Evaluation of continuous ultrasound-guided sciatic popliteal nerve block with longitudinal approach in the management of vascular pain in patients with chronic limb-threatening ischemia

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Abstract

Aim: the aim of this study was to assess the analgesic effectiveness of the ultrasound-guided continuous sciatic nerve block with longitudinal approach (UCSNB) for the management of acute pain due to Chronic limb-threatening ischemia (CLTI); measured by decreasing pain, numerical rating scale (NRS), success and complications associated with the procedure, measure of opioid use and patient satisfaction.

Methods: Descriptive observational prospective cross-sectional study, sample of all patients with vascular pain due to who consulted during the period from December 2019 to March 2020 at the pain unit of San Vicente Fundación Hospital. Preprocedural and postprocedural at 30 minutes, 24, 48, 72, 96 and 120 hours NRS, pinprick test as objective evaluation of success block, complications of the procedure as a measure of security, preprocedural and postprocedural opioid use (24h morphine equivalent) and side effect secondary to these and the satisfaction patient scale were evaluated.

Results: 14 patients with CLTI were treated with UCSNB, the postprocedural NRS compared with preprocedural scores were significantly lower (p=0.0001, IQR=2 (Q1=1 y Q3=2)); there was no difference in the NRS between the evaluations at the evaluated postprocedural times. The mean opioid use previous to the UCSNB was 52,01 $\pm$ 28.85 mg and postprocedural 5,64 $\pm$2.15, the prevalence of opioid side effects previous to block was delirium 42%, nauseas and vomiting 28%, and sedation 14%, non-cases of respiratory depression were reported and non-side effect was reported postprocedural. The block was success in the 100% of the patient and the only complications associated to the procedure was catheter migration in 28,6%, the satisfaction score was 4 in all the cases.

Conclusion: UCSNB is an effectiveness and safe technique for the control of acute vascular pain in CLTI while a surgical of non-surgical management is defined, with an excellent rate of success and a low complication incidence within the 5 days after procedure. Randomized controlled studies are required for this method to be included in treatment algorithms.

Keyword: continuous sciatic block; Chronic limb-threatening ischemia; acute vascular pain.

Introduction

Peripheral vascular disease represents a wide spectrum of diseases ranging from asymptomatic ischemia to critical limb ischemia, the latest consensus proposed the term Chronic limb-threatening ischemia (CLTI) to include a larger and more heterogeneous group of patients with varying degrees of ischemia, which requires the presence of objectively documented atherosclerotic peripheral arterial disease for diagnosis in association with ischemic pain at rest and tissue loss (ulceration or gangrenous) of one or both extremities (1). Treatment requires a multidisciplinary approach that includes the management of ischemia as the first measure, for which revascularization surgery with or without a percutaneous stent, vasodilator agents, among others, have been described. For pain control, a multimodal approach is recommended that includes systemic analgesics and regional analgesic techniques (1,2,3).

Although systemic analgesia solves the pain crisis, in the long term its complications or contraindications prevent satisfactory pain control achieved. Peripheral nerve blocks can be an excellent option in cases of intractable pain that does not respond to standard treatments, (4). Adding an axonal block in the affected limb can reduce the consumption of systemic analgesia and its side effects, as well as reducing sympathetic output, producing vasodilation that improves perfusion of the limb (1).

Regional ultrasound-guided techniques provide greater safety in terms of nerve damage, the latest studies show a difference in favor of using ultrasound for catheter localization with a report of a higher success rate with fewer complications associated with puncture (5); for CLTI pain axonal blocks are directed towards the sciatic nerve that innervates the area below the knee level including L5-S1-S2 dermatomes, and its widely used for the management of

the pain and anesthetic option combined with femoral block mainly; in knee and foot interventions with adequate. effectiveness and safety (6, 7).

The approach of the continuous sciatic block in the longitudinal axis of the plane, although challenging; theoretically, it places the catheter in the same position and orientation of the nerve, achieving greater stability and less displacement and duration over time than the conventional axial axis technique (8, 9).

The effectiveness of the ultrasound-guided continuous sciatic nerve block (UCSNB) is described in the literature mainly by achieving unilateral motor and sensory block and by the time of postoperative analgesia with a lower risk of hemodynamic changes, preserving intestinal and bladder function compared to other techniques; multiple procedures are used that are described in their various approaches, requiring knowledge and experience in the technique for a greater frequency of success (10); in addition to its low complication rate, among which failure in placement is described in 0.5% -26%, displacement of the catheter, systemic and local toxicity; neurological injury 0.07 to 9 months with a report of complete neurological recovery one year, local infection in <1%, colonization 6-57% at 48h (11); which makes the continuous sciatic nerve block a management option for pain in patients with CLTI pain, being a useful and safe tool in the multimodal management of this pathology that poses so many challenges for the clinician and sometimes faces a limited spectrum of management given the complexity of the pathophysiology involved in chronic ischemic pain; and the associated comorbidities of these patients (1).

The aim of this study was to assess the analgesic effectiveness of the UCSNB for the management of acute pain due to CLTI; measured by decreasing pain, using the numerical rating scale (NRS), objective success of the block using pinprick test, opioid use and its side effect, technical associated complications and patient satisfaction.

Material and Methods

It is a descriptive observational prospective cross-sectional study of an exploratory nature, intentional non-probability sample of all patients over 18 years of age or older, in the acute / chronic pain department who present vascular pain due to CLTI and accepted the offered technique who consulted during the period from December 2019 to April 2020 at the pain Service of San Vicente Fundación Hospital. Ethics Committee approval was obtained from San Vicente Fundación Hospital and University of Antioquia bioethics´ section. Patient information and files was obtained from the patient directly and completed with the hospital information system and archive. UCSNB were performed by a training anesthesiologist specialist in pain medicine in a procedural room with continuous monitoring of vital signs according to the Americas Society of Anesthesiology (ASA) standards (electrocardiography, pulse oximetry, and non-invasive blood pressure) during or without conscious sedation , with a high-frequency linear transducer (Philips CX 30 ultrasound system, Germany), the sciatic nerve was located at the popliteal level in the transverse axis, 3 ml of lidocaine 2% were administered to anesthetize skin and subcutaneous cellular tissue, subsequently with a Pajunk set needle and catheter , 10 ml of bupivacaine 0,1% were administered peri -neural to hydro dissect its upper portion, then the probe is turned to the longitudinal axis and the catheter is advanced , leaving 10 cm from the skin and corroborating its final positioning by administering 5 ml of bupivacaine at 0.1% (Figure 1), the catheter is fixed with n-butyl-cyanoacrylate adhesive (Histoacryl) and transparent dressings (Tegaderm), continuous infusion of 6ml/h bupivacaine at 0.1% was continued until the removal of the catheter.

Age, gender, weight, height, body mass index (BMI) , diagnostic, anticoagulant / antiplatelet therapy, opioid use (in morphine equivalent oral doses in milligram) and effect adverse

secondary to opioid (delirium, nauseas, vomit, sedation and respiratory depression) were evaluated previous to the block; numbers of punctures; time to execute the block, pinprick test, complication of block procedure (hematoma, vascular puncture, infection at the site of puncture, migration of the catheter, filtration of local anesthetic and nerve lesion) were evaluated post procedural.

To determinate the effectives of the technique preprocedural and postprocedural at 30 minutes, 24, 48, 72, 96, 120 hours pain was evaluated by the NRS , opioid use (in morphine equivalent oral doses in milligram), effect adverse secondary to opioid and the satisfaction patient scale (like scale from 0 to 4) were examined posterior to the procedure.

Statistical analysis; frequency distributions and their percentages to qualitative variables were calculated. For quantitative variables, descriptive summary statistics or central tendency, mean and their respective standard deviation were reported if the data were normal, when the normality assumption was not fulfilled, the median and interquartile range (IQR) were reported. The normality assumption was verified using the Shapiro-Wilks test. In addition, in order to evaluate the effectiveness of block in patients with CLTI an exploratory parametric ANOVA were performed with previous fulling assumptions of normality and homogeneity verified by the Levene test. A type I or alpha error of 0.05 ($p < 0.05$) were accepted for all tests.

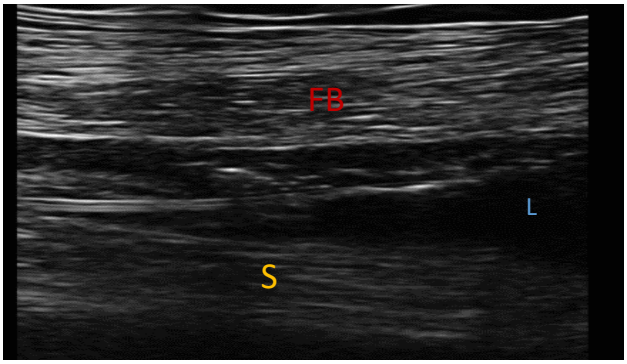

Figure 1. Ultrasound image of the catheter position; Femoral Biceps FB; local anesthetics LA; sciatic Nerve SN

Results

14 patients with CLTI treated with UCSNB at the pain service of San Vicente Fundación hospital between December 2019 to April 2020 were included in this prospective observational study, all patient (14) accepted to participate in the study. 57.1% (n = 8) were female and 42.9% (n = 6) were male , patient age ranged from 31 to 93 years, with mean of 66.54 ± 4.78 years; the patients` weight ranged from 42 to 88 kg, with a mean weight of 59.85 ± 3.49 kg: height measurements ranged from 143 to 175 cm, with a mean of 155.46 ± 2.86 cm: and BMI measurements ranged from 18.4 to 39.1 kg/m2, with a mean BMI of 25 ± 1,68 kg/m2 . According to the Shapiro-Wilks test both age and weight, height and BMI are normally distributed. Demographic characteristics of the patients are show in table 1.

Table 1. Demographic characteristics

Age (years)	Min-max (Median)	31 – 71 (66)
	Mean ± SD	66.54 ± 4.78
Gender n (%)	Female	8 (57.1) %
	Male	6 (42.9%)
Weight (kg)	Min – max (median)	42 – 88 (60)
	Mean ± SD	59.85 ± 3.49 kg
Height (cm)	Min – max (median)	143-175 (152)
	Mean ± SD	155.46 ± 2.86
BMI (kg/m^2)	Min – max (median)	18.4 – 39.1 (24)
	Mean ± SD	25 ± 1,68 kg/m^2

All the patients were under therapy with antiplatelet and anticoagulant agents; the execution time of the procedure was between 15 to 30 minutes with a mean of 19.28 ± 5.13 min; the number of punctures was one for the 85.7% (n=12) and two for 14.4% (n=2)

of the patients. Not patient presented hematoma, vascular puncture, nerve injury or local anesthetics toxicity or filtration. Catheter migration was presented in 28,6% (n=4) of the cases; the success of the block measured by the pinprick test in the sciatic innervation area was positive in the 100% (n=14) of the patient treated. Table 2 shows the characteristics evaluated of the procedure.

Table 2. Procedural characteristics

Execution time (minutes)	Min – max (median)	15-30
	Mean ± SD	19.28 ± 5.13
Number of punctures n (%)	1	12 (85.7)
	2	2 (14.4)
Success block n (%)	Positive	14 (100)
	Negative	0 (0)
Complications n (%)		
	Hematoma	0
	Vascular puncture	0
	LA toxicity	0
	LA filtration	0
	Catheter migration	4 (28,6)

LA; local anesthetics

When postprocedural NRS of the patients were compared with preprocedural scores it was found that postprocedural 30 minutes, 24 hours, 48 hours, 72hours, 96 hours and 120 hours NRS scores were significantly lower compares to preprocedural NRS ($p=0.0001$, IQR=2 (Q1=1 y Q3=2)); there was no difference in the NRS between the evaluations at the that postprocedural 30 minutes, 24 hours, 48 hours, 72hours, 96 hours and 120 hours. and all

the patients reported the highest score on the satisfaction evaluation. Table 3 Evaluation of NRS.

Table 3: Evaluation of NRS

Preprocedural	Min – max (median)	6-10 (9)
30 min	Min – max (median)	0-1 (0)
24 h	Min – max (median)	0-1 (0)
48 h	Min – max (median)	0-1 (0)
72 h	Min – max (median)	0-2 (0)
96 h	Min – max (median)	0-2 (0.5)
120 h	Min – max (median)	0-2 (0)

The mean opioid use previous to the UCSNB was 52,01 $\pm$ 28.85 mg and the prevalence of side opioid effects was delirium 42% (n=3), nauseas and vomiting 28% (n = 2), and sedation 14% (n=1=), non-cases of respiratory depression were reported. The mean post procedural opioid used was 5,64 $\pm$2.15 and non-sedation, delirium, nauseas and vomiting, sedation or respiratory depression were reported. According to the paired samples student test on average, opioid consumption prior to the procedure is higher than the post procedural consumption (p=0,001, 46,4; 95% CI: 29,1 to 63.6).

Discussion

The conventional management of acute pain related to CLTI consists of a multidisciplinary approach that includes the management of ischemia for which revascularization surgery with or without percutaneous stent, vasodilator agents, regenerative therapies, or palliative when there are no options of revascularization; while defining the therapy to be followed or achieving its desired effect, these patients require an analgesic approach that is based on systemic analgesics such as opioids, NSAIDs and neuromodulators (1,2,3,12). But as can be seen in the demographic data of our study, most patients have some contraindications for this type of medication such as anticoagulant therapy, kidney or cardiac disease, in addition to the side effects associated with the consumption of opioids. Therefore, the simultaneous consumption of these medications and their use for pain management in this population is not advisable. Regarding the use of the analgesic infusions, there are studies that show that intravenous lidocaine is effective in relieving pain and, compared to narcotics, can generate a faster and more efficient analgesic state without the need for repeated doses of opioids and their associated risks. However, they have less impact than interventionist techniques (2, 13). The advantages of adding a regional technique to CLIT pain management are diverse; axonal block is usually more effective than systemic analgesics since it is selectively directed to the nerves involved in the painful area of the limb, it reduces the side effects of systemic analgesics, mainly those related to the use of opioids; by reducing sympathetic output, it produces vasodilation that improves perfusion of the limb (1). In this study, the presence of side effects associated with opioids such as delirium (n = 3), nausea and vomiting (n = 2) and sedation (n = 1) was evidenced when opioids were started as basic analgesic therapy with an average consumption of oral morphine equivalents of 52.01 + 28.85 mg which decreased to

5.64 +2.15 after the intervention as well as the side effects to opioids showed the first important outcome of this intervention in this population.

The interventional techniques for the episode of acute pain in CLTI described are lumbar sympathectomy, mainly femoral, sciatic peripheral nerve blocks and its branches. Sanni A. carried out a systematic review, where he showed that the patients who underwent sympathectomy achieved a significant improvement in pain and a reduction in morbidity (14). Destructive and non-destructive sympathectomy are tools to consider in this patient population, however, they have limitations since they require suspension of anticoagulation, there is a risk of neuroaxis injuries, hypotension, exposure to x-rays, and it is a more complex technique to perform than it implies higher infrastructure costs versus the USBN, which has a low rate of complications (3, 15, 16, 17). It was observed, the average USBN execution time was 19.28 $\pm$ 5.13 min, with successful blockade in all patients objectively measured by pinprick, with no report of complications other than catheter migration of 28.6% and was performed in a basic procedure room , no X-ray or discontinuation of anticoagulant agent were required; demonstrating that is a safe, reproducible and easily accessible technique .

Indications for continuous sciatic nerve block, include surgery associated with severe pain such as major orthopedic surgery of the lower extremities below the knee level, either for anesthetic, postoperative analgesic management, or postoperative painful physical therapy (11, 18). In peripheral vascular surgery of the lower limb, there are studies that show high impact in the control of postoperative pain for up to 48 hours and as a safe anesthesia technique in patients with multiple comorbidities (19). However, no previous studies were found that evaluated the effectiveness of UCSNB in non-surgical settings such as CLIT pain. In this study, it was found that application of USNB in CLTI patients is an effective technique for managing acute pain for the first 5 days until definitive or chronic treatment is defined, it

significantly decreased the NRS compared preprocedural and procedural scores. and all the patients reported the highest score on the satisfaction evaluation without mayor complications reported.

Regarding the procedure approach; The continuous sciatic block can be performed from the posterior approach, described by Rorie, or from the lateral approach, described by Vloka. Both approaches provide equivalent anesthesia and are easy to perform for trained professional (20). The classic technique, either posteriorly or laterally, positions the catheter in the axial axis perpendicular to the nerve, have the problem of easy migration of the catheter over time (8, 9). An ultrasound-guided technique in the longitudinal axis of the plane places the catheter parallel to the nerve, which is challenging and may take longer than the previously discussed technique, but allowing the catheter to maintain its functionality for longer. In our study, we evaluated this technique. showing an average execution time of 19.28 $\pm$ 5.13 min the success of the block measured by the pinprick test in the sciatic innervation area were positive in the 100% (n = 14) of the patient treated and a percentage migration rate of the catheter of 28.6% , it is important because there is no evidence of the migration rate for time interval more than 48 hours.

There are certain limitations of this study. The small number of cases and the lack of a control group are chief among these limitations. Another limitation of the study is that the follow-up period was limited to 5 days which was the average number of days patients had the catheter while definitive management was defined and when not followed for effectiveness after this period.

Conclusion

Ultrasound-guided continuous sciatic popliteal nerve block with longitudinal approach is an efectiveness and safe technique for the control of acute vascular pain in lower limb ischemia while a quirurgical of non quirurgical management is defined, with an acceptable success rate and a low complication rate within the 5 days after procedure. Randomized controlled studies are required for this method to be included in treatment algorithms.

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