SUCCESS OF ULTRASOUND GUIDED POPLITEAL SCIATIC NERVE CATHETERS IS NOT INFLUENCED BY NERVE STIMULATION

Christopher B. Robards*, Steven B. Porter*,
Ilana Logvinov** and Steven R. Clendenen*

Abstract

Background: There is debate as to whether nerve stimulation (NS) is required to place peripheral nerve catheters when using ultrasound (US) guidance. There is conflicting evidence for whether stimulating catheters improve postoperative analgesia compared to non-stimulating catheters. The use of US in combination with NS has been shown to be superior to NS alone in terms of popliteal nerve blockade. Given the previously published reports, we hypothesized that there is improvement in sensory and motor blockade for stimulating popliteal perineural catheters placed under US guidance when NS is used.

Methods: Following IRB approval, 21 patients undergoing elective foot and ankle surgery were randomly assigned to either a US or US+NS-guided continuous popliteal sciatic nerve block using a lateral approach. The primary end-point of the study was successful nerve blockade at 20 minutes. Secondary end-points included: block performance time, minimum stimulating current, pain scores on postoperative day 1 and day 2, and patient satisfaction.

Results: There was no significant difference in successful nerve blockade at 20 minutes in the US versus US+NS groups (73% vs. 80%, p=1). Procedure time was significantly shorter in the US only group (median 62 seconds vs. 130.5 seconds, p<0.01). Postoperative pain scores and overall patient satisfaction were not significantly different between the two groups.

Conclusion: We have found that the addition of NS provides no benefit over US alone. US alone was associated with a significantly shorter block performance time. US+NS showed no significant difference in pain control, patient satisfaction, or block success.

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Key words: postoperative analgesia; popliteal sciatic nerve block; ultrasound; nerve stimulation; foot and ankle surgery.

* MD.
** RN.
Department of Anesthesiology, Mayo Clinic, Jacksonville, FL.
Corresponding author: Christopher B. Robards, MD**,** Assistant Professor, Mayo Clinic, 4500 San Pablo Road, Jacksonville, FL 32224, USA. Tel: 904-956-3327, Fax: 904-956-3332. Robards.christopher@mayo.edu

Introduction

There is debate as to whether nerve stimulation (NS) is required to place peripheral nerve catheters when using ultrasound (US) guidance. US guidance has been shown to improve the onset, decrease the amount of local anesthetic required, and improve the quality of peripheral nerve blockade[1,2]. There is also information that indicates nerve block needles can have an intimate relationship with a nerve (including intraneural needle tip location) and fail to elicit an appropriate motor response[3,4]. Furthermore, there is conflicting evidence as to whether stimulating catheters improve postoperative analgesia when compared to non-stimulating catheters[1,5,6]. There is also evidence that US in combination with NS is superior to NS alone when performing popliteal nerve blockade[7]. In a recent study, when combined with NS, US was shown to increase block success compared to NS alone during popliteal sciatic nerve blockade[8]. Given the previously published data, we hypothesized that there is improvement in sensory and motor blockade for the placement of stimulating catheters for popliteal sciatic nerve block when NS is combined with US guidance.

Methods

Following institutional board review approval, full description of the study, and informed consent, 21 volunteers (male or female, age greater than 18 years) scheduled for foot or ankle surgery were assigned to receive a US-guided continuous popliteal sciatic nerve block using a lateral approach. Randomization of the two arms of the study was performed via sealed envelopes. Based on previous studies[7,8] and the experience of the research team, it was felt that a reasonable estimate for the rate of complete blockage for catheters placed without nerve stimulation would be approximately 70%. An absolute increase of 15% in the successful block rate is considered clinically significant. The detection of this increase with 80% power, using a chi-square test at the at the α=0.05 le.vel, will require 58 participants per group. Thus, we proposed to enroll a total of 120 participants All volunteers received an intravenous catheter and an infusion of Lactated Ringer's solution. Pateints were sedated using a combination of midazolam (2-5 milligrams) and fentanyl (50-250 micrograms). Under US guidance, the sciatic nerve was identified at the point where the nerve divides into its two components, the tibial (TN) and common peroneal nerves (CPN). That point was marked on the skin and measured from the popliteal crease and documented. Following thorough chlorhexadine prep and sterile drape placement, the skin was infiltrated using a solution of 1% lidocaine.

In one arm of the study (US/NS), a nerve stimulator was connected (initial current setting of 1.0 mA, pulse duration 100 μs, frequency 2 Hz) to a 17 gauge 4 inch (100 cm) Tuohy needle (Arrow International, Reading, PA) and advanced towards the bifurcation of the sciatic nerve under US guidance (Logiq-e General Electric, 12 L probe, Milwaukee, WI). The needle was advanced and repositioned until a dorsiflexion (indicating CPN stimulation) or plantar flexion motor response (indicating TN stimulation) was obtained. After eliciting a motor response, a stimulating catheter (19 gauge X 60 cm Stimucath, Arrow International, Reading, PA) was advanced to 5 cm past the tip of the needle. Dorsi- or plantar flexion through stimulation of the catheter was confirmed at a current of less than 1.0 mA and documented. After securing the catheter in place, 30 mL of plain mepivacaine 1.5% was injected incrementally with aspiration every 5 mL.

In the second arm of the study (US), the same stimulating catheter and needle system was used. However, the nerve stimulator was not turned on during the placement of the catheter. The end point for needle advancement was ultrasonographic appearance of the Tuohy needle being beneath the thick epineurial sheath of the sciatic nerve at the level of the bifurcation of the sciatic nerve proximal to the popliteal fossa. After advancing the needle to that point, the catheter was advanced 5 cm past the needle tip and secured in place. The nerve stimulator was turned on and an attempt was made to elicit a motor response. If one was obtained, it was documented. No catheter maniupulations occurred based upon the presence or absence of a motor response. At that point, 30 mL of plain mepivacaine 1.5% was injected incrementally with aspiration every 5 mL. The anesthesiologist performing the block was aware of the randomization of each patient so that he or she knew how to perform the nerve block procedure. A separate

anesthesiologist assessing motor and sensory blockade was blinded to the randomization. The time from Touhy needle insertion into the skin, after attainment of a US image of the nerve, to final catheter positioning at 5 cm past the needle tip was documented for each patient. After injection of local anesthetic, sensory and motor distribution of anesthesia was assessed by a blinded observer at 5, 10, and 20 minutes using pin-prick test. Sensory distributions assessed included the superficial peroneal, deep peroneal, sural, and tibial nerves. Assessment was based on a three point scale: no sensation (0), dull sensation (1), and sharp sensation (2). Motor strength was assessed in the distribution of the CPN and the TN by testing the patient's strength with respect to dorsiflexion (CPN) and plantar flexion (TN) using a 3 point scale: no visible contraction (0), able to dorsiflex/plantarflex against gravity (1), and able to dorsiflex/plantar flex against resistance (2). A successful nerve block was defined as a score of <2 in all four sensory nerve distributions at 20 minutes. A follow up visit (if the patient was an inpatient) or a telephone call (if the patient was an outpatient) was made every 24 hours for the duration of catheter use (approximately 48-72 hours) to assess for patient satisfaction and numeric pain score on an 11 point scale (no pain [0], worst pain imaginable [10]). Descriptive statistics, Fisher's exact test, and the Mann-Whitney U test were performed using http://www.vassarstats.net.

Results

Patient characteristics for both groups are presented in Table 1. The overall success of catheter placement as defined by a sensory deficit in both the TN and CPN components of the sciatic nerve at 20 minutes following injection of local anesthetic was 72.73% in the nonstimulating group and 80% in the stimulating group, and was not statistically significant (p = 1) (Table 2). Pain score assessment was not significantly different at any point assessed during the postoperative period, and overall patient satisfaction was similar between the two groups. The time required

Table 1
Patient Characteristics

Variable	Nerve stimulator technique (n = 10)	Ultrasound technique (n = 11)
Age (years)	52 (15)	56 (14)
Gender (Male)	5 (50%)	4 (36%)
Gender (Female)	5 (50%)	7 (64%)
Height (cm)	172 (12)	170 (9)
Weight (kg)	97 (20)	90 (28)

Categorical variables are summarized by n (%). Continuous variables are summarized by mean (standard deviation).

Table 2
Block Characteristics and Results

	US			US/ NS			P Value
Block Time (seconds)	MIN	MEDIAN	MAX	MIN	MEDIAN	MAX	P<0.01
	45	62	96	98	130.5	256	
Current (mA)	0.48	0.715	3.77	0.32	0.745	1.0	
Patient Satisfaction (0-3)	2	2	2	2	3	3	P=0.67
Pain Score 1 (0-10)	0	0	8	0	3.5	8	
Pain Score 2 (0-10)	0	3	5	0	2	6	P=0.14
Success of Block	72.3%			80.0%			P=1
Distance of Sciatic Nerve Bifurcation from Popliteal Crease (cm)	5.8		6.1			10.5	

to place the catheters was significantly longer in the stimulating group (130.5 seconds vs. 62 seconds, p=0.01). The average distance from the bifurcation of the sciatic nerve above the popliteal crease was 5.8 cm (US/NS) and 6.0 cm (US) in the two groups and similar to previous data[9].

Discussion

The results of this data set suggest that the use of NS during placement of a stimulating catheter at the popliteal sciatic nerve under US guidance does not significantly add to the success rate as measured by sensory deficit at 20 minutes, postoperative pain scores, or overall patient satisfaction. By adding nerve stimualtion there is a significant increase in the time it takes to place the catheter. Recent studies on popliteal sciatic nerve blockade have shown that US guidance can reduce local anesthetic consumption[10], as well as improve the success rate of sensory block, number of needle passes, patient satisfaction during catheter placement, and morphine consumption[11] when compared to NS alone. Whether a stimulating catheter improves continuous catheter placement depends on which block is being performed and the data are mixed[6,12,13]. It appears from our limited data set that there is no benefit to using NS when placing a stimulating catheter under US guidance at the popliteal fossa. Therefore, it would seem that using a stimulating catheter is not necessary when perfoming this block and that a multiorificed flexible catheter (for example, an epidural catheter) may be simlarly effective, faster, and less costly to place.

While seemingly low, the 72.3% and 80% success rate in the the US and US/NS groups respectively is comparable to recently published data at 20 minutes following popliteal sciatic nerve blockade[14]. It is known that the sciatic nerve has a slow onset of nerve blockade[15], and the fact that postoperative pain scores were low and satisfaction was high in our patients suggests successful blockade. We suspect that if time had permitted and we would have continued to assess both sensory and motor blockade for 30 minutes post-block we would have been able to demonstrate a higher success rate. Furthermore, our definition of successful blockade was strict in that it was sensory deficit in all four terminal branches of the sciatic nerve.

We made the decision to stop our study prior to enrollment of the initially planned 120 patients because of a series of complications we experienced with stimulating catheters at our institution[16,17]. We did not feel it appropriate to continue enrolling patients in a study that used stimulating catheters following these incidents. Of note, the complications we experienced with stimulataing catheters did not involve any of the study patients, and all involved upper extremity blocks. Despite stopping enrollment early, our data agrees with previous studies that US is superior to NS for popliteal sciatic nerve blockade[11,18]. Anecdotally, a patient in the US group had a successful nerve block with a minimum stimulating current of 3.77 mA. This undescores the fact that there is still a gap in understanding when it comes to the relationship betweeen minimum stimulating current, elicited motor response, and succcessful nerve blockade. In conclusion, in this limited data set, it appears that there is no benefit to adding NS when placing a stimulaing catheter under US guidance when performing a continuous popliteal sciatic nerve block. The addition of NS only adds time to the procedure without offering an increase in successful nerve blockade.

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