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Review Article

The clinical effect of the minimally-invasive model based on anterograde venography in the treatment of left iliac vein compression syndrome

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Abstract: Objective: To propose a new, comprehensive, minimally-invasive treatment scheme and to verify the effectiveness and superiority of this treatment scheme in clinical treatment. Methods: Nine patients without thrombotic left IVCS (iliac vein compression syndrome) were selected as the study cohort. According to the classification of their conditions and the different surgical treatment plans, the patients were divided into three groups (A, B, and C). Next, according to the evaluation criteria, namely, the CEAP (clinical-etiology-anatomic-pathophysiologic) classification, the VCSS (venous clinical severity score), and the CIVIQ-2 (Chronic Venous Insufficiency Questionnaire-2), the patients were evaluated, and their results preoperatively, and at three months, six months, and 12 months postoperatively were recorded. Doppler ultrasound was conducted to re-examine the postoperative treatment effects, and the data of these three groups were input into the database for a comparative analysis. Results: Postoperatively, both the CEAP grades and the VCSS of all three groups decreased ($P<0.05$). Six months and 12 months postoperatively, the VCSS of group A was significantly different from the VCSS of the other two groups ($P<0.05$). The postoperative QOL (Quality of Life) scores in all three groups were improved ($P<0.05$). Three months postoperatively, the QOL score of group B was the highest ($P<0.05$). Six months and 12 months postoperatively, compared to the other two groups, the difference in group A was significant ($P<0.05$). Group A had the highest reoccurrence rate (13.2%), followed by group C, and group B had the lowest reoccurrence rate (4.4%). Conclusion: The comprehensive minimally invasive model (CMI) of anterograde venography of the lower extremities has a good effect on the treatment of left IVCS, and it can improve the postoperative QOL and reduce the disease's recurrence rate. It is a widely-used, safe, and effective treatment plan worthy of promotion.

Keywords: Anterograde venography of the lower extremities, left iliac vein compression syndrome, varicose veins of the lower extremities, vascular lumen

Introduction

Iliac vein stenosis, also known as iliac vein compression syndrome (IVCS), is a lower extremity and pelvic venous reflux disorder caused by iliac vein compression and abnormal adhesion structures in the lumen, occurring more commonly in the left lower extremities [1, 2]. Iliac vein stenosis cannot only cause venous insufficiency and varicosity but it can also induce deep vein thrombosis of the lower extremities [3]. It is often manifested as DVT (deep venous thrombosis) of the lower extremities and chronic venous diseases without thrombosis, such as swelling and pain of the lower extremities, asymmetric edema, tortuous expansion of the lower extremity superficial vein, superficial phlebitis, pigmentation of the skin, venous claudication, and venous ulcers [4]. The disease is a common and frequently-occurring disease in vascular surgery, and it seriously affects people's health and QOL (quality of life) [5, 6]. The diagnosis of IVCS mainly depends on image examination, color Doppler ultrasound of the ilium vein, anterograde angiography of the deep veins of the lower extremities using an injection of a contrast agent through the superficial vein of the dorsalis pedis, catheterization angiography by a puncture of the femoral vein of the affected side, or CTV (computed tomography venography) of the ilium vein [7]. The disease's main treatment goal is to relieve iliac vein ste-

nosis and restore the unobstructed blood flow of the compressed iliac vein [8].

In addition to iliac vein compression, if there are factors such as slow blood flow and a hypercoagulable blood state, it is very easy for deep vein thrombosis of the lower extremities to occur [9, 10]. To effectively treat DVT, reduce DVT complications, and improve the patency rate of the deep veins, the treatment of IVC (ilium vein compression) combined with DVT of the lower extremities aims to clear the main thrombi of the deep veins and relieve the stenosis and occlusion of the ilium vein in time [11, 12]. Therefore, the treatment of IVC combined with acute lower extremity deep venous thrombosis (LEDVT) should clear DVT as early as possible. At the same time, effective treatment should be selected according to the primary lesion of the IVC to reduce the pressure of the lower extremity veins, protect the function of the deep vein valves as much as possible, reduce the incidence of PTS (post-thrombotic syndrome), and alleviate the PTS symptoms [13, 14]. It has been found that IVC and stenosis can reduce the incidence of pulmonary embolisms by 80%. Reddy et al. believed that the pathogenesis of IVC was mechanical obstruction, with LEDVT a secondary cause. IVC and stenosis play a certain protective role in preventing thrombi from falling off and causing pulmonary embolisms [15]. However, if IVC is combined with acute mixed LEDVT, it is difficult to completely remove the thrombi in the ilium, thigh, and popliteal veins, whether mechanical thrombus is aspirated or catheterized for thrombolysis or other surgical thrombectomies [16]. In recent years, many proposed treatment schemes have had some disadvantages. For example, the improvement of the disease is insignificant, and the recurrence rate is also high.

In this paper, the clinical effect of the minimally-invasive model based on the anterograde venography of the lower extremities in the treatment of left IVCS was studied. Patients without thrombotic left IVCS were recruited as the study cohort and divided into three groups according to the grades of their conditions and the different surgical treatment method each received. Through this method, the clinical effect of the comprehensive minimally invasive (CMI) model of anterograde venography of the lower extremities on left IVCS was studied and analyzed. Through the research, it was found that the CMI model of anterograde venography of the lower extremities can treat left IVCS well, and it can reduce the clinical grade and VCSS (Venous Clinical Severity Score). Moreover, it can effectively improve QOL. After a Doppler ultrasound re-examination, it was found to effectively reduce the recurrence rate of the disease. We show that the CMI model of anterograde venography of the lower extremities, i.e. endovascular treatment combined with surgery, has a very good effect in the treatment of varicose veins of the left lower extremities secondary to severe stenosis of the left iliac vein. It can provide direction and guidance for the treatment of IVCS in the future and is a treatment very worthy of promotion.

Materials and methods

Study cohort

One hundred and twenty-nine patients without thrombotic left IVCS admitted to the First Affiliated Hospital of Bengbu Medical College from April 2018 to April 2019 were recruited as the study cohort. Prior to the study, they were all diagnosed with thrombotic left IVCS through an anterograde venography of the left lower extremities and of the femoral vein using lateral venography. The degree of IVS in all the patients was determined by the senior doctors. The diagnostic criteria for the degree of IVS were: 20% to 50%, mild; 50% to 70%, moderate; more than 70%, severe. If the degree of stenosis was more than 70%, endovascular treatment was needed. Before the study, the informed consent of all the patients and their families was obtained, and approval for this study was obtained from our hospital's ethics committee.

Inclusion criteria: Patients admitted to the Department from April 2018 to April 2019 and diagnosed with left IVCS and left lower extremity superficial varicosity using digital angiography anterograde venography.

Exclusion criteria: Patients with a history of LEDVT; patients with pelvic cancer; patients who are allergic to contrast media and who have contraindications to anticoagulation; patients whose survival period of malignant tumors is not more than one year; patients who have previously undergone pelvic surgery and

radiotherapy and have iliac vein trauma; patients who have K-T syndrome.

Grouping: according to the degree of IVC and the corresponding treatment, the patients were divided into three groups: group A, group B, and group C. Group A was the operation group of ilium vein severe stenosis and simple varicosity and had 22 patients; group B was the operation group of the left ilium vein cavity with severe stenosis and had 30 patients; group C was the operation group of ilium vein light and medium stenosis and left lower extremity varicosity and had 67 patients.

This study was approved by the Ethics Committee of the First Affiliated Hospital of Bengbu Medical College and was conducted in accordance with the Helsinki Declaration. All the participants and their families signed informed consent forms before we carried out the study.

Operation method and postoperative follow-up

Operation method: in the experiment, both group A and group C underwent operations on the varicose veins of the lower extremities. After the operations, they needed to wear elastic socks for 3 to 6 months. During the varicose veins of the lower extremities operations, the great saphenous vein was ligated using high ligation, then the great saphenous vein of the thigh was stripped. After that, a small incision was used for stripping and combined with a foam sclerosing agent for the leg vein operation.

During the balloon angioplasty and stent implantation of the ilium vein, the patient was first placed in a supine position, and then the left femoral vein of the patient was punctured. The 8F blood vessel sheath was put in, and then the double J tube was put into the distal end of the external ilium vein for further left ilium vein angiography. There were three main manifestations: in the first case, it showed that the diameter of the compressed ilium vein was widened, there was a filling defect in the blood vessel and an occlusion in the lumen or the color of the contrast agent became lighter. In the second case, a large amount of development could be seen in the collateral, and the blood flowed back to the iliac vein through the pelvic vein. In the third case, there would be a delay in the emptying of the contrast media. Once this happened, the appropriate balloon was selected for expansion. Generally, the diameter of the balloon was 10-14 mm, and angiography was carried out after the expansion. If there was an elastic retraction of the blood vessels, it meant that the collateral vessels were rich in blood flow, and a 12-16 mm stent should be placed inside. The length of the stent had to be longer than the narrow one, and the most suitable distance was 5 mm from the proximal inferior vena cava. At this time, the lateral ilium venography could be performed first to further determine where the inferior vena cava bifurcated and to determine the position of the bifurcations. After the stent was released, the angiography could be performed again, to determine the position of the stent and the blood flow of the vessels. During the operation, 4000 IU heparin solution was used.

The patients in group B were different from those in the other two groups. First, they underwent interventional therapy and then they underwent varicosity surgery on the same day or the next day. After the operation, they needed anticoagulation treatment for three days, and the anticoagulation solution used was 4000 IU heparin solution. Also, warfarin was administered. According to the INR (international normalized ratio), the dosage was adjusted. The patients also needed to wear elastic socks after discharge for 3 to 6 months and continue to take warfarin for anticoagulation for 6 months. After 6 months, if the INR was between 2.0 and 3.0, they were advised to stop taking warfarin and switch it to aspirin for anticoagulation for the rest of their lives.

Postoperative follow-up: the times of the postoperative follow-up were at 3 months, 6 months, and 12 months, mainly using the questionnaire method and lower extremity ultrasound examinations. The main measures taken at the follow-up examinations were the CEAP grades, the VCSS and CIVIQ scores, and checking the stent and for any recurrence of varicose veins.

Evaluation criteria

CEAP grading is a classification system for lower extremity chronic diseases. It mainly looks at the patients' pathophysiology, anatomy, causes of disease, and clinical conditions. It reflects the severity of the lower extremity varicose veins and is divided into six levels according to the severity of the condition [17].

Table 1. General information of patients

Classification	Group A	Group B	Group C	P
Age (years old)	46.4±10.11	49.4±11.30	50.6±10.30	0.514
Female/male	23/7	14/8	50/17	0.689
Course of disease (year)	17.3	16.5	15.2	0.562
Level 0 (case)	0	0	0	
Level 1 (case)	0	0	0	
Level 2 (case)	6	4	17	
Level 3 (case)	10	6	18	
Level 4 (case)	8	4	20	
Level 5 (case)	2	3	5	
Level 6 (case)	4	5	7	1.24 (General classification)

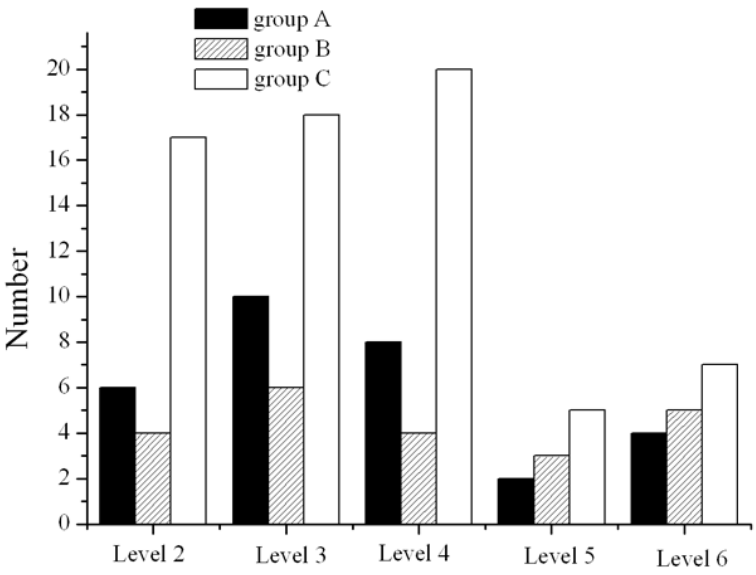

Figure 1. The number of patients with clinical grades 2-6.

The main purpose of the VCSS is to evaluate the severity and improvement of the veins of the lower extremities. We used it for the post-treatment evaluation. The total possible score is 30 points, and each index has a corresponding score, which ranges from 0-3 points. There were 10 evaluation indexes in total, and the higher the total score, the more serious the disease, and the lower the total score, the better the recovery of the disease.

CIVIQ-2 was mainly used to evaluate the degree of improvement in the patients' QOL. It is mainly aimed at patients with chronic lower extremity diseases [18]. It records 20 key problems from four angles at each time point. Each problem is divided into five grades, and from heavy to light, and the possible scores are 5, 4, 3, 2, 1. The heavier the grade, the higher the score. If the final score was more than 90 points, it indicates that an ideal QOL was achieved.

Three-separation method

To ensure the professionalism and scientific nature of endovascular treatment and varicose operations of the lower extremities, this experimental study used highly-qualified equipment operators, statistical analysts, and observation recorders, and we ensured that a qualified person was in charge of each step. The three were blinded to each other's work and did not affect each other's work. This method is called "three-separation".

Statistical methods

After the experimental study, the results of the patient survey scales and the scoring scales were recorded. After no errors were found, the results were entered in the database. The statistical analysis was carried out using SPSS 22.0, the measurement data were expressed as $x \pm s$, the count data were checked using chi-square tests, and the three groups' data were compared using one-way ANOVA (analysis of variance). The results before and after the operations were compared using t-tests, and a difference was statistically significant when $P<0.05$.

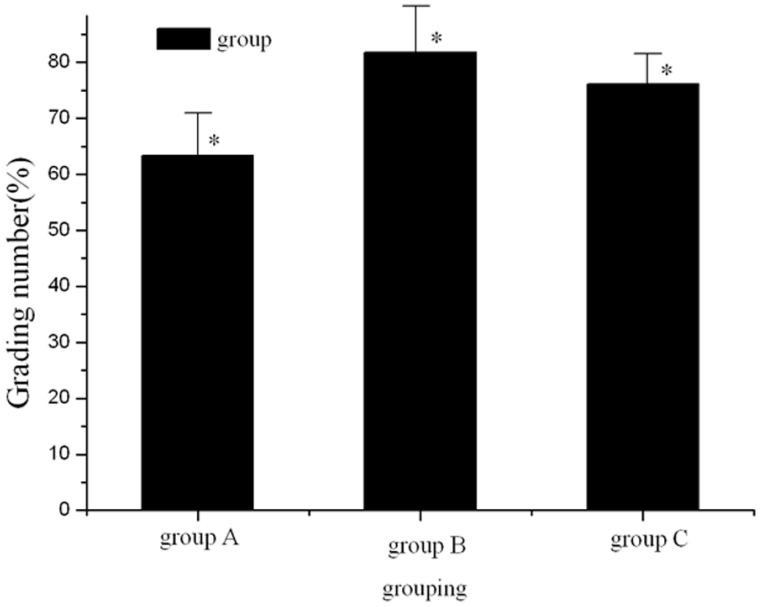

Figure 2. The number of patients in grade 0 of CEAP after the operations in the three groups (* indicates that the difference from the other groups was statistically significant).

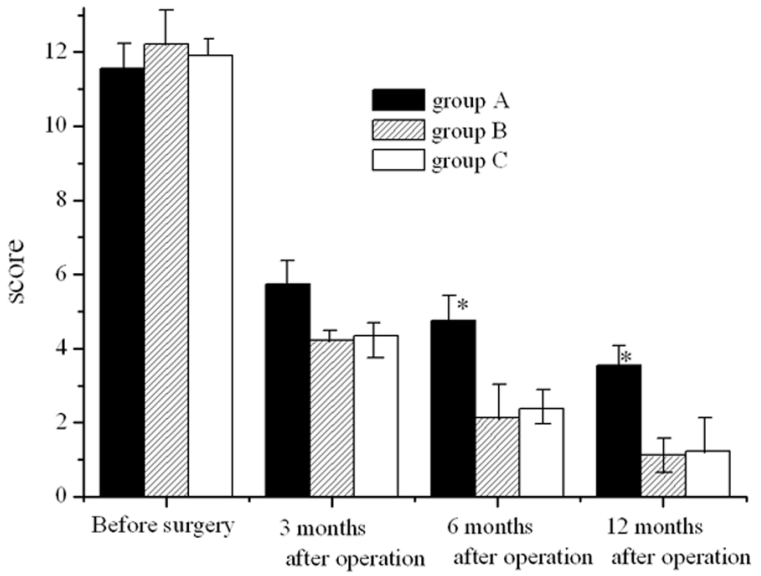

Figure 3. The patients' VCSS results before the operations and at 3, 6, and 12 months after the operations (* indicates that the differences from the other groups were statistically significant).

Results

Comparison of general patient data

The comparison results of the general patient data of patients were obtained (**Table 1**). There were no great differences among the three groups regarding age distribution, gender distribution, or clinical-grade (P> 0.05), so the three groups of patients can were comparable. The patients' clinical grades were obtained (**Figure 1**). The clinical level of the patients was represented by "level".

Comparison of the patients' CEAP grades before the operations and at 3, 6, and 12 months after the operations

It was found that the CEAP grades of the three groups of patients decreased after the operations. The patients' median grade before the operation was grade 4, but after the operation it was 0, which was decreased. It showed that the CMI model of anterograde venography of the lower extremities had a good recovery effect in the clinical treatment. Group A accounted for 63.3%, group B, 81.8%, and group C, 76.1% of the population at level 0 (**Figure 2**). Compared with group A, the recovery effect of groups B and C was relatively better, especially group B, and there was a great difference among the three groups (P< 0.05).

Comparison of the VCSS of the three groups before the operations and at 3, 6, and 12 months after the operations

The VCSS results of the three groups of patients at 3, 6, and 12 months after the operations were obtained (**Figures 3** and **4**), and they were reduced after the operations and had great differences (P<0.05). Comparing group A with the other two groups, we found that the VCSS of group A was relatively higher at 12 months after the operations, but the scores of the other two groups were relatively lower, all of which dropped to about 1 point, especially group B, which had the lowest score. This suggests that the CMI model of lower extremity

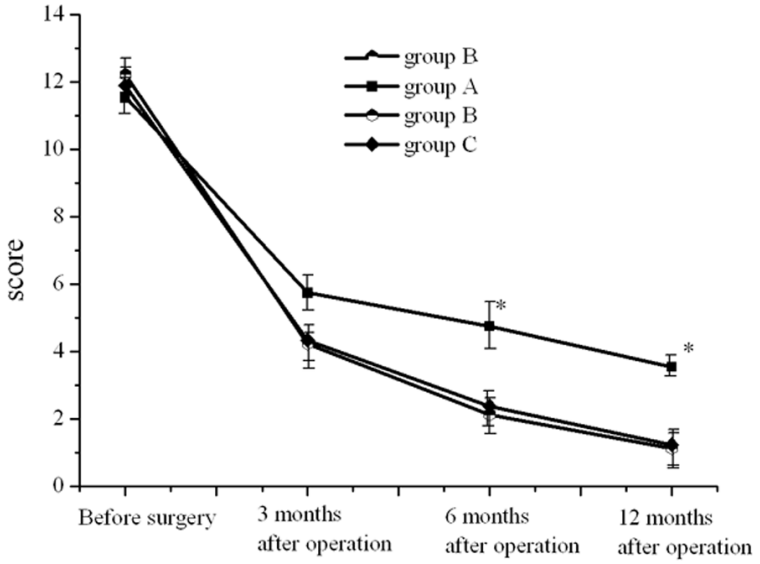

Figure 4. The VCSS trends before the operations and at 3, 6, and 12 months after the operations (* indicates that the differences from the other groups were statistically significant).

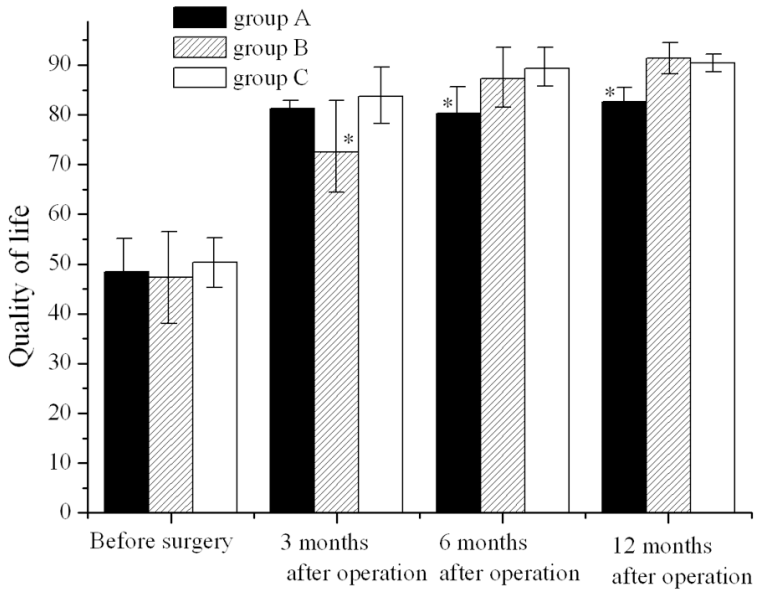

Figure 5. Comparison of the QOL scores of the three groups of patients at 3, 6, and 12 months after the operations (* indicates that the differences from the other groups were statistically significant).

venography has a good recovery effect and can be widely used in clinical treatment. There were no statistical differences in the scores of the three groups at 3 months after the operations (P>0.05). 6 months after the operations, there was a statistical difference between group A and the other two groups (P<0.05), but there was no statistical difference between group B and group C (P<0.05). 12 months after the operations, there was a statistical difference between group A and the other two groups (P<0.05), but group B had no great difference from group C (P>0.05).

Comparison of the QOL of the three groups before the operations and at 3, 6, and 12 months after the operations

The QOL scores of the three groups at 3, 6, and 12 months after the operations are shown in **Figures 5**, **6**. They were improved after the operations but had no great differences (P<0.05). The QOL scores of group A were relatively lower at 12 months after the operations, while the other two groups' QOL scores were relatively higher and were raised to about 90 points, especially group B, as it had the highest QOL scores. The CMI model of anterograde venography of the lower extremities had a good recovery effect in the clinical treatment, so it can be widely used clinically. Three months after the operations, it was found that there was a significant statistical difference between group B and the other two groups (P<0.05), but group A was not greatly different from group C (P>0.05). Six months after the operations, it was found that there was a significant statistical significance between group A and the other two groups (P<0.05), but there was no statistical difference between group B and group C (P>0.05). Twelve months after the operations, the QOL scores of group A and the other two groups were statistically significant (P<0.05), but there was no statistical difference between group B and group C (P>0.05).

Results of the Doppler ultrasound re-examinations

The Doppler ultrasound re-examination results one year after the operations are shown in

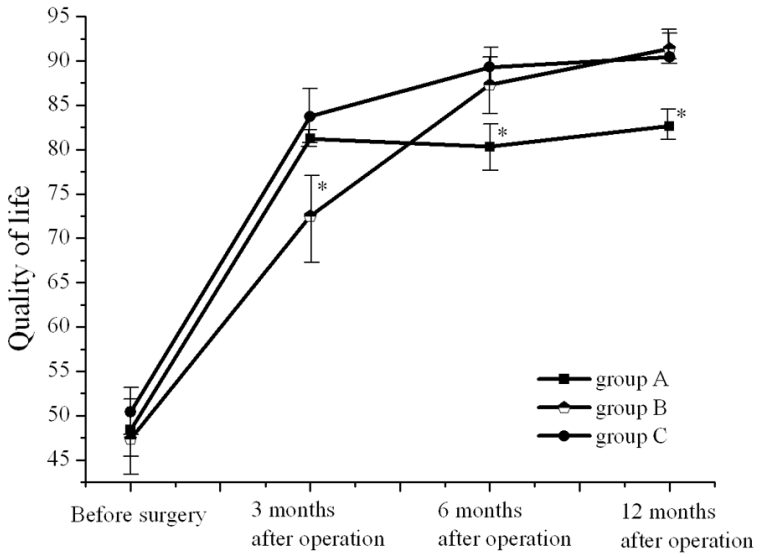

Figure 6. The changing trends of the QOL scores in the three groups before the operations and at 3, 6, and 12 months after the operations (* indicates that the differences from the other groups were statistically significant).

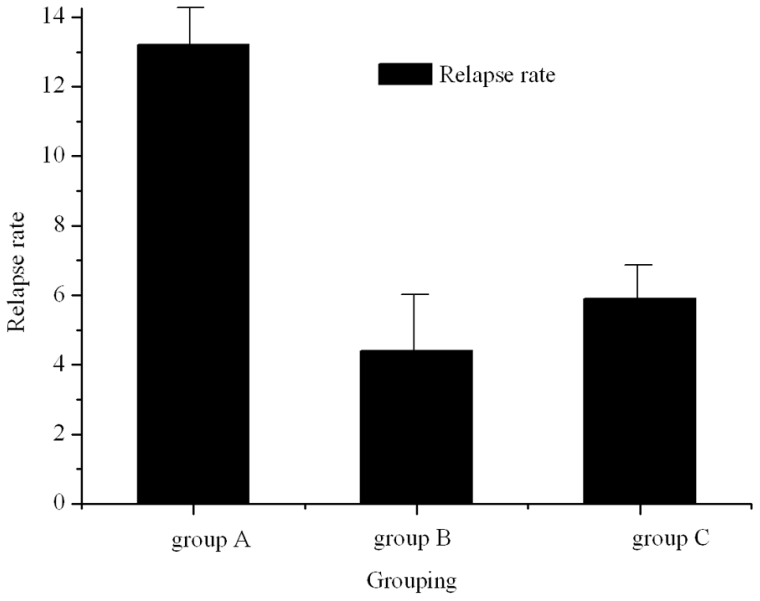

Figure 7. Results of the Doppler ultrasound re-examinations.

Figure 7. The recurrence rate of group A was the highest, and it was 13.2. The recurrence rates of the other two groups were relatively lower, and the recurrence rate of group B was the lowest at 4.4%, followed by group C. It can be seen that the CMI model of anterograde venography of the lower extremities had a good recovery effect in the clinical treatment. Compared with the other simple surgical treatments, it was superior and more effective.

Discussion

The recurrence rate of left IVCS is very high, and it will continue to develop into LEDVT, a condition which seriously impacts patients' QOL, so it needs to be diagnosed and treated promptly [19-22]. In recent years, many diagnostic and treatment schemes for non-thrombotic IVCS have been proposed, but these treatments still have many shortcomings [23-25]. Therefore, we propose this new clinical diagnosis and treatment scheme.

Through the study of the treatment scheme for left IVCS, a CMI model of anterograde venography of the lower extremities is proposed. Through patient follow-up after their operations, we found a meaningful basis for the endovascular treatment of iliac vein stenosis. After studying the three groups, we found that three months after the operations, group B had significant differences from the other two groups ($P<0.05$), but group A had no great differences from group C ($P>0.05$). Six months after the operations, group A had great statistically significant differences from the other two groups ($P<0.05$), but group B had no significant differences from group C ($P>0.05$). Twelve months after the operations, the QOL scores of group A had a significant difference from the other two groups ($P<0.05$), but there were no statistical differences between group B and group C ($P>0.05$). Liu et al. (2018) explored the application of computer venography in the diagnosis of iliac vein compression syndrome; in addition, the factors associated with the occurrence and development of iliac vein compression syndrome, as well as the recurrence of varicosis, were discussed; the results suggested that computer venography

can identify the severity of iliac vein compression syndrome [26]. Also, it was shown that the computer venography technique has a shorter examination time than venography. However, the research works above suggest that the surgical plan model has a good treatment effect, so it can effectively improve patients' quality of life and reduce the recurrence rate of the disease. Therefore, this model is worthy of extensive application in clinical diagnosis and treatment. The experimental results met the expectations and have an important reference significance for subsequent works. For severe iliac vein stenosis, it is necessary to solve the problem of superficial venous reflux and to operate on the varicose veins of the lower extremities. After the operation, the patients can wear elastic socks to prevent it. For severe iliac vein stenosis, surgeons should carry out the combined surgical treatment of the vascular lumen, which fundamentally solves the problem of venous hypertension.

However, in this study, only venography is used to judge the degree of iliac vein stenosis. The method is too simple, the quantitative index may have errors, and finally, the diagnosis may be mistaken. In future research, scientists should pay attention to the application of various schemes to ensure the accuracy of the quantitative results.

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Disclosure of conflict of interest

None.

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