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Review Article

Percutaneous coronary intervention effectively improves hemodynamics and myocardial injury in elderly patients with coronary heart disease

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Abstract: Objective: This study set out to investigate the effects of percutaneous coronary intervention (PCI) on hemodynamics (HR, LVEF, E/A) and myocardial injury (CK, CK-MB, TnI) in elderly patients with coronary heart disease. Methods: A total of 199 elderly patients with coronary heart disease were admitted to our hospital. Among them, 99 patients treated by PCI via the femoral artery approach were selected as a control group (CG), and 100 patients treated by PCI via the radial artery approach were selected as the research group (RG). The incidence of complications, serious cardiac adverse events within one year, clinical indexes (X-ray exposure time, puncture time, operation time, and hospitalization time), hemodynamics and myocardial injury indexes of the two groups were observed and compared. We analyzed the risk factors affecting the occurrence of complications of patients. Results: The complications of the RG and the incidence of serious cardiac adverse events within one year were significantly lower than those of the CG. The X-ray exposure time, puncture time and operation time were not significantly different between the CG and RG, but the hospitalization time was significantly lower in the RG. HR, LVEF, E/A, CK, CK-MB, TnI and other indexes in the RG were significantly better than those in the CG. Treatment methods, CK, CK-MB and TnI were the risk factors that affected the occurrence of complications. Conclusion: PCI via the radial artery approach can effectively improve hemodynamics and myocardial injury in elderly patients with coronary heart disease.

Keywords: Radial artery approach, percutaneous coronary intervention, elderly patients with coronary heart disease, hemodynamics, myocardial injury

Introduction

Coronary heart disease, as a cardiovascular disease, is one of the main causes of human death [1, 2]. Data from the American Heart Association showed that up to 15.5 million people in the United States suffered from coronary heart disease after they were over 20 years old, with the prevalence rate being proportional to age, and the elderly are also a high-risk group for the disease [3]. At present, the treatment methods of coronary heart disease include drug therapy, surgical treatment and interventional therapy [4]. Percutaneous coronary intervention (PCI), as an interventional therapy, is the most commonly used therapy for patients with coronary heart disease [5]. Studies have shown that the quality of life of elderly patients receiving PCI treatment has been significantly improved to the same extent as that of non-elderly patients [6]. Although pharmacological strategies have been developed to reduce the risk of hemorrhage, PCI via the radial artery approach is more effective than simple pharmacological strategies in reducing the risks of hemorrhage [7]. In addition, hemodynamic indexes are predictive measures for the potential risk degree of coronary heart disease, while myocardial injury indexes have the potential to predict the short-term prognosis of patients with coronary heart disease [8, 9]. Therefore, studying the treatment of elderly patients with coronary heart disease and its impact on hemodynamics, myocardial injury and other indicators are of great value to improve their quality of life.

PCI includes two interventional approaches: PCI via the radial artery approach and PCI via the femoral artery approach [10]. Among them, PCI via the radial artery approach has become the preferred treatment method for most doc-

tors due to high patient acceptance and faster recovery speed. However, it is also characterized by high complexity and time-consuming catheter delivery. Therefore, many doctors prefer PCI via the femoral artery approach to perform emergency PCI [11]. Studies have shown that PCI via the femoral artery approach has a higher risk of hemorrhaging and higher incidence of complications at the approach site compared with PCI via the radial artery approach [12]. Although PCI is one of the main treatment methods for patients with coronary heart disease, there are still some disadvantages. Some patients treated with PCI may have negative psychology, which is related to a lack of operation-related knowledge [13].

At the present moment, there is little research on PCI treatment of elderly patients with coronary heart disease and its influence on hemodynamics and myocardial injury. We study its influence by applying PCI via the radial artery approach and PCI via the femoral artery approach to patients, hoping to provide clinical references for treatment.

Materials and methods

General information

A total of 199 elderly patients with coronary heart disease were admitted to our hospital from January 2017 to December 2018. Among them, 99 elderly patients with coronary heart disease treated by PCI via the femoral artery approach were selected as the control group (CG), including 59 males and 40 females aged 60 to 76, with an average age of (68.86±8.13) (years). There were 100 elderly patients with coronary heart disease treated by PCI via the radial artery approach who were taken as the research group (RG), including 63 males and 37 females aged 61 to 79, with an average age of (69.15±8.42) (years). The study was approved by the ethics committee of our hospital. The subjects and their guardians were fully informed about the study and they signed an informed consent form.

Inclusion and exclusion criteria

Inclusion criteria were as follows: patients diagnosed with coronary heart disease [14]; 60-80 years old; no contraindication for PCI operation; no infectious diseases; patients who could successfully complete a one-year follow-up.

Exclusion criteria were as follows: patients with malignant tumors or serious heart, lung and renal dysfunction; those with a history of previous PCI operation; those who have taken medication for nearly half a year that might have potential influences on the indexes of this study; those with coagulation disorders, active bleeding, or repeated arterial puncture. The inclusion criteria were applicable to patients in both groups.

Follow-up

Patients were followed up for one year to record any serious adverse cardiac events within one year. The frequency of follow-up was once every two months. Patients were interviewed by telephone, medical records, visits and regular reexamination.

Treatment methods

CG: PCI via the femoral artery approach was performed with the patient recumbent with extend right lower limb. Local anesthesia was performed with 1% lidocaine (Shifeng Biological Technology Co., Ltd., Shanghai, China, EB02644) at the puncture point. Seldinger technique was used to puncture the most pulsatile part of the right femoral artery, a 6F arterial sheath was placed and 100 U/kg heparin was infused (Yijishiye Co., Ltd., Shanghai, China, YJ-P184200), then 6F Jndkins angiography catheter was used to perform left and right coronary angiography. After surgery, bleeding was stopped 6 h with a radial artery compressor.

RG: PCI via the radial artery approach was performed with the patient lying down, with extend right upper limb and slight lift of the forearm at 30°, there was a bracket that was supported the right hand which was fixed on the bracket, with the wrist was slightly elevated. Local anesthesia was performed with lidocaine at the puncture point. Seldinger technique was used to puncture the patient's right forearm at the radial styloid process about 1 cm near the cardiac end, a 6F arterial sheath was placed and infused with 100 mg lidocaine and 100 U/kg heparin, and then left and right coronary angiography was performed with a 5F multifunctional angiography catheter. After surgery, bleeding was stopped 6 h with a radial artery compressor.

Patients in both groups underwent routine examination and treatment before and after surgery.

Outcome measures

We observed and compared the myocardial injury indexes between the two groups. Namely, the incidence of complications, serious adverse cardiac events within one year, clinical indexes (X-ray exposure time, puncture time, operation time, hospitalization time), heart rate (HR), left ventricular ejection fraction (LVEF), mitral valve early and late peak velocity ratio (E/A) and other hemodynamic indexes, creatine kinase (CK), creatine phosphokinase isoenzyme (CK-MB), and cardiac troponin (TnI).

Statistical analysis

The counting data were expressed by the number of cases/percentage (n/%), and tdata between groups were compared via chi-square test. When the theoretical frequency in chi-square test was less than 5, the continuity correction chi-square test was adopted. The measurement data were expressed by mean ± SEM, and data between groups were compared via independent-samples t test. Comparison of data before and after treatment in the groups was performed with paired t test, and data was drawn with the GraphPad Prism 6 (GraphPad Software, San Diego, USA). The risk factors of complications in elderly patients with coronary heart disease were analyzed via SPSS 22.0 (Bioeasy (Beijing) Technology Co., Ltd., China) Logistics multivariate regression analysis. A *p*-value less than 0.05 was deemed as statistically significant.

Results

Baseline data

There were no significant differences in gender, average age, course of disease, body mass index (BMI), family history of coronary heart disease, hypertension, diabetes, drinking history, smoking history and place of residence between the two groups (P>0.05). More details were shown in **Table 1**.

Complications of elderly patients with coronary heart disease

The incidence of complications in the RG, such as arteriovenous fistula, vagovagal reflex, pseudoaneurysm and local hematoma were lower than those in the CG, and the total incidence of complications was significantly lower than that in the CG, (P<0.05). More details were shown in **Table 2**.

Severe adverse cardiac events in elderly patients with coronary heart disease

Patients in the two groups were successfully followed up for one year. The incidence of serious adverse cardiac events in the RG, such as target lesion revascularization, myocardial infarction and cardiovascular death, were lower than those in the CG. The total incidence of serious adverse cardiac events in the RG was lower than that in the CG, with statistically significant difference (P<0.05). More details were shown in **Table 3**.

Clinical indicators of elderly patients with coronary heart disease

There was no significant difference in X-ray exposure time, puncture time, operation time and other clinical indicators between the two groups (P>0.05). The hospitalization time of the RG was significantly lower than that of the CG, and the difference was statistically significant (P<0.05). More details were shown **Figure 1**.

Hemodynamics and myocardial injury indexes in elderly patients with coronary heart disease

The hemodynamic indexes such as HR, LVEF, E/A and myocardial injury indexes such as CK, CKMB, TnI before treatment had no significant difference between the two groups (P>0.05). After treatment, HR of patients in the two groups decreased to different degrees, while LVEF, E/A, CK, CKMB and TnI increased to different degrees. HR, CK, CKMB and TnI of the RG were significantly lower than those of the CG; while LVEF and E/A of the RG were significantly higher than those of the CG (P<0.05). More details were shown **Figure 2**.

Risk factors affecting complications in elderly patients with coronary heart disease

There were 30 patients with complications in this study. The differences of clinical parameters and related indexes between patients with complications (complications group) and patients without complications (no complications group) were compared. There were no significant differences between the two groups in

Table 1. Baseline data of patients in the two groups [n (%), mean ± SD]

Factor	n	Control group (CG) (n=99)	Research group (CG) (n=100)	χ^2/t	P
Gender				0.243	0.622
Male	122	59 (59.60)	63 (63.00)		
Female	77	40 (40.40)	37 (37.00)		
Age (years)				0.043	0.836
<70	108	53 (53.54)	55 (55.00)		
≥70	91	46 (46.46)	45 (45.00)		
Average age (years)	199	68.86±8.13	69.15±8.42	0.247	0.805
Course of disease (years)	199	7.81±2.19	8.14±2.43	1.006	0.316
BMI (kg/m^2)	199	24.25±2.03	24.53±2.37	0.895	0.372
Family history of coronary heart disease				0.433	0.510
No	157	80 (80.81)	77 (77.00)		
Yes	42	19 (19.19)	23 (23.00)		
History of hypertension				1.787	0.181
No	61	26 (26.26)	35 (35.00)		
Yes	138	73 (73.74)	65 (65.00)		
History of diabetes				0.071	0.790
No	58	28 (28.28)	30 (30.00)		
Yes	141	71 (71.72)	70 (70.00)		
Drinking history				0.483	0.487
No	50	27 (27.27)	23 (23.00)		
Yes	149	72 (72.73)	77 (77.00)		
Smoking history				0.687	0.407
No	57	31 (31.31)	26 (26.00)		
Yes	142	68 (68.69)	74 (74.00)		
Place of residence				0.464	0.496
Countryside	54	29 (29.29)	25 (25.00)		
Cities and towns	145	70 (70.71)	75 (75.00)		

Table 2. Complications of patients in the two groups [n (%)]

Category	Control group (CG) (n=99)	Research group (RG) (n=100)	χ^2 value	*P* value
Arteriovenous fistula	2 (2.02)	0 (0.00)	-	-
Vagovagal reflex	4 (4.04)	0 (0.00)	-	-
Pseudoaneurysm	6 (6.06)	2 (2.00)	-	-
Local hematoma	12 (12.12)	4 (4.00)	-	-
Total	24 (24.24)	6 (6.00)	12.931	<0.001

gender, average age, course of disease, body mass index (BMI), family history of coronary heart disease, hypertension, diabetes, drinking history, smoking history, place of residence, HR, LVEF, and E/A (P>0.05); while there were statistical differences in treatment methods of; CK, CKMB, and TnI (P<0.05). Multivariate Logistic regression analysis was carried out on the different factors. The results revealed that treatment methods (P=0.004), CK (P=0.001), CKMB (P<0.001) and TnI (P=0.007) were independent risk factors affecting the occurrence of complications in elderly patients with coronary heart disease. PCI via the femoral artery approach, high level of CK, CKMB, or TnI increased the risk of complications in elderly patients with coronary heart disease. More details were shown in **Tables 4**-**6**.

Discussion

Coronary heart disease, as a cardiovascular disease, is a major threat to human health. According to global epidemiological statistics,

Table 3. Severe adverse cardiac events within one year of patients in the two groups [n (%)]

Category	Control group (CG) (n=99)	Research group (RG) (n=100)	χ^2 value	*P* value
Target lesion revascularization	3 (3.02)	2 (2.00)	-	-
Myocardial infarction	4 (4.04)	1 (1.00)	-	-
Cardiovascular death	3 (3.03)	0 (0.00)	-	-
Total	10 (10.10)	3 (3.00)	4.108	0.043

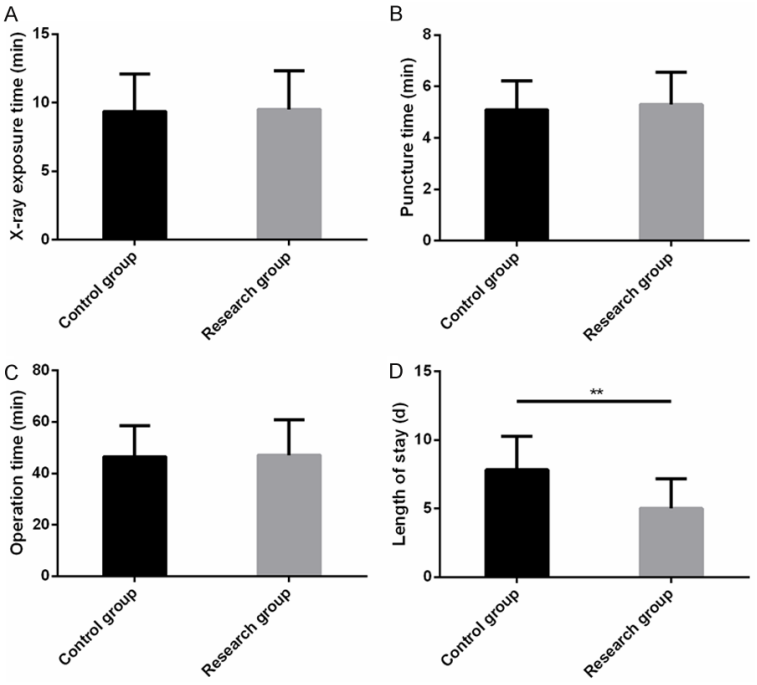

Figure 1. Clinical indicators of patients in the two groups. A: There was no significant difference in X-ray exposure time between the RG and CG. B: There was no significant difference in puncture time between the RG and CG. C: There was no significant difference in operation time between the RG and CG. D: The hospitalization time of the RG was significantly lower than that of the CG. Note: **P<0.01.

the number of deaths from coronary heart disease in the world has reached 740,000 [15]. The prognosis of patients with coronary heart disease deteriorates with age, and the elderly are the group with the worst prognosis among them [16]. PCI is a universal and evidence-based surgical treatment for coronary heart disease, which can reduce the risk of bleeding and vascular complications in patients' access sites [17]. Therefore, studying PCI therapy for elderly patients with coronary heart disease is quite significant to improve their prognosis and reduce mortality.

Recently, many researchers have shown great interest in PCI and have carried out relevant research. For example, Sedlis and others [18] studied that PCI could be used to relieve angina pectoris of patients with stable ischemic heart disease, and also has certain improvement effects on myocardial ischemia. Besides, Dehghani and others [19] discovered that the failure of PCI via the femoral artery approach was significantly related to patients who had undergone surgery before treatment, short stature and older age (>75 years old); suggesting that PCI via the femoral artery approach had certain risk of failure for elderly patients. Gada and others [20] also reported that PCI was used in patients with stable ischemic heart disease and had a lower risk of death compared with drug therapy. In this study, we mainly compared the impact of PCI via the femoral artery approach and PCI via the radial artery approach on elderly patients with coronary heart disease. The results showed that the main complications in the CG were arteriovenous fistula, vagovagal reflex, pseudoaneurysm and local hematoma; while the RG mainly had pseudoaneurysm and local hematoma. The incidence of complications in the RG was significantly lower than that in the CG, indicating that PCI via the radial artery approach had significantly lower incidence of complications. We examined the clinical indicators of patients in the two groups. The results signified that the X-ray exposure time, puncture time and operation time of patients in both groups were not significantly different; while the hospitalization time required by the RG was significantly lower, suggesting that the recovery speed of elderly patients with coronary heart disease treated by PCI via the radial artery

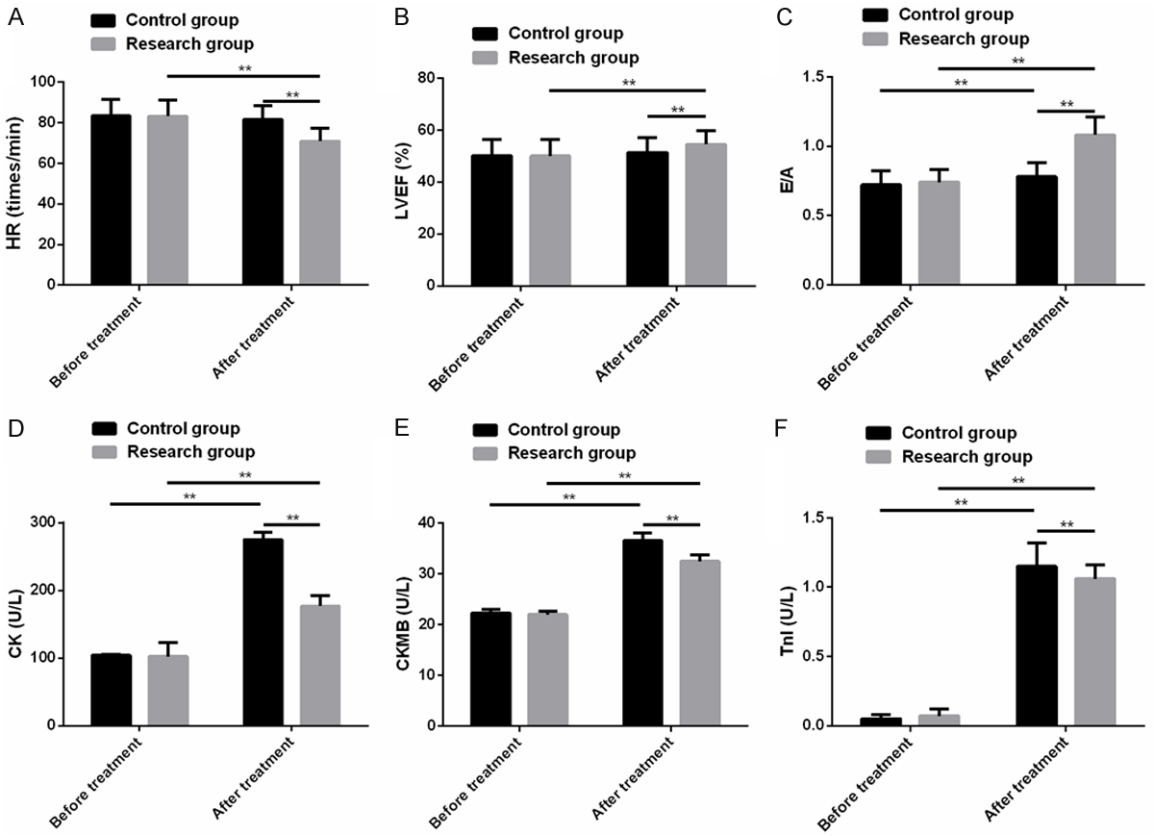

Figure 2. Hemodynamics and myocardial injury indexes of patients in the two groups. A: HR in the RG decreased significantly after treatment and was significantly lower than that in the CG. B: LVEF in the RG increased significantly after treatment and was significantly higher than that in the CG. C: E/A in the RG increased significantly after treatment and was significantly higher than that in the CG. D: CK in the RG increased significantly after treatment and was significantly lower than that in the CG. E: CKMB in the RG increased significantly after treatment and was significantly lower than that in the CG. F: TnI in the RG increased significantly after treatment and was significantly lower than that in the CG. Note: **P<0.01.

Table 4. Relationship between clinical parameters, indicators and complications in elderly patients with coronary heart disease [n (%)]

Factor	n	Complications group (n=30)	No complications group (n=169)	χ^2/t	P
Gender				0.243	0.622
Male	122	18 (59.60)	104 (63.00)		
Female	77	12 (40.40)	65 (37.00)		
Age (years)				0.043	0.836
<70	108	16 (53.54)	92 (55.00)		
≥70	91	14 (46.46)	77 (45.00)		
Average age (years)	199	69.48±8.84	68.72±8.49	0.247	0.805
Course of disease (years)	199	8.20±2.45	7.76±2.18	1.006	0.316
BMI (kg/m^2)	199	24.58±2.39	24.23±2.15	0.895	0.372
Family history of coronary heart disease				0.433	0.510
No	157	20 (80.81)	137 (77.00)		
Yes	42	10 (19.19)	32 (23.00)		
History of hypertension				1.787	0.181
No	61	11 (26.26)	50 (35.00)		

Yes	138	19 (73.74)	119 (65.00)		
History of diabetes				0.071	0.790
No	58	7 (28.28)	51 (30.00)		
Yes	141	23 (71.72)	118 (70.00)		
Drinking history				0.483	0.487
No	50	8 (27.27)	42 (23.00)		
Yes	149	22 (72.73)	127 (77.00)		
Smoking history				0.687	0.407
No	57	9 (31.31)	48 (26.00)		
Yes	142	21 (68.69)	121 (74.00)		
Place of residence				0.464	0.496
Countryside	54	6 (29.29)	48 (25.00)		
Cities and towns	145	24 (70.71)	121 (75.00)		
Treatment methods				12.931	<0.001
PCI via femoral artery approach	99	24 (70.71)	75 (70.71)		
PCI via radial artery approach	100	6 (70.71)	94 (70.71)		
HR (times/min)	199	84.37±3.15	83.26±3.01	1.848	0.066
LVEF (%)	199	52.85±6.84	53.47±6.99	0.449	0.654
E/A	199	0.86±0.21	0.95±0.24	1.926	0.056
CK (U/L)	199	254.62±12.57	182.84±14.73	25.104	<0.001
CKMB (U/L)	199	35.96±1.76	33.02±1.36	10.407	<0.001
TnI (U/L)	199	1.13±0.20	1.02±0.15	3.506	<0.001

Table 5. Logistic multivariate regression analysis assignment

Factor	Variable	Assignment
Treatment methods	X1	PCI via radial artery approach =0, PCI via femoral artery approach =1
CK (U/L)	X2	Continuous variable
CKMB (U/L)	X3	Continuous variable
TnI (U/L)	X4	Continuous variable

Table 6. Multivariate Logistic regression analysis on complications of elderly patients with coronary heart disease

Variable	B	S.E	Wals	P	OR	95% CI
Treatment methods	1.018	0.052	8.594	0.004	2.679	1.382-5.348
CK (U/L)	0.412	0.119	10.673	0.001	1.493	1.169-1.890
CKMB (U/L)	0.097	0.031	12.387	<0.001	1.087	1.034-1.148
TnI (U/L)	0.516	0.189	7.768	0.007	1.639	1.138-2.436

approach might be faster. Eichhöfer and others [21] pointed out that patients treated by PCI via the radial artery approach had lower incidence of complications and shorter hospitalization time, similar to our results. In addition, some studies revealed that arteriovenous fistula was a possible complication in patients with coronary heart disease [22].

We also measured the occurrence of serious adverse cardiac events of patients in the two groups within one year. The results showed that the CG had some serious adverse cardiac events such as target lesion revascularization, myocardial infarction, and cardiovascular death, while the RG had all except cardiovascular death; while the incidence of serious cardiac adverse events in the RG was significantly lower than that in the CG, indicating that PCI via the radial artery approach had certain improvements for the prognosis of elderly patients with coronary heart disease. Suh and others [23] studied that target lesion revascularization, myocardial infarction, and cardiovascular death were all possible adverse prognoses of coronary heart disease patients after treatment, which was also similar to our research results. We chose to analyze HR, LVEF, E/A and other

hemodynamic indexes [24] which were of guiding significance for the treatment of coronary heart disease patients and typical myocardial injury indexes [25] related to PCI such as CK, CK-MB, and TnI. The results suggested that the RG had significant advantages in hemodynamics and myocardial injury and other indexes, suggesting that PCI via the radial artery approach had great relief advantages for hemodynamics and myocardial injury of elderly patients with coronary heart disease. Finally, we analyzed the risk factors affecting the occurrence of complications in elderly patients with coronary heart disease. The results showed that treatment methods, CK, CK-MB, and TnI were the risk factors affecting the occurrence of complications in elderly patients with coronary heart disease. It indicated that the risk of postoperative complications in elderly patients with coronary heart disease treated by PCI via the radial artery approach, had lower levels of CK, CK-MB, and TnI. Jaffe [26] and others studied that 80-year-old patients treated by PCI via the radial artery approach had reduced the risk of postoperative vascular complications, which was similar to our research results.

To sum up, PCI via the radial artery approach has more prominent clinical advantages in hemodynamics and myocardial injury in elderly patients with coronary heart disease. However, there is still room for improvement in this study. To begin with, we can increase the follow-up time for the prognosis of elderly patients with coronary heart disease and analyze the influential prognostic factors. Secondly, we can also supplement the analysis of risk factors affecting the PCI efficacy of elderly patients with coronary heart disease, and even expand the discussion on nursing strategies based on this.

Disclosure of conflict of interest

None.

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