Int J Clin Exp Med 2015;8(8):14127-14129
www.ijcem.com /ISSN:1940-5901/IJCEM0010137

Original Article

Evaluating ECG-aided tip localization of peripherally inserted central catheter in patients with cancer

Yan-Jin Liu[1*], Lei Dong[2*], Xiao-Ping Lou[1], Jin-Hong Miao[1], Xiu-Xia Li[1], Xiao-Jing Li[1], Jing Li[1], Qian-Qian Liu[2], Zhi-Wei Chang[2]

[1]*Department of Nursing, The First Affiliated Hospital of Zhengzhou University, Zhengzhou 450052, China;* [2]*Department of Oncology, The First Affiliated Hospital of Zhengzhou University, Zhengzhou 450052, China.* [*]*Equal contributors.*

Received May 12, 2015; Accepted June 26, 2015; Epub August 15, 2015; Published August 30, 2015

Abstract: Objective: To evaluate ECG-aided tip localization of peripherally inserted central catheter (PICC) in the patients with cancer. Methods: Between September and December 2014, 170 patients undergoing PICC were divided into observation group and control group (each group with 85 patients). In observation group, patients received ECG-aided tip localization of PICC. In control group, PICC was performed with conventional method. After PICC was performed, all patients took orthophoria chest radiograph (OCR) to check whether the tip position of PICC was appropriate. Finally, successful rate of the first PICC was compared between the two groups. Results: In observation group, OCR showed that the tip of PICC was located in middle and low one-third of superior vena cava in 85 patients. In control group, OCR showed that the tip of PICC was located between superior vena cava and right atrium in 75 patients. The successful rate of the first PICC was significantly higher in observation group than in control group ($P < 0.05$). Conclusion: ECG-aided tip localization of PICC is accurate and safe, and is worth clinically recommending.

Keywords: ECG, localization technology, patients with cancer, peripherally inserted central catheter

Introduction

With application of peripherally inserted central catheter (PICC) in the patients with cancer, catheter misplacement has become one of the most common complications with an incidence of 6-10% [1]. At present, orthophoria chest radiograph (OCR) is routinely used to check whether the tip position of PICC was appropriate. This increases X-ray exposure to patients, and an anew preparation of aseptic processing is required to adjust the tip position whenever catheter misplacement occurs. Peng et al. [2] have reported that when the tip of PICC is located in middle or low one-third of superior vena cava or above the intersection of superior vena cava and right atrium, a distinctive high and sharp P wave occurs in ECG; when the tip of PICC enters the right atrium, P wave rises to as high as 50-80% of R wave; so ECG may used for the tip localization of PICC. Between September and December 2014, we selected 170 patients undergoing PICC, and randomly divided them into observation group and control group. In observation group, the tip position of PICC was guided by P wave in II-lead ECG. In control group, the predicted length of catheter was inserted along the blood vessel from the upper arm under the guidance of B ultrasound. After PICC was performed, all patients took OCR to check whether the tip position of PICC was appropriate. Finally, successful rate of the first PICC was compared between the two groups to explore the accuracy and safety of ECG-aided tip localization technology for PICC.

Subjects and methods

All study methods were approved by the Ethics Committee of the First Affiliates Hospital of Zhengzhou University. All the subjects enrolled into the study gave written formal consent to participate.

Subjects

Between September and December 2014, 170 patients undergoing PICC in our department were randomly divided into observation group

Table 1. General data in the two groups

Items	Observation group (n = 85)	Control group (n = 85)	Statistical values	*P* values
Sex				
Male	36 (42.3)	44 (51.8)	0.000	1.000
Female	49 (57.7)	41 (48.2)		
Age (year)				
< 60	43 (50.6)	48 (56.5)	5.120	0.09
≥ 60	42 (49.4)	37 (43.5)		
Diseases				
Lung cancer	32 (37.6)	38 (44.7)		
Malignant tumor of digestive tract	34 (40.0)	30 (35.3)		
Gynecological malignant tumor	15 (17.6)	13 (15.3)	482.270	0.85
Lymphoma	2 (2.4)	4 (4.7)		
Aneurysm of carotid artery	2 (2.4)	0 (0)		

Table 2. Tip position of peripherally inserted central catheter in the two groups

Groups (n)	Tip position		
	Internal carotid vein	Axillary vein	Superior vena cava
Observation group (85)	0	0	85
Control group (85)	8	2	75
X^2 Values		123.129	10.625
P Values		0.000	0.005

and control group, each group with 85 patients. Of the 170 patients, 80 were male and 90 female, with a mean age of 57.94 ± 1.55 years. Inclusion criteria were (1) more than one week chemotherapy; (2) voluntarily receiving PICC; and (3) normal ECG. Exclusion criteria were (1) atrial fibrillation; (2) heart block; (3) with implantable defibrillator or pacemaker. Of the 170 patients, 70 had lung cancer, 64 had malignant tumor of digestive tract, 28 had gynecological malignant tumor, 6 had lymphoma and 2 had aneurysm of carotid artery. There was no statistical difference in age, sex and constituent ratio of disease between the two groups (all $P > 0.05$) (**Table 1**).

Methods

Upper arm-placement and STS-5500Plus B ultrasound-guided PICC with 5F-type tip opening was used in the two groups. In observation group, after alcohol was applied to right arm, left arm, right leg and left leg, they were respectively connected with red, yellow, green and black ECG leads followed by selecting II-lead. After one end of a sterile metal clip was connected with the guide wire of PICC and another end of the metal clip was connected with ECG-red lead wire on the right arm, PICC began. When the predicted length of catheter was inserted along the blood vessel in the upper arm, the tip position of PICC was guided by P wave in II-lead ECG. Increased P wave in ECG indicated that the tip of PICC has the entered superior vena cava, and bimodal P wave indicated that the tip of PICC has entered the right atrium. When the tip of PICC entered the right atrium, we stopped intubation and pulled back 2-3 cm of the catheter until the bimodal P wave disappeared and P wave was high as much as 50%-80% of QRS wave. The catheter was fixed followed by drawing a little back blood and by washing the catheter. After the guide wire and metal clip were removed, the catheter was linked to a needle-free infusion connector followed by sealing the catheter with heparin and saline. In control group, the predicted length of catheter was inserted along the blood vessel in the upper arm under the guidance of B ultrasound. After PICC was performed, all patients took OCR to check the tip position of PICC.

Statistical analysis

Statistical treatment was performed with SPSS17.0 software. When $5 >$ the theoretical value (T) ≥ 1 and $n \geq 40$, X^2 correction for continuity was used.

Results

In the observation group, the tip of PICC was located in the superior vena cava in all patients with a successful rate of 100%. In control group, the tip of PICC was located in the supe-

rior vena cava in 75 patients with a successful rate of 88.2%. There was a statistical difference in the successful rate between the two groups ($P < 0.05$) (**Table 2**).

Discussion

At present, the method to determine the tip position of PICC includes OCR and ECG-aided localization technology [3]. ECG can clearly and reliably reflect the tip position of PICC except the patients with heart disease [4]. It has been reported that the accurate rate of ECG-assisted localization technology is more than 90% [5]. Nurses should master ECG-aided localization technology instead of OCR because ECG is effective and safe [6]. This study indicated that the tip of PICC was accurately placed in low one-third of the superior vena cava, between the sixth rib and seventh rib, under ECG guidance. When maximum P wave occurs, a length of 0.5-1 cm catheter is pulled back to ensure that the tip of PICC is located at the intersection of superior vena cava and the right atrium or in low segment of the superior vena cava [7]. In the localization technology of OCR, once catheter misplacement occurs, another OCR is required, increasing X-ray exposure to patients and nurses.

Before intubation, the inserted length of PICC was first estimated according to the following method: when upper arm was abducted and formed an angle of 90 degree with the central axis of the body, the predicted length of catheter included the length from the puncture point to the right sternoclavicular joint, and the length from the right sternoclavicular joint to the third anterior rib [8]. The total length of the superior vena cava is usually 5-7 cm showed in the OCR from the fifth rib to seventh rib. The predicted length of PICC is only approximately estimated according to the superficial bony landmarks, and is not completely equal to the actual length of body's blood vessels. Because of individual differences, the predicted length can not vouch for the tip position of PICC in the low one-third of the superior vena cava. The low one-third of the superior vena cava is an optimal tip position for PICC because it can reduces the occurrence of complications such as thrombus. Therefore, ECG-aided localization technology is worth clinically recommending, because it can reduce X-ray exposure to patients and nurses, and can improve safety of PICC.

Disclosure of conflict of interest

None.

Address correspondence to: Yan-Jin Liu, Department of Nursing, The First Affiliated Hospital of Zhengzhou University, 1 Constructive East Road, Zhengzhou 450052, China. Tel: +86-024-51085195; Fax: +86-024-51085195; E-mail: lilyleionline@163.com

References

[1] Jamal NM, Hermandez JF, Wyso EM. CVP catheter tip. Location by means of intra-atrial lead. N Y State J Med 1974; 74: 2348-2351.

[2] Peng X, Wen Q, Yao QL. Progress in tip localization of PICC. Journal of Nursing Administration 2012; 12: 861-862.

[3] Yao H, Song M, Liu YY. Clinical study on ECG-assisted tip localization of PICC. Zhonghua Hu Li Za Zhi 2011; 46: 748-750.

[4] Simon L, Teboul A, Gwinner N, Boulat G, Cerceau-Delaporte S, Hamza J. Central venous catheter placement in children: evaluation of electrocardiography using J-wire. Paediatr Anesth 1999; 9: 501-504.

[5] Pittiruti M, Scoppettuolo G, Greca AL, et al. The EKG Method for Positioning the Tip of PICCs: Results from Method for Positioning the Tip of PICCs: Results from Two Preliminary Studies. Res Int 2008; 13: 112-119.

[6] Sette P, Azzini AM, Dorizzi RM, Castellano G. Serendipitous ECG guided PICC insertion using the guidewire as intra-cardiac electrode. J Vasc Access 2010; 11: 72.

[7] Feng BL, Yao SY, Zhou SJ, Qin HM. Changes in ECG during PICC and ECG guidance for PICC. Zhonghua Hu Li Za Zhi 2010; 45: 26-28.

[8] Qiao AZ, Su X, et al. Technique and management of peripheral central venous catheter. Beijing: People's Military Medical Publishing House; 2010. pp. 30.