in general clinical data and catheter placement (P>0.05). The occurrence time of phlebitis in the high concentration group were later than that in the low concentration group, the incidences of phlebitis were lower than that in the low concentration group (P<0.05). The occurrence time of phlebitis in the low concentration group were later than that in the control group, the incidences of phlebitis were lower than that in the control group (P<0.05). The degree of phlebitis in high concentration group and low concentration group was lower than that in control group (P<0.05) and there was no significant difference in the degree of phlebitis between the high and the low concentration group (P>0.05). The differences were not statistically significant in the comparison of other early complications (P>0.05). Multivariate regression analysis showed that the pre-treatment of catheters by dexamethasone solution is an independent favoring risk factor for the incidence of phlebitis (OR 0.56, 95% CI (0.43-0.78), P<0.001).

Conclusions: The pre-treatment of catheters by dexamethasone solution can obviously reduce the incidences and degree of PICC-induced phlebitis, delay its occurrence without leading to the ascent of risks of other complications. It has the best preventive effect to do the pre-treatment of catheter by using 30 ml dexamethasone solution with a concentration of 0.08 mg/ml, but the time for pre-treatment still needs further exploration.

Keywords: Dexamethasone, Pre-treatment, PICC, Phlebitis, Preventive effect.

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Introduction

Peripherally Inserted Central Catheter (PICC) is a new type of infusion technique, which can open treatment access to patients requiring long-term intravenous infusion and in addition to avoiding the damage caused by repeated vein puncture, it can also reduce peripheral vein injury. Since it was introduced to China since 1990s, its safety, simplicity and other advantages have already been proved [1]. However, long-term PICC indwelling may cause phlebitis and other complications because of mechanical injury and bacterial infection, which can increase pain in patients, prolong hospitalization and add the cost of treatment. Some patients with severe phlebitis even need early extubation, which bring great obstacles for follow-up treatment [2]. In recent years, some scholars put forward the idea of using antibiotics or glucocorticoid pre-treated catheter to reduce the risks of PICC-induced phlebitis. Nevertheless, there were no agreement on pre-treatment drugs and the concentration [3]. We intend to investigate the preventive effect of dexamethasone solution pre-treated catheter on Peripherally Inserted Central Catheter (PICC)-induced phlebitis and its clinical value and best concentration.

Materials and Methods

General data

320 cases of patients undergone PICC in our hospital between August 2013 and August 2016 were selected and randomly divided into control group and observation group with 160

cases respectively. The observation group was in turn separated into high concentration group and low concentration group with 80 cases of each group. This study was approved by the Medical Ethics Committee and both the patients and their families were informed and signed consent forms.

Criteria for selection and exclusion

All the cases selected should be adults' patients who receive long-term parenteral nutrition, chemotherapy or infusion therapy, meet the standards for catheter placement [4] and have no PICC treatment history. For patients who have glucocorticoid drug allergy history or were combined with abnormal platelet count or coagulation disorders or were head vein catheterization or whose puncture site has skin ulceration or infection were not enrolled in our study. In addition, patients who were died 7 days after catheterization were removed from the samples.

Methods

Catheter pre-treatment: We immersed the catheters of high concentration group, low concentration group and control group in 30 ml of 0.08 mg/ml dexamethasone, 0.04 mg/ml dexamethasone and saline respectively for about 5 min [5]. This operation was conducted by a same nurse from PIVAS (Pharmacy Intravenous Admixture Services) without knowing the soaking liquid ingredients.

Catheterization: We chose the appropriate puncture way, arms and vein according to different kinds of diseases and catheter placing requirements. We used the Groshong Nxt ClearVue catheter (Bard International, USA). The procedure of puncture and catheterization were conducted by a nurse of our hospital who was supervised by doctors and strictly followed relevant process specifications [6].

Observation indexes: We sorted out the general clinical data and catheterization situations of patients and compared the incidences of phlebitis and other complications, including the incidences rate, degree and time of occurrence of phlebitis and the incidence rate of other complications.

Statistical analysis

All the clinical data were analysed by SPSS 18.0. Count data were expressed by n% and tested by χ^2, while rank data were tested by rank sum test. Measurement data were expressed by $\bar{x} \pm s$. If normal distribution was satisfied and the variance was homogeneous, independent sample t-test was used and if the variance was not homogeneous, corrected t-test was used. If normal distribution was not satisfied, the results were expressed by M (Q_1, Q_3) and tested by Wilconx rank sum test. A logistic regression model was used to conduction the multivariate regression analysis. The results were statistically significant when $p<0.05$.

Results

General clinical data

There were no statistical significance in differences of patients' age, upper arm circumference, blood routine before catheterization, gender, original disease, catheterization purpose ($p>0.05$, Table 1).

Table 1. Baseline characteristics of all patients enrolled.

Clinical data		High concentration group (n=80)	Low concentration group (n=80)	Control group (n=160)	P value
		54.81 ± 12.63	54.55 ± 12.84	54.69 ± 12.51	>0.05
Age (years)		25.26 ± 4.81	25.33 ± 4.90	25.19 ± 4.76	>0.05
Upper arm circumference (cm)	Leukocyte (× 10^9/L)	7.39 ± 1.85	7.42 ± 1.88	7.44 ± 1.80	>0.05
	Neutrophil absolute value	5.20 ± 1.50	5.27 ± 1.48	5.22 ± 1.39	>0.05
Blood routine before catheterization	Neutrophil percentage (%)	70.72 ± 18.25	70.31 ± 18.66	70.58 ± 18.42	>0.05
Gender (n/%)	Male	42 (52.50)	45 (56.25)	87 (54.38)	>0.05
	Female	38 (47.50)	35 (43.75)	73 (45.63)	
Original disease (n/%)	Malignant tumor	55 (68.75)	58 (72.50)	115 (71.88)	>0.05
	Nervous system disease	17 (21.25)	16 (20.00)	31 (19.38)	>0.05
	Other diseases	8 (10.00)	6 (7.50)	14 (8.75)	>0.05
Catheterization purposes (n/%)	Chemotherapy	52 (65.00)	51 (63.75)	107 (66.88)	>0.05
	Hyperosmotic drugs	15 (18.75)	17 (21.25)	32 (20.00)	>0.05
	Parenteral nutrition	3 (3.75)	3 (3.75)	7 (4.38)	>0.05
	Others	10 (12.50)	9 (11.25)	14 (8.75)	>0.05

Pharmacy	ACEI/ARB	4 (5.00)	6 (7.50)	11 (6.87)	>0.05
	Statin	2 (2.50)	3 (3.75)	8 (5.00)	>0.05
	Aspirin	4 (5.00)	6 (7.50)	9 (5.63)	>0.05

Catheterization

There were no statistical significance in differences of catheter length, pre-treatment time, catheterization time, puncture way, puncture site and placement times (p>0/05, Table 2).

Table 2. *General information about the catheterization.*

Catheterization		High concentration group (n=80)	Low concentration group (n=80)	Control group (n=160)	P value
Catheter length (cm)		44.96 ± 5.09	45.08 ± 5.11	44.88 ± 5.21	>0.05
Pre-treatment time (min)		5.03 ± 0.42	4.97 ± 0.45	5.11 ± 0.48	>0.05
Time (min)		17.35 ± 2.18	17.44 ± 2.26	17.39 ± 2.08	>0.05
Puncture way	Routine puncture	49 (61.25)	51 (63.75)	99 (61.88)	>0.05
	Ultra-sound guided puncture	31 (38.75)	29 (36.25)	61 (38.13)	
Puncture	Left arm	55 (68.75)	53 (66.25)	109 (68.13)	>0.05
	Right arm	25 (31.25)	27 (33.75)	51 (31.88)	
Placement times	Once	67 (83.75)	65 (81.25)	133 (83.13)	>0.05
	Twice	11 (13.75)	12 (15.00)	25 (15.63)	
	≥ Three times	2 (2.50)	3 (3.75)	2 (1.25)	

Incidences of phlebitis

The occurrence time of phlebitis in the high concentration group were later than that in the low concentration group, the incidences of phlebitis were lower than that in the low concentration group (p<0.05). The occurrence time of phlebitis in the low concentration group were later than that in the control group, the incidences of phlebitis were lower than that in the control group (p<0.05). The degree of phlebitis of high concentration group and low concentration group was lower than that in control group (p<0.05). There was no significant difference in the degree of phlebitis between the high and the low concentration group (p>0.05, Table 3).

Table 3. *Comparison of incidences of phlebitis ($\bar{x}$ ± s).*

Incidences of phlebitis		High concentration group (n=80)	Low concentration group (n=80)	Control group (n=160)	P value
Occurrence time (d)		4.58 ± 0.71	3.49 ± 0.85*	2.60 ± 0.54*#	<0.05
Degree (n/%)	I	3 (3.75)	8 (10.00)	9 (5.63)	<0.05
	II	5 (6.25)	5 (6.25)	10 (6.25)	
	III	2 (2.50)	5 (6.25)	21 (13.13)	
	IV	0	3 (3.75)	16 (10.00)	
	Total	10 (12.50)	21 (26.25)*	56 (35.00)*#	

Notes: Compared to high concentration group, *P<0.05; Compared to low concentration group, #P<0.05

Other early complications

The differences were not statistically significant in the comparison of other early complications (p>0.05, Table 4).

Table 4. Comparison of other early complications.

Other early complications	High concentration group (n=80)	Low concentration group (n=80)	Control group (n=160)	P value
Oozing of blood	3 (3.75)	2 (2.50)	5 (3.13)	>0.05
Catheter occlusion	1 (1.25)	1 (1.25)	1 (0.63)	>0.05
Allergy	1 (1.25)	0	2 (1.25)	>0.05
Red swelling in puncture site	0	1 (1.25)	0	>0.05
Catheter dislocation	0	0	1 (0.63)	>0.05
Total	5 (6.25)	4 (5.00)	9 (5.63)	>0.05

Multivariate regression analysis

Multivariate regression analysis showed that placement time is the risk factor for the incidence of phlebitis (OR; 95% CI, 1.69 (1.22-2.93), P=0.012), while the pre-treatment of catheters by dexamethasone solution is the protective risk factor (OR 0.56, 95% CI (0.43-0.78), P<0.001, Table 5).

Table 5. Multivariate regression analysis of the incidence of phlebitis.

Variate		OR	95% CI	P
Gender (male)		0.90	0.75-2.78	0.465
Age		1.56	0.66-4.21	0.587
Original disease	Malignant tumor	1	1	0
	Nervous system disease	0.78	0.54-1.67	0.365
	Other diseases	1.21	0.92-2.21	0.341
Placement time		1.69	1.22-2.93	0.012
Pre-treatment of catheters by dexamethasone solution		0.56	0.43-0.78	P<0.001

Discussion

Phlebitis is the inflammation of vein intima, which can be caused by chemical, mechanic, bacterial or thrombotic factors. As a common complication of infusion therapy, its occurrence rate can reach 80% high [7]. In recent years, with the wide application of PICC, the occurrence rate of phlebitis has been effectively controlled. However, during the procedure of catheterization, mechanic damage caused by puncture needle, sheath and catheter can also lead to phlebitis to some patients after catheterization, which can significantly influence the effect and cost of treatment [8]. Therefore, clinicians have been committed to the PICC technology and catheter material improvements to reduce the risk of phlebitis.

Although the Groshong Nxt ClearVue catheter we used in our study is regarded as one of the most effective catheters in preventing phlebitis, the occurrence rate of control group was still 35.0% high, which demonstrated that it is hard to reduce all the risk of phlebitis only through improvement of materials of catheters and it is a clinical problem to be solved to further control the occurrence of phlebitis by other means. Some scholars applied heat, diclofenac cream, enhanced transparent paste to the treatment of wound after puncture, which had certain effect in preventing phlebitis. However, heat and diclofenac cream need repeated operation, which greatly increase the workload of nurses, and enhanced transparent paste cost is too high to be accepted by patients [9-11]. The obvious drawbacks of the above-mentioned methods make the clinical application greatly restricted.

As a long-acting glucocorticoid, dexamethasone has a stronger anti-inflammatory effect and a lower allergic response than prednisone and has been widely used in the control and treatment of various types of inflammatory responses. Some scholars have taken means of dexamethasone infusion or smear to reduce the risk of phlebitis after catheterization. But, dexamethasone infusion has high incidence of side-effects and it is a tedious operation to smear repeatedly. Both of them are not conducive in clinical promotion [12,13]. We concluded the advantages and disadvantages of previous studies and adopted dexamethasone solution pre-treated catheter method, which successfully controlled the occurrence rate of phlebitis of 160 cases in observation group at 19.38%. It shows that this method has a positive meaning in reducing occurrence risks, delaying occurrence time and decreasing the degree of phlebitis. While phlebitis below II degree is light and harmless, most patients can self-heal without special treatment, indicating that this method can control the majority of PICC phlebitis in patients without intervention. Meanwhile, we found that it had a more ideal control effect by immersing catheter in 30 ml of 0.08 mg/ml dexamethasone solution than 0.04 mg/ml with no apparent increase in other early complications, which further proved the clinical effect and safety of this method. Its advantages mainly reflect in the following aspects: 1. Phlebitis is an inflammatory response caused by mechanic stimulation on vein wall. Dexamethasone can inhibit the inflammatory cells move to the inflammatory site, restrain the generations of inflammatory mediators, and alleviate various factors causing inflammatory responses [14] to reduce the risks of phlebitis. 2. Since we only used a dose of 0.08 mg/ml dexamethasone solution, the amount which can enter patients' body is less than 0.01 mg/Ml, which is far below the 0.10 mg/d physiological replacement dose [15]. This can effectively ensure the safety of this pre-treatment method. As we excluded patients who have dexamethasone allergic

history, we could not make it clear whether this method had reliable preventive effect for dexamethasone allergic patients, which will be further discussed in our subsequent research.

This study is only restricted to the comparison of a dose of 0.08 mg/ml and 0.04 mg/ml dexamethasone solution, which cannot ensure 0.08 mg/ml is the best concentration. What's more, it still needs research for the best immersing time. In conclusion, dexamethasone solution pre-treated catheter can obviously reduce the risks and degree of PICC-induced phlebitis without elevating incidences of other early complications. It's good prevention effect and safety should be affirmed. It is recommended to do further in-depth study and extensive promotion.

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*Correspondence to

Xin-juan Wang

Medical College of Taizhou University

Taizhou

PR China