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Comparison of endovascular microwave ablation and traditional vein stripping for lower extremities varicose veins: a retrospective study

Poređenje endovaskularne mikrotalasne ablacije i tradicionalnog uklanjanja vena kod varikoznih vena donjih ekstremiteta: retrospektivna studija

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Abstract

Background/Aim. Varicose veins typically occur in the superficial veins of the lower extremities and are a significant manifestation of chronic venous disease. Patients' symptoms may vary depending on the pathogenesis, location, and severity of chronic venous disease. The aim of this study was to examine the efficacy of endovascular microwave ablation (EMA) and conventional high ligation with saphenous vein stripping in managing lower extremity varicose veins. **Methods.** This retrospective study included 100 patients diagnosed with unilateral varicose veins of the lower extremity. Of these, 50 underwent ultrasound-guided EMA (EMA group), and 50 received traditional vein stripping (traditional group). We assessed and compared operative duration, blood loss during surgery, number of incisions, hospital stay length, and postoperative complications across both groups. Additionally, the Venous Clinical Severity Score (VCSS) and Aberdeen Varicose Vein Questionnaire (AVVQ) were evaluated at 6 and 12 months postoperatively to determine treatment effectiveness. **Results.** All procedures were completed in the 100 cases. The EMA group had considerably reduced operating durations, less blood loss, fewer incisions, and abbreviated hospital stays relative to the traditional group ($p < 0.05$). Differences in subcutaneous bruising, hematoma formation, and skin burns across the groups were statistically significant ($p < 0.05$), while differences in local sensory changes and incision infection were not ($p > 0.05$). The preoperative and postoperative groups showed no substantial difference in VCSS and AVVQ scores ($p > 0.05$). However, both VCSS and AVVQ scores improved at 6 and 12 months post-surgery ($p < 0.05$). **Conclusion.** Clinical evaluation indicates that EMA's effectiveness is comparable to traditional vein stripping in treating lower extremity varicose veins. EMA also presents safety advantages, suggesting its broader adoption in clinical settings.

Key words:
ablation techniques; ligation; lower extremity; saphenous vein; treatment outcome; varicose veins.

Apstrakt

Uvod/Cilj. Varikozne vene se obično javljaju u površinskim venama donjih ekstremiteta i predstavljaju značajnu manifestaciju hronične venske bolesti. Simptomi kod bolesnika mogu se razlikovati u zavisnosti od patogeneze, lokacije i stepena hronične venske bolesti. Cilj rada bio je da se ispita efikasnost endovaskularne mikrotalasne ablacije (EMA) i konvencionalne visoke ligacije sa uklanjanjem vene safene u lečenju varikoznih vena donjih ekstremiteta. **Metode.** Ova retrospektivna studija obuhvatila je 100 bolesnika sa dijagnozom unilateralnih varikoznih vena donjih ekstremiteta. Od toga, 50 je podvrgnuto ultrazvučno-vođenoj EMA (EMA grupa), a 50 je podvrgnuto tradicionalnom uklanjanju vena (tradicionalna grupa). Procenjivano je i upoređivano trajanje operacije, gubitak krvi tokom operacije, broj rezova, dužina boravka u bolnici i postoperativne komplikacije u obe grupe. Pored toga, *Venous Clinical Severity Score* (VCSS) i *Aberdeen Varicose Vein Questionnaire* (AVVQ) procenjivani su 6 i 12 meseci nakon operacije kako bi se utvrdila efikasnost lečenja. **Rezultati.** Sve procedure su uspešno završene kod svih 100 slučajeva. EMA grupa imala je značajno kraće trajanje operacije, manji gubitak krvi, manje rezova i kraći boravak u bolnici u odnosu na tradicionalnu grupu ($p < 0,05$). Razlike u potkožnim modricama, formiranju hematoma i opekotinama kože među grupama bile su statistički značajne ($p < 0,05$), dok razlike u lokalnim senzitivnim promenama i infekciji reza nisu bile statistički značajne ($p > 0,05$). Preoperativne i postoperativne grupe nisu

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pokazale značajnu razliku u skorovima VCSS i AVVQ ($p > 0,05$). Međutim, i VCSS i AVVQ rezultati su se poboljšali 6 i 12 meseci nakon operacije ($p < 0,05$). **Zaključak.** Klinička procena ukazuje da je efikasnost EMA uporediva sa tradicionalnim uklanjanjem vena u lečenju varikoznih vena donjih ekstremiteta. EMA takođe pokazuje prednosti u pogledu bezbednosti, što sugeriše širu primenu ove procedure u kliničkoj praksi.

Ključne reči:
ablacija, tehnike; ligacija; donji ekstremiteti; v. saphena; lečenje, ishod; vene, varikozne.

Introduction

Lower extremity varicose veins (LEVV) are a prevalent chronic venous disorder in vascular surgery, particularly among middle-aged and elderly individuals. This condition is associated with multiple contributing factors, including genetic predisposition, prolonged standing or sitting, pregnancy, and obesity [1, 2]. In its early stages, patients may experience discomfort in the lower extremities, particularly after prolonged periods of standing or sitting. Additionally, visible clusters of twisted veins often appear due to compromised venous return [3, 4].

Without timely intervention, varicose veins can progress, leading to more severe symptoms. Advanced stages may involve complications such as localized itching in the lower leg area, likely due to underlying inflammatory responses [4]. Hyperpigmentation, or darkened skin, is another frequently observed symptom. Moreover, chronic blood stasis and inflammation can cause further complications, including skin induration, ulcers, and eczema [5, 6]. More severe issues, such as phlebitis and venous thrombosis, can lead to intense pain, swelling, and in rare cases, life-threatening pulmonary embolism [6, 7].

Historically, high ligation and stripping of the saphenous vein have been the primary interventions for LEVV. This surgical approach involves the removal of the affected vein while preserving healthy venous circulation [7, 8]. Although effective, this technique is more invasive, leading to extended recovery times and potential postoperative complications. Recently, advances in medical technology have introduced minimally invasive options, such as endovenous microwave ablation (EMA), which have garnered increasing interest [8, 9]. In EMA, a microwave probe is inserted into the vein, generating heat to occlude the damaged vein and restore normal blood flow. Compared to traditional surgery, EMA offers advantages in reduced trauma and expedited recovery [9].

LEVV warrant timely treatment to avoid progression to more severe complications. Contemporary medical advancements offer several treatment options, allowing patients to choose an approach tailored to their individual circumstances [9, 10].

The aim of this study was to compare the clinical outcomes of EMA with conventional high ligation and stripping of the great saphenous vein in the treatment of LEVV.

Methods

Study population

This study comprised 100 patients with LEVV admitted to the Department of Vascular Hernia Surgery, the First People's Hospital of Linping District, Hangzhou, Zhejiang, China, between August 2022 and March 2024. The cohort consisted of 56 men and 44 women, aged 23 to 72 years, with a mean age of 55.4 ± 10.1 years. Patients were randomly assigned to two groups using a computer-generated randomization sequence, with each group comprising 50 individuals: a group that received ultrasound-guided EMA (the EMA group) and a group that underwent traditional high ligation and stripping of the saphenous vein (the traditional group). The study was approved by the Ethics Committee of the First People's Hospital of Linping District (No. LDSTYU, from February 20, 2022).

Inclusion criteria included the following: clinical assessment of LEVV classified as C2–C6; unilateral onset of varicose veins, confirmed by Doppler ultrasound showing a varicose great saphenous vein; patients who provided informed consent before the surgical procedure on their own or *via* their relatives.

Exclusion criteria were as follows: significant cardiac, pulmonary, or renal failure preventing surgery; presence of deep venous valve insufficiency or deep vein thrombosis (deep venous insufficiency was diagnosed using duplex ultrasound examination, showing reflux duration > 1.0 second in deep veins with provocative maneuvers); prior surgical history of LEVV; pregnancy or lactation; long-term bed rest or high risk of thrombosis; coagulation disorders.

Procedural approach to preoperative preparation

Patients were instructed to walk for 20 min before surgery, with varicose veins marked based on their protrusion.

Endovenous microwave ablation under ultrasound guidance

A SonoScape S8 EXP ultrasound machine (Medsinglong Co., Ltd, Guangdong, China) with a 5–10 MHz probe was used. Patients were placed in a supine position and given epidural anesthesia. Epidural anesthesia was chosen to provide adequate regional anesthesia while allowing patient cooperation and minimizing systemic effects, which is particularly beneficial for elderly patients with comorbidities. The great saphenous vein was punctured 5 cm below the medial knee joint, and a PSI-6F-11-035-18G vascular sheath (Merit Medical Systems, Utah, United States) was introduced, followed by insertion of the ECO-100F-2016 microwave ablation catheter (Nanjing Yigao Medical Technology Co., Ltd., Zhejiang, China). Upon reaching the vein's entrance, the catheter was retracted 2.5 cm, and a tumescent solution (500 mL of normal saline, 10 mL of so-

dium bicarbonate injection, 0.5 mL of epinephrine, and 5 mL of lidocaine) was administered along the vein. The EMA was then performed with a microwave power setting between 30 and 60 W and catheter movement maintained at 1–2 millimeters *per* second, adjusted based on local vascular and skin conditions. Superficial varicose veins in the lower leg were treated using the ECO-100F-1213 microwave ablation needle (Nanjing Yigao Medical Technology Co., Ltd., Zhejiang, China) at 35 W according to premarked areas.

Traditional high ligation and stripping

Patients were positioned supine under epidural anesthesia. Incisions (1–2 cm) were made at the medial ankle and groin. After ligation and severance of the great saphenous vein, it was stripped using the 02R2000 catheter (Gamida Tech, Eaubonne, France). The excised location was compressed for 10 min to manage bleeding, followed by therapy along the vein. Superficial varicose veins in the lower leg were excised and locally stripped *per* preoperative markings.

Postoperative care

Patients received low-molecular-weight heparin calcium injections at a dosage of 4,100 anti-Xa (AXa) international units *per* day from the first postoperative day until discharge. This specific dosage was chosen based on current guidelines for venous thromboembolism prophylaxis in moderate-risk surgical patients [11]. Rivaroxaban (10 milligrams *per* day) was prescribed for anticoagulation for one month to prevent deep vein thrombosis and maintain venous patency during the critical healing period. Patients were advised to wear compression stockings (23–32 millimeters of mercury) for six months to reduce venous hypertension, prevent recurrence, and optimize long-term outcomes. The duration of compression therapy was based on the European Society for Vascular Surgery guidelines, which recommend extended compression therapy following varicose vein interventions to minimize recurrence rates and improve functional outcomes [12].

Outcomes and follow-up

Key outcome measures included operation time, number of incisions, blood loss, hospital stay, and postoperative complications (e.g., subcutaneous bruising, hematoma, paresthesia, incision infection, and skin burns). Ultrasound was used to assess the great saphenous vein on the first postoperative day. Venous Clinical Severity Score (VCSS) and Aberdeen Varicose Vein Questionnaire (AVVQ) scores were recorded at 6 and 12 months postoperatively to evaluate clinical effectiveness. All procedures were performed by experienced vascular surgeons with more than 10 years of experience in varicose vein surgery. Prophylactic antibiotics (cefazolin 1 g) were administered 30 min before surgery in both groups.

Statistical analysis

Data were compiled in WPS Office 2019 software (Kingsoft) and analyzed with SPSS 26.0. Data were analyzed across groups using the χ^2 test. Continuous data are expressed as mean ± standard deviation. The Shapiro-Wilk test for normality was followed by independent sample *t*-tests for normally distributed data, and the Mann-Whitney *U* test was used for non-normal data. The Wilcoxon signed-rank test was used for non-normally distributed data in intra-group comparisons, whereas paired *t*-tests were employed for normally distributed data. The threshold for statistical significance was established at $p < 0.05$.

Results

Comparison of general data between the two groups

There was no statistical significance in the general data between the two groups ($p > 0.05$), as shown in Table 1. In this study, the underlying disease history of the patients was compared between groups using a Chi-square test for the overall distribution of disease categories (including hypertension, diabetes mellitus, coronary artery disease, and no underlying disease), which showed no significant difference ($\chi^2 = 0.921$, $p = 0.105$). Additionally, smoking status was analyzed separately and also showed no significant difference between groups ($\chi^2 = 0.136$, $p = 0.885$). Clinical-Etiology-Anatomy-Pathophysiology (CEAP) grade classification was assessed ($p = 0.078$). The injured extremity showed a *p*-value of 0.304.

Observation index and follow-up

All patients underwent successful treatment. Postoperative ultrasonography confirmed that the great saphenous vein was effectively occluded in the EMA group, whereas it was not detectable in the traditional group. Key indicators, including operation time, intraoperative blood loss, number of incisions, and length of hospital stay, were significantly lower in the EMA group compared to the traditional group ($p < 0.05$) (Table 2). The treated veins included the great saphenous vein in all patients, with mean vein diameters of 6.8 ± 1.2 mm in the EMA group and 7.1 ± 1.4 mm in the traditional group ($p > 0.05$). The great saphenous vein diameter was measured at the saphenofemoral junction using duplex ultrasound in a standing position with the patient bearing weight on the contralateral extremity. No concomitant procedures for the small saphenous vein or accessory saphenous veins were performed in this study.

Following the operation, subcutaneous bruising was observed in 9 cases in the EMA group and 20 cases in the traditional group. Local paresthesia was noted in 6 cases in the EMA group and 12 cases in the traditional group. All cases of bruising and paresthesia gradually resolved without further treatment. The incidence of subcutaneous bruising was significantly higher in the traditional group compared to the EMA group ($p < 0.05$).

In the EMA group, five patients experienced skin burns, all located at the proximal thigh region where the vein was more superficial, which healed with the application of topical burn cream. In the traditional group, 7 cases developed subcutaneous hematomas, and 6 cases experienced incision infections, including one severe infection. These complications improved with symptomatic treatment, anti-inflammatory therapy, and local incision drainage. Significant differences were observed in the incidence rates of subcutaneous hematoma and skin burns between the two groups ($p < 0.05$) (Table 3).

Comparison of VCSS and AVVQ scores between the two groups

There were no significant differences in VCSS and AVVQ scores between the two groups before surgery ($p > 0.05$). However, statistically significant differences in both VCSS and AVVQ scores were observed before and after surgery within each group ($p < 0.05$). The VCSS and AVVQ scores at both 6 and 12 months post-surgery were significantly lower than the preoperative scores ($p < 0.05$). Additionally, there were no statistically significant differ-

Table 1

Comparison of general data between the two groups

Parameters	EMA group	Traditional group	t/χ^2 value	*p*-value
Age, years	57.3 ± 11.2	58.8 ± 10.9	0.873	0.214
Gender			0.265	0.781
male	26	28		
female	24	22		
Weight, kg	72.34 ± 12.65	73.21 ± 11.78	0.642	0.487
Course of disease, years	9.00 (4.00–18.00)	7.00 (2.00–12.00)	1.873	0.096
Underlying disease history			0.921	0.105
hypertension	8	9		
diabetes mellitus	5	6		
coronary artery disease	4	3		
Smoking	11	13	0.136	0.885
CEAP classification			3.168	0.078
C2	5	6		
C3	20	18		
C4	15	13		
C5	6	8		
C6	4	5		
Injured extremity			0.782	0.304
left	24	28		
right	26	22		

EMA – endovenous microwave ablation; CEAP – Clinical-Etiology-Anatomy-Pathophysiology.
All values are presented as numbers, mean ± standard deviation, or median (interquartile range).

Table 2

Comparison of intraoperative and postoperative observation indexes between the two groups

Parameters	EMA group	Traditional group	Z/χ^2	*p*-value
Time of operation, min	58.00 (51.00–66.00)	67.00 (55.00–83.00)	3.674	0.012
Peroperative bleeding, mL	23.00 (18.00–37.00)	73.00 (58.00–92.00)	8.432	0.006
Number of intraoperative incisions	1 (1.00–1.00)	6 (4.00–8.00)	9.241	0.004
Length of stay, days	4.00 (3.00–7.00)	8.00 (6.00–10.00)	6.345	0.009

EMA – endovenous microwave ablation.
All values are presented as medians (interquartile ranges).

Table 3

Comparison of postoperative complications between the two groups

Postoperative complications	EMA group	Traditional group	χ^2 value	*p*-value
Subcutaneous bruising	9	20	4.374	0.018
Subcutaneous hematoma	0	7	/	0.015
Paresthesia	6	12	2.481	0.095
Infection of the incisional wound	0	6	/	0.103
Skin burn	5	0	/	0.009

EMA – endovenous microwave ablation.
All values are presented as numbers.

Table 4

Comparison of VCSS and AVVQ scores between the two groups

Parameters	EMA group	Traditional group	*t*/Z	*p*-value
VCSS score				
before operation	7.00 (4.00–9.00)	8.00 (5.00–10.00)	1.263	0.104
6 months after surgery	3.00 (2.00–4.00)*	2.50 (2.00–3.00)*	1.487	0.097
12 months after surgery	2.00 (2.00–3.00)*	2.00 (1.00–3.00)*	0.873	0.146
AVVQ score				
before operation	12.38 ± 3.19	11.87 ± 2.87	0.784	0.263
6 months after surgery	4.67 ± 2.15*	6.42 ± 2.89*	1.625	0.083
12 months after surgery	3.04 ± 1.85*	4.16 ± 2.16*	1.324	0.099

VCSS – Venous Clinical Severity Score; AVVQ – Aberdeen Varicose Vein Questionnaire; EMA – endovenous microwave ablation.
All values are presented as median (interquartile range) or mean ± standard deviation.
***Note*: *$p < 0.05$ – compared with the same group before operation.**

ences between the scores recorded at 6 months and those recorded at 12 months post-surgery ($p > 0.05$) (Table 4).

Discussion

LEVV are a prevalent vascular condition marked by venous dilation, tortuosity, and functional impairment. This condition impacts not only the appearance of the extremities but also contributes to discomfort, fatigue, and progressive skin changes, which can lead to severe complications in advanced cases [13, 14]. For symptomatic varicose veins (CEAP C2–C6), treatment options include conservative management with compression therapy for patients with C2 disease, while endovenous thermal ablation or surgical intervention is recommended for those with more severe disease (C3–C6) or for patients with C2 disease who have failed conservative treatment [14–16]. Traditionally, the surgical approach involves high ligation and stripping of the saphenous vein, a method designed to remove the affected vein segments, thereby alleviating symptoms and minimizing the risk of further complications. However, this traditional method can be associated with significant tissue trauma, extended postoperative recovery, and risks such as pain, bruising, and other complications [16].

In recent years, advancements in medical technology have led to the emergence of minimally invasive techniques, such as EMA, as effective alternatives for treating LEVV. The EMA offers several advantages over conventional surgery, including reduced trauma, faster recovery, and fewer complications, resulting in improved clinical outcomes and a more aesthetically pleasing cosmetic appearance [17, 18]. By employing a microwave probe within the affected vein, EMA generates heat that effectively closes the dysfunctional vein, restoring normal blood flow with minimal impact on surrounding tissues. This method allows for a more targeted approach, reducing the likelihood of postoperative bruising and minimizing recovery time compared to traditional stripping and ligation procedures.

Our study demonstrates that EMA not only provides comparable efficacy to traditional high ligation and stripping but also offers advantages in terms of safety, with lower rates of complications, including subcutaneous bruising, subcutaneous hematoma, and skin burns. The relatively high complication rates observed in both groups may be attributed to the learning curve associated with these procedures, despite the surgeons' extensive experience. Skin burns in the EMA group (10%) occurred primarily in areas where the saphenous vein was more superficial, suggesting the importance of adequate tumescent anesthesia and careful power adjustment in these regions. These findings support EMA as a valuable treatment modality that may enhance patient outcomes and quality of life. Further research with larger patient cohorts and long-term follow-up is warranted to fully establish EMA as a standard treatment option for LEVV, potentially expanding its use in clinical practice.

The extended hospital stays observed in both groups (median 4 days for EMA and 8 days for traditional surgery) reflect our institutional protocol for postoperative monitoring and anticoagulation management. Although international standards typically advocate for same-day discharge after EMA procedures, our conservative approach was adopted due to the following: a) the need for careful monitoring of anticoagulation therapy initiation, b) patient education regarding compression therapy and ambulation, and c) local healthcare system requirements for insurance coverage. We acknowledge that shorter hospital stays are feasible and may be implemented as experience with these procedures increases.

High saphenous vein ligation combined with EMA is a practical approach for treating LEVV, offering efficacy similar to traditional stripping but with reduced tissue damage [19, 20]. Previous studies have highlighted that EMA provides better outcomes for saphenous vein occlusion, with a lower rate of postoperative recurrence compared to foam sclerotherapy [20, 21]. Additionally, research comparing EMA with endovenous laser ablation suggests that EMA is a safer and more effective alternative, associated with fewer complications and reduced recurrence rates in the management of LEVV [22–24].

In our study, EMA demonstrated advantages over traditional methods in terms of shorter operation times, reduced intraoperative blood loss, fewer incisions, and shorter hospital stays. Although no significant differences were observed in preoperative and postoperative VCSS and AVVQ scores between the EMA and traditional groups, both groups showed substantial improvements in these scores at 6 and 12 months post-surgery, consistent with findings reported by other researchers [25–29]. This suggests that both ultrasound-

guided EMA and traditional stripping effectively reduce the severity of LEVV, with EMA offering the added benefits of less tissue trauma and quicker recovery, contributing to an improved quality of life for patients [28, 29].

The primary postoperative complications observed in the EMA group included subcutaneous bruising and skin burns, along with occasional cases of local paresthesia. In the traditional group, complications such as subcutaneous bruising, local paresthesia, subcutaneous hematoma, and incision infections were noted. Our findings revealed statistically significant differences in the rates of subcutaneous bruising, hematoma, and skin burns between the two groups, while the incidence of incision infections did not differ significantly. The study's limited sample size may contribute to the lack of significance in infection rates.

EMA is a safe and effective alternative to traditional saphenous vein stripping for treating LEVV, providing comparable efficacy with fewer adverse effects. However, the retrospective nature of this study, combined with a small sample size from a single center, suggests the need for further validation through multicenter, prospective studies with larger patient cohorts.

Conclusion

Clinical studies demonstrate that EMA provides efficacy comparable to traditional saphenous vein stripping in the treatment of LEVV. However, EMA offers enhanced safety and fewer complications, making it a favorable option. Therefore, promoting EMA in clinical practice is recommended to improve patient outcomes and recovery in the management of varicose veins.

Conflicts of interest

The authors declare no conflict of interest.

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