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Clinical Research

Less Painful Tumescent Solution for Patients Undergoing Endovenous Laser Ablation of the Saphenous Vein

Tevfik Gunes,[1] Firat Altin,[2] Baris Kutas,[3] Selim Aydin,[4] Kamuran Erkoc,[5] Bortecin Eygi,[6] Ihsan Alur,[1] and Ferit Ozdemir,[3] Denizli, Istanbul, Diyarbakir, Bursa, Bursa, and Izmir, Turkey

Background: This study aims to investigate the efficacy of lidocaine, prilocaine, and bupivacaine used in tumescent solution during endovenous laser treatment (EVLT) on intraoperative and postoperative pain.

Methods: This prospective randomized study included 90 patients. The patients were divided into 3 groups including 30 patients in each group, according to the content of local anesthetics in tumescent solution. All patients received EVLT treatment with lidocaine in group 1, prilocaine in group 2, and bupivacaine in group 3. Visual analog scale was used for the evaluation of intraoperative and postoperative pain.

Results: The mean intraoperative pain score was 2.27 ± 1.53 in group 1, 1.97 ± 1.54 in group 2, and 3.05 ± 0.73 in group 3. On the first day postoperatively, the mean pain score was 2.57 ± 1.7 in group 1, 3.27 ± 1.23 in group 2, and 1.13 ± 0.94 in group 3 ($P = 0.0001$). Intraoperative and postoperative mean pain scores during first day follow-up were significantly lower in group 3.

Conclusions: Tumescent anesthesia is the most critical component of EVLT to improve comfort by reducing the pain. Therefore, we conclude that bupivacaine is an optimal alternative to lidocaine and prilocaine in tumescent anesthesia and can be used safely.

INTRODUCTION

Venous insufficiency, which is a debilitating medical condition, affects approximately 20−40% of individuals.[1−3] The most common symptoms include pain and swelling of the legs and skin color changes.[4] Conventional treatment modalities are ligation and stripping, which require spinal or general anesthesia. In 2001, endovenous laser treatment (EVLT), a minimally invasive modality, was first proposed by Navarro et al.[5] as an alternative to ligation and stripping. EVLT has become increasingly popular for the treatment of varicose veins with incompetent saphenous veins. The possibility of performing the treatment under local anesthesia instead of general anesthesia has been widely accepted among both surgeons and patients.[6]

[1]*Department of Cardiovascular Surgery, Pamukkale University School of medicine, Denizli, Turkey.*

[2]*Department of Cardiovascular Surgery, Mehmet Akif Ersoy Training and Research Hospital, Istanbul, Turkey.*

[3]*Department of Cardiovascular Surgery, Diyarbakır Training and Research Hospital, Diyarbakir, Turkey.*

[4]*Department of Cardiovascular Surgery, Acıbadem Atakent Hospital, Istanbul, Turkey.*

[5]*Department of Cardiovascular Surgery, Medikal Park Hospital, Bursa, Turkey.*

[6]*Department of Cardiovascular Surgery, İzmir Atatürk Training and Research Hospital, Izmir, Turkey.*

Correspondence to: Tevfik Gunes, MD, Department of Cardiovascular Surgery, Pamukkale University Hospital, Denizli 20070, Turkey; E-mail: tevfik04@yahoo.com

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The most critical component for EVLT procedure is the utilization of tumescent anesthesia.[6] Jeffrey A. Klein was the first person who performed tumescent technique with lidocaine in 1987.[7] Currently, prilocaine and bupivacaine as well as lidocaine are often used.[6]

In this study, we aimed to investigate the efficacy of lidocaine, prilocaine, and bupivacaine used in tumescent solution during EVLT on intraoperative and postoperative pain.

MATERIALS AND METHODS

Informed consents were obtained from all patients. The study protocol was approved by the institutional ethics committee. The study was conducted in accordance with the principles of Helsinki Declaration. All patients were willing to participate in the study. This study included a total of 90 consecutive patients with primary venous insufficiency who were diagnosed with great saphenous vein (GSV) reflux between January 2013 and September 2013 in Cardiovascular Outpatient Clinic at Diyarbakir Research and Training Hospital. The patients were divided into 3 groups with 30 patients in each group, according to the content of local anesthetics in tumescent solution. All patients received EVLT treatment with lidocaine in group 1, prilocaine in group 2, and bupivacaine in group 3. Patients' symptoms, varicosities, and signs were assessed using the Clinical, Etiological, Anatomical, Pathological (CEAP)[8] classification and Venous Clinical Severity Score (VCSS)[9] classification. All patients underwent preoperative assessment one day before surgery including complete blood count as well as renal and hepatic function tests. Venous duplex ultrasonography (DUS) (GE LOGIQ 7; General Electrics, Milwaukee, WI) was performed by a radiologist before surgery. Venous reflux was defined as outward flow lasting for >0.5 sec, as assessed by Valsalva maneuver through DUS or distal venous compression–decompression maneuver (augmentation–release test) through spectral Doppler ultrasound. Patients with primary venous insufficiency along with GSV reflux lasting for >0.5 sec were included. Exclusion criteria were as follows: anterior accessory GSV insufficiency, deep venous insufficiency, deep vein thrombosis (DVT), bilateral GSV insufficiency, hypercoagulability, poor overall health status, an aneurysmal saphenous vein diameter of >20 mm, excessive tortuous of the saphenous vein, peripheral arterial disease, pregnancy or nursing, and immobilization. All patients were treated using 1,470-nm diode laser (Ceralas E; Biolitec AG, Bonn, Germany) using a radial fiber probe (ELVeS Radial Fiber; Biolitec AG). The diameter (at the saphenofemoral junction to middle and distal portion of the thigh) and length of the vein which was treated, total energy applied, total tumescent solution, and intraoperative and postoperative pain score according to the visual analog scale (VAS) during follow-up were assessed.[10]

Surgical Technique

All procedures were performed under local anesthesia by 2 same cardiovascular surgeons. One surgeon carried out ultrasonography (USG), while the other performed saphenous vein cannulation as well as EVLT using tumescent solution. All patients underwent repeated DUS preoperatively via MicroMaxx (Sonosite, Inc., Bothel, WA) with a high-resolution HFL 38/13-6 transducer (Sonosite, Inc.) in the standing position to exclude DVT and view the ending of the reflux. Standard EVLT procedure was performed. The optimal cannulation entry site was detected and the saphenous vein was cannulated by using the Seldinger technique. All patients were treated using 1,470-nm diode laser (Ceralas E, Biolitec AG) using a radial fiber probe (ELVeS Radial Fiber; Biolitec AG). The laser fiber catheter was advanced through the introducer sheath toward saphenofemoral junction. The tip of the laser fiber catheter was positioned 2-cm distal to the superficial epigastric vein with ultrasound guidance. Tumescent solution was applied to the perivenous area using a 19-gauge (G) needle (Argon Medical Devices, Plano, TX) under USG. Tumescent solution was infused along the whole saphenous vein trace from the saphenofemoral junction to the puncture site. Attention was paid to the injection of tumescent solution to ensure uniform vein compression around the laser fiber catheter. The location of the catheter was confirmed by USG and the patient was then placed in the trendelenburg position. A measured laser catheter was used with intermittent energy for 5 sec with 1-sec intermittence at a rate of 2 mm/sec. Minimum 55 J/cm energy was planned. The patient was questioned for pain during laser ablation and asked to grade based on the VAS. Saphenous vein occlusion was confirmed by USG following EVLT.

Mini-phlebectomy was performed in patients with >5-mm varicosities under tumescent anesthesia, while patients with <5-mm variocosities were left untouched. A pad was put on the vein treated and elastic bandage compression was applied for the first 24 hr. All patients were instructed to wear compression stockings reaching to the groin

Table I. Demographic characteristics of the patients

	Lidocaine group	Prilocaine group	Bupivacaine group	*P* value
Mean age	36.27 ± 11.87	41.37 ± 13.01	37.37 ± 8.61	0.191
Sex				
Male	21 (70.00%)	14 (46.67%)	19 (63.33%)	0.164
Female	9 (30.00%)	16 (53.33%)	11 (36.67%)	
Mean BMI	25.82 ± 4.21	28.44 ± 4.22	26.13 ± 6.88	0.114
Mean CEAP classification	2.1 ± 0.71	2.37 ± 1.07	2.2 ± 1	0.541
Mean VCSS	4.17 ± 1.91	4.4 ± 1.48	4.4 ± 1.28	0.804

area (20−30 mm Hg) for 4 weeks. Postoperative mobilization was started on the day of surgery. Regular walking exercises were recommended and intensified exercises were not allowed during recovery. All patients were discharged on the day of surgery. No analgesics were given. The patients were scheduled for a visit 3 days later. The pain scores and clinical status were assessed. DUS control was done for reflux and DVT in the postoperative visits. Procedure-related complications included the presence of flow in the venous segment, chronic venous insufficiency symptoms, ecchymosis, skin burn, paresthesia, induration, swelling, and DVT.

Tumescent Solution

Tumescent solution was used to achieve perivenous compression and to prevent intraoperative pain and thermal energy-induced tissue damage.[11] The solution included 500 mL physiological saline; 10 mL, 8.4% sodium bicarbonate (0.84 g sodium bicarbonate); and 1 mL, 0.5 mg adrenalin. In addition to tumescent solution, group 1 received 2% lidocaine hydrochloride (7 mg/kg), group 2 received 2% prilocaine (5 mg/kg), and group 3 received 0.5% bupivacaine (1.75 mg/kg).[12] All solutions were prepared before surgery.

Statistical Analysis

Statistical analysis was performed using NCSS (Number Cruncher Statistical System) v2007 software (NCSS, Inc., Utah). In addition to descriptive studies (mean, standard deviation), repetitive variance analysis and Friedman test were used to assess repeated measurements in multiple groups with normally distributed variables. The Newman−Keuls test was used to compare the means of multiple subgroups, while one-way variance analysis was carried out to evaluate differences between the groups. The Tukey multiple comparison test was performed for subgroup analysis. In addition, the Kruskal−Wallis test was used to compare abnormally distributed variables among the groups, while the Dunn's multiple comparison test was carried out for subgroup analysis. The chi-squared test was used to compare qualitative data. A P value of <0.05 was considered statistically significant. Using the data obtained in our study, power analysis showed 95% confidence interval and 95% power.

RESULTS

In this study, 90 patients underwent EVLT including 30 patients operated in each group. The mean age was 38.3 ± 11.4 years (range 20−70 years). The mean body mass index (BMI) was 27.1 ± 4.7 kg/m^2 (range 16.5−38.5 kg/m^2). Demographic characteristics of the patients are shown in Table I. There was no statistically significant difference in the mean age ($P = 0.191$), BMI ($P = 0.114$), CEAP ($P = 0.541$), and VCSS ($P = 0.804$) among the groups.

Intraoperative data are presented in Table II. No statistically significant difference was observed in the intraoperative data among the groups.

The mean and median pain scores of the patient groups are shown in Table III. Pain scores of the patients intraoperatively ($P = 0.0001$) and on the first day postoperatively ($P = 0.0001$) were statistically significantly lower in group 3, compared with group 1 and group 2. However, there was no statistically significant difference in the mean pain score intraoperatively and on the first day postoperatively between group 1 and group 2 ($P = 0.3880$ and $P = 0.107$).

On the other hand, 8 patients (8.8%) had minor procedure-related complications, including paresthesia in the puncture site in 5 patients (5.5%) and ecchymosis in the mini-phlebectomy site in 3 patients (3.3%). No statistically significant difference was observed in the complications among the groups.

DISCUSSION

In recent years, the minimally invasive laser ablation has become popular in the treatment of venous

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Table II. Intraoperative data

	Lidocaine group	Prilocaine group	Bupivacaine group	*P* value
Mean vein diameter (mm)	6.52 ± 1.33	6.99 ± 1.6	7.04 ± 2.36	0.482
Mean tumescent volume (cc)	302 ± 97.57	299 ± 66.46	332.67 ± 91.65	0.252
Mean treated saphenous length (cm)	31.3 ± 7.41	29.47 ± 6.98	30.07 ± 7.53	0.614
Mean total energy (J)	2,486.83 ± 592.59	2,541.43 ± 770.74	2,522.73 ± 816.54	0.958
Additional intervention				
No	24 (80.00%)	26 (86.67%)	26 (86.67%)	0.713
Varicosity	6 (20.00%)	4 (13.33%)	4 (13.33%)	

Table III. The mean and median pain scores of the patient groups

Pain score	Group I	Group II	Group III	*P* value
Intraoperative				
Mean ± SD	2.27 ± 1.53	1.97 ± 1.54	0.5 ± 0.73	0.0001
Median (IQR)	2 (1−3.25)	1.5 (1−3)	0 (0−1)	
Postoperative day 1				
Mean ± SD	2.57 ± 1.7	3.27 ± 1.23	1.13 ± 0.94	0.0001
Median (IQR)	2 (2−4)	4 (2.75−4)	1 (0−2)	
P value	0.0001	0.0001	0.0001	

IQR, interquartile range; SD, standard deviation.

insufficiency. Thanks to its easy handling under local anesthesia, and it has been widely adopted by both physicians and patients.[6]

Tumescent anesthesia, which is one of the most critical components of EVLT, offers a safer and effective anesthesia status for patients. The major goals of perivenous tumescent anesthesia are to prevent thermal energy-induced tissue damage and to compress the vein being treated and allowing early mobilization. It also reduces the incidence of postoperative DVT.[13] Anesthesia techniques may range from general anesthesia combined with tumescent anesthesia, spinal anesthesia combined with tumescent anesthesia, sedation combined with tumescent solution without local anesthetic drug, or tumescent anesthesia alone, when EVLT is performed with synchronous phlebectomy.[6,14] In our study, we used the latter anesthesia technique in all patients.

Minor and usually transient complications including bruising, tenderness, stiffness, and pain along the vein segment treated may develop following EVLT. These complications are reduced over time and spontaneously resolved.[15] In our study, we observed no significant difference in the procedure-related complication rates among the groups. Kendler et al.[6] and Sadick and Wasser[16] reported similar incidences of paresthesia in their study. However, the incidence of ecchymosis was quite lower in our patients (3.3%), compared with the reports of Sadick and Wasser (61.7%).[16]

Postoperative pain is common following EVLT. Several studies have shown that postoperative pain is not associated with the energy applied.[17] In our study, we observed no statistically significant difference in the energy applied among the groups ($P = 0.958$). However, there was statistically significant difference in the intraoperative pain scores among the groups ($P = 0.0001$). Bupivacaine group had lower intraoperative pain scores.

In a study, Roos et al.[18] used lidocaine for the local anesthesia. The authors reported that the mean pain score (VAS: 0−10) was 2 in the postoperative period. Similarly, Rasmussen et al.[19] and Shepherd et al.[20] reported a mean pain score of 2 and 2.3, respectively. Likewise, we reported 2.57 (VAS: 0−10) in the lidocaine group, 3.27 in the prilocaine group, and 1.1 in the bupivacaine group on the first postoperative day. It indicated a statistically significantly lower pain score in the bupivacaine group ($P = 0.0001$). In another study using lidocaine in combination with prilocaine, Kendler et al.[6] reported a mean pain score of 0.44 on the first postoperative day.

In another study comparing EVLT and radiofrequency (RF) using lidocaine as a local anesthetic agent, Shepherd et al.[20] reported lower mean pain scores in patients undergoing RF within the first 10 days of the procedure (2.2 vs. 3.4, respectively). In contrast, we performed EVLT in all patients with a mean pain score of 1.57 in the lidocaine group, 2.24 in the prilocaine group, and 0.61 in the bupivacaine group during 3-day follow-up.

Although rare, local anesthetics may induce allergic reactions in some patients. High systemic

exposure to lidocaine or prilocaine or bupivacaine may lead to systemic toxicities. The major manifestations of systemic toxicity which may also affect the central nervous system include stimulation, numbness in the lips and tongue, tinnitus, somnolence, convulsion, apnea, and coma. Moreover, cardiovascular events such as tachycardia and hypertension at low plasma concentrations, and bradycardia, arrhythmia, and cardiac arrest at high plasma concentrations may be triggered. Methemoglobinemia which is related to the use of prilocaine may also develop. Clinical cyanosis may present if plasma methemoglobin level exceeds 12−15%. Methemoglobinemia can be treated by an intravenous injection of methylene blue 1% (1 mg/kg) or ascorbic acid (vitamin C, 1,000−2,000 mg).[21,22] In this study, we did not observe any allergic reaction or systemic toxicity because of local anesthetic agents.

CONCLUSION

In conclusion, tumescent anesthesia is the most critical component of EVLT to improve comfort by reducing the pain. Our study results indicate that bupivacaine offers more prolonged pain relief intraoperatively and postoperatively than lidocaine or prilocaine. Therefore, we conclude that bupivacaine is a good alternative to lidocaine and prilocaine in tumescent anesthesia and can be used safely.

REFERENCES

1. Beebe-Dimmer JL, Pfeifer JR, Engle JS, et al. The epidemiology of chronic venous insufficiency and varicose veins. Ann Epidemiol 2005;15:175−84.
2. Lurie F, Creton D, Eklof B, et al. Prospective randomized study of endovenous radiofrequency obliteration (closure) versus ligation and vein stripping (EVOLVeS): two year follow-up. Eur J Vasc Endovasc Surg 2005;29:67−73.
3. Oguzkurt L. Endovenous laser ablation for the treatment of varicose veins. Diagn Interv Radiol 2012;18:417−22.
4. Weiss RA, Feied CF, Weiss MA. Vein Diagnosis and Treatment: A Comprehensive Approach. New York: McGraw-Hill, 2001.
5. Navarro L, Min RJ, Bone C. Endovenous laser: a new minimally invasive method of treatment for varicose veins: preliminary observations using an 810 nm diode laser. Dermatol Surg 2001;27:117−22.
6. Kendler M, Simon JC, Wetzig T. Local anesthesia with lidocaine and prilocaine, using the tumescent technique, for the radiofrequency ablation of lower extremity varicose veins. Int J Dermatol 2013;52:739−44.
7. Klein JA. The tumescent technique for liposuction surgery. Am J Cosmetic Surg 1987;4:263−7.
8. Eklöf B, Rutherford RB, Bergan JJ, et al., American Venous Forum International Ad Hoc Committee for Revision of the CEAP Classification. Revision of the CEAP classification for chronic venous disorders: consensus statement. J Vasc Surg 2004;40:1248−52.
9. Rutherford RB, Padberg FT Jr, Comerota AJ, et al. Venous severity scoring: an adjunct to venous outcome assessment. J Vasc Surg 2000;31:1307−12.
10. Hawker GA, Mian S, Kendzerska T, et al. Measures of adult pain: Visual Analog Scale for Pain (VAS Pain), Numeric Rating Scale for Pain (NRS Pain), McGill Pain Questionnaire (MPQ), Short-Form McGill Pain Questionnaire (SF-MPQ), Chronic Pain Grade Scale (CPGS), Short Form-36 Bodily Pain Scale (SF-36 BPS), and Measure of Intermittent and Constant Osteoarthritis Pain (ICOAP). Arthritis Care Res (Hoboken) 2011;63(Suppl 11)):240−52.
11. Wetzig T, Averbeck M, Simon JC, et al. Local anesthesia in dermatology. J Dtsch Dermatol Ges 2010;8:1007−17.
12. Rosenberg PH, Veering BT, Urmey WH. Maximum recommended doses of local anesthetics: a multifactorial concept. Reg Anesth Pain Med 2004;29:564−75.
13. Memetoglu ME, Kurtcan S, Kalkan A, et al. Combination technique of tumescent anesthesia during endovenous laser therapy of saphenous vein insufficiency. Interact Cardiovasc Thorac Surg 2010;11:774−7.
14. Cavallini A, Marcer D, Bernardini G, et al. Endovenous laser ablation of great saphenous veins performed using tumescent cold saline solution without local anesthesia. Ann Vasc Surg 2014;28:951−6.
15. Caliskan KC, Cakmakci E, Celebi I, et al. Endovenous 1470 nm laser treatment of the saphenous vein: early report of pain assessment. J Cardiovasc Surg (Torino) 2013;54:263−7.
16. Sadick NS, Wasser S. Combined endovascular laser plus ambulatory phlebectomy for the treatment of superficial venous incompetence: a 4-year perspective. J Cosmet Laser Ther 2007;9:9−13.
17. Proebstle TM, Moehler T, Herdemann S. Reduced recanalization rates of the great saphenous vein after endovenous laser treatment with increased energy dosing: definition of a threshold for the endovenous fluence equivalent. J Vasc Surg 2006;44:834−9.
18. Roos MT, Borger van der Burg BL, Wever JJ. Pain perception during and after VNUS ClosureFAST™ procedure. Phlebology 2011;26:209−12.
19. Rasmussen LH, Lawaetz M, Bjoern L, et al. Randomized clinical trial comparing endovenous laser ablation, radiofrequency ablation, foam sclerotherapy and surgical stripping for great saphenous varicose veins. Br J Surg 2011;98:1079−87.
20. Shepherd AC, Gohel MS, Brown LC, et al. Randomized clinical trial of VNUS ClosureFAST radiofrequency ablation versus laser for varicose veins. Br J Surg 2010;97:810−8.
21. Dillane D, Finucane BT. Local anesthetic systemic toxicity. Can J Anaesth 2010;57:368−80.
22. Guay J. Methemoglobinemia related to local anesthetics: a summary of 242 episodes. Anesth Analg 2009;108:837−45.