Comparison of high ligation of great saphenous vein using pneumatic tourniquets and conventional method for great saphenous vein varicosis

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Abstract
To investigate the efficiency of high ligation, great saphenous vein stripping and subfascial perforator vein surgery for treating great saphenous vein varicosis under the assistance of sterilized electric pneumatic tourniquet and Esmarchs bandage.

In total, 274 patients confirmed with primary varicosis between January 2014 and November 2017 were included in this study. Patients were divided into
1. treatment group (n=137), received high ligation, great saphenous vein stripping, and subfascial perforator vein surgery under the assistance of sterilized electric pneumatic tourniquet and Esmarchs bandage; and
2. control group (n=137), received high ligation, great saphenous vein stripping, and subfascial perforator vein surgery only.

After surgery, the affected limbs in both groups were wrapped up using the elastic bandage for 2 weeks, followed by wearing elastic stocking for 6 months. Then we analyzed the intraoperative bleeding, surgery time, subcutaneous hemorrhage after surgery and postoperative pains.

The surgical time in the treatment group was significantly lower than that of control group (58.62 ± 7.47 minutes vs 76.35 ± 9.24 minutes, \(P < .01\)). The intraoperative bleeding in the treatment group was significantly lower than that of the control group (17.56 ± 3.52 ml vs 49.87 ± 8.78 ml, \(P < .01\)).

High ligation, great saphenous vein stripping, and subfascial perforator vein surgery under the assistance of sterilized electric pneumatic tourniquet and Esmarch’s bandage was effective for the treatment of varicosis in lower limbs featured by reduced surgery time and less bleeding.

Abbreviation: CEAP = clinical etiology anatomic pathphysiologic.

Keywords: great saphenous vein, ligation, pneumatic tourniquet, surgery

1. Introduction
Great saphenous vein varicosis is commonly reported with a high prevalence worldwide. There are several treatment options for the treatment, and the efficiency varies among individuals.

Conventionally, its treatment is mainly relied on high ligation, great saphenous vein stripping, and subfascial perforator vein surgery. To date, mini-invasive technique has been utilized for treating great saphenous vein varicosis besides conventional methods. To our best knowledge, high ligation combined with stripping is still the golden standard for treating superficial vein reflux in lower limbs. For the patients with grade C3-C6 lesions, surgery is the major treatment option for primary varicose in lower limbs. For the cases with severe C4-C6 lesions, conventional therapy is reported to lead to more intraoperative bleeding, unclear surgical field, extended surgical duration, postoperative subcutaneous ecchymosis, and high incidence of hematoma. In this study, we modified the conventional therapy for treating great saphenous vein varicosis with an aim to overcome these short-comings.

Conventional surgery for treating great saphenous vein varicosis involves multiple incisions, large trauma, more hemorrhage, and poor recovery and cosmetic appearance. We
hope to modify such surgery based on the utilization of sterilized electric pneumatic tourniquet and Esmarch’s bandage, with an aim to reduce the perioperative and postoperative hemorrhage, the surgery duration, as well as the potential injuries to the peripheral vascular tissues. Meanwhile, small or micro-incisions used for treating varicose veins resulted in less trauma and hemorrhage, rapid recovery, and satisfactory appearance. Such method would improve the satisfaction of the patients, promote the rapid recovery, and reduce the high risks of recurrence.

2. Materials and methods

2.1. Subjects

A total of 274 patients (male: 189; female: 85) confirmed with primary varicosis between January 2014 and November 2017 were included in this study. Patients were divided into 7 grades (C0-C6) according to the criteria of CEAP grading system.[1–3]

The inclusion criteria were as follows:
1. those aged >25 years;
2. with a CEAP grade of C3-C6.

The exclusion criteria were as follows:
1. those with recurrent great saphenous vein varicosis;
2. those with severe return disturbance in the deep veins of lower limb;
3. those with sequela after deep venous thrombosis of lower limbs.

Then the patients were randomly divided into 2 groups:
1. treatment group (n=137), received high ligation, great saphenous vein stripping, and subfascial perforator vein surgery under the assistance of sterilized electric pneumatic tourniquet and Esmarch bandage; and
2. control group (n=137), received high ligation, great saphenous vein stripping, and subfascial perforator vein surgery only.

All cases received the surgery at the affected body side. After surgery, the affected limbs in both groups were wrapped up using the elastic bandage for 2 weeks, followed by wearing elastic stocking for 6 months. Each patient signed the informed consent. The study protocols were approved by the Ethical Committee of Yantai Yuhuangding Hospital.

2.2. Methods

All the patients received color Doppler ultrasonography for the veins of lower extremities before surgery. The patients were randomly divided into 2 groups. The distribution of the varicose veins on the body surface in a standing position was depicted together with the position of the perforator vein of the leg. In the treatment group, patients received pressure dressing with the application of Esmarch bandage with a width of 10 cm, in order to render the reflux of blood in the veins of lower extremities to the heart. The superficial veins were in a state of exsanguine. Then sterilized electric pneumatic tourniquet was used at the middle of the thigh, and the pressure was set at 40 to 45 kpa (Fig. 1). Then the blood flow in the artery of lower extremity was blocked. Then the lower extremity was still in a state of exsanguine. Afterwards, the Esmarch bandage was loosed and removed, followed by maintaining the sterilized electric pneumatic tourniquet in a persistent compressing state (the pressure was in a state of 40–45 kpa). The sterilized electric pneumatic tourniquet was removed after the surgery. High ligation of great saphenous vein and ligation of the perforator vein were given. Few bleeding was noticed in the incisions. The surgical fields were clear. The superficial veins could be managed without ligation. These procedures reduced the surgical time and the incidence of intraoperative bleeding. In the control group, no blockage was given before surgery. Surgery was performed in the lower limbs with normal blood circulation. The active bleeding was obvious in the incisions, and the surgical fields were vague with a longer surgical time and more bleeding. After surgery, the affected limbs in both groups were wrapped up using the elastic bandage and all the patients in both groups were encouraged to have moderate exercises, and anticoagulant (e.g., lower molecular heparin or rivaroxaban) was given to prevent the deep venous thrombosis. The patients wore elastic stocking for about 6 months after application of elastic bandage for about 15 days.

2.3. Observational indices

The intraoperative hemorrhage, surgical time and postoperative subcutaneous ecchymosis, hemATOMA, and pain were evaluated for each group. A single subcutaneous ecchymosis with a diameter of >4 cm was defined as positive findings.

2.4. Statistical analysis

SPSS 19.0 software was used for the data analysis. Measurement data were presented as mean ± standard deviation. Student t test was performed for the inter-group comparison. Numeration data were compared using Chi-Squared test. P < .05 was considered to be statistically significant.
3. Results

3.1. Patient characteristics

The patients aged 32 to 75 years (median, 56.25 ± 8.04 years). No statistical differences were noticed in the age, gender, and clinical grading between the 2 groups (P > 0.05, Table 1).

3.2. Comparison of intra- and post-operative features

In the treatment group (Fig. 1), all patients accomplished the surgery successfully, with no intraoperative bleeding, and deep vein injury. Besides, no subcutaneous hematoma was observed after surgery. In treatment group, only rare cases showed incisal bleeding. The surgical fields were clear in treatment group, and the surgical duration was short. The total bleeding volume was small. In the control group, many cases presented bleeding, which affected the visualization of surgical field. The surgical duration showed extension, and the bleeding volume was larger. Significant decline was noticed in the surgical duration in the treatment group compared with the control group (P < 0.01). Besides, the bleeding volume in treatment group showed significant decrease compared with the control group (P < 0.01). The postoperative subcutaneous hemorrhage in the treatment group showed significant decline compared with the control group, together with significant remission in the pain (P < 0.01, Table 2).

4. Discussion

Great saphenous vein varicosity is commonly reported with a high prevalence worldwide. Varicose of lower limbs are a frequently encountered vascular disorder in the general population. There are several treatment options for the treatment, and the efficiency varies among individuals. Conventionally, its treatment is mainly relied on high ligation, great saphenous vein stripping and subfascial perforator vein surgery. High ligation and stripping has been considered as the classical method for treating such disease as it can eliminate the great saphenous vein reflux and lower the recurrence rate. To our best knowledge, high ligation combined with stripping is still the golden standard for treating superficial vein reflux in lower limbs. However, conventional therapy is reported to induce more intraoperative bleeding, unclear surgical fields, extended surgical duration, postoperative subcutaneous ecchymosis, and high incidence of hematoma. To date, mini-invasive technique has been utilized for treating great saphenous vein varicosity besides conventional methods. Indeed, such technique showed many advantages in the treatment compared to conventional high ligation and stripping, but the long-term recurrence in patients received mini-invasive therapies was higher. Additionally, a number of patients required the second surgery. Furthermore, certain indications and contraindications were already available for each disease, and it should not be performed for all the cases with varicosity. Therefore, we designed this study to raise the attention of conventional methods for the management of such disease.

We hope to improve the conventional surgery techniques using this method. Specifically, the sterilized electric pneumatic tourniquet was used to eliminate the intraoperative hemorrhage, and attenuate the injuries to the peripheral vessel tissues. It increased the possibility of making incisions in a mini-invasive manner, and achieved satisfactory treatment efficiency. Moreover, it could shorten the surgery duration, reduce the intraoperative and postoperative hemorrhage, which finally improved the recovery of affected limbs. We also considered the risks induced by using pneumatic tourniquet. The pressure was set at 40 to 45 kpa, and the persistent duration was controlled within 1 hour. As the block duration was short, the tolerated time for the ischemia of the limbs was more than 1 hour. This would not trigger the severe ischemic necrosis or thrombosis in the lower limbs. After surgery, close attention was paid to the atrial pulse of the lower limb and the edema of the affected limbs, together with evaluation of the risks of lower limb ischemia and thrombosis. Meanwhile, anticoagulant agents were used to prevent the thrombosis as well as the potential complications. In our study, no one showed ischemia in the lower limb and/or thrombosis. Besides, we should carefully exclude the possibility of arteriosclerosis in the lower limb as these patients were not candidate for this surgery in order to prevent the deterioration of ischemia.

In China mainland, high ligation, great saphenous vein stripping and subfascial perforator vein surgery have been commonly utilized for treating varicosity, as they show satisfactory efficiency and low recurrence. Meanwhile, the surgery is easy to perform with no demanding requirements in clinical settings. The reflux of superficial veins was blocked and the varicose superficial veins were cut, which then eliminated the high pressure in veins and varicose superficial veins. Such method is suitable for treating insufficiency of superficial veins of lower limb and valvular insufficiency in the perforator vein, as well as those with moderate reflux or no obstruction in the deep veins. Additionally, it can be helpful to treat the varicosity in superficial veins of lower limb and can block the reflux of perforator vein with poor function to the superficial veins, which contributes to the cure of feet ulcer. Therefore, it is recommended as a type B treatment by Society for Vascular Surgery and the American Venous Forum.

Indeed, there are some limitations in this study. Firstly, there might be differences in the CEAP grade by the physicians.

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Secondly, the sample size in this study was not large enough. In future, large sample sized studies are required, together with close monitoring and follow-up. Thirdly, patients with arteriosclerosis obliterans in the lower limbs were not suitable for this therapy. This may be related to the deterioration of lower limb ischemia induced by hemostasis after compression, which may result in amputation.

In summary, high ligation, great saphenous vein stripping, and subfascial perforator vein surgery under the assistance of sterilized electric pneumatic tourniquet and Esmarchs bandage is effective for the treatment of varicosis in lower limbs. It shows superiorities such as short surgical time, few hemorrhage, rapid recovery, and lower incidence of postoperative subcutaneous hemorrhage. In the developing countries, conventional therapy may be a candidate for such lesion.

Author contributions

Conceptualization: Hui Chen.
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