Improving image quality and efficiency of cardiac four-chamber view scanning using three-point positioning method

INTRODUCTION: Cardiac morphology often changes with age and especially with disease, making cardiac magnetic resonance (CMR) imaging difficult and time-consuming. The four-chamber view is the basic acquisition in CMR to simultaneously visualize the mitral valve, tricuspid valve, and cardiac apex, providing important morphological information. It is also the anatomical basis for subsequent acquisitions such as left ventricle, outflow tract, and myocardial perfusion imaging. Therefore, fast and accurate acquisition of the four-chamber view is critical in CMR. However, individual differences in cardiac morphology and dynamic cardiac motion pose certain challenges to the four-chamber view scanning, which have often been overcome through multiple positioning and acquisitions.

The three-point positioning method obtains a scanning plane by three anatomical landmarks, thus improving the scanning speed and positioning accuracy. At present, it has achieved good results in scanning scoliosis, axillary nerve, sciatic nerve, and fetal head. In the scenario of CMR, the positioning of four-camber view can be performed using three-point positioning method by selecting the mitral valve, tricuspid valve, and cardiac apex as landmarks, which accelerate the process with fewer positioning steps and easier operations. To date, no study has confirmed the application value of the three-point positioning method in four-chamber view imaging.

Therefore, this study aimed to evaluate the application value of the three-point positioning method in improving the image quality and scanning efficiency of the four-chamber view in CMR.

METHODS: A total of 215 patients who underwent four-chamber view imaging from January 2022 to October 2023 were retrospectively collected and divided into two groups. The control group (before the introduction of the three-point positioning method, n=109) used the conventional positioning method, while the study group (n=106) used the three-point positioning method. Image quality of the mitral valve, tricuspid valve, and cruciform structure in the four-chamber view images were assessed by two radiologists using a 4-point Likert scale. The time from scout imaging to completion of the four-chamber view imaging was recorded. Chi-squared test and two-sample t-test were used to compare constituent data and numerical data, respectively. The kappa test was used to analyze the interobserver consistency.

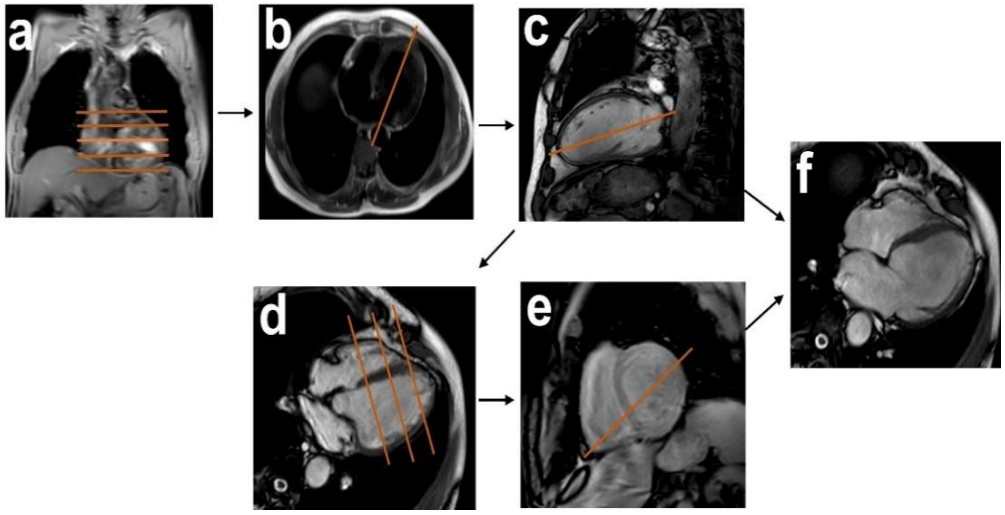

Fig. 1 Scanning procedure of the four-chamber view with traditional localization method

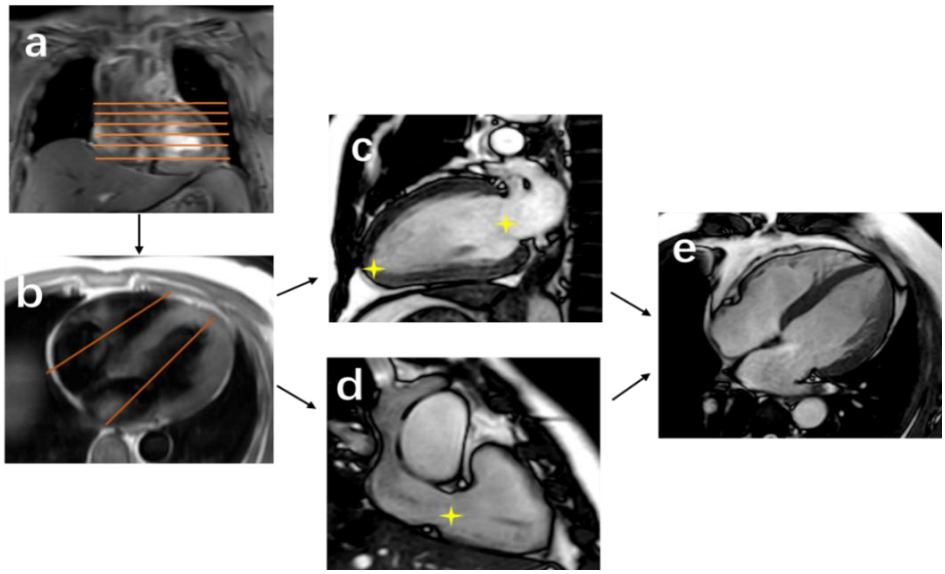

Fig. 2 Scanning procedure of the four-chamber view with three-point localization method

RESULTS: There were no significant inter-group differences in the experience of radiographer, as well as the gender, age, and disease profile of patients. The mean quality scores of mitral valve, tricuspid valve, and cruciform structure for the control group and study group were 3.44 ± 0.64 and 3.63 ± 0.49 (P=0.023), 3.43 ± 0.67 and 3.53 ± 0.60 (P=0.202), 3.71 ± 0.49 and 3.83 ± 0.35 (P=0.047), respectively. The difference in image quality scores for mitral valve and cruciform structure reached statistical significance. The mean time to complete a four-chamber view acquisition for the control group and study group were 11.67 ± 3.49 minutes and 7.212 ± 1.83 minutes, respectively, with statistically significant differences (P<0.001).

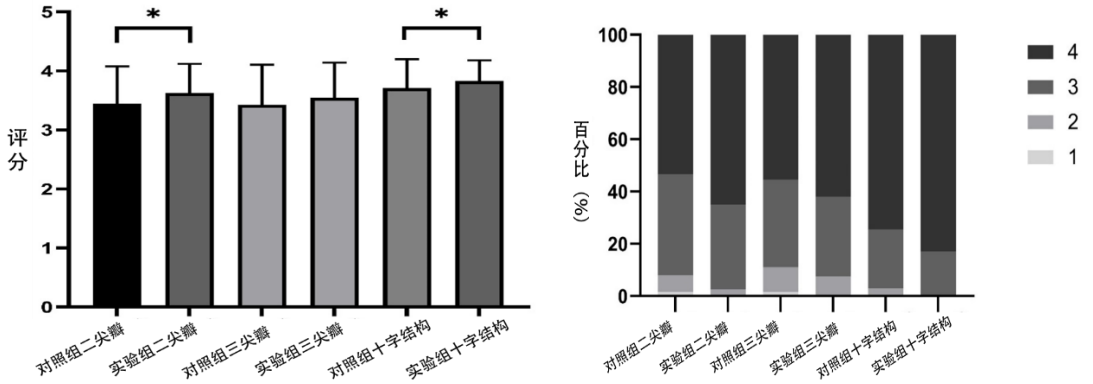

Fig. 4 The mean image quality scores of mitral valve, tricuspid valve, and cruciform structures for control and study group

Fig. 5 The percentages of each image quality score for mitral valve, tricuspid valve, and cruciform structures for both groups

DISCUSSION

By comparing the image quality and time consumption of the four-chamber view obtained by the conventional positioning technique and the three-point positioning method, it was found that the image quality of the mitral valve and the cruciform structure in the four-chamber view obtained by the three-point positioning method was significantly better than that of the conventional positioning technique, and the scanning efficiency was also significantly improved. This study has several limitations. First, the time for patients to complete all CMR sequences was not analyzed. However, the four-chamber view is the basis for the subsequent examination sequence, and the rapid acquisition of high-quality four-chamber views may therefore help to speed up the entire CMR examination. Second, the radiographer for the control group and the study group were not strictly identical because of shift changes and personal rotation, which may lead to the bias of imaging quality and efficiency. However, in this study, there was no significant difference in the work experience between the groups, which could reduce the bias.

Compared with the conventional positioning method, the four-chamber view obtained by the three-point positioning method can better display the mitral valve, tricuspid valve, and cruciform structure, and also shorten the imaging time.