European Review for Medical and Pharmacological Sciences 2021; 25: 6566-6572

Efficacy analysis and hemodynamic changes of hematological system diseases after PICC chemotherapy

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Abstract. – OBJECTIVE: The aim of the study was to investigate the efficacy analysis and hemodynamic changes of hematological system diseases after peripherally inserted central catheter (PICC) chemotherapy.

PATIENTS AND METHODS: From March 2017 to March 2020, patients with hematological diseases who received chemotherapy in our hospital were selected. The experimental group consisted of 80 patients with PICC, and the control group consisted of 70 patients with routine intravenous injection. The indwelling time, prevalence rate of adverse reactions, hemodynamic indicators before and after chemotherapy and compliance of patients in the two groups were compared.

RESULTS: The longest time and average time of indwelling catheter in experimental group were significantly higher than those in control group ($p<0.05$). The total prevalence rate of adverse reactions in experimental group (3.75%) was significantly lower than that in control group (20%) ($p<0.05$). The compliance of patients with PICC in experimental group was significantly better than that of patients with superficial intravenous injection in control group. There was no significant difference in hemodynamic indicators between experimental group and control group before and after chemotherapy ($p>0.05$). There was significant difference in high-shear whole blood indicators, low-shear whole blood viscosity and high-shear whole blood viscosity after chemotherapy ($p<0.05$), while there was no significant difference in changes of other hemodynamic indicators ($p>0.05$) or in hemorheological indicators between the two groups after chemotherapy ($p>0.05$).

CONCLUSIONS: The total prevalence of adverse reactions in hematological diseases by PICC infusion is lower than that by superficial vein infusion, and the catheter has no significant influence on hemodynamic indicators in patients. Therefore, PICC catheter is worthy of application and promotion in hematological diseases.

Key Words:
PICC, Hematological system diseases, Haemodynamics, Chemotherapy, Efficacy.

Abbreviations

PICC, peripherally inserted central catheter; VAD, vincristine adriamycin dexamethasone; CHOP, cyclophosphamide adriamycin oncovin prednisone; DA, daunorubicin cytarabine; HA, harringtonine cytarabine.

Introduction

Most serious diseases occurring in hematological system are characterized by hemorrhage, infection and anemia, and chemotherapy is the main treatment method[1]. The systemic diseases not only have a long-term treatment process, but also often use chemotherapy drugs. The puncture of human veins for many times in a short time will lead to infection, which will cause great damage to the blood vessels of patients[2]. It has a significant negative impact on the quality of life and treatment effect of patients. Therefore, good venous access is of great positive significance to the physical and mental health of patients.

Peripherally inserted central catheter (PICC) is one of the main drug delivery methods for chemotherapy of hematological malignancies. It has special characteristics, such as small trauma and convenient use[3]. PICC is usually punctured

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through skin from peripheral static pulse and its tip is placed in central vein[4]. The therapeutic agent can be directly transported to the central vein through PICC, thus reducing osmotic pressure and concentration of the therapeutic agent, effectively avoiding damage and stimulation of peripheral blood vessels, effectively reducing repeated venipuncture, relieving pain, and improving their quality of life. The catheterization technique is easy to master and maintain, relatively safe to use, reducing nurses' work and mental pressure, so that it is widely used in clinical practice[5-7]. Hemodynamics refers to the fluidity of visible components in blood, changes in allergy and component aggregation, and changes in indicators are of great significance to the diagnosis and prognosis of diseases[8]. Moreover, PICC is a foreign body in blood vessel of patients. Therefore, we need to know whether it causes hemodynamic changes and affects the formation of blood clot.

At present, there is little clinical research on the efficacy and hemodynamic changes of hematological diseases after PICC chemotherapy. Therefore, this article aims to investigate the efficacy and hemodynamic changes of hematological diseases after PICC chemotherapy.

Patients and Methods

General Information

From March 2017 to March 2020, patients with hematological system diseases who received chemotherapy in our hospital were selected. The experimental group consisted of 80 patients with PICC, including 45 males and 35 females, with an average age of 39.72±4.15 years. The control group consisted of 70 patients with superficial intravenous injection, including 40 males and 30 females, with an average age of 38.62±3.87 years; among them, 48 patients in the experimental group received PICC, 24 patients received central venous catheterization, 8 patients received cephalic vein catheterization, 54 patients received PICC of 4-mm diameter and 26 patients of 5-mm diameter. Patients in experimental group received VAD chemotherapy in 15 cases, CHOP chemotherapy in 18 cases, DA chemotherapy in 23 cases, and HA chemotherapy in 24 cases. Patients in control group received VAD chemotherapy in 12 cases, CHOP chemotherapy in 15 cases, DA chemotherapy in 21 cases, and HA chemotherapy in 22 cases. There was no significant difference in age, gender, and chemotherapy between the two groups.

Inclusion and Exclusion Criteria

Inclusion criteria were as follows: patients with hematological diseases who needed PICC catheter; patients who had not received chemotherapy before the diagnosis and had not complicated with other malignant tumors; patients with complete clinical data. Exclusion criteria were as follows: patients with coagulation dysfunction, phlebitis, and thrombosis; patients who did not receive treatment and did not cooperate with it; patients with pathological changes in other organs of the body. All patients and their families agreed to participate in the experiment and sign informed consents. This study was approved by the Ethics Committee of Zhangqiu Maternity and Child Care Hospital.

Methods

Patients in experimental group were punctured by PICC, while patients in control group were punctured by superficial vein. Two groups of fasting patients collected 5 ml of antecubital venous blood at 8:00 a.m. Venous blood 5 ml was collected with heparin anticoagulant tube at 8:00 am on the day after admission and the day after 2 cycles of chemotherapy, when the patients were fasting overnight. Hemodynamic indicators were measured within 4 hours. The fully automatic hemorheology tester of SUCCEEDER SA-5000 of Beijing SUCCEEDER Science and Technology Development Co., Ltd. and the matching reagents were adopted, and the operation process was strictly carried out in accordance with the instructions.

Observation Indicators

The indwelling time, the number of adverse reactions, hemodynamic indicators before and after chemotherapy and the compliance of patients in two groups were recorded and compared. Compliance: Level 0 was the willingness of patients to complete 6 to 8 cycles of chemotherapy on time; level 1 referred to patients completing 4-6 cycles of chemotherapy on time with the reminding of medical staff and family members; level 2 was that the patient completed 4 or more cycles of chemotherapy with repeated reminding of medical staff and family members; level 3 was that patients received chemotherapy on time with repeated supervision of medical staff and their families, but less than 4 treatment cycles; the fourth grade

was that the patient refused to accept second chemotherapy after the first chemotherapy was completed and discharged from hospital.

Statistical Analysis

SPSS 20.0 [BIZINSIGHT (Beijing) Information Technology Co., Ltd., Beijing, China] was used to perform statistical analysis. Chi-square test was used for counting data, mean±standard deviation was used for measurement data, paired *t*-test was used for comparison before and after chemotherapy, and covariance analysis was used for comparison between groups after chemotherapy. A *p*-value less than 0.05 was considered statistically significant.

Results

General Information

As shown in Table I, there was no significant difference in gender, age, and chemotherapy scheme between two groups ($p>0.05$).

Time of Indwelling PICC for Patients in Two Groups

As shown in Figure 1, the longest time and average time of indwelling catheter in experimental group were significantly higher than those in control group, $p<0.05$.

Number of Adverse Reactions in Patients from Two Groups

As shown in Table II, the total prevalence of adverse reactions in experimental group (3.75%) was significantly lower than that in control group (20%), $p<0.05$.

Compliance of Patients Between Two Groups

As shown in Table III, the compliance of patients receiving PICC in experimental group was significantly higher than that in control group, $p<0.05$).

Hemodynamic Indicators of Patients in Experimental Goup Before and After Chemotherapy

As shown in Table IV, there was no significant difference in hemodynamic indicators of patients in experimental group before and after chemotherapy, $p>0.05$.

Hemodynamic Indicators of Patients in Control Group Before and After Chemotherapy

As shown in Table V, the changes of high shear whole blood relative indicator, low-shear whole blood viscosity and high-shear whole blood viscosity indicators of the patients in control group after chemotherapy were statistically significant, $p<0.05$, while the changes of other hemodynamic indicators were not statistically significant, $p>0.05$.

Covariance Analysis of Hemorheological Indicators of Patients in the Two Groups After Chemotherapy

Taking the value of hemodynamic indicators before chemotherapy as a covariate, the covariance analysis of hemodynamic indicators of patients in two groups after chemotherapy was carried out. The results showed that there was no statistically significant difference in the hemodynamic indicators of patients in two groups after chemotherapy ($p>0.05$; Table VI).

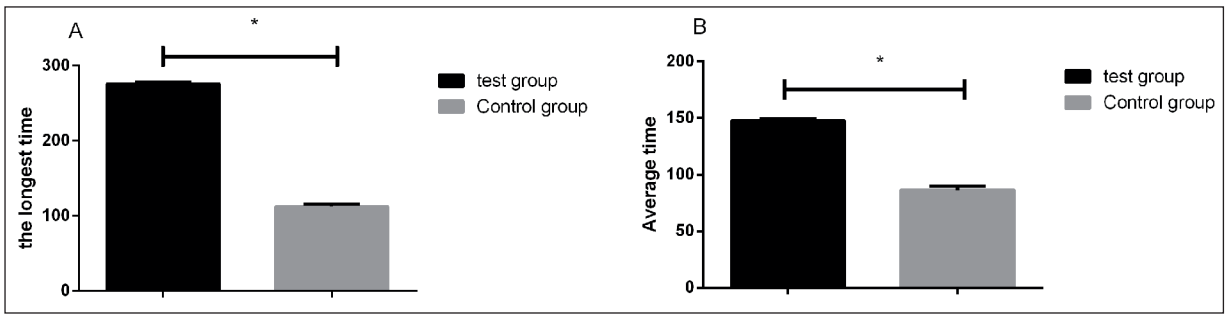

Figure 1. Time of indwelling pipe for patients in the two groups. **A,** The longest time of indwelling catheter in the experimental group was significantly longer than that in the control group, and the difference was statistically significant ($p< 0.05$). **B**, The average time of indwelling catheter in the experimental group was significantly higher than that in the control group, and the difference was statistically significant ($p<0.05$). * Indicated $p<0.05$.

Table I. General data of patients in the two groups (n/%).

Group	Experimental group (n=80)	Control group (n=70)	t/x^2	p
Age	39.72±4.15	38.62±3.87	1.671	0.097
BMI	21.5±3.62	21.8±3.98	0.392	0.696
Gender				
Male	45 (56.25)	40 (57.14)		
Female	35 (43.75)	30 (42.86)	0.012	0.912
Average course of disease (years)	1.58±0.2	1.64±0.3	1.457	0.147
Disease type				
Multiple myeloma	15 (18.75)	12 (17.14)	0.065	0.798
Non-Hodgkin lymphoma	18 (22.50)	15 (21.43)	0.025	0.874
Acute myeloblastic leukemia	23 (28.75)	21 (30)	0.028	0.867
Acute non-lymphocytic leukemia	24 (30)	22 (31.43)	0.036	0.850
Hypertension				
Yes	48 (60)	43 (61.43)		
No	32 (40)	27 (38.57)	0.032	0.858
Diabetes				
Yes	43 (53.75)	38 (54.29)		
No	37 (46.25)	32 (45.71)	0.004	0.948
Hyperlipidemia				
Yes	36 (45)	31 (44.29)		
No	44 (55)	39 (55.71)	0.007	0.930
Smoking				
Yes	42 (52.5)	37 (52.86)		
No	38 (47.5)	33 (47.14)	0.002	0.965

Discussion

Hematological diseases are multiple diseases that seriously affect human health, and the prevalence is increasing year on year[9]. Currently, PICC is the most used therapeutic tool in hematology[10]. The causes of hematological diseases may be related to environmental factors and genetic factors[11]. The main principle of clinical treatment for patients with hematological diseases is to prolong the life of patients and improve their quality of life, because there is still no complete cure[12]. However, the common treatment method is chemotherapy, which has the characteristics of high concentration and strong irritation. It has certain stimulating effect on blood components and blood vessels and will affect human hemodynamic indicators[13]. Superficial intravenous injection is a traditional method for infusion of chemotherapy drugs, but this method is destructive to the blood vessels of patients[14].

From the results of this study, it was found that the longest and average time of indwelling PICC was longer than that in patients with intravenous infusion, and the total occurrence of complications in patients with intravenous infusion was significantly lower than that of patients with PICC. Presumably, the reason was that PICC could reduce the concentration of chemical agents quickly by utilizing the fast blood flow speed of human body's great vein, which could avoid the excessive contact between drugs and arm veins and greatly avoid the stimulation of drugs on venous vessels of patients[15], thus effectively reducing the occurrence of phlebitis, prolonging the time of catheter indwelling, and

Table II. Number of complications of patients in the two groups (n/%).

Group	Experimental group (n=80)	Control group (n=70)	t/x^2	p
Infection	2 (2.5)	5 (7.14)	1.809	0.179
Allergic reaction	1 (1.25)	1 (1.43)	0.009	0.924
Phlebitis	0	2 (2.86)	2.317	0.128
Catheter blockage	0	6 (8.57)	7.143	0.007
Total incidence rate	3 (3.75)	14 (20)	9.810	0.002

Table III. Comparison of compliance between of patients in the two groups (n/%).

Group	Level 0	Level 1	Level 2	Level 3	Level 4
Experimental group (n=80)	39 (48.75)	29 (36.25)	9 (11.25)	2 (2.5)	1 (1.25)
Control group (n=70)	19 (27.14)	15 (21.43)	23 (32.86)	10 (14.29)	3 (4.28)
x^2	21.12	3.956	10.39	7.046	1.326
p	<0.001	0.047	0.001	0.008	0.249

Table V. Hemodynamic indicators of patients in control group before and after chemotherapy.

Group	Before chemotherapy	After chemotherapy	*t*	*p*
Whole blood viscosity value				
Shear rate 1	14.69±0.26	14.72±0.32	0.609	0.544
Shear rate 5	7.09±0.12	7.13±0.15	1.742	0.083
Shear rate 50	4.06±0.28	4.10±0.32	0.787	0.433
Shear rate 100	3.58±0.31	3.62±0.34	0.727	0.468
Shear rate 200	3.35±0.42	3.32±0.45	0.408	0.684
Plasma viscosity	1.35±0.10	1.33±0.09	1.280	0.202
Hematocrit	0.38±0.03	0.37±0.04	1.673	0.097
Whole blood low shear relative indicator	11.73±2.76	11.12±2.56	1.356	0.177
Whole blood high shear relative indicator	2.83±0.51	2.59±0.41	3.069	0.003
Red cell assembling index	4.29±0.53	4.28±0.63	0.102	0.919
Whole blood low shear reduction viscosity	37.84±7.43	34.21±5.42	3.302	0.001
Whole blood high shear reduction viscosity	6.09±1.12	5.63±0.66	2.960	0.004
Erythrocyte rigidity exponent	4.34±0.85	4.23±0.68	0.846	0.399
Erythrocyte deformation exponent	0.84±0.21	0.87±0.34	0.628	0.531

laying a good foundation for their life and prognosis. In addition, clinical literature has reported that[16] PICC can effectively reduce infection rate and improve clinical symptoms of patients with hematological diseases. However, superficial intravenous injection is very irritating to blood vessels, which is easy to cause local pain, infection, allergy, and even phlebitis[17]. In addition, we also found that the compliance of patients undergoing chemotherapy through PICC was significantly better than that of patients undergoing intravenous infusion, because PICC had a longer indwelling time, simpler operation, and lower incidence of adverse reactions. Meanwhile, the damage to blood vessels caused by repeated puncture was reduced, and the total treatment cost effectively was reduced during

Table IV. Hemodynamic indicators of patients in experimental group before and after chemotherapy.

Group	Before chemotherapy	After chemotherapy	*t*	*p*
Whole blood viscosity value				
Shear rate 1	14.75±0.28	14.73±0.32	0.379	0.705
Shear rate 5	7.15±0.13	7.12±0.11	1.576	0.117
Shear rate 50	4.02±0.21	4.08±0.24	1.683	0.094
Shear rate 100	3.66±0.21	3.68±0.25	0.548	0.585
Shear rate 200	3.28±0.12	3.28±0.12	1.034	0.302
Plasma viscosity	1.33±0.08	1.34±0.07	0.841	0.401
Hematocrit	0.39±0.21	0.38±0.25	0.273	0.785
Whole blood low shear relative indicator	11.3±2.20	11.4±2.10	0.294	0.769
Whole blood high shear relative indicator	2.57±0.35	2.55±0.38	0.346	0.730
Red cell assembling index	4.22±0.65	4.24±0.63	0.198	0.844
Whole blood low shear reduction viscosity	34.35±5.56	35.21±5.42	0.323	0.991
Whole blood high shear reduction viscosity	5.47±0.83	5.51±0.79	0.312	0.755
Erythrocyte rigidity exponent	4.14±0.53	4.13±0.58	0.114	0.910
Erythrocyte deformation exponent	0.83±0.12	0.82±0.17	0.429	0.668

Table VI. Covariance analysis of hemorheological indicators of patients in the two groups after chemotherapy.

Group	Experimental group (n=80)	Control group (n=70)	F	p
Whole blood viscosity value				
Shear rate 1	14.73±0.32	14.72±0.32	0.191	0.849
Shear rate 5	7.12±0.11	7.13±0.15	0.469	0.639
Shear rate 50	4.08±0.24	4.10±0.32	0.436	0.663
Shear rate 100	3.68±0.25	3.62±0.34	1.241	0.217
Shear rate 200	3.28±0.12	3.32±0.45	0.765	0.446
Plasma viscosity	1.34±0.07	1.33±0.09	0.764	0.446
Hematocrit	0.38±0.25	0.37±0.04	0.331	0.741
Whole blood low shear relative indicator	11.4±2.10	11.12±2.56	0.736	0.463
Whole blood high shear relative indicator	2.55±0.38	2.59±0.41	0.620	0.536
Red cell assembling index	4.24±0.63	4.28±0.63	0.388	0.699
Whole blood low shear reduction viscosity	35.21±5.42	34.21±5.42	1.127	0.261
Whole blood high shear reduction viscosity	5.51±0.79	5.63±0.66	1.001	0.318
Erythrocyte rigidity exponent	4.13±0.58	4.23±0.68	0.972	0.333
Erythrocyte deformation exponent	0.82±0.17	0.87±0.34	1.160	0.248

chemotherapy treatment, thus further improving the treatment compliance of patients.

As a common venous channel for patients with hematological diseases, PICC also has serious complications, such as infection, blood clot and displacement. Cortelezzia et al[18] reported that thrombosis rate of PICC-related symptoms in malignant tumor patients is 1.5%-25.7%. The indwelling catheter will scratch the blood vessel wall, causing certain damage to the blood vessel, and hemodynamic abnormalities will cause other symptoms in the body[19]. Therefore, monitoring the changes of hemodynamic indicators before and after chemotherapy with indwelling PICC has important value for judging whether the catheter is used as a foreign body to affect the occurrence of other diseases in the body. This study revealed that there was no significant change in hemodynamic parameters of patients in experimental group before and after chemotherapy, but there was significant difference in the changes of high-shear whole blood relative indicator, low-shear whole blood viscosity and high-shear whole blood viscosity indicator of the patients in control group after chemotherapy. All the remaining hemodynamics and indicators were decreased. It was presumed that the reason was that chemotherapy agent killed hyperproliferative tumor cells and even the whole blood viscosity decreased, which was similar to the results of a previous stud[20]. Lee et al[21] showed that some tumor cells acted as coagulation factors in the exogenous coagulation system, causing the initial degradation products of fibrous protein and fibrinogen in blood to increase, showing hypercoagulable and high viscosity in blood, while too high blood viscosity would lead to thrombosis, embolism and other formation, endangering the life of patients[22]. In this study, the chemotherapy scheme adopted was effective, but the high-shear whole blood relative indicator was a potential risk factor for thrombosis. The higher the value was, the more viscous the blood was, the worse the fluidity was, and the thrombosis was easy to occur[23]. However, the specific mechanism of thrombosis was not clear, and further research was needed in the subsequent experiments. Therefore, when using venous channels, the changes of indicators should be paid more attention to, and anticoagulants should be used in a timely manner to prevent thrombosis. The difference in hemorheological indicators between experimental group and control group after chemotherapy had no statistical significance. The difference before and after chemotherapy might be caused by the effect of chemotherapy drugs and substances produced by human cancer-causing cells in blood. Therefore, the long-term indwelling PICC, as a foreign body in blood vessels, did not have a great impact on the hemorheological indicators of tumor patients.

Conclusions

To sum up, the total prevalence of adverse reactions in hematological diseases by PICC infusion is lower than that by superficial vein infusion, and the catheter does not have significant impact on hemodynamic indicators in the body of patients, so PICC catheter is worthy of application and promotion in hematological diseases, but the sample size studied in this paper is small, which might

impact the research results, so it will be improved in future studies.

Conflict of Interest

The authors declare that they have no competing interests.

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