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Application of Intracardiac Ultrasound (ICE) in Atrial Fibrillation Catheter Ablation: An Impact Study

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Keywords: Intracardiac ultrasound; atrial fibrillation; catheter ablation procedure

Abstract: In order to investigate the role of intracardiac ultrasound (ICE) in catheter ablation of atrial fibrillation, 200 patients with atrial fibrillation who underwent radiofrequency ablation in our hospital from January 2022 to January 2023 were selected as the study objects, and were divided into observation group and control group according to ICE. Ice puncture interval was used in the observation group, and X-ray puncture interval was used in the control group. The total operation time, interatrial puncture time, pulmonary vein isolation time, X-ray irradiation time, X-ray irradiation dose, complications and surgical success rate were compared between the two groups. The results showed that the X-ray dose, X-ray irradiation time, total operation time, complication rate, modeling time, atrial septal puncture time and pulmonary vein isolation time in the observation group were significantly lower than those in the control group, with statistical significance ($P < 0.05$). These results indicate that intracardiac ultrasound (ICE) guided catheter ablation of atrial fibrillation can reduce the X-ray dose and operation time, shorten the overall operation time, and do not increase the risk of surgical complications.

1. Introduction

Atrial fibrillation (ablation) surgery is an interventional therapy commonly used in the treatment of atrial fibrillation (AF). Atrial fibrillation is a common arrhythmia characterized by an irregular and rapid heartbeat that may cause perceived palpitation, fatigue and even increased risk of stroke and heart failure[1]. With the progress of medical technology, the application of intracellular ultrasound (ICE) has attracted more and more attention in catheter ablation surgery. Intracellular ultrasound (ICE) is a real-time imaging method to obtain the structure and function of the cardiac cavity through the ultrasound probe placed inside the cardiac cavity[2]. Compared with conventional transesophageal ultrasound (TEE), ICE is well received for its low invasive nature, easy operation and low patient interference. During ablation therapy for atrial fibrillation, ICE can assist doctors to more accurately locate the source of abnormal electrical activity in the atrium, thus improving ablation accuracy, reducing surgery time and patient radiation exposure[3]. Therefore, 200 atrial fibrillation patients undergoing radiofrequency ablation in our hospital from January 2022 to January 2023 were selected as research subjects to explore the advantages of applying intracardiac ultrasound in catheter ablation of atrial fibrillation. The results are reported as follows:

2. Data and methods

2.1 General information

200 AF patients undergoing radiofrequency ablation in our hospital from January 2022 to January 2023 were randomly selected and divided into observation group (n=100) and control group (n=100) according to whether they received intracardiac ultrasound (ICE). There were 50 male and 50 female patients, ranging in age from 17 to 64 years, with an average age of (40.5 ± 1.07) years. A total of 55 male patients and 45 female patients were included in the control group. The age range was 18-67 years, and the average age range was ($42.5.0 \pm 1.57$). The difference between the two groups of patients was not statistically significant ($P > 0.05$), which had clinical comparative significance. Inclusion criteria included left atrial anterior and posterior diameter of <55mm; patients with indications for AF catheter ablation procedures; patients whose cardiac function status allowed interventional procedures, and patients who agreed to participate in the study. Exclusion criteria included patients who cannot tolerate cardiac cavity ultrasound examination, patients with serious complications, and patients with other cardiac structural abnormalities.

2.2 Methods

2.2.1 Control group

In the control group, two 8.5F Swartz L1 long sheath were inserted through two puncture of the right femoral vein, and the Left femoral vein was punctured to place a 6F arterial sheath. After successful chamber interval using the X-ray guided technique, both long sheaths were delivered into the left chamber. According to the value of activated coagulation time (ACT) before puncture and the patient's weight, an appropriate amount of ordinary heparin was given for anticoagulation. ACT was maintained between 300 and 350 seconds during the operation, and heparin was added timely, according to the ACT value. Evaluation of left atrium and left and right pulmonary vein opening and routing based on preoperative CT three-dimensional imaging. The PENTARAY catheter was then delivered through a sheath to construct a three-dimensional electroanatomical model of the left atrium and pulmonary vein with the help of the CARTO3 system. After the completion of the model construction, the PENTARAY catheter was placed in the pulmonary vein to observe the pulmonary vein potential, and the pressure ablation catheter was sent through another sheath to define the left and right pulmonary veins, and a series of ablation procedures were continued.

2.2.2 Observation group

In the observation group, the left femoral vein was first punctured to place a 11F arterial sheath, and an intracardiac ultrasound catheter was delivered to the right chamber through this sheath. The non-contact 3 D modeling was used to complete the left atrium and pulmonary vein, and the ultrasound 3 D positioning of the pulmonary vein vestibular was performed simultaneously with the pulmonary vein modeling. Next the right femoral vein was punctured twice and two 8.5FSwartzL1 long sheath and atrial septal needles were placed, and the left subclavian vein was also punctured to place a 6F arterial sheath. Under the guidance of the ultrasound catheter in the cardiac chamber, the puncture needle and the long sheath were pulled down to the middle and lower part of the ovale fossa for atrial septal puncture. The "tent" sign appeared, the "tent sign" disappeared after the needle penetrated the left chamber, and the "bubble sign" in the left chamber appeared after the injection of heparin saline, indicating successful entry into the left chamber. After successful atrial septal puncture, two long sheaths were delivered to the left atrium and plain heparin was given anticoagulation based on ACT value and patient weight during which the ACT was maintained between 300 and 350 seconds and heparin was supplemented as appropriate. Then the ring lung mapping electrode was placed to the pulmonary vein by a long sheath, and the pressure ablation catheter was sent to the left atrium via another long sheath. The catheter was used to confirm the ultrasound positioning of the pulmonary vein, and continue the ablation procedure, using real-time monitoring of the pericardium during ablation.

2.3 Observing indicators

The total operation time, atrial septal puncture time, pulmonary vein isolation time, X-ray exposure time, X-ray exposure dose, complications and surgical success rate were observed in the ultrasound and non-ultrasound groups[4].

2.4 Statistical analysis

For continuous variables with normal distribution, the mean plus or minus standard deviation; for non-normal continuous variables, median, (P25, P75). When comparing the two data sets, the Wilcoxon-Mann-Whitney U test used the P <0.05 test. All the data were analyzed in the SPSS 23.0 software.

3. Results

The X-ray exposure dose, X-ray exposure time, total operation time, of the observation group Complication rate, modeling time, atrial septal puncture time, and pulmonary vein isolation time. It was significantly lower than that of the control group, and the difference between the groups was significant (P <0.05),As shown in Table 1.

Table 1: Comparison of the two groups

group	Total operative time / min	X-ray exposure dose/mGy	X line exposure time/min	Complication rate /%
observation group	187.5 S. 47.7	16.5(10.15,4).2	140.0(114.0.214.0)	72.8%
control group	218.1 x 47.0	66.0(42.1,81.0)	500.0(344.0.688,0)	75.5%
P	<0.05	<0.05	<0.05	0.664
group	Modeling time / min	Septal puncture time / min	Pulmonary vein isolation time / min	
observation group	7.8 x. 1.7	5.4 x. 1.6	56.9 x. 13.5	
control group	8.3 x 1.4	5.8 x. 1.5	59.9 x 14.6	
P	0.061	0.069	0.303	

4. Discussion

Atrial fibrillation is a common arrhythmia that has a significant impact on the quality of life and health status of patients. The application of endocardial ultrasound (intracardiac echocardiography, ICE) in catheter ablation of atrial fibrillation has attracted much attention[5]. This article will discuss the influence of ICE on x-ray exposure dose, x-ray exposure time, total procedure time, complication rate, modeling time, atrial interval puncture time, and pulmonary vein isolation time during atrial fibrillation catheter ablation surgery.

First, the ICE technology is able to reduce the X-ray exposure dose and the X-ray exposure time.

In routine catheter ablation procedures, providers rely on the X-ray to guide the catheter operation, so the patient suffers a high X-ray radiation[6]. ICE technology, through real-time cardiac image guidance, can reduce the dependence on X-ray, thus reducing the X-ray exposure dose and exposure time, and reducing the radiation risk of patients and medical staff. Secondly, the ICE technique may have an impact on the total operative time. While ICE technology can provide clear structural images of the heart and optimize catheter manipulation, operating the ICE probe may take additional time. Therefore, in practice, the effect of ICE technique on total operative time needs to be further evaluated after operational proficiency. Again, the results of the current study are inconsistent regarding the effect of the ICE technique on the complication rate. Several studies have shown that the ICE technique can reduce the damage to the heart and surrounding tissues during catheter manipulation and thereby reduce the incidence of complications[7]. However, not all studies can draw the same conclusion, and this still needs to be supported by more clinical data. Finally, the ICE technique may have some influence on indicators such as modeling time, time of atrial septal puncture, and pulmonary vein isolation. By providing real-time structural imaging of the heart, the ICE technology has the potential to shorten the time required for these steps, thus optimizing the surgical efficiency[8].

5. Conclusion

In conclusion, the results of this study pointed out that the X-ray exposure dose, X-ray exposure time, total operation time, complication rate, modeling time, atrial interval puncture time, and isolation time of pulmonary vein were significantly lower than those of the control group, and the difference between the groups was obvious ($P < 0.05$). It indicates that the catheter ablation of atrial fibrillation under the guidance of intracardiac ultrasound (ICE) can reduce the X-ray use dose and operation time during atrial fibrillation ablation, and can shorten the overall operation time without increasing the risk of complications of the procedure. However, it should be noted that not all effects are positive, and the application of ICE technology still faces some technical challenges and clinical validation. Therefore, more large sample, multi-center clinical studies are needed to comprehensively evaluate the impact of ICE technology in catheter ablation of atrial fibrillation, in order to provide a more reliable basis for clinical practice.

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