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Clinical efficacy of different side branch protection techniques on patients receiving coronary intervention and prognostic analysis

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Abstract. – OBJECTIVE: To investigate and analyze the clinical efficacy of different side branch protection techniques on patients receiving coronary intervention and the patient's prognosis.

PATIENTS AND METHODS: A total of 80 patients with coronary heart disease treated in Jiangmen Central Hospital from January 2014 to January 2017 were collected. According to different side branch protection strategies selected during operation, they were divided into jailed wire technique (JWT) group (n=20), jailed balloon technique (JBT) group (n=20), balloon-stent kissing technique (BSKT) group (n=20), and BSKT+RW group (n=20). The relevant operation parameters and the prevalence of adverse reactions at 1 month and 6 months after operation were compared among the four groups.

RESULTS: The success rate of operation and relevant operation parameters in BSKT+RW group were slightly superior to those in other three groups, but there were no significant differences among the four groups ($p>0.05$). Besides, the prevalence rates of adverse reactions at 1 month and 6 months after the operation had no significant differences among the four groups, but they were slightly lower in BSKT+RW group than those in the other three groups.

CONCLUSIONS: There are no significant differences in the clinical efficacy and postoperative recovery of patients receiving coronary intervention among the four kinds of different side branch protection techniques. However, BSKT+RW is slightly superior to the other three treatment methods, which, therefore, is a preferred choice if the patient's economic conditions permit.

Key Words:
Side branch protection technique, Percutaneous coronary intervention, Jailed wire technique, Balloon-stent kissing technique.

Introduction

Coronary heart disease (CHD) refers to a kind of heart disease caused by vascular stenosis or obstruction due to atherosclerosis of coronary artery[1], which often leads to myocardial ischemia, hypoxia, and necrosis in patients, and may endanger the patient's life in severe cases. A variety of factors can result in CHD in clinic, among which the coronary arterial branch lesion accounts for 10%-20% of pathogenic factors of CHD[2]. Coronary arterial branch lesion refers to severe stenotic lesions in the main and side branches of the coronary artery, seriously affecting the myocardial blood supply and left heart function in the body. Therefore, it is extremely important to protect the site with coronary artery bifurcation lesion[3]. In recent years, the clinical treatment method of coronary artery bifurcation lesion is the mainly percutaneous coronary intervention (PCI)[4], which dredges the vascular stenosis and obstruction using the catheter, balloon or other special instruments under the guidance of the angiographer. It is characterized by a high success rate of operation and can effectively protect the main and side branches of the coronary artery.

Currently, the side branch protection strategies in PCI of bifurcation lesion mainly include jailed wire technique (JWT), jailed balloon technique (JBT), balloon-stent kissing technique (BSKT), and BSKT+RW[5,6]. To investigate the therapeutic effects of different side branch protection techniques and the patient's prognosis, and determine the optimal side branch protection strategy, the immediate, short-term and long-term therapeutic effects of different side branch protection techniques on patients with coronary artery bifurcation lesion were detected in this study. It is now reported as follows.

Patients and Methods

Patients

A total of 80 CHD patients treated in Jiangmen Central Hospital from January 2014 to Ja-

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nuary 2017 were randomly selected, and they all met the relevant diagnostic criteria for coronary artery bifurcation lesion developed by the Cardiovascular Society, Chinese Medical Association. Patients enrolled were divided into JWT group (n=20), JBT group (n=20), BSKT group (n=20), and BSKT+RW group (n=20) according to different side branch protection strategies selected during operation. Inclusion criteria: (1) patients diagnosed with coronary artery bifurcation lesion via coronary angiography, (2) patients with more than 50% stenosis in branch opening, (3) patients with the branch diameter of 1.5-2.25 mm, and (4) patients who were expected to suffer from serious consequences after branch occlusion. Exclusion criteria: (1) patients with chronic renal insufficiency, (2) patients with the branch diameter <1.5 mm or >2.25 mm, or (3) patients with congenital heart disease.

Operation Methods

Before the operation, all patients received the routine examinations of hepatic-renal function, electrolytes, myocardial enzyme, troponin and coagulation function, as well as electrocardiography, chest radiography, echocardiography, and carotid ultrasonography. Patients began to take Plavix (75 mg/d), aspirin enteric-coated tablets (100 mg/d), and Lipitor (20 mg/d) at 3 d before operation. The physician selected the appropriate operation opportunity according to the patient's cardiac and renal functions.

(1) JWT group: the standard PCI guidewire was placed in the main and side branches of the bifurcation lesion. The coronary stent was sent into the main branch and released under the nominal pressure. If there was no damage to blood flow in the side branch [thrombolysis in myocardial infarction (TIMI) level 3], the guidewire in the side branch was withdrawn. The stent balloon was inflated *in situ* to the appropriate pressure to ensure that the stent adhered to the wall. The guidewires in the main and side branches were withdrawn after positive results were displayed in the coronary angiogram. However, if the side branch was affected markedly in the coronary angiogram, the guidewire could be delivered to the side branch through the main branch stent mesh, and then the original jailed wire in the side branch was withdrawn. The side branch balloon was dilated or the stent was implanted according to the actual situations.

(2) JBT group: the standard PCI guidewire was placed at the same position in JWT. The semi-compliant balloon was used to pre-dilate the main branch lesion. The single-track balloon with a similar diameter to that of side branch was sent into the side branch, while the coronary stent was sent into the main branch. The proximal end of the side branch balloon was about 2 mm beyond that of the main branch stent; the distal end of the balloon should be sufficient to cover the side branch opening; the main branch stent was released under the nominal pressure, and the negative-pressure stent balloon was retained *in situ*. If there was no damage to blood flow in the side branch (TIMI level 3), the side branch balloon was inflated under 3-4 atm (1 atm = 101.325 kPa). If there was damage to blood flow in the side branch after low-pressure expansion, the balloon was fully dilated according to the actual situations; the side branch balloon was withdrawn, and the side branch guidewire was retained. The stent balloon was inflated *in situ* to the appropriate pressure to ensure that the stent adhered to the wall. The guidewires in the main and side branches were withdrawn after positive results were displayed in the coronary angiogram. However, if the side branch was affected significantly in the coronary angiogram, the same treatments as those in JWT were performed.

(3) BSKT group: the operation procedures were basically similar to those of JBT. The major difference was that the side branch balloon was first inflated under the nominal pressure; the main branch stent was released under the nominal pressure, and the side branch balloon was withdrawn after main branch stent-side branch balloon kissing. The remaining steps were consistent with those in JBT.

(4) BSKT+RW group: on the basis of BSKT, the guidewire was sent to the side branch again for the side branch protection before stent post-dilatation.

Observation Indexes

(1) The curative effect was observed immediately after the operation, and the postoperative degree of side branch stenosis, postoperative TIMI level of side branch blood flow, postoperative degree of main branch residual stenosis and postoperative TIMI level of main branch blood flow were compared among the four groups. The patient's vascular residual stenosis <30% and TIMI level 3 indicated the success of the operation.

(2) Patients were followed-up via telephone at 1 month and 6 months after operation. Adverse reactions in patients, such as death, acute myocardial infarction, stent thrombosis, and recurrent angina, were recorded, and the overall prevalence

rate of adverse reactions was compared among the four groups.

Statistical Analysis

Statistical Product and Service Solutions (SPSS; IBM Corp. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY, USA) 22.0 statistical software was used for data analysis. Kruskal-Wallis H test in the non-parametric test was used. $p<0.05$ suggested that the difference was statistically significant.

Results

Postoperative Degrees of Side Branch Stenosis and Relevant Operation Parameters in Different Groups of Patients

In this study, 17 patients (85%) in JWT group, 17 patients (85%) in JBT group, 18 patients (90%) in BSKT group, and 20 patients (100%) in BSKT+RW group received the operation successfully. The success rate of operation in BSKT+RW group was slightly higher than those in the other three groups, but there were no significant differences among the four groups ($p>0.05$). The postoperative degree of side branch stenosis, postoperative TIMI level of side branch blood flow, postoperative degree of main branch residual stenosis, and postoperative TIMI level of main branch blood flow in the four groups of patients are shown in Table I.

Prevalence of Adverse Reactions in Different Groups of Patients at 1 Month After Operation

At 1 month after operation, the overall prevalence rate of adverse reactions in JWT group, JBT group, BSKT group, and BSKT+RW group was 15% (n=3), 10% (n=2), 5% (n=1), and 0%, respectively. The prevalence rate of adverse reactions in BSKT+RW group was slightly lower than those in the other three groups, but there were no significant differences among the four groups ($p>0.05$). The prevalence of adverse reactions, such as death, acute myocardial infarction, stent thrombosis, and recurrent angina, in the four groups of patients at 1 month after the operation is shown in Table II.

Prevalence of Adverse Reactions in Different Groups of Patients at 6 Months After Operation

At 6 months after operation, the overall prevalence rate of adverse reactions in patients was 25% (n=5) in JWT group, 30% (n=6) in JBT group, 10% (n=2) in BSKT group, and 5% (n=1) in BSKT+RW group. The prevalence rate of adverse reactions in BSKT+RW group was slightly lower than those in the other three groups, but there were no significant differences among the four groups ($p>0.05$). The prevalence of adverse reactions, such as death, acute myocardial infarction, stent thrombosis, and recurrent angina, in the four groups of patients at 6 months after the operation is shown in Table III.

Discussion

The coronary artery bifurcation lesion accounts for about 10%-20% in PCI of coronary atherosclerotic heart disease (CHD). The side branch occlusion may have a fatal risk, so it is extremely important to protect the side branch. The involvement mechanisms of side branch in PCI for bifurcation lesion include plaque distribution on one side of the vascular crest, displacement of vascular crest, plaque displacement, low TIMI level, and low rate of main branch blood flow, severe stenosis in bifurcation, large bifurcation angle and

Table I. Postoperative degrees of side branch stenosis and relevant operation parameters in different groups of patients.

Group	Postoperative side branch stenosis >70% (n/%)	Postoperative TIMI level 3 of main branch blood flow (n/%)	Postoperative main branch residual stenosis >30% (n/%)	Postoperative TIMI level 3 of side branch blood flow (n/%)	Side branch stent (n/%)
JWT group	7/35	17/85	1/5	17/85	0/0
JBT group	8/40	17/85	1/5	18/90	2/10
BSKT group	7/35	18/90	2/10	16/80	1/5
BSKT+RW group	3/15	20/100	0/0	19/95	0/0

Table II. Incidence of adverse reactions in different groups of patients at 1 month after operation.

Group	Death (n/%)	Acute myocardial infarction (n/%)	Stent thrombosis (n/%)	Recurrent angina (n/%)	Overall incidence rate of adverse reactions (n/%)
JWT group	0/0	1/5	0/0	2/10	3/15
JBT group	0/0	0/0	1/5	1/5	2/10
BSKT group	0/0	0/0	0/0	1/5	1/5
BSKT+RW group	0/0	0/0	0/0	0/0	0/0

Table III. Incidence of adverse reactions in different groups of patients at 6 months after operation.

Group	Death (n/%)	Acute myocardial infarction (n/%)	Stent thrombosis (n/%)	Recurrent angina (n/%)	Overall incidence rate of adverse reactions (n/%)
JWT group	0/0	1/5	1/5	3/15	5/25
JBT group	0/0	1/5	2/10	3/15	6/30
BSKT group	0/0	0/0	0/0	2/10	2/10
BSKT+RW group	0/0	0/0	0/0	1/5	1/5

large ratio of main branch diameter/side branch diameter[7,8]. It is generally believed that protection measures should be taken in case of >50% stenosis in the branch opening with a diameter of >1.5 mm, so as to avoid serious consequences after branch occlusion. Currently, there are 4 kinds of clinically common side branch protection strategies in PCI for the bifurcation lesion: JWT, JBT, BSKT, and BSKT+RW. However, there have been no comparative studies on the clinical efficacy of these four different side branch protection techniques on patients receiving coronary intervention and the patient's postoperative recovery, while such studies have important guiding significance for clinicians faced with patients receiving a coronary intervention. Therefore, the clinical efficacy of the four methods was compared and studied from the perspective of success rate of operation and the prevalence rate of adverse reactions after operation in this study.

In JWT, the side branch angle and vascular wall tension are changed, and the opportunity of side branch opening is increased, which is of important significance for the remedial intervention after side branch occlusion, but usually not used to prevent side branch occlusion[9]. After side branch occlusion occurs, the guidewire used for protection can be sent again for guidance, and the guidewire placed in the side branch in advance can also be used to change the bifurcation angle, thus helping the re-entry of remedial guidewire. However, the effect of JWT on the side branch occlusion is lower, and the posterior side branch is often affected. If only the guidewire is retained to protect the side branch, it is often hard to send the guidewire due to the obstruction of vascular crest and plaque, and perioperative myocardial infarction will occur easily[10].

Compared with JWT, JBT can reduce the displacement of vascular crest and main branch plaque towards side branch after the release of main branch stent, and lower the risks of side branch involvement and acute occlusion, thereby reducing the necessity of expansion after kissing and side branch stent implantation. Moreover, JBT can also reduce the risk of entry into false lumen even when the balloon dilatation or side branch stent implantation is necessary, thus improving the success rate of side branch remedial intervention, and lowering the risks of side branch loss and perioperative myocardial infarction[11,12]. However, JBT is not completely effective, because there are still risks of stent deformation and displacement, and its long-term effect remains unknown.

BSKT is particularly appropriate for PCI of left main artery bifurcation lesion in high-risk patients. The acute occlusion of either anterior descending branch or circumflex branch for too

long a time can immediately affect the hemodynamics, resulting in serious consequences. The pre-buried balloon dilatation can often quickly restore the side branch blood flow, thus stabilizing the hemodynamics[13,14]. In the case of the above-mentioned side branch loss, experienced surgeons can also slightly dilate the pre-buried balloon till the blood flow is restored without significantly compressing the stent, so that the operation can continue to be performed after the hemodynamics is stabilized. However, there has been little clinical research on BSKT currently, and its long-term effect remains unclear[15]. Theoretically, some problems may exist in BSKT, such as plaque rupture, dissection, intimal injury, stent structure damage, stent coating damage, and stent malapposition, which will result in stenosis or even occlusion of the side branch opening[16]. In BSKT+RW, based on BSKT, the guidewire is sent again into the side branch for protection before stent post-dilatation, and this method is novel with the best protective effect on side branch in theory. Results of this study also proved that the success rate of operation and relevant operation parameters in BSKT+RW group were slightly superior to those in the other three groups, but there were no significant differences among the four groups ($p>0.05$). Besides, the prevalence rates of adverse reactions at 1 month and 6 months after operation in BSKT+RW group were slightly lower than those in the other three groups, but no significant differences were found among the four groups. The possible reason is that the observation sample size was small in this study, so there may be significant differences after the number of cases increased.

Conclusions

We observe that there are no significant differences in the clinical efficacy and postoperative recovery of patients receiving coronary intervention among the four kinds of different side branch protection techniques. According to research results, however, BSKT+RW is slightly superior to the other three treatment methods, which, therefore, is a preferred choice for clinicians if the patient's economic conditions permit.

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Ethics Approval and Consent to Participate

The study was approved by the Ethics Committee of Jiangmen Central Hospital. Patients who participated in this research, signed the informed consent and had complete clinical data. Signed written informed consents were obtained from the patients.

Conflict of Interest

The Authors declare that they have no conflict of interest.

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