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ORIGINAL

EVALUATING THE IMPACT OF PDCA CYCLE NURSING ON CARDIOVASCULAR IMAGING OUTCOMES IN ATHLETES UNDERGOING CORONARY ARTERY CT ANGIOGRAPHY

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ABSTRACT

Objective: To study the effects of PDCA cycle nursing on athletic patients with coronary artery CT angiography. **Methods:** The medical records of 68 athletic patients (coronary artery CT angiography, 2020.4-2022.4) were selected and analyzed retrospectively. The athletic patients were divided into groups according to the nursing plan. The subjects in the control group were treated with routine nursing plan, while the athletic patients in the observation group were treated with PDCA cycle nursing plan. The image quality, success rate of one examination and nursing satisfaction were compared between the two groups, and the changes of vital signs and the change of anxiety of the two groups during the examination were compared. **Results:** All indexes of image quality in the observation group were better than those in the control group, and the success rate of one examination and nursing satisfaction were higher than those in the control group ($P<0.05$); the measured values of heart rate, diastolic blood pressure and systolic blood pressure in the observation group were lower than those in the control group, and the scores of the self-rating anxiety scale (SAS) at each time point after the examination were lower than those in the control group ($P<0.05$). **Conclusion:** The PDCA cycle nursing mode applied in the nursing of athletic patients with coronary artery CT angiography can ensure the image quality, improve the success rate of one examination, and help to stabilize the emotional state and vital signs of athletic patients, improve anxiety, and has the value of further promotion and application.

KEYWORDS: PDCA cycle nursing; Coronary artery; CT; Angiography; Image quality; Anxiety

1. INTRODUCTION

Coronary atherosclerosis is a common clinical coronary artery disease with stenosis and occlusion of vascular lumen as its main manifestation. This disease can affect the blood supply of myocardium and can lead to myocardial hypoxia/ischemic necrosis in severe case. Palpitation, vomiting, chest pain, etc. are the main clinical manifestations of the disease, which can seriously disturb the daily life of athletic patients, and even threaten their life and health (Liu et al., 2021). Early and accurate diagnosis of disease is conducive to the timely implementation of scientific and reasonable clinical treatment by clinical medical personnel, and the improvement of symptoms and prognosis (Baran et al., 2019). At present, coronary artery CT angiography is the main measure for early clinical diagnosis of coronary atherosclerosis, which has the advantages of fast examination, economy and applicability and can clearly show the fine structure of artery wall (Hamal et al., 2020). However, it is found in the process of clinical examination that the image quality of coronary artery CT angiography technology is extremely affected by the athletic patients' heart rate, respiration and other factors, and athletic patients are difficult to actively cooperate during the examination process due to the lack of awareness, or they are affected by anxiety, fear and other emotions, which affect the image quality and the accuracy of the examination results (Monizzi et al., 2020).

Relevant clinical research shows that (De Rubeis et al., 2020; Niu, Shi, & Yang, 2020) the implementation of reasonable nursing management during the peri-examination period for athletic patients undergoing coronary artery CT angiography can stabilize the heart rate of athletic patients during the examination process and ensure the examination efficiency and quality (BORDBAR, FERREIDOUNI, ZHILA, MORANDINI, & MORTEZA, 2020). (Tunç & Keskin, 2020) This article mainly analyzes the values of applying PDCA cycle nursing mode to patients undergoing coronary artery CT angiography. The specific contents are summarized as follows.

2 Data and methods

2.1 Data

In this paper, 68 athletic patients with coronary artery CT angiography were selected as the study objects, and the sample selection period was from April 2020 to April 2022 and their medical records were retrospectively analyzed. They were divided into control groups and observation group according to the nursing plan, with 34 athletic patients in each group. The data presented by the two groups of athletic patients were compared and the difference was small ($P>0.05$). See Table 1 and Figure 1 for details:

Table 1: Comparison of data of two groups of patients with coronary artery CT angiography

GROUP	N	MALE (N)	FEMALE (N)	AGE	BODY MASS (KG/M2)	SCANNING RANGE (MM)
CONTROL GROUP	34	22	12	56.24±1.13	22.41±1.73	237.32±11.34
OBSERVATION GROUP	34	20	14	56.29±1.03	22.33±1.58	237.56±11.41
X2/T	-	0.249		0.224	0.199	0.087
P	-	0.618		0.824	0.843	0.931

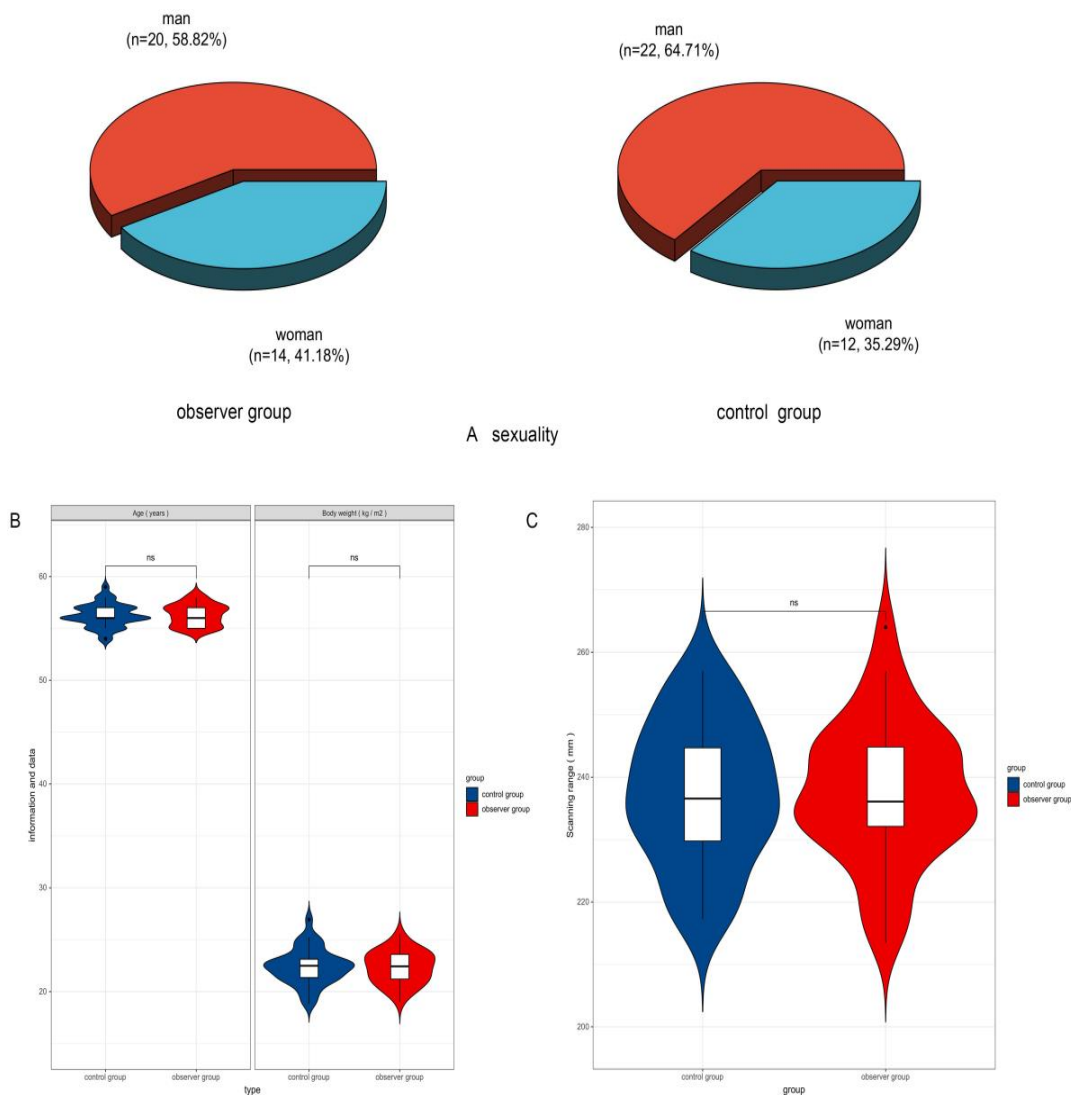


Figure 1: Analysis of data of the two groups

Inclusion criteria: Patients with suspected angina pectoris, chest tightness and precordial pain; The results of ECG of athletic patients showed that there was sinus rhythm; Patients with no history of coronary artery CT angiography or

related contraindications; Patients with normal mental state.

Exclusion criteria: Patients who had an allergic reaction to an iodine contrast agent; patients with incomplete function of important organs; athletic Patients with serious infectious diseases or malignant tumors; athletic patients with hyperthyroidism or asthma; athletic patients with diseases related to immune deficiency.

2.2 Methods

2.2.1 Control group

All the subjects in this group were performed with the routine nursing plan. The details were as follows. Blood pressure, heart rate and other indicators should be measured 2 hours before the examination, and health education was carried out for the athletic patients. The oral education was conducted to the athletic patients on the process of coronary artery CT angiography examination, relevant precautions and other contents, and the correct breathing method was demonstrated to the athletic patients, and the patients' medical history, allergy history were asked, then they were arranged to sign the consent form; 0.5mg of nitroglycerin was taken under the patients' tongue 10 minutes before the examination; during the examination, the heart rate and blood pressure of athletic patients were monitored and recorded in detail.

2.2.2 Observation group

The athletic patients in this group was performed with PDCA cycle nursing plan during the examination, mainly including the following contents:

(1) The quality control team is composed of the medical staff of the imaging department. The head nurse is responsible for the formulation of nursing measures and operating specifications at all stages. The imaging doctor measures the feasibility and effectiveness of various nursing measures. The nursing staff implements the relevant work according to the nursing plan and timely feedback the executive condition of nursing work to the head nurse.

(2) P (development of improvement plan): ① The relevant factors that affects the examination work are analyzed. The medical staff determine the key words of literature retrieval through discussion, and uses the "factors affecting the coronary artery CT angiography examination" as the key words to carry out the literature retrieval work. The retrieval content are sorted out and analyzed, finding that the medical staff did not carry out detailed guidance, did not prepare enough. The athletic patients had poor respiratory coordination, tension and anxiety during the examination and equipment and other factors can affect the inspection work. ② To summarize the actual situation of clinical nursing. The quality control team members will discuss the executive condition of clinical

nursing work and the quality of inspection, analyze the cases of inspection failure, and summarize the relevant factors affecting the inspection work. ③ Nursing guidance standards, health guidance and other plans are formulated combined with relevant influencing factors.

(3) D (Implementation of improvement plan): ① Inspection operation instructions and specifications (hereinafter referred to as "specifications") are formulated, which include inspection preparation content, specific steps of inspection related operations and relevant precautions, guidance after inspection, inspection standards and image standards, etc. The team members are instructed to read and memorize the contents of the "specification" in detail, so that they can master the inspection steps and relevant precautions and implement the intervention measures in strict accordance with the relevant contents of the specification. An inspection flow sheet should be made, in which the relevant operations and requirements in the inspection process are reflected in detail. After the operation is completed, the staff should mark the corresponding parts of the form. ② The nursing training work is examined. The nursing staff can master the relevant steps and requirements of the examination through operation demonstration and other methods, and the training is mainly carried out on the relevant contraindications and indications of examination, heart rate standards and respiratory coordination requirements during the examination process and other contents. ③ The management of equipment. The equipment condition and inspection quality are closely related. Before and after the end of the relevant inspection work of the day, and before and after the end of the relevant monthly inspection work, the hardware (host, electrical control cabinet, detector, workstation, etc.) and software (whether the imaging software runs smoothly, etc.) of the equipment are evaluated and tested. The nursing staff should inspect the equipment condition according to relevant standards, and if problems are found, it is necessary to feedback maintenance suggestions to the superior in time; in order to ensure that the fault can be eliminated as soon as possible, the department needs to be equipped with spare parts, equipment, etc. ④ Sorting out the examination operation, preparation before examination, precautions after examination, cooperation matters and other contents. The above contents should be presented in the form of the examination operation execution sheet that issued to the athletic patients before the examination, and the nursing staff will introduce the examination contents and relevant precautions to the athletic patients in detail according to the relevant contents involved in the execution sheet, so as to help the athletic patients initially understand the relevant operation of the examination and fully understand the relevant requirements of the examination cooperation to improve their cooperation with the inspection work; The propaganda video should be broadcast for the athletic patients in the waiting room, and the patients should be guided to watch and summarize the video content, and the relevant questions raised by the athletic patients and family members should be patiently answered. ⑤ The athletic patients should be instructed to carry out breathing training. Patients are

conducted to adjust the body position to a flat position, put both hands on the abdomen, then inhale slowly through the nose, hold their breaths after the abdomen bulges to the maximum, and exhale slowly through the mouth after holding 4-6 seconds, during which the abdomen is in a depressed state. During the training, the patients should be instructed to exert force on the abdomen with their hands, in order to promote the gas discharge, and the training should be carried out repeatedly 3-5 times; the patients should be instructed to practice the cough action. Before the examination, the patients should be instructed to adjust the position as sitting position, maintain the upper body lean forward, then inhale deeply through the nose, and hold the breath after the maximum limited inhalation, waiting for 4-6 seconds, and after that, the nursing staff gently pat the back of patients, and guide them to carry out indirect vigorous cough after continuous cough to promote the athletic patients to cough up the sputum; because the athletic patients are required to hold their breaths during the examination, the nursing staff should guide the athletic patients to carry out the breath-holding exercise before the examination. The nursing staff should adjust the patients' position to supine position, instruct them to inhale naturally, and maintain the breath-holding state after receiving the breath-holding command. At the first exercise, the breath-holding time should be controlled at about 5s and with the increase of training times, the breath-holding time can be appropriately extended, and instruct the patients to resume the breathing state after receiving the breathing command; before the examination, the nursing staff should guide athletic patients to carry out breath-holding training for 10 times to improve their tolerance of breath-holding. ⑥ Patients are prone to fear, anxiety, tension and other emotions due to examination operation and unfamiliar environment, so the nursing staff should strengthen the efforts of communication and introduce the examination equipment and procedures to athletic patients in detail to help athletic patients understand the progressiveness and safety of examination work, and also show patients relevant examination data to improve their self-confidence, and reduce fear, anxiety and other emotions; if patients have a sense of irritability, the nursing staff should guide them to close their eyes for a rest, play smooth music to calm their minds, and guide them to take a deep breath, so as to achieve the purpose of relaxing their bodies and mind and reducing their negative emotions.

(4) Examination (C): All team members will be assessed after the training and will be assessed through scenario simulation. The assessment questions will be set according to the relevant operation instructions and specifications of the examination. The nursing staff will randomly select questions, which will be set and evaluated by the trainers.

(5) Treatment (A): For those who fail the assessment, the next round of training needs to be organized; for those who fail to pass the spot check of the operation specification, they are required to learn the content of "specification" again.

2.3 Observation indicators

The image quality between the two groups was counted and evaluated by subjective scoring and objective index analysis. The subjective scoring was evaluated according to Liker's 4-point scoring standard. If the image quality was excellent, and the blood vessel edge was clearly displayed and there was no artifact, it was 4 points; If the image quality was good, and the blood vessel edge imaging was clear, and there were slight artifacts, it was 3 points; if the blood vessel edge imaging was blurred, and the image quality was average, and there were moderate artifacts, it was 2 points; if the image quality was poor, and the blood vessel edge was blurred, and there were serious artifacts, it was 1 point (Hecht, Shaw, Chandrashekhar, Bax, & Narula, 2019). The objective index was to measure the CT values and standard deviations of the left main coronary artery, the middle segment of anterior descending branch, the circumflex branch and the right main coronary artery on the original cross-sectional image. The CT value was taken as the signal intensity value, and the noise intensity was taken as the standard deviation. Then the CT value of the erector spinae at the same level was measured, and it was taken as the background signal intensity, and the standard deviation was taken as the background noise, and the ROI was adjusted to 5mm². The calcified plaque area should be avoid to carry out measurement work, and the signal to noise ratio and contrast to noise ratio were calculated (Zhang, Zhang, Wang, & Zu, 2021). The success rate of one examination of the two groups was counted. After the first examination, the subjective image quality score was 3-4 points indicating that was successful. The nursing satisfaction of the two groups of patients was analyzed. After the examination, the nursing satisfaction was assessed by issuing the nursing satisfaction questionnaire.

The full score was 100, and the very satisfied was the score of 90 points and above, satisfied was the score of 70-89 points, the dissatisfied was the score less than 70 points, and the nursing satisfaction was the sum of the very satisfied rate and the satisfied rate. The changes of vital signs of patients in the two groups were counted, and their heart rate, systolic blood pressure and diastolic blood pressure were measured and recorded before and during the nursing work. The change of anxiety mood of patients in the two groups was evaluated. The self-rating anxiety scale (SAS) was used to assess the change of anxiety mood of patients before, during, immediately after and 24h after the examination, and 50 points were the critical value. The higher the score was, the more serious the anxiety was.

2.4 Statistical treatment

The relevant indicators involved in this study were all treated with SPSS20.0, and the measurement data between groups were expressed in the form of $(\bar{x} \pm s)$ and the count data were expressed in the form of "%", and the

results were obtained by t and chi-square/rank sum test respectively. $P < 0.05$ indicating the data difference was statistically significant.

3. Results

3.1 Comparison of subjective scores of image quality between groups

The data in Table 2 and Figure 2 were analyzed. The image quality scores of the observation group were significantly more dominant than those of the control group ($P < 0.05$).

Table 2: Comparison of subjective scores of image quality of patients with coronary artery CT angiography between the two groups [n (%)]

GROUP	N	1 POINT	2 POINTS	3 POINTS	4 POINTS
CONTROL GROUP	34	6 (17.65)	9 (26.47)	8 (23.53)	11 (32.35)
OBSERVATION GROUP	34	1 (2.94)	4 (11.76)	12 (35.29)	17 (50.00)
Z	-	2.218			
P	-	0.027			

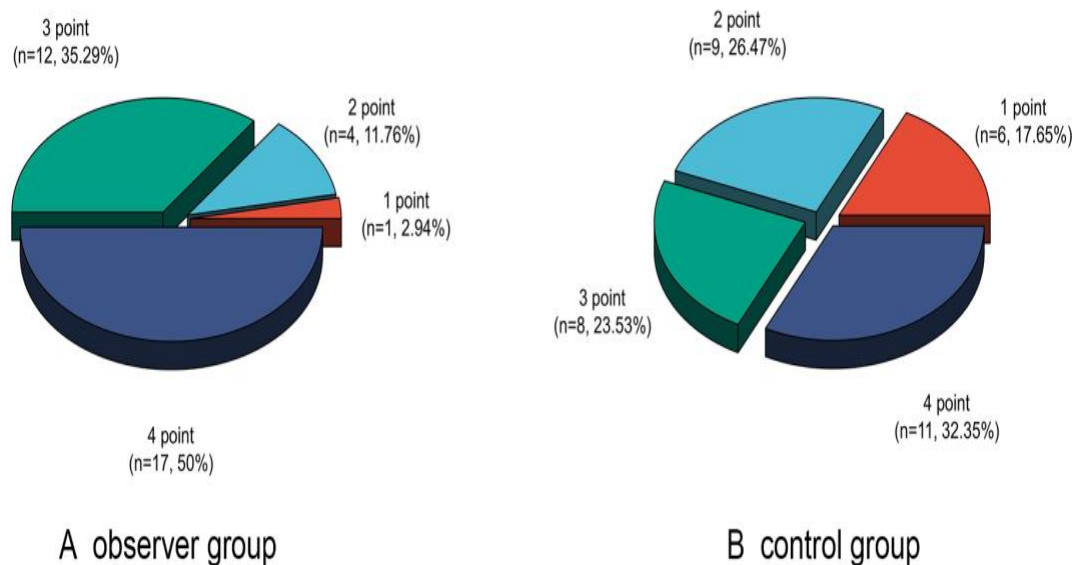


Figure 2: Analysis of subjective scores of image quality in the two groups

3.2 Comparison of objective indicators of image quality between groups

The data in Table 3, Table 4 and Figure 3, Figure 4 were analyzed. The signal-to-noise ratio and contrast noise ratio of the left coronary artery trunk, the middle segment of the anterior descending branch, the middle segment of the circumflex branch and the middle segment of the right coronary artery trunk in the observation group were higher than those in the control group ($P < 0.05$).

Table 3: Comparison of signal-to-noise ratio between two groups (n=34)

GROUP	LEFT CORONARY ARTERY	MIDDLE SEGMENT OF ANTERIOR DESCENDING BRANCH	MIDDLE SEGMENT OF CIRCUMFLEX BRANCH	MIDDLE SEGMENT OF MAIN RIGHT CORONARY ARTERY
CONTROL GROUP	19.34±1.31	15.98±0.33	20.22±1.34	17.26±1.08
OBSERVATION GROUP	25.67±1.79	27.71±1.06	25.65±1.42	28.97±1.15
T	16.640	61.609	16.217	43.281
P	0.001	0.001	0.001	0.001

Table 4: Comparison of contrast to noise ratio between two groups (n=34)

GROUP	LEFT CORONARY ARTERY	MIDDLE SEGMENT OF FRONT DESCENDING BRANCH	MIDDLE SEGMENT OF CIRCUMFLEX BRANCH	MIDDLE SEGMENT OF MAIN RIGHT CORONARY ARTERY
CONTROL GROUP	17.13±1.42	13.89±1.05	16.02±1.01	13.95±2.06
OBSERVATION GROUP	23.97±1.76	24.68±1.17	22.97±1.63	26.13±2.58
T	17.637	40.021	21.134	21.512
P	0.001	0.001	0.001	0.001

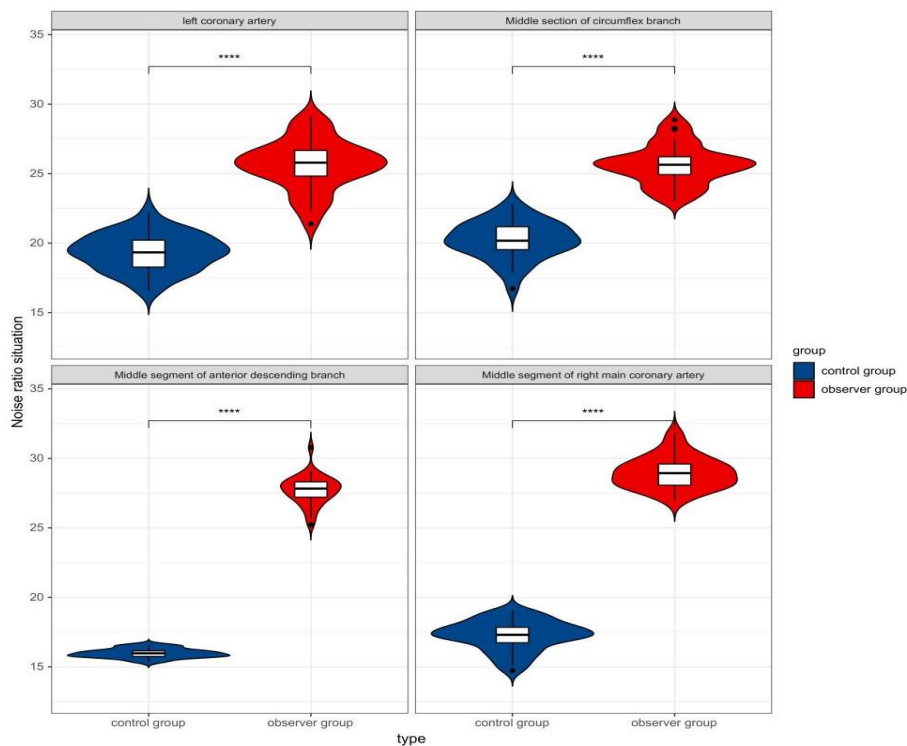


Figure 3: Analysis of noise ratio situation of two groups

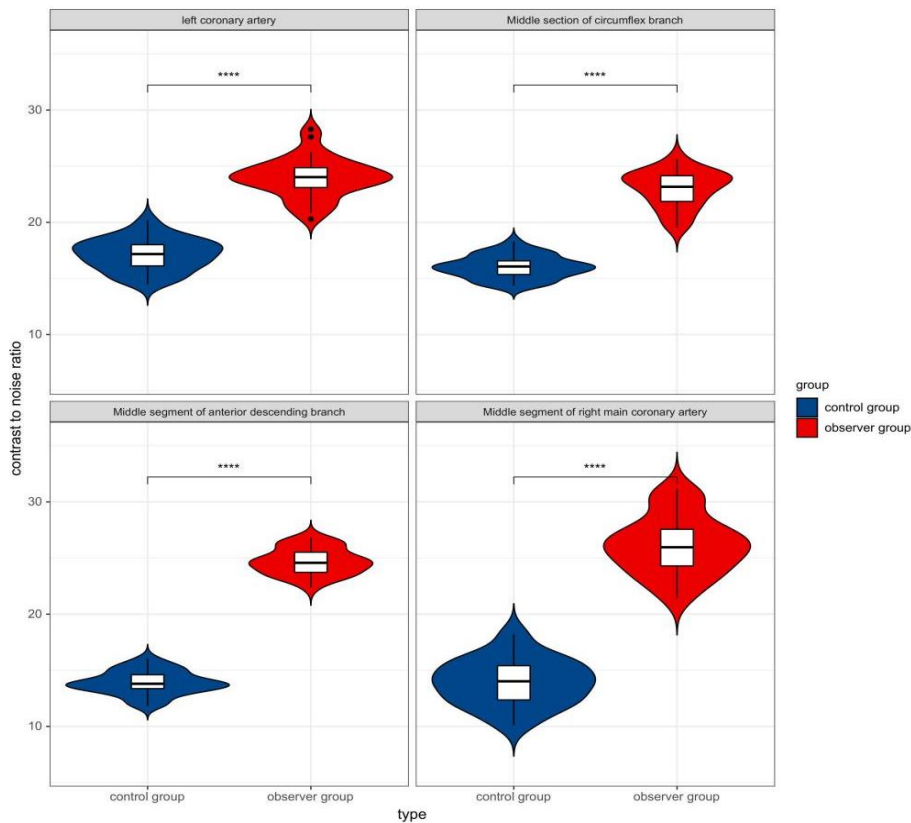


Figure 4: Analysis of contrast to noise ratio of the two groups

3.3 Comparison of success rate of one examination and nursing satisfaction between groups

The data in Table 5 and Figure 5 were analyzed. The success rate of one examination of the subjects in the observation group was significantly higher than that in the control group, and their nursing satisfaction was also significantly higher than that in the control group ($P < 0.05$).

Table 5: Comparison of success rate of one examination and nursing satisfaction between the two groups

GROUP	N	SUCCESS RATE OF ONE EXAMINATION [%]	VERY SATISFIED (N)	SATISFIED (N)	DISSATISFIED (N)	NURSING SATISFACTION (%)
CONTROL GROUP	3	26 (76.47)	8	19	7	79.41
OBSERVATION GROUP	3	33 (97.06)	13	20	1	97.06
X ²	-	6.275	-	-	-	5.100
P	-	0.012	-	-	-	0.024

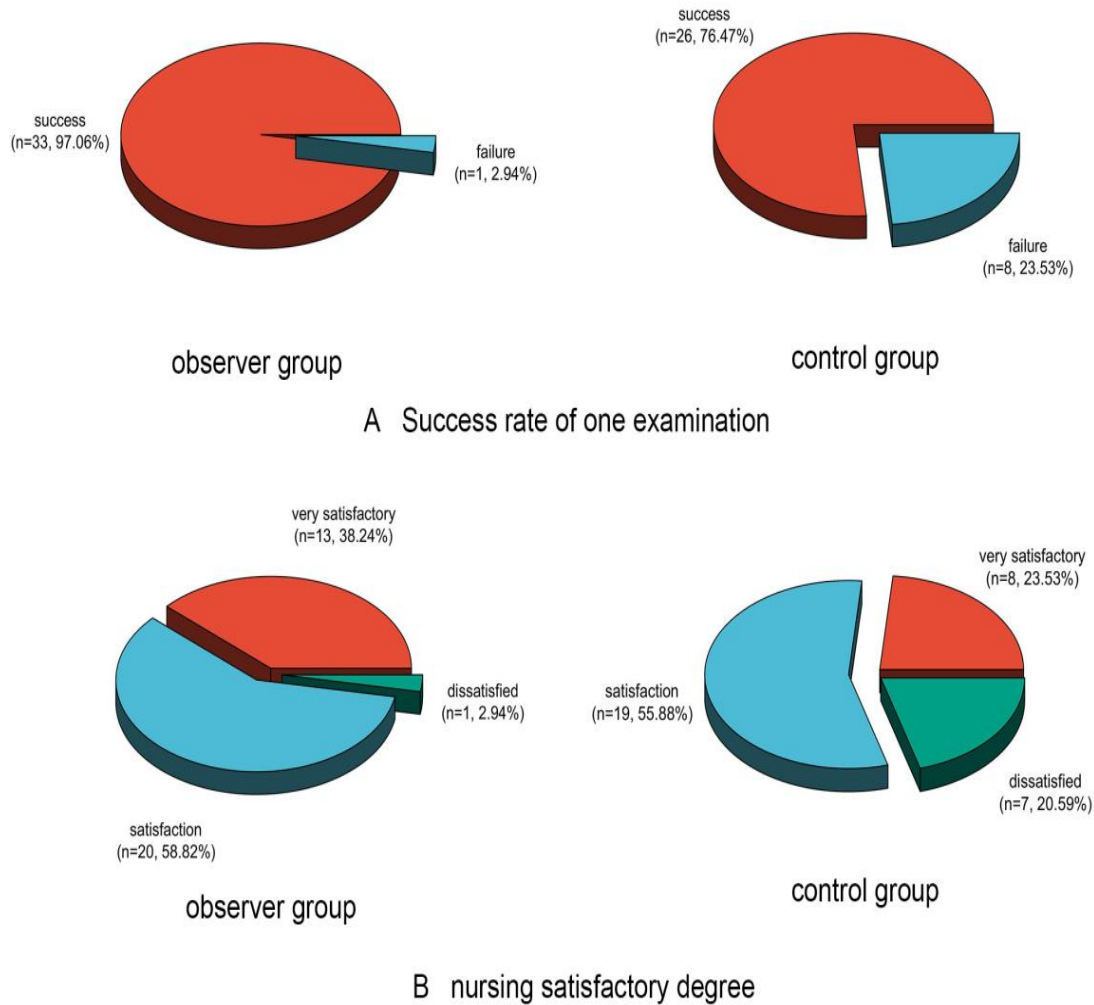


Figure 5: Analysis of the success rate of one examination and nursing satisfaction of the two groups

3.4 Comparison of vital signs between groups

The data in Table 6 and Figure 6 were analyzed. There was a small difference in the measured values of heart rate, systolic blood pressure and diastolic blood pressure between groups before nursing ($P>0.05$); during the examination, the levels of each index in the observation group were lower than those in the control group ($P<0.05$).

3.5 Comparison of anxiety between groups

The data in Table 7 and Figure 7 were analyzed. There was no significant difference in the SAS scores between the two groups before the examination ($P>0.05$); the SAS scores during the examination, immediately after the examination and 24h after the examination were analyzed and the scores of the observation group were lower than those of the control group ($P<0.05$).

Table 6: Comparison of the levels of vital signs of patients in the two groups before nursing and during examination (n=34)

GROUP	RATE HEART (TIMES/MIN)		DIASTOLIC PRESSURE (MMHG)		SYSTOLIC BLOOD PRESSURE (MMHG)	
	Before	During	Before	During	Before	During
	Nursing	Examination	Nursing	Examination	Nursing	Examination
CONTROL GROUP	70.53±2 .68	68.76±1.28	80.18±2 .31	78.85±2.43	125.47±2 .63	128.03±3.76
OBSERVATION GROUP	70.62±2 .23	66.00±1.04	80.26±2 .29	76.29±2.08	125.51±2 .76	123.19±2.98
T	0.067	10.556	0.143	4.667	0.061	5.882
P	0.947	0.001	0.886	0.001	0.951	0.001

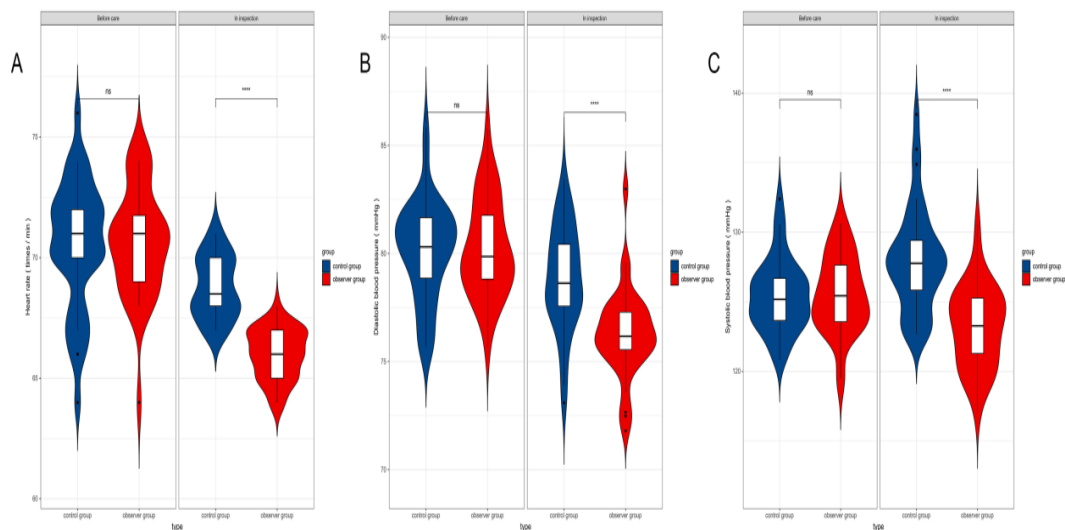


Figure 6: Analysis of vital signs in the two groups

Table 7: Comparison of changes in SAS scores between the two groups (n=34, points)

GROUP	BEFORE EXAMINATION	DURING EXAMINATION	IMMEDIATELY AFTER EXAMINATION	AFTER EXAMINATION	24H
CONTROL GROUP	38.46±1.39	41.73±2.26	35.49±2.05	29.32±3.14	
OBSERVATION GROUP	38.53±1.45	30.98±1.57	27.61±1.53	26.11±1.05	
T	0.203	22.779	17.962	5.653	
P	0.840	0.001	0.001	0.001	

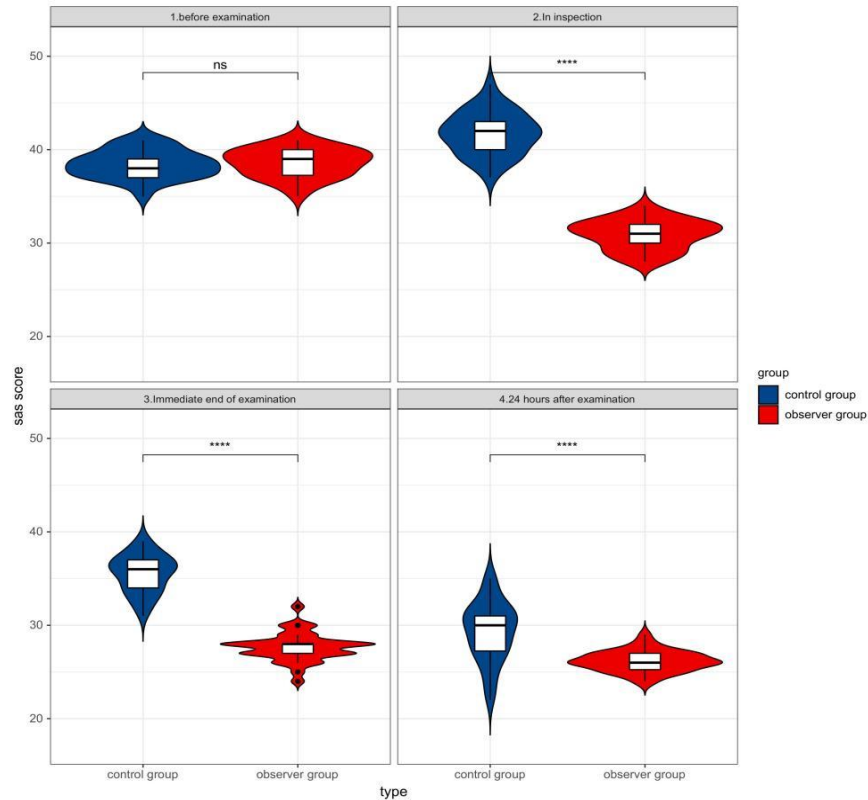


Figure 7: Analysis of SAS scores of the two groups

4. Discussion

Coronary atherosclerosis is closely related to the occurrence and development of a variety of high-risk heart diseases, but the disease lacks specific symptoms at the early stage. At present, imaging technology is mainly used in clinical diagnosis of the diseases (Bertoldi et al., 2020; Grandison et al., 2023). Coronary artery CT angiography is one of the commonly used imaging inspection measures for clinical diagnosis of coronary atherosclerosis, which can help clinical medical personnel judge the condition of coronary artery and provide a reference for the formulation of clinical treatment plans (Bordbar, Fereidouni, Morandini, & Kalyani, 2020). However, with the further deepening of clinical research, it has been found that the imaging quality of this examination method is closely related to the degree of cooperation of patients. And most patients are easily affected by factors such as illness and examination operation, they are prone to anxiety, tension and other emotions before the examination. In addition, if no systematic breathing training is carried out before the examination, it can lead to respiratory movement artifacts, which have adverse effects on image clarity and accuracy of diagnosis results (Doğru et al., 2021; Wang et al., 2021). Therefore, before carrying out coronary artery CT angiography, medical staff need to actively implement nursing intervention to ensure the smooth completion of the examination and improve the image quality (Shi, Ghisi, Hyun, Zhang, & Gallagher, 2021). The PDCA cycle plan is

to analyze the relevant factors affecting coronary artery CT angiography examination, determine the key influencing factors, formulate improvement plans based on specific factors, and implement the corresponding nursing management work according to the plan contents by establishing a quality control management team, retrieving the documents by relevant staff, and organizing the team members to carry out discussion meetings and other ways. By standardizing nursing guidance and strengthening the efforts of equipment management, we can ensure the orderly progress of clinical nursing work and avoid the impact of equipment failure on the examination, and the implementation of the health education work on patients before the examination can improve their cognitive levels and self-confidence, make them understand the matters related to cooperation, and actively cooperate with the examination to ensure the smooth and high-quality completion of the examination (Jin, Neubeck, Koo, Ding, & Gullick, 2020); the strict implementation of staff training and assessment is conducive to improving the quality of nursing and examination (Jin et al., 2020; Yong, Owen, & Hoseana, 2022). In the study, the image quality of the observation group was significantly better than that of the control group, suggesting that PDCA cycle nursing mode can improve the image quality of coronary artery CT angiography (Oliveira, Stall, Coelho, Silva, & Franca, 2022). The reasons are that the training carried out directing at the inspection operation can make the staff master the inspection steps and relevant operation skills in depth, and it can help the nursing staff to understand the inspection operation specifications and promote the improvement of the inspection quality through the formulation of "specifications" (Bosselmann et al., 2020); it can also help the patients understand the examination process, actively cooperate with relevant requirements, and reduce the impact of patient factors on the examination quality by means of broadcasting education videos and other means; the implementation of respiratory training can improve the patients' tolerance and examination quality (Mansour, Alajerami, & Najim, 2021). In the study, the scores of success rate of one examination, vital signs and SAS of the patients in the observation group were significantly better than those in the control group. The reasons are that implementing reasonable propaganda and education before the examination can help the patients establish correct understanding, and the implantation of multi-dimensional emotional comfort work can relieve their tension, anxiety and other emotions, help the patients build up confidence in the examination, and avoid negative emotions to accelerate heart rate and affect the stability of blood pressure level (Demarchi, Souza, Souza, Galli, & Pilati, 2022; Mortezaeian et al., 2021; Paalimäki-Paakki, Virtanen, Henner, Nieminen, & Kääriäinen, 2021) in addition, breathing training is beneficial to stabilize the heart rate. Through breath-holding training, the patients' breath-holding time can be prolonged and the success rate of examination can be improved. In conclusion, the effects of PDCA cycle nursing in patients with coronary artery CT angiography are ideal and it is suitable for further promotion.

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