Cardiovasc Intervent Radiol
DOI 10.1007/s00270-012-0366-4

CLINICAL INVESTIGATION

US-Guided Femoral and Sciatic Nerve Blocks for Analgesia During Endovenous Laser Ablation

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Received: 25 November 2011 / Accepted: 8 February 2012

Abstract
Purpose Endovenous laser ablation may be associated with significant pain when performed under standard local tumescent anesthesia. The purpose of this study was to investigate the efficacy of femoral and sciatic nerve blocks for analgesia during endovenous ablation in patients with lower extremity venous insufficiency.
Methods During a 28-month period, ultrasound-guided femoral or sciatic nerve blocks were performed to provide analgesia during endovenous laser ablation in 506 legs and 307 patients. The femoral block ($n = 402$) was performed at the level of the inguinal ligament, and the sciatic block at the posterior midthigh ($n = 124$), by injecting a diluted lidocaine solution under ultrasound guidance. After the blocks, endovenous laser ablations and other treatments (phlebectomy or foam sclerotherapy) were performed in the standard fashion. After the procedures, a visual analogue pain scale (1–10) was used for pain assessment.
Results After the blocks, pain scores were 0 or 1 (no pain) in 240 legs, 2 or 3 (uncomfortable) in 225 legs, and 4 or 5 (annoying) in 41 legs. Patients never experienced any pain higher than score 5. The statistical analysis revealed no significant difference between the pain scores of the right leg versus the left leg ($p = 0.321$) and between the pain scores after the femoral versus sciatic block ($p = 0.7$).
Conclusions Ultrasound-guided femoral and sciatic nerve blocks may provide considerable reduction of pain during endovenous laser and other treatments, such as ambulatory phlebectomy and foam sclerotherapy. They may make these procedures more comfortable for the patient and easier for the operator.

Keywords Nerve block · Varicose veins/therapy · Sclerotherapy/methods

Introduction

Endovenous laser ablation (ELA) is a well-accepted alternative to surgery for the treatment of superficial venous insufficiency [1–7]. The procedure is normally performed by using local tumescent anesthesia (TA). TA not only eliminates pain during ELA, but also protects the surrounding tissues from the conduction of heat from the laser [1, 2]. However, multiple needle punctures and, particularly, injection of the local anesthetic (LA) solution along the veins, such as great saphenous vein (GSV) and small saphenous vein (SSV), may induce considerable pain during TA [8]. Although the intensity of the pain is "tolerable" for most patients, it may be quite a "bad experience" for the others. Pain may be particularly intense if the patient develops venous spasm during the catheterization. Additional pain also may be created if ambulatory phlebectomy (AP) or ultrasound-guided foam sclerotherapy (USGFS) are performed concomitantly following ELA.

A number of methods are used currently to decrease pain during ELA. Some physicians, particularly surgeons, perform the procedure under spinal or even general anesthesia [8]. Although the patient has "no pain" with these methods, they are generally not recommended because: (1) delayed mobilization may increase the risk of deep venous thrombosis; (2) deep anesthesia may increase the risk of accidental saphenous or sural nerve injury during ELA [9, 10]; (3) although rare, serious complications can occur,

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Published online: 14 March 2012

such as myocardial infarction, cardiac arrest, and neurologic deficits [11, 12]; and (4) the cost is increased because the procedure requires a dedicated staff and hospital stay. Other physicians use oral or parenteral analgesics to overcome the pain problem. Our personal experience does not favor this method because: (1) standard NSAIDs are generally effective for postoperative pain, but they are not sufficient against pain during the procedure; and (2) narcotic analgesics are more effective, but may cause hypotension, respiratory depression, decreased consciousness, and hemodynamic problems, especially when given parenterally, and thus, may interfere with the mobility of the patient after the procedure.

Alternatively, ultrasound-guided (US)-guided femoral nerve block (FNB) or sciatic nerve block (SNB) may be used for analgesia during ELA. FNB has been widely used in orthopedic and trauma surgery [13, 14], but in varicose vein surgery, it has not been very popular [15, 16], although sensory innervation areas of the femoral and sciatic nerves may strongly favor their use for interventions on GSV and SSV [17]. The purpose of this study was to investigate the efficacy of FNB and SNB for analgesia during endovenous ablation in patients with lower extremity venous insufficiency.

Material and Methods

Between June 2009 and October 2011, US-guided FNB or SNB were performed in 506 legs in 307 consecutive patients. In all of these patients, there were typical symptoms and signs of chronic venous insufficiency, and color Doppler ultrasound showed incompetence of the GSV, SSV, perforating vein (PV), or a combination of them. The incompetent veins were treated with ELA and the remaining varicosities, with AP or USGFS, mostly in the same session. In these patients, the nerve blocks were performed shortly before the treatments to provide analgesia mainly for ELA. The data for these patients were retrospectively collected and analyzed for the present study. The demographic and clinical aspects of our patients are given in Table 1.

Before all the nerve blocks and subsequent treatments, potential risks and benefits were explained in detail, and an informed, written consent was obtained from each patient. Also, throughout the study, the principles of Helsinki declaration were strictly followed. Institutional review board approval was not obtained, because it is not required for retrospective studies at our institution. We performed FNB when the patient had an incompetent GSV or PV located in the anterior or medial aspect of the leg, and SNB when the patient had an incompetent SSV or PV located in the posterior or lateral aspect of the leg (Fig. 1).

Table 1 Demographic and clinical aspects of the study population

No. of patients	307 patients, 506 legs (bilateral in 199 patients)
Age (year)	23–66
Sex	251 female, 56 male
Incompetent veins	547 (398 GSV, 110 SSV, 39 PV)
Clinical classification (CEAP) in 506 legs	C1 ($n = 29$)
	C2 ($n = 308$)
	C3 ($n = 43$)
	C4a ($n = 39$)
	C4b ($n = 34$)
	C5 ($n = 28$)
	C6 ($n = 25$)

For the FNB, the patient was put supine. After the groin was disinfected with alcohol, the common femoral artery (CFA) and common femoral vein (CFV) were visualized at the level of the inguinal ligament with a 7.5-MHz linear transducer in transverse section. Lateral to the CFA, a hyperechoic triangle formed by the fascia iliaca, CFA and iliopsoas muscle was demonstrated, where the femoral nerve fibers were located. Then, 40–50 mg of lidocaine diluted in 10–20 ml of saline was injected into this triangle under US guidance, using a 22-gauge needle and a short connection line (Fig. 2). In FNB, we injected the LA diffusely into this triangle via multiple injections, because femoral nerve fibers are scattered in this area. We paid particular attention to injecting the solution along the posterior border of this triangle, because the posterior branch of the femoral nerve, which innervates the below-the-knee region, is located in this section.

For sciatic block, the patient was put prone. The posterior aspect of the knee and lower thigh were disinfected with alcohol. The popliteal artery and vein were visualized in the popliteal fossa with a 7.5-MHz linear transducer in transverse section. The sciatic nerve was first identified posterolateral to the popliteal artery at the knee, and then scanned up to the midthigh level, where it was easily seen as a round echogenic area (Fig. 3). Then, 40–50 mg of lidocaine diluted in 10–20 ml of saline was injected around the nerve under US guidance. In SNB, we injected the LA solution around the sciatic nerve, rather than inside the nerve, because the latter may result in a profound motor block rather than a predominantly sensory block. In both FNB and SNB, when the patient felt an electric shock sensation in the leg, we presumed that the needle was inside the nerve and continued the LA injection only after we withdrew the needle 1–2 mm.

After the blocks, ELA procedures were performed using our standard TA [lidocaine (400 mg/l = 0.04 %), epinephrine (1 mg/l = 1:1,000,000) and sodium bicarbonate (10 milliequivalents/l) in a physiologic saline solution] by

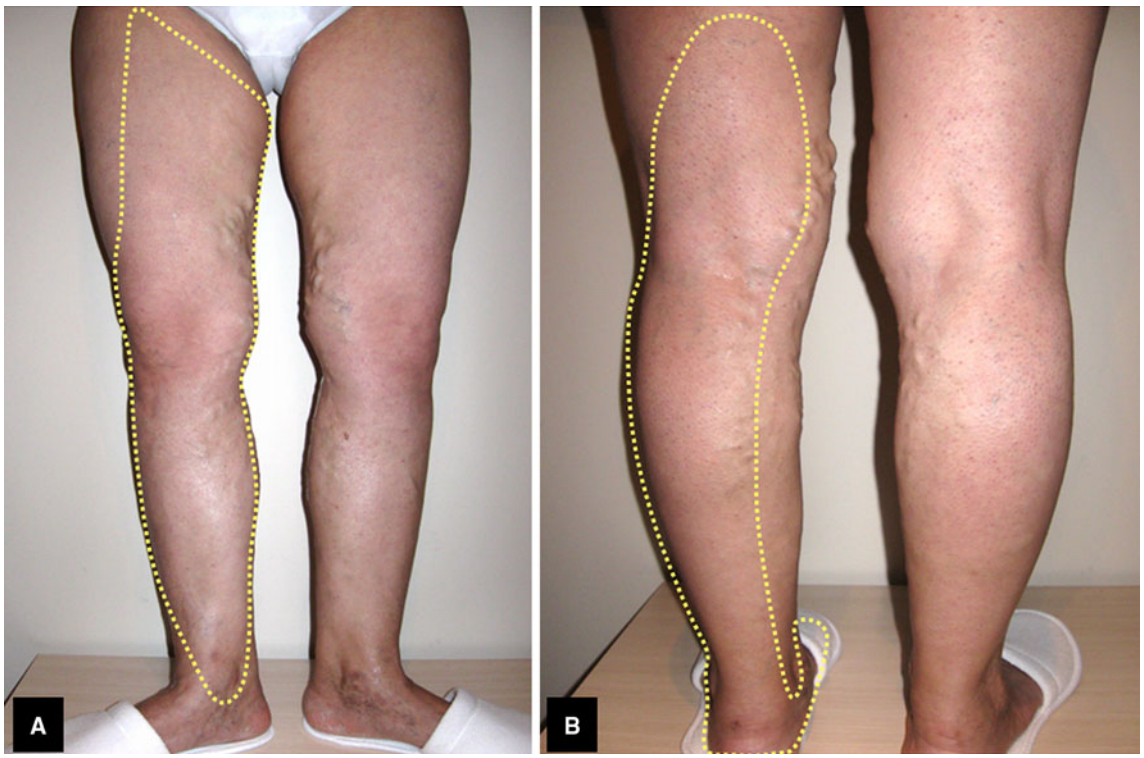

Fig. 1 The approximate cutaneous sensory innervation areas of the femoral nerve (**A**) and sciatic nerve (**B**). Note that the former corresponds to the location of the GSV and resultant varicosities, and the latter corresponds to the location of the SSV and resultant varicosities

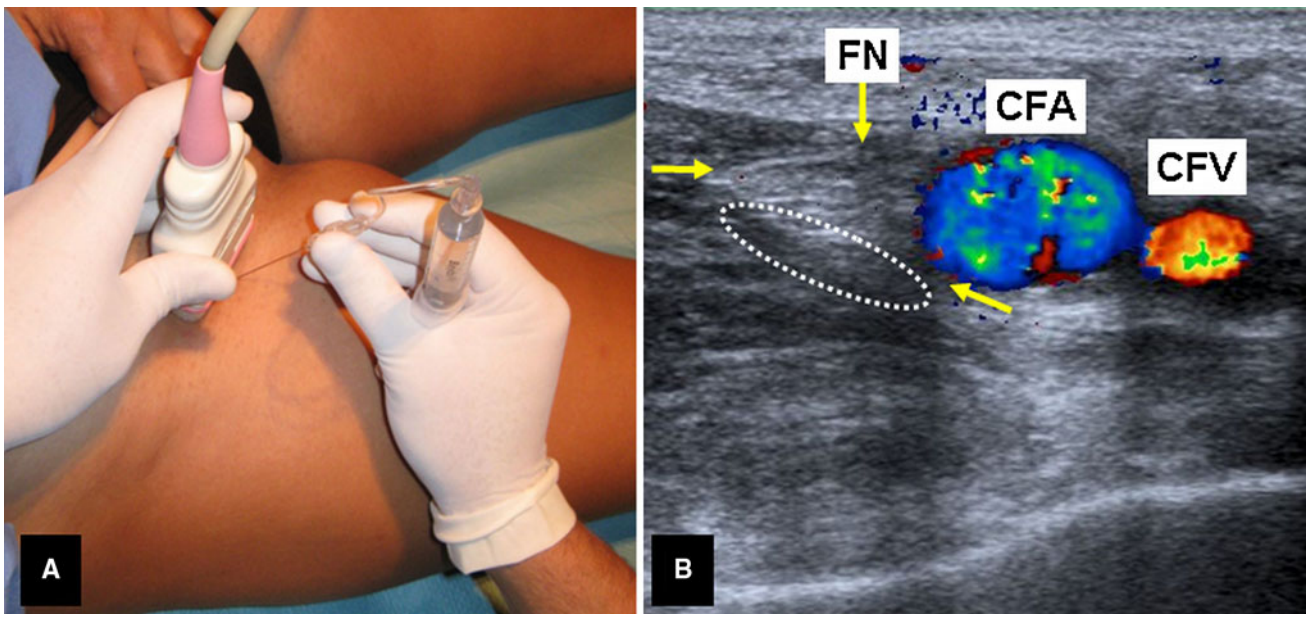

Fig. 2 For femoral block, transducer is held parallel to the inguinal ligament and femoral vessels are visualized in transverse section (**A**). The anterior branch of the femoral nerve (FN) is within the echogenic triangular area (*arrows*) lateral to the common femoral artery (CFA) and vein (CFV), whereas the posterior branch is located along the posterior border of this triangle (*dashed ellipse*) (**B**). For an ideal FNB, the local anesthetic should be injected diffusely into both areas

means of a power pump (Klein Pump, HK Surgical, San Clemente CA). In 506 legs, 547 refluxing veins were ablated by using 980-nm (A.R.C. Laser GmbH Nürnberg, Germany) or 810-nm (Angiodynamics, Queensbury, NY) laser fibers. For the ELA, the patient was placed supine on the table in the reverse Trendelenburg position to distend

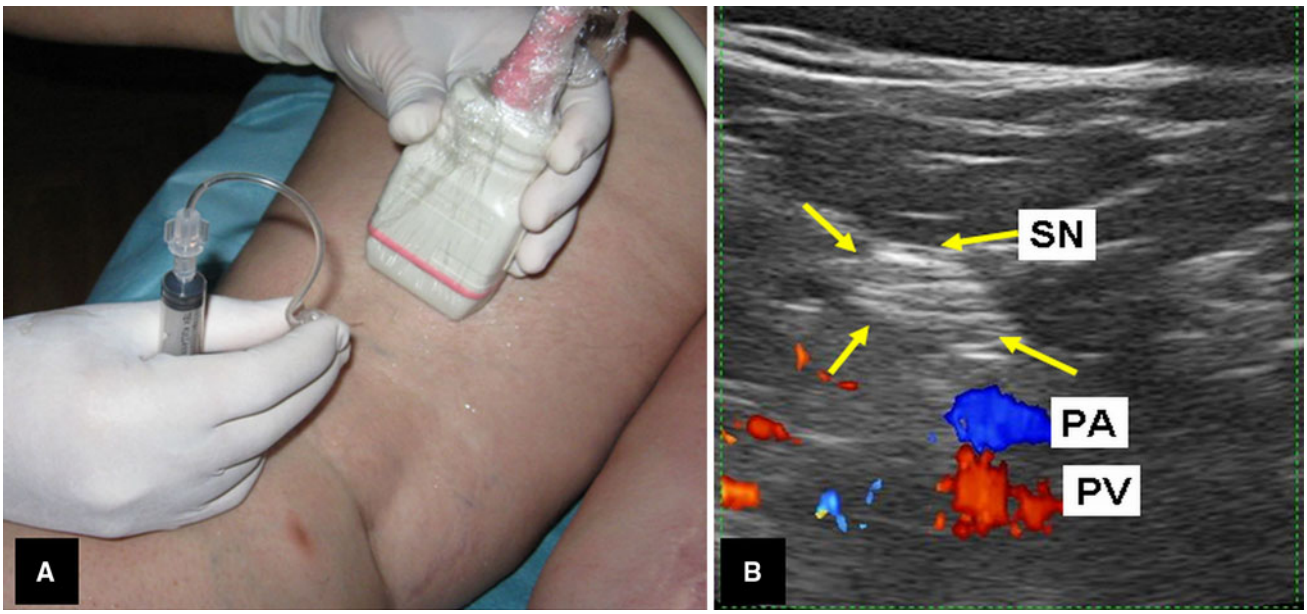

Fig. 3 For sciatic block, transducer is held proximal to the popliteal fossa and popliteal vessels are visualized in transverse section (**A**). Sciatic nerve (SN) is seen as a large, round, and echogenic structure posterolateral to the popliteal artery (PA) and vein (PV) (**B**). For an ideal SNB, the local anesthetic should be injected circumferentially around the nerve

the veins. After intradermal injection of a small amount of local anesthetic, the incompetent vein was punctured with an 18-gauge needle under US guidance. An angled tip 0.035-inch guidewire was then advanced and passed through the junction of the incompetent vein with the deep veins. The laser catheter (or sheath) was advanced over the guidewire and placed near to the junction. The guidewire was then removed and the tumescent solution was injected around the vein under US guidance. After TA, the laser fiber was inserted into the catheter and its tip was positioned several centimeters below the junction. For the PV incompetence, we tried to advance the catheter and laser as deep as possible, close to the junction with the deep veins. In those patients, where this was not possible due to the tortuosity of the PV, we ablated at least a several centimeter straight portion of the PV. Depending on the diameter of the refluxing veins, 50–120 J/cm energy was given during the laser ablation.

After all ELA procedures were completed (unilateral or bilateral), the remaining varicosities were treated with AP and/or USGFS in the same session in 485 legs (96 %) or with USGFS alone in a separate session in the remaining 21 legs (4 %). For USGFS, first, multiple butterfly needles were placed into the varicosities under US guidance with the patient in the reverse trendelenburg position. In patients with small varicose veins, we placed the butterfly needles shortly before the TA, because thereafter, these small veins may become much smaller or even disappear, making it very difficult to place a needle. Then, thick foam was prepared using a mixture of 1–3 % polidocanol solution and air in a ratio of 1:4. The foam was then injected via the butterfly needles into the varicosities under US guidance with the patient in a slight Trendelenburg position. When necessary, USGFS was repeated once or twice for residual varicosities or recurrent reflux. FNB or SNB were not performed for these repeat USGFS sessions.

After treatments, the patient was put on compression stockings and examined for the presence of motor block. For FNB, we ask the patient to flex his/her hip and keep the knee in full extension, to evaluate the strength of the quadriceps femoris muscles. We defined the femoral motor block as severe (unable to extend the knee), moderate (unable to keep the knee extended against gravity), or mild (unable to keep the knee extended against manual resistance). For SNB, we asked the patient to perform dorsiflexion and plantar flexion of the foot. We defined the sciatic motor block as severe (unable to move the foot), moderate (able to move toes but unable to perform dorsiflexion and plantar flexion), or mild (able to perform dorsiflexion and plantar flexion but not in full range). In the presence of a femoral or sciatic motor block, the patient was accompanied by another person during walking until the motor function was completely recovered. In femoral motor block, a temporary (2–3 h) elastic bandage also was applied around the knee to prevent sudden flexion, because these patients might potentially fall down due to weakness of the quadriceps femoris muscles.

After the procedures, a visual analogue scale (1–10) was used for pain assessment in our patients (Fig. 4). This assessment included the pain experienced during the whole

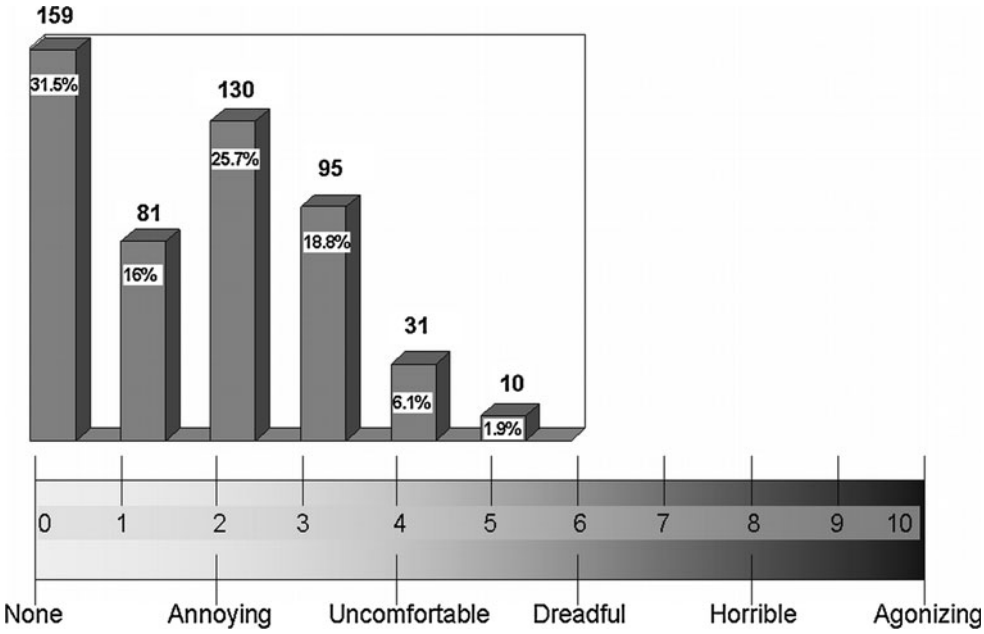

Fig. 4 The distribution of our patients according to the postoperative pain scores measured with the visual analogue pain score (1–10) used in our study

procedure, including ELA, AP, and USGFS. Pain scores between the different groups were statistically compared using the Mann–Whitney *U* test.

Results

US-guided FNB and SNB were technically successful in all legs. In two legs, the CFA was inadvertently punctured during the FNB, with no consequences. FNB was used for the ELA of 398 GSVs and 14 perforating veins, and SNB was used for the ELA of 110 SSVs and 25 perforating veins. All ELA and concomitant treatments (AP and/or USGFS) were technically successful. After the treatments, pain scores were 0 or 1 (no pain) in 240 legs, 2 or 3 (uncomfortable) in 225 legs, and 4 or 5 (annoying) in 41 legs. Patients never experienced any pain higher than score 5 (Fig. 4; Table 2). According to Mann–Whitney *U* analysis, there was no statistically significant difference between the pain scores of the right leg versus the left leg ($p = 0.321$) and between the pain scores after the FNB versus SNB ($p = 0.7$).

After FNB, an increase in the diameter of the GSV was visually noticed in most patients, but no comparison was made before and after the block. In seven patients, venous spasm developed during the catheterization of the GSV, characterized by difficulty in advancing the catheter and pain. These patients were all females aged 25–38 years with a relatively thin GSV, and the venous spasm occurred in the below-the-knee portion of the GSV after the guidewire was placed. In these patients, we first performed TA and then advanced the catheter over the guidewire so that the patient did not feel any further pain.

After FNB, no motor block was seen in 385 of 402 legs (96 %), whereas mild ($n = 16$) or moderate ($n = 1$) motor block occurred in 17 legs (4 %). After SNB, no motor block was seen in 120 of 124 legs (97 %), whereas mild ($n = 2$) or moderate ($n = 2$) motor block occurred in 4 legs (3 %). None of the patients developed a severe motor block after FNB or SNB. All of the patients who developed

Table 2 Technical details and results of US-guided nerve blocks

Extremity	Right leg ($n = 247$), left leg ($n = 259$)					
Nerve block	Femoral ($n = 402$), sciatic ($n = 124$) [both in 20 legs]					
Total pain scores	Visual analogue pain scores (0–10)					
	0	1	2	3	4	5
Right leg	79	42	66	45	9	6
Left leg	80	39	64	50	22	4
Femoral block[a]	121	62	94	73	24	8
Sciatic block	32	19	29	17	5	2

[a] 20 legs were excluded where both femoral and sciatic blocks were performed

mild or moderate motor block were able to walk, although we preferred them to be accompanied by another person. All patients were discharged after a routine 20–30 min walking under observation and instructed to be active (walking or performing foot exercises) for at least 4 h while at home.

Discussion

The femoral nerve is formed by the dorsal divisions of the anterior rami of L2–L4, and it descends along the lateral border of the CFA beneath the inguinal ligament where it divides into anterior and posterior branch. The anterior branch provides motor innervation to the sartorius and pectineus muscles and sensory innervation to the skin of the anterior and medial thigh. The posterior branch provides motor innervation to the quadriceps muscle and sensory innervation to the medial aspect of the lower leg via the saphenous nerve [17–19]. Thus, when it is blocked at the level of the inguinal ligament, sufficient analgesia (or anesthesia) is provided to the anterior and medial aspects of the thigh and leg, where an incompetent GSV and the resultant varicose veins are typically located (Fig. 1). The sciatic nerve is the largest nerve in the human body and originates from the lumbosacral plexus (L4–5 and S1–3). It is composed of tibial nerve and common peroneal nerve, which provide sensory and motor innervation to the posterior thigh and posterior and lateral aspect of the leg and foot [17–19]. When it is blocked at mid-upper thigh level, sufficient analgesia (or anesthesia) are provided to the posterior and lateral aspects of the thigh and leg, where an incompetent SSV and the resultant varicose veins are typically located (Fig. 1). Thus, it may be postulated that FNB and SNB can be used for analgesia during the treatment of varicose veins due to GSV, SSV, or a local PV insufficiency.

In the literature, we could find only one study that reports the use of nerve blocks for analgesia during ELA [8]. In this prospective, nonrandomized study, Dzieciuchowicz et al. performed FNB in 25 of 50 patients who underwent ELA and compared the pain scores in the two groups. They found that in the group with FNB, the pain scores were significantly lower compared with the group without FNB. Thus, they concluded that FNB was very effective for analgesia during ELA of the GSV. In our experience, FNB and also SNB were very effective for the elimination of pain during the ELA procedure. Our patients felt “no pain” in 47 % of the procedures and only a slight discomfort in another 45 % despite the fact that only 40–50 mg of lidocaine was given for blocks, and other painful procedures (AP and USGFS), performed in the same session, also were included in the pain evaluation. Even in our first cases, this analgesic effect of the FNB and SNB was so apparent (compared with our previous patients in whom no block was used) that it hindered us from performing a comparative study, because we felt that such a comparison would be practically difficult.

In our study, we performed ELA and other treatments (AP and USGFS) mostly in the same session. In patients with bilateral venous insufficiency or in those with multiple incompetent veins, we first ablated all these veins with ELA and continued the treatment with AP and/or USGFS as necessary. Because combined treatments may prolong the procedure time and the use of USGFS may potentially increase the risk of deep vein thrombosis [9, 10, 20], we preferred our patients to walk shortly after the treatments and keep active for some hours thereafter. To achieve this, our nerve blocks needed to provide analgesia with minimal or no motor block. This could have been done either by using LAs that create relatively more sensory block than motor block (good sensory-motor dissociation), such as bupivacaine or ropivacaine, or by simply diluting a standard LA, such as lidocaine [18]. We did not want to use bupivacaine or ropivacaine, because they were long-acting (undesirable in case of a motor block) and may be associated with serious side effects [18, 19]. We preferred to use lidocaine, because it was relatively short-acting, had fewer side effects, and was already available (also used in TA during ELA). By diluting 40–50 mg of lidocaine (without adrenaline) in 10–20 ml of saline, we were able to achieve a good analgesia without a significant motor block in the vast majority of our patients. This low lidocaine dose also enabled us to perform multiple FNB or SNB, and thus, multiple ELAs in the same session. Unlike us, Dzieciuchowicz et al. [8] treated their patients with a single ELA and AP, without concomitant foam sclerotherapy. Thus, they preferred to use a relatively large amount (200 mg) of lidocaine for FNB, but following ELA, they kept their patients in bed for another 2–4 h until the motor block was resolved. Despite these differences, both studies show that US-guided FNB is safe and effective and the dose and concentration of lidocaine can be tailored according to different treatment protocols.

Use of lidocaine in both nerve blocks and TA may raise the issue of lidocaine toxicity. For infiltration local anesthesia, the FDA-approved maximum recommended dosage for lidocaine is 4 mg/kg when used without epinephrine and 7 mg/kg when used with epinephrine (280 and 490 mg respectively for a 70-kg person). For tumescent anesthesia, however, much larger dosages of lidocaine have been used, due to the much slower absorption when very dilute lidocaine and epinephrine is infiltrated into subcutaneous tissue. The reported dosage in liposuction patients has ranged from 35 to 55 mg/kg in the literature [21, 22]. In the vast majority of our patients, the total lidocaine dose used in

nerve blocks and TA was below the limits recommended by the FDA. In several patients in whom we performed FNB and SNB bilaterally, we gave 160–200 mg of lidocaine without epinephrine for blocks and approximately 400 mg of lidocaine with epinephrine for the TA. The total lidocaine dose in these patients was slightly above the FDA limits but much lower than those reported for liposuction. Although none of our patients developed any manifestation of lidocaine toxicity, we believe that the amount of lidocaine should be kept as low as possible, until its maximum safe dosage in TA specifically for ELA is determined in appropriate studies.

To our knowledge, our study is the first to report the use of SNB for analgesia during endovenous ablation. In our study, SNB was found to be as effective as FNB, as demonstrated by the statistically similar pain scores. Although the sciatic nerve also can be blocked in the gluteal region and would probably provide better analgesia to the upper posterior thigh [18, 19], we preferred to block this nerve at the midthigh level, because it was more readily visualized on US and, thus, easier to perform. In our experience, SNB is different from the FNB in some aspects; first, it is technically more difficult to perform SNB compared with FNB because sciatic nerve is more deeply located and thus, more difficult to visualize on US. We found it very useful to visualize the sciatic nerve posterior to the popliteal artery and vein at the knee level and then scan it cranially to the most proximal level where it was still seen and, thus, easily blocked. Second, the sciatic nerve is formed by a large, single bundle unlike the femoral nerve, which is formed by numerous nerve fibers scattered along the lateral border of the CFA. Thus, in FNB, we aimed to give the LA diffusely among the fibers by multiple injections, whereas in SNB, we aimed to give the LA circumferentially around the sciatic nerve, which also was recommended in a recent study [23]. For a good circumferential injection, the needle tip should be as close to the nerve as possible or ideally touch it but not enter inside the nerve, in which case the patient would feel an electric shock sensation and may develop a severe motor block (dropfoot) if injection is done intraneurally. And third, the manifestations of a motor block are different in FNB and SNB. In FNB, the motor block is manifested by the weakness of the quadriceps femoris muscles, which may make walking difficult and potentially dangerous in case of a sudden knee flexion. In SNB, the motor block is manifested by dropfoot, which is undesirable for the patient but does not cause any danger or significant difficulty in walking [19].

In our experience, US-guided FNB and SNB provided some important advantages during ELA. First and most important, both blocks eliminated the pain significantly during ELA and subsequent treatments (AP and USGFS). The pain relief was particularly evident during the tumescent injection; in our past patients, the TA often was disturbing even at injection rates of 2–3 ml/s with the power pump, whereas after nerve blocks, our patients felt virtually nothing even at injection speeds of 6–7 ml/s. Thus, in our experience, FNB and SNB have not only created an apparent increase in patient satisfaction but also allowed us to perform TA in a shorter time. Absence of pain after nerve blocks also may allow the operator to reduce the amount of TA or lidocaine concentration in the tumescent solution, which was shown in our study and by Dzieciuchowicz et al. [8]. Second, nerve blocks decreased (at least in our experience) the frequency of venous spasm. In the previous patients in whom we performed ELA solely with TA, we encountered venous spasm relatively frequently, particularly when the vein was thin and when nonhydrophilic guidewires and catheters were used. In the present study, although we used the same materials, we saw venous spasm in only seven (1.7 %) legs. In the remaining patients, there was no venous spasm during the ELA, and we observed a slight increase in the diameter of the refluxing veins after the nerve blocks due to the sympathetic blockade, which is a well-known effect of the regional anesthesia [24]. In our experience, this venous distension made the puncture and catheterization easier, and together with the absence of venous spasm, facilitated the ELA procedure. Third, US-guided FNB and SNB do not require any additional equipment and staff; all the medications and materials as well as the US machine are already available during the ELA. Thus, there is no additional cost and the procedures can be performed in the office setting. Finally, US-guided FNB and SNB are easier to perform for interventional radiologists who are familiar with US-guided interventions, which can offer an advantage in competition with other physicians who want to perform ELA and other endovenous treatments.

Our study has some limitations mostly because of its retrospective design. First, it does not make any comparison between the patients with and without nerve blocks, which would have provided a more solid conclusion regarding the efficacy of FNB and SNB. Second, some data are not available, such as the amount of TA given for each ELA and the difference in vein diameters before and after the blocks, which might have weakened our conclusions. Third, the dose and concentration of lidocaine in nerve blocks were arbitrarily chosen. It is possible that a higher or lower amount or concentration of lidocaine may be more optimal. Therefore, our results should be interpreted with caution. On the other hand, the relatively large number of patients in whom nerve blocks were performed, absence of major complications, and considerably low pain scores obtained despite multiple ELA, AP, and USGFS performed in the same session may suggest that US-guided FNB and SNB are safe and effective.

In conclusion, US-guided FNB and SNB may provide considerable reduction of pain during ELA and other treatments, such as AP and USGFS with almost no additional cost. They may make these procedures more comfortable for the patient and easier for the operator, which may potentially improve patient satisfaction and referrals.

Acknowledgment The authors thank Akdeniz University Scientific Research Projects Unit for supporting this study. None of the authors has a financial arrangement or other relationship that could be construed as a conflict of interest.

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