

Stimulating Popliteal Catheters for Postoperative Analgesia After Hallux Valgus Repair

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Stimulating catheters have been recently introduced in clinical practice. We assessed the efficacy of stimulating and nonstimulating catheter placement for pain control and local anesthetic requirements after hallux valgus repair with continuous sciatic popliteal nerve block in this comparative, randomized, blinded-to-observer study of 48 patients. A stimulating catheter was placed in groups S-125 and S-0625. The same catheter was inserted without stimulation in group NS-125. An infusion of 0.125% levobupivacaine was given in groups S-125 and NS-125, whereas 0.0625% levobupivacaine was used in group S-0625. All patients received an infusion of the test drug at a basal rate of 3 mL/h, with the possibility of an additional bolus of 3 mL every hour. Verbal analog scale (VAS) scores for pain were assessed between 6–8 h and between 19–23 h postoperatively.

Multiple attempts were required for catheter insertion in all patients in groups S-125 and S-0625. Lower median (range) VAS scores for pain (0–100 points) were found in group S-125 at 6–8 h postoperatively when compared with groups S-0625 and NS-125: 5 (0–17.5) versus 60 (15–80) and 70 (25–80), respectively ($P < 0.05$); and lower VAS scores for pain were also found in group S-125 at 19–23 h when compared with group NS-125: 0 (0–0) and 7.5 (0–10), respectively ($P < 0.05$). Fewer patients required IV opioid analgesia in group S-125 than in groups S-0625 and NS-125: 0, 5, and 7 patients, respectively ($P < 0.05$). We conclude that efficacy in pain control was increased with stimulating catheter placement.

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Continuous perineural infusion has recently been introduced for acute pain control in orthopedic surgery (1–4). However, insertion and maintenance of perineural catheters may present technical problems leading to failure in analgesia in 10%–40% of patients (5–7). If a catheter is not advanced sufficiently during its insertion, the catheter can become dislodged in the postoperative period. Conversely, if too much of the catheter is introduced during insertion, it may move away from the nerve while it is being advanced (6). In a volunteer study, the use of an analgesic infusion of local anesthetic (LA) through a stimulating catheter for continuous femoral block increased the tolerance to transcutaneous electrical stimulation compared with the same infusion through a nonstimulating catheter (8).

Our main objective was to test efficacy in pain control of the use of stimulating catheter placement

against nonstimulating catheter placement for continuous sciatic popliteal nerve block in patients undergoing hallux valgus repair. Our secondary objective was to compare two different concentrations of LA to determine the optimal concentration when using a catheter inserted with stimulation.

Methods

After Ethics Committee approval and patients' written informed consent, each of 48 patients scheduled for hallux valgus repair was randomly assigned to 1 of 3 groups by computer generated randomization (C-Study 4 Design Pack; GlaxoSmithKline S.A., Madrid, Spain). Inclusion criteria were age >18 yr and ability to understand the information provided. Exclusion criteria were any contraindication for regional anesthesia, patient inability to use a patient-controlled analgesia (PCA) pump, or inability to rate pain with the verbal analog scale (VAS). In groups S-125 ($n = 16$) and S-0625 ($n = 16$), we used a technique of stimulation and subsequent introduction of the catheter by means of the assembled stimulating catheter-needle set from the beginning of the procedure. An infusion

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of 0.125% or 0.0625% levobupivacaine was administered in the postoperative period, respectively. In group NS-125 ($n = 16$), patients received an infusion of 0.125% levobupivacaine via the same type of catheter that was inserted without stimulation. Patients were blinded as to group assignment, although it was not possible to mask the muscular contractions produced by the catheter insertion technique.

A 22-gauge stimulating catheter set with a 19.5-gauge, 100-mm long insulated needle (Stimulong Plus, Pajunk, Geisingen, Germany) was used to provide both surgical anesthesia and postoperative analgesia with the posterior popliteal approach for sciatic nerve block in all patients. The puncture site was located at the midline of the popliteal fossa, 11–12 cm above the popliteal crease (9). The needle was inserted cephalad at an angle of 30° to the skin surface. In groups S-125 and S-0625, initial stimulation was performed at 2 Hz with an intensity of 1.5 mA and a pulse duration of 0.1 ms. The catheter, connected to the nerve stimulator, was introduced into the stimulating needle with its tip 1 cm behind the tip of the needle in groups S-125 and S-0625. In this way, the tip of the stimulating catheter conducted the electrical current to the tip of the needle. The tibial component of the sciatic nerve was located by elicitation of a motor response of plantar flexion of the foot. The needle, with the catheter inside, was slowly advanced to locate the nerve with an intensity below 0.5 mA. Then, the catheter was advanced into the needle. A perception of slight resistance indicated the appearance of the catheter at the distal hole of the needle. At this time, if plantar flexion was still being elicited at least below 0.6 mA, the catheter was advanced 5–10 cm beyond the tip of the needle. If, during this advancement, it was not possible to elicit plantar flexion with that minimal intensity of current, the insertion was stopped and the catheter was gently withdrawn through the needle until the tip of the catheter was inside the shaft of the needle, still making electrical contact with the needle. The needle was repositioned slightly and another attempt to introduce the catheter was made as described above. If easy withdrawal was not possible, the needle was withdrawn with the catheter to avoid the risk of shearing the catheter. A new attempt for location with the assembled catheter-needle set was initiated.

After satisfactory perineural placement of the catheter, the needle was withdrawn and the catheter was maintained with the aid of a sterile, transparent plastic dressing. For surgical anesthesia, 20 mL of plain 1.5% mepivacaine was injected through the catheter in groups S-125 and S-0625. In group NS-125, after elicitation of plantar flexion at or below 0.5 mA with the stimulating needle, 20 mL of plain 1.5% mepivacaine was injected through the needle, then the catheter was introduced 5–10 cm beyond the tip of the needle. Mepivacaine was given in the following manner: first,

1–2 mL was injected; then, if the motor response was abolished and no pain was produced, the remaining mepivacaine was administered incrementally with intermittent aspirations every 5 mL. A transsartorial saphenous nerve block (10) or a femoral nerve block with 20 mL 1.5% mepivacaine was performed to allow calf tourniquet inflation. In case of intraoperative pain, the attending anesthesiologist was allowed to administer fentanyl IV or to implement general anesthesia, accordingly to clinical judgment.

All patients received an infusion of LA through the catheter with an electronic pump (CADD-Legacy 6300; Deltec, Inc. St. Paul, MN) that was started 20–30 min after the block. The reservoir was filled with 150 mL of the selected LA solution. All patients received an infusion of the test drug at a basal rate of 3 mL/h, with the possibility of 1 additional bolus of 3 mL every hour, initiated by the patient in case of insufficient pain control. All patients were also given 30 mg ketorolac trometamol every 8 h IV. In case of insufficient analgesia, patients were instructed to request 100 mg tramadol HCl IV as rescue medication.

The efficacy of analgesia was assessed by a blinded investigator twice: between 6–8 h and between 19–23 h after block placement. During these visits patients were asked to rate their pain on VAS, where 0 represented no pain and 100 the worst pain imaginable. Furthermore, the ability or inability to move the ankle was recorded. The infusion was discontinued 19–23 h after the connection of the pump to the patient. The consumption of LA was recorded and any possible adverse effect of treatment was noted. Catheters were then also evaluated for technical problems (partial or total dislodgement, leakage of LA at the puncture site). The catheters were removed before discharging patients from the hospital. Patients were questioned about the presence of neurological symptoms 1 and 2 wk after the operation at the surgeon's office.

From previous experience we observed a maximum VAS score of 60 ± 30 after the primary surgical block with mepivacaine and the infusion through a non-stimulating catheter resolved. A sample size of 14 subjects per group was calculated to allow us to detect a possible difference of 30 points in VAS score with an α error of 5% and a β error of 20% between 2 groups. Two extra patients were included in each group to allow for possible dropouts.

Statistical analysis was performed with G-Stat 2.0 software package (GlaxoSmithKline S.A.). Normal distribution of the collected data was first verified with the Kolmogorov test with Lilliefors correction (11). Quantitative variables were compared with analysis of variance or Kruskal-Wallis test on the basis of data distribution. *Post hoc* comparisons were performed with least significant difference (LSD) test or Dunn test when appropriate (11). Categorical variables were

Table 1. Demographic Characteristics of the Three Groups

	Group S-125 (n = 16)	Group S-0625 (n = 16)	Group NS-125 (n = 16)
Gender (male/female)	2/14	0/16	0/16
Age (yr)	59 ± 12	64 ± 11	57 ± 11
Weight (kg)	70 ± 11	66 ± 8	68 ± 11
Height (cm)	162 ± 8	159 ± 7	158 ± 7
Needle current (mA)	0.46 (0.44-0.5)	0.46 (0.34-0.6)	0.42 (0.38-0.46)
Catheter current (mA)	0.42 (0.3-0.5)	0.52 (0.34-0.6)	NA
Catheter advancement (cm)	7 (7-10)	8 (6.5-10)	7.5 (7-10)

Group S-125 = stimulating catheter, 0.125% levobupivacaine; Group S-0625 = stimulating catheter, 0.0625% levobupivacaine; Group NS-125 = nonstimulating catheter, 0.125% levobupivacaine; NA = not applicable. Differences were not statistically significant.

analyzed with χ^2 test or Fisher's exact test when indicated. A *P* value < 0.05 was considered statistically significant. Data are expressed as mean ± SD, median (range), or absolute frequencies when appropriate.

Results

No statistically significant difference was found in gender, age, weight, or height of patients among the three groups or in the distances that the catheters were advanced. Needle and catheter were stimulated at similar currents in the S-125 and S-0625 groups. Needle stimulation in NS-125 group was similar to that of the other 2 groups (Table 1). Requirements for fentanyl supplementation and for general anesthesia were similar in the three groups. In groups S-125, S-0625, and NS-125, 2, 1, and 3 patients required 100 μ g fentanyl IV for pain control during surgery, respectively. One patient in group S-0625 required general anesthesia.

Postoperatively, at 6-8 h, a significantly lower VAS score was found in group S-125 when compared with groups S-0625 and NS-125 (*P* < 0.05). Scores in VAS after 19-23 h were higher in group NS-125 than in group S-125 (*P* < 0.05) (Table 2).

Requirements for rescue medication were smaller in group S-125 than in the other 2 groups (*P* < 0.05). The number of PCA boluses and the consumption of LA were larger in group NS-125 than in the other groups (*P* < 0.05). The degree of motor block at 6-8 h was higher in group S-125 than in the S-0625 and NS-125 groups (*P* < 0.05) (Table 2). No catheter was dislodged and no leakage of LA was observed.

Among our series, we had 2 elderly people in group S-125 who fell when they tried to walk without any assistance during the first postoperative night, despite the nurses' instructions.

Postoperatively, 2 of 35 patients had dysesthesias in the cutaneous distribution of the saphenous nerve after transartorial saphenous nerve blocks. One patient complained of transient hypoesthesia in the distribution of superficial peroneal nerve in group S-125. Another patient in group NS-125 had prolonged paralysis of the calf and toes with preservation of sensory function with full recovery after 6 mo.

Discussion

Continuous sciatic nerve analgesia via an indwelling catheter is increasingly used to provide pain relief after foot surgery (2-4,12). We assessed the efficacy of stimulating and nonstimulating catheter placement for analgesia and LA requirements with a continuous popliteal block after hallux valgus repair. We found that a basal infusion of 3 mL/h 0.125% levobupivacaine via a stimulating catheter (group S-125) produced superior analgesia with smaller LA requirement and without additional PCA boluses in most patients, suggesting close perineural position of the catheter. However, it was also associated with prolonged paralysis of the foot in most of these cases. Paralysis of the lower limb may be considered a contraindication for discharging patients from the hospital by some anesthesiologists and remains a patient care issue. Patients must be reminded to walk with crutches or assistance; as was demonstrated by the two elderly patients who sustained falls during their hospitalization (13). There was no difference in the total volume of LA given between groups S-125 and S-0625. This was probably a result of the small size of the groups and also to the 60-minute lockout interval for LA boluses in this study. Likewise, no difference in pain control was found between groups S-0625 and NS-125 despite the difference in drug concentration. This may be explained by a closer perineural location of the catheter tip in group S-0625 than in group NS-125. However, our study has the limitation of not being sufficiently powered to detect a difference between those two groups. Postoperatively, there was one patient with prolonged paralysis of the foot. It is unclear if this was associated with the use of the catheter or with direct trauma by the stimulating needle. Further studies are needed to determine the relative safety of stimulating versus nonstimulating catheter placement.

Stimulating catheters (14-16) share the characteristic of having a stimulating tip that connects to a nerve stimulator via an internal conducting wire. There is debate concerning whether this type of catheter may

Table 2. Quality of Analgesia in the Three Groups.

	Group S-125 (n = 16)	Group S-0625 (n = 16)	Group NS-125 (n = 16)
VAS 6–8 h	5 (0–17.5)	60 (15–80)*	70 (25–80)†
VAS 19–23 h	0 (0–0)	1 (0–10)	7.5 (0–10)†
Duration of infusion (h)	22.5 (20–23)	21.5 (19.7–22.7)	20.5 (20–22.5)
3-mL boluses of LA	1.5 (0.5–2)	3 (2–6.5)	5 (4.5–6.5)†
Total LA infusion (mL)	68.3 (63–74)	73.4 (67.7–81.5)	77.9 (72.8–86)†
LA (mL/h)	3.1 (3–3.3)	3.4 (3.2–3.9)	3.7 (3.6–4.1)†
Patients requiring tramadol HCl	0	5*	7†
Motor block at 6–8 h (patients)	14	5*	4†

Group S-125: Stimulating catheter, 0.125% levobupivacaine. Group S-0625: Stimulating catheter, 0.0625% levobupivacaine. Group NS-125: Nonstimulating catheter, 0.125% levobupivacaine. VAS 6–8 h: Score in verbal analogic scale for pain at 6–8 h. VAS 19–23 h: Score in the verbal analogic scale for pain at 19–23 h. LA: local anesthetic. * $P < 0.05$ group S-125 versus group S-0625; † $P < 0.05$ group S-125 versus group NS-125.

or may not reduce the rate of failure of surgical anesthesia or of postoperative analgesia (17). Our findings are in accordance with those of other studies involving stimulating catheters. Pham-Dang et al. (18), in a descriptive study about the use of stimulating catheters with several approaches for peripheral nerve blocks, reported a rate of failure in analgesia of 3% after elicitation of a distal motor response at or below 3 mA with a stimulating catheter, which is less than the rate of 10%–40% reported by others (5–7) using nonstimulating catheters. Salinas et al. (8), in a prospective, comparative, randomized study of femoral nerve block in volunteers, observed a superior quality of analgesia to transcutaneous nerve stimulation when catheter placement had been confirmed by actual catheter stimulation at 0.5 mA after insertion. Conversely, Ilfeld et al. (2), using nonstimulating catheters, reported excellent pain control after surgery below the knee. However, they used a larger dose of LA than ours (a continuous infusion of 8 mL/h with a 2-mL PCA bolus available every 20 minutes of 0.2% ropivacaine) and only a small number of their patients underwent hallux valgus repair, which is reputed to be associated with a more intense postoperative pain than other types of surgical procedures of the foot.

It is questionable whether the observed reduction in the concentration of the LA to achieve the same efficacy in pain control with stimulating catheters may be of clinical relevance. In addition, we must recognize that pain control at 6–8 h in groups S-0625 and NS-125 can not be considered satisfactory because high VAS scores were found in those two groups, perhaps as a result of our selection of LA concentration and dosing for postoperative analgesia. However, VAS scores after 19–23 h were low in the 3 study groups. This raises the question of whether a continuous sciatic nerve block is needed for analgesia after hallux valgus repair. Further studies will be needed to determine if there is a LA regimen that provides better analgesia with minimal motor block via a stimulating popliteal catheter.

To save time and to avoid multiple maneuvers for the connection and disconnection between the nerve stimulator and the corresponding needle or catheter during the attempts to insert the stimulating catheter, we performed direct stimulation through the assembled catheter-needle set. This is possible because the stimulating needles we used have no insulation at the internal aspect of their shafts. The electrode at the tip of the catheter makes electrical contact with the internal aspect of the shaft of the needle, with subsequent transmission of the impulse to the tip of the needle. Accidental shearing of the catheter when it is withdrawn through the needle is a potential risk, and that maneuver is not recommended by the manufacturer (Pajunk). In our study, all catheters could be placed at the first attempt in group NS-125. However, in the other two groups all insertions required multiple attempts. The exact number of attempts and the time spent on the procedure were not recorded; this is a major limitation of our study. Although we did not note shearing of the catheter among the 32 patients included in our study who required multiple catheter insertions and withdrawals through the needle, the safety of this technique remains undefined because of the small sample size.

In conclusion, after an initial bolus of mepivacaine, and using slow infusion rates, the infusion of 0.125% levobupivacaine via a stimulating catheter for continuous popliteal sciatic nerve block provided better analgesia than 0.0625% levobupivacaine infused through a stimulating catheter or with 0.125% levobupivacaine infused through a catheter placed without stimulation. It was also associated with a higher rate of motor block of the foot.

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