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Research Article

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The Reasonability of Using Complex Medical Prescriptions for Tumescent Anesthesia When Performing Endovenous Laser Obliteration of Varicose Veins

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INTRODUCTION Despite the widespread use of methods for thermoobliteration of varicose veins, there are no standards for prescribing solutions for tumescent anesthesia when performing these operations. Existing prescriptions can be difficult, both in terms of finding the necessary components in a certain concentration, and in terms of correct dilution of the components in saline.

AIM OF STUDY To determine the reasonability of using complex medicinal prescription solutions for tumescent anesthesia when performing endovenous laser obliteration of varicose veins of the lower extremities.

MATERIAL AND METHODS The prospective study included 64 patients who underwent endovenous laser obliteration of the great or small saphenous vein. The operations were performed in accordance with the standard protocol on a device with a wavelength of 1,940 nm and radiation power from 5.0 to 6.0 W. Tumescent anesthesia was created using an automatic infiltration pump using 21 G needles with a length of 120 mm. Group I included patients (n=34) who were anesthetized with a 0.1% lidocaine solution at room temperature. Group II included patients (n=30), for whom the anesthesia solution was prepared according to Klein's standard prescription for tumescent anesthesia. The distribution of patients into groups was carried out using random sampling. Evaluation criteria: the presence or absence of complaints of pain during surgery and the level of pain assessed using a visual analogue scale.

RESULTS The groups did not differ statistically significantly in terms of main clinical and demographic indicators ($p<0.05$). Complaints of pain or burning during surgery were made by 2 patients (5.9%) in group I and 5 patients (16.7%) in group II ($p=0.0023$). The average pain value according to the visual analogue scale in group I was 0.75 cm [0.30; 1.44], in group II – 1.85 cm [0.85; 2.72], $p=0.0017$, while in group I the maximum number of patients — 24 (70.6%) were distributed in the range of 0–1 cm, in group II the maximum number of patients, 17 (56.7%) were distributed in the range of 1.5–3 cm according to a visual analogue scale.

CONCLUSIONS When using a simple 0.1% lidocaine solution for tumescent anesthesia, a significantly lower average pain value according to VAS was obtained in comparison with the group of patients who used the standard D. Klein solution (0.75 cm and 1.85 cm, respectively, $p=0.0017$). Also, for the study group, a significantly lower frequency of perioperative complaints and complaints of severe pain was obtained ($p<0.01$). The use of complex prescriptions of solutions for tumescent anesthesia when performing endovenous laser obliteration of varicose veins is impractical. The use of a simple 0.1% lidocaine solution at room temperature, while following the surgical protocol, provides comfortable anesthesia.

Keywords: varicose veins, endovenous laser obliteration, tumescent anesthesia, pain, visual analogue scale

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EVLO – endovenous laser obliteration
GSV – great saphenous vein
RFA – radiofrequency ablation
SSV – small saphenous vein
VAS – visual analogue scale
VVLE – varicose veins of the lower extremities

INTRODUCTION

Endovenous laser ablation (EVLO) and radiofrequency ablation (RFA) are recognized not only as the "gold standard" of surgical treatment of varicose veins of the lower extremities (VVLE), but are already considered traditional [1, 2]. To date, due to good long-term results, convenience and availability, and the possibility of using local tumescent anesthesia, endovenous thermal methods have become the most widespread [3].

At the same time, a number of authors point to the presence of discomfort and pain during EVLO under tumescent anesthesia, often associating this with the pH of the anesthetic medium. In reality, the physiological solution has a pH that fluctuates in the range from 5.0 to 7.5.

When lidocaine and adrenaline are added, the solution environment becomes more acidic. It is believed that this fact is the cause of painful sensations when creating tumescent anesthesia. The addition of sodium bicarbonate shifts the environment towards alkaline, which reduces pain [4]. Thus, the most common is the classic D. Klein solution, which involves adding 12.5 ml of 8.4% sodium bicarbonate solution to 1000 ml of 0.05% lidocaine solution with the addition of 0.4 ml of adrenaline [5]. However, the frequent use of 0.05% lidocaine solution, the lack of production of sodium bicarbonate in Russia in the specified concentration prompt a number of specialists to search for the most optimal drug prescriptions.

For example, there is a publication that shows the advantage of an increased content of sodium bicarbonate (142.8 ml of 4% sodium bicarbonate solution per 1000 ml of 0.05% lidocaine solution) [6]. Another work indicates the advantage of a tumescent anesthesia solution without the addition of adrenaline, but with the addition of 25 ml of 5% sodium bicarbonate solution per 500 ml of physiological solution [7]. Finally, a textbook describing the standards and protocol for EVLO also calls for abandoning the addition of adrenaline, but recommends using a 0.1% lidocaine solution in large volumes [8].

Another controversial issue is the optimal temperature of the anesthetic solution - some publications indicate the need to cool the solution to 4-10°C [9], on the other hand, increasing the temperature of the solution to 37°C allows increasing the pH, which can serve as an additional factor in reducing pain [10, 11]. At the same time, a number of publications do not indicate the need to maintain the temperature of the anesthetic solution at a certain level to achieve a greater effect, which means that it is possible to use a solution at room temperature [8, 12].

Thus, it is obvious that there are no standards for the prescription of solutions for tumescent anesthesia in EVLO. In addition, existing prescriptions may present certain difficulties, both in terms of finding sodium bicarbonate of the required concentration and in terms of diluting the components in physiological solution.

Aim of study: to determine the feasibility of using complex medicinal formulations of solutions for tumescent anesthesia during endovenous laser obliteration of varicose veins of the lower extremities.

MATERIAL AND METHODS

The prospective study included patients who underwent EVLO for VVLE in 2021–2022. All patients underwent EVLO in compliance with the standard protocol using a laser device with a wavelength of 1940 nm. The radiation power was selected depending on the vein diameter and ranged from 5.0 to 6.0 W. For all patients, radial-type light guides with a diameter of 375 μm were used. In all observations, a continuous pulse delivery mode was set from constant pressing on the pedal.

The study included only patients who underwent EVLO of the great saphenous vein (GSV) or small saphenous vein (SSV). A number of operations were supplemented by miniphlebectomy. The study did not include patients who underwent EVLO of perforating or non-aphenous veins due to the short duration of EVLO.

Tumescent anesthesia was created using an automatic infiltration pump with 21G needles of 120 mm length. The anesthetic solution was supplied to the fascial sheath of the GSV or SSV, thus forming an aqueous "muff" around the vein, pressing the latter to the light guide and creating a barrier between the vein and the surrounding tissues (Fig. 1). In the case of mini-phlebectomy of subcutaneous tributaries, infiltration of the tissues surrounding the vein was created until the soft ridges were reached (Fig. 2).

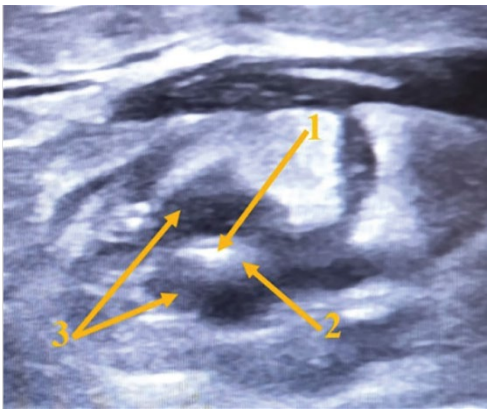

Fig. 1. Tumescent anesthesia. 1 — light guide; 2 — large saphenous vein, pressed against the light guide; 3 - anesthetic solution

Fig. 2. Infiltrative anesthesia for mini-phlebectomy

Group I included patients (n = 34) who underwent tumescent anesthesia with 0.1% lidocaine solution at room temperature. To prepare this anesthetic, 5 ml of 10% lidocaine solution were added to 500 ml of physiological solution. Group II included patients (n = 30) for whom the anesthetic solution was prepared according to the standard prescription of D. Klein in terms of 5% sodium bicarbonate solution: 5 ml of 10% lidocaine solution, 25 ml of 5% sodium bicarbonate solution and 0.2 ml of 0.1% adrenaline solution were added to 500 ml of physiological solution. Patients were distributed into groups using random sampling.

The evaluation criteria were: the presence or absence of complaints of pain during surgery and the level of pain assessed using a visual analogue scale (VAS).

Statistical processing of the material was performed using the *STATISTICA program* for *Windows* Version 10.0 (*Statsoft* , *Inc.* , USA). The normality of distribution was tested using the Shapiro–Wilk method. The χ^2 criterion was used to compare qualitative variables; for groups by quantitative characteristics, the Mann–Whitney criterion was used. Differences were considered statistically significant at p <0.05.

RESULTS

The characteristics of patients in the groups are presented in Table 1.

Table 1

Characteristics of patients in groups

Indicators	Group I (*n* =34)	Group II (*n* =30)	*p*
Gender, *n* (%): male female	 24 (70.6) 10 (29.4%)	 22 (73.3%) 8 (26.7%)	0.604
Age, years	46.1±10.4	47.8±11.2	0.876
Clinical class of the disease according to CEAP			0.227
C 2	18 (52.9%)	16 (53.4%)	
C 3	5 (14.7%)	4 (13.3%)	
C 4	6 (17.7%)	6 (20.0%)	
C 5	4 (11.8%)	4 (13.3%)	
C 6	1 (2.9%)	–	
EVLO GSV	25 (73.5%)	23 (76.7%)	0.447
EVLO SSV	9 (26.5%)	7 (23.3%)	0.509
Supplementation of EVLO with mini-phlebectomy	24 (70.6%)	23 (76.7%)	0.244
Average duration of operation, min	53±12	52±10.5	0.907

Notes: EVLO GSV — endovenous laser obliteration of the great saphenous vein; EVLO SSV — endovenous laser obliteration of the small saphenous vein

Directly during the manipulations, 2 patients (5.9%) in group I and 5 patients (16.7%) in group II complained of painful sensations or burning (p = 0.0023).

The average pain value according to VAS in group I was 0.75 cm [0.30; 1.44], in group II — 1.85 cm [0.85; 2.72], p = 0.0017 (Fig. 3). Complete absence of pain was reported by 4 patients (11.8%) in group I and 1 patient (3.3%) in group II (p < 0.001). Severe pain (> 5 cm according to VAS) was reported by 2 patients (6.7%) in group II. In group I, none of the patients reported pain > 5 cm according to VAS. The maximum pain values for patients in group I were 3.85 cm, for patients in group II — 6.2 cm.

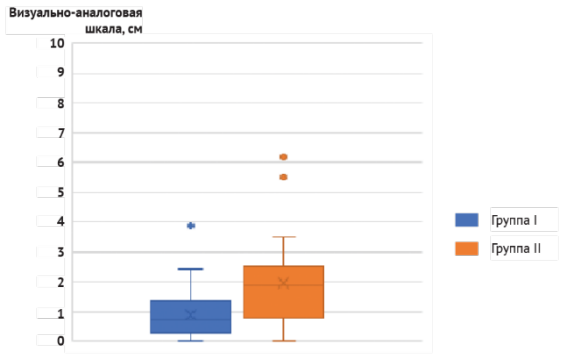

Fig. 3. Average pain values according to the visual analogue scale in the study groups

In group I, the maximum number of patients, 24 (70.6%), were distributed in the 0-1 cm interval according to VAS, in group II, the maximum number of patients, 17 (56.7%), were distributed in the 1.5-3 cm interval according to VAS (Fig. 4).

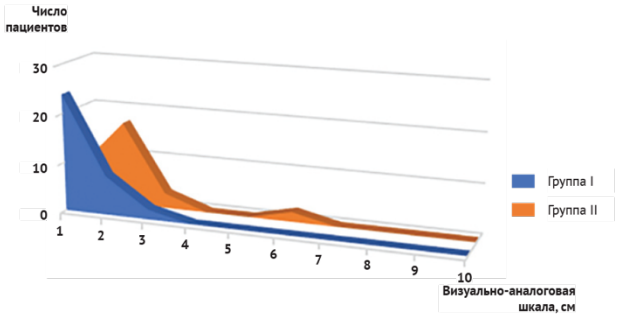

Fig. 4. Distribution of patients by pain level, according to the visual analogue scale

DISCUSSION

Currently, there are no standards in the prescription of anesthetics for tumescent anesthesia for thermal methods of varicose vein obliteration, and the combinations of drugs and their dosages are determined by the preferences and skills of surgeons, and probably by the availability of funds. The introduction of a number of drugs into anesthetic solutions is designed to achieve certain effects. Thus, the addition of adrenaline provides vasoconstriction , which is important for complete obliteration of the thermally treated vein, as well as for the prevention of hematomas [13]. At the same time, adrenaline, which is part of the standard D. Klein solution for tumescent anesthesia, prolongs the effect of lidocaine. The latter can cause side effects such as headache, dizziness, arrhythmia. Therefore, a number of surgeons prefer to refuse the use of adrenaline. In addition, high-quality vein obliteration and minimal tissue trauma are achieved not by the vasoconstriction effect, but by following the surgical protocol, creating the correct case from the anesthetic solution around the vein and choosing the optimal energy mode [8, 14]. This also serves as a determining factor in protecting surrounding tissues, so we also refuse to cool the solution.

Sodium bicarbonate solution increases the pH of the medium, which, according to some authors, reduces pain and accelerates the onset of lidocaine action [15, 16]. The literature also describes studies on the use of more alkaline solutions obtained by adding large volumes of sodium bicarbonate [4, 6, 10]. In our opinion, the validity of obtaining such solutions is controversial. Firstly, tumescent anesthesia traditionally uses a low-concentration lidocaine solution (0.05% or 0.1%), which cannot significantly reduce the pH of the physiological solution, which is close to neutral. Secondly, such low concentrations of lidocaine make it possible to use large volumes of the solution. In our observations, the maximum volume of 0.1% lidocaine solution was 1200 ml, which is significantly lower than the threshold dose (35 mg/kg body weight), which corresponds to 3,000 ml of such a solution [17]. Such volumes of lidocaine solution ensure thorough tissue infiltration and the creation of a uniform volumetric cushion around the vein, which is a determining factor in reducing pain.

The simple 0.1% lidocaine solution we used showed a number of advantages for both patients and surgeons. Statistically significantly lower values of pain sensations according to VAS and almost complete absence of complaints from patients of group I compared to patients of group II objectively indicate the advantage of this solution over D. Klein's solution or its analogues. The simplicity of the solution preparation, the absence of the need for its cooling significantly save the doctor's time, eliminate the risks of practical errors.

CONCLUSIONS

1. When using a simple 0.1% lidocaine solution for tumescent anesthesia, a statistically significantly lower mean pain value was obtained on the visual analogue scale compared to the group of patients who used the standard D. Klein solution (0.75 cm and 1.85 cm, respectively, $p = 0.0017$). Also, for the study group, a statistically significantly lower frequency of perioperative complaints and complaints of severe pain was obtained ($p < 0.01$).

2. The use of complex formulations of solutions for tumescent anesthesia when performing endovenous laser obliteration of varicose veins is inappropriate.

3. The use of a simple 0.1% lidocaine solution at room temperature, while following the surgical protocol, ensures comfortable anesthesia.

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