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## Original Article

# 4-in-1 and 5-in-1 blocks in percutaneous forefoot surgery

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## Abstract

**Objective:** To analyze the effectiveness of peripheral nerve blocks in the ankle in percutaneous forefoot surgery and their potential complications.

**Methods:** Retrospective study with a survey of the medical records of patients who underwent percutaneous orthopedic surgery on the forefoot between 2009 and 2015, performed by the orthopedic foot and ankle surgery group of our hospital, in which 4-in-1 and 5-in-1 anesthetic nerve blocks were used. We evaluated 239 cases, consisting of 222 female and 17 male subjects with a mean age of 61.2 years, seeking to observe the effectiveness and potential complications of the anesthetic technique.

**Results:** Complications were observed in 3.34% of the 239 patients, with seven cases of neuritis and one case of tachycardia. Regarding the anesthetic technique, there were nine cases of block failure (3.76%), with four cases requiring supplementary local anesthetic, one case spinal anesthesia, and four cases general anesthesia.

**Conclusion:** Having observed the low rate of complications and the almost complete success of 5-in-1 blocks in percutaneous forefoot surgery, we concluded that it is a safe and effective anesthetic technique.

**Level of Evidence IV, Therapeutic Study; Case Series.**

**Keywords:** Anesthesia; Nerve block; Peripheral nerves; Forefoot; Minimally invasive surgical procedures.

## Introduction

In forefoot deformities, which can be corrected by percutaneous techniques, when surgical treatment is indicated, it is imperative to plan the surgical intervention carefully. The intention is to reduce surgery and anesthesia risks, since due to an aging population and a greater number of obese individuals, the incidence of comorbidities, especially those of a cardiovascular and pulmonary nature, is increasing[1-3].

In general, peripheral nerve blocks are very useful in urgent procedures (sharps injuries or removal of a foreign body). In the ankle, small volumes of local anesthetics in perineural regions promote analgesia and anesthesia over an extensive area, corresponding to the cutaneous topography of the nerve.[2] When applied to orthopedic forefoot surgery, they are also of practical interest, as they are relatively safe and easy to perform, when specific standards are followed. This technique avoids spinal and general anesthesia and has a lower operative and postoperative risk, especially in elderly patients or individuals with comorbidities[3].

The aim of this study was to analyze the effectiveness of peripheral nerve blocks in the ankle when performing percutaneous forefoot surgery and their potential complications.

## Methods

This study was approved by the Institutional Review Board and registered on the Plataforma Brazil database under CAAE (Ethics Evaluation Submission Certificate) number: 28597920.0.0000.5501.

Study performed at the Hospital Universitário de Taubaté, Taubaté, SP, Brazil.

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Retrospective study with survey of medical records of patients in which we indicated 5-in-1 anesthetic nerve block at ankle level, who underwent percutaneous orthopedic surgery on the forefoot between 2009 and 2015, performed by the orthopedic foot and ankle surgery group of our hospital and at a private clinic owned by one of the authors. We evaluated 239 patients, 222 of whom were female and 17 male, with a mean age of 61.2 years, a minimum age of 14 years and a maximum age of 84 years, seeking to observe the effectiveness and potential complications of the anesthetic technique and its adverse effects. For the anesthetic doses commonly administered in this study, there are no absolute contraindications for the use of this technique except for a history of hypersensitivity to one of its components. However, we emphasize the following relative contraindications: skin infections or wounds at the nerve block sites; patient's inability to cooperate during the procedure.

The anesthetic technique was used to perform percutaneous forefoot surgery, as follows: 185 cases of hallux valgus, seven cases of hallux rigidus, four cases of hallux valgus interphalangeus, 138 claw toes, 10 bunionettes, four cases of Morton's neuroma, one of Freiberg's disease, and 109 patients with metatarsalgia, distributed as follows (48 of the second metatarsal, 40 of the third, 25 of the fourth, and one of the fifth): 17 rheumatoid feet, five neurological feet, one case of shortening of the second and third toes and one case of digital callus. In those cases where we operated only on the first and second rays of the foot, we used a 4-in-1 block without sural nerve block. When the condition affected the third and/or fourth and/or fifth ray, we supplemented the anesthesia with sural nerve block, thereby performing a 5-in-1 block.

The anesthetics used for the blocks were 10ml of 2% lidocaine combined with 10ml of 7.5mg/ml ropivacaine, both without a vasoconstrictor, thus preventing complications arising from their use. The anesthetic infusion material consisted of a 5ml syringe attached to a long, thin, flexible needle with a 27Gx1.5" blunt tip. In the first 50 blocks we used a conventional 30x0.7mm needle.

All patients were prepared before the anesthetic procedure, placing them in the horizontal supine position, with the limb to be operated on extended over the operating table. The other limb was placed off the side of the operating table on a rest, keeping it at 90 degrees of knee flexion. From this point on, the surgical team performed a surgical skin prep on the foot and ankle, followed by asepsis and antisepsis, then marked the topography of the nerves to be blocked before administering the anesthetic drug infusion. Having established the effectiveness of the anesthesia, we commenced the surgery.

To identify specific nerve block landmarks we made use of previous anatomical knowledge and anatomical reference points inherent to the target nerve.

The tibial nerve block was performed after positioning the patient's ankle in external rotation, followed by palpation of the medial malleolus in the posteroinferior direction until the posterior tibial artery pulse was palpated, located 0.5 to 1cm posterior to the artery. The needle was then introduced at an angle of 45 degrees in the mediolateral plane, distributing the anesthetic in a fanwise manner (Figure 1).

To perform the deep fibular nerve block, we placed the patient's ankle in neutral position. First, we requested the patient to actively extend the toes. Then, we palpated the extensor hallucis longus and extensor digitorum longus. Locating the deep fibular nerve in the lateral part of the extensor hallucis longus, over the proximal segment of the first and second ray, the surgeon was able to palpate the dorsalis pedis artery of the neurovascular bundle (Figure 2) as a reference, and create a bleb of local anesthetic.

**Figure 1.** Site of posterior tibial nerve block in the medial retromalleolar region of the ankle.

**Figure 2.** Site of deep fibular nerve block on the dorsum of the foot.

In order to identify the saphenous nerve block landmark, the patient's ankle was positioned in slight external rotation. We palpated the medial malleolus and the saphenous vein. We then inserted the needle about 1.5cm anterior and proximal to the medial malleolus in the direction of the anterior tibial tendon, forming a subcutaneous ring with the anesthetic solution between these reference points.

The superficial fibular nerve block was marked while positioning the patient's ankle in internal rotation, identifying an imaginary line joining the lateral to the medial malleolus. We identified the superficial fibular nerve between the lateral malleolus and the tibialis anterior. We inserted the needle in the region anterior to the lateral malleolus and proceeded towards the medial malleolus with infiltration, forming a subcutaneous ring up to 4cm from the medial malleolus (Figure 3).

The sural nerve block was performed using a bleb of local anesthetic, with internal rotation of the ankle, after marking and identifying a 1.5cm retromalleolar space lateral to the fibular tendons in the distal direction (Figure 4).

In all the blocks performed, aspiration was undertaken prior to infusion to avoid accidental intravenous infiltration. In cases where the patient reported an electric shock-like sensation when the needle was inserted, we retracted the needle 3 to 5mm and resumed the block procedure.

All surgeries started only after the patients confirmed the success of the anesthesia in the areas stimulated by the orthopedic team. In cases where insufficient anesthesia was observed, we combined other techniques such as reinforcement of the locoregional block, spinal anesthesia, or general anesthesia.

All participating patients were apprised of the objectives of the study and were asked to sign an informed consent form.

## Results

In the 239 blocks performed, we observed eight cases of complications (3.34%), including seven cases of neuritis (six of the tibial nerve and one of the deep fibular nerve), which progressed to full recovery after the use of neuroprotectors. There was also one case of intraoperative tachycardia, promptly reversed by the anesthetist present. Of the seven cases in which traumatic neuritis occurred, we used conventional needles in five and blunt-tipped needles in two. We did not observe any complications such as infection, hemorrhage, or inadvertent intravascular infusion.

Regarding the anesthetic technique, the anesthesia was effective in 96.26% of the blocks, enabling us to perform the proposed surgical procedures. Failure of the anesthetic block only occurred in nine cases (3.76%), necessitating supplementation with local anesthetic in four cases, spinal anesthesia in one case, and general anesthesia in four cases.

## Discussion

A number of recent authors advocate the percutaneous surgical approach to correct forefoot deformities, due to the good results shown with this technique[3-5].

Since the mean age of these patients is usually high (as shown in our sample: 61.2 years) and sometimes accompanied by comorbidities, peripheral nerve blocks of the ankle are a good option for interventions in these cases, due to the lower risks to the patient,[1-3] and as they are easy and safe to execute when the technique described in this study is respected.

Peripheral blocks are widely used for surgical anesthesia, as well as for postoperative analgesia[3]. There has been significant growth in the use of this technique in surgeries in

**Figure 3.** Site of superficial fibular and saphenous nerve block by means of anesthetic cord injection, in the anterior region of the ankle.

**Figure 4.** Site of saphenous nerve block in the lateral region of the ankle below the fibular tendons.

specific areas such as orthopedic, vascular, and dermatological procedures[6-8]. Nowadays, regional anesthesia in the lower limbs is considered preferable to general anesthesia. Postoperative recovery and length of stay are shorter, while hospital costs are lower[8].

Ultrasound/electrostimulation-guided peripheral nerve blocks, used alone or in combination, have gained popularity in the last decade due to their simplicity and precision, and particularly in the technological advancement of their portability. They are beneficial in settings where the nerves are deeply positioned. However, they do not substitute experience and knowledge of the relevant anatomy. In certain scenarios, ultrasound may not offer additional benefit, and a substantial amount of time may be spent attempting to find relevant structures, or the procedure may even provide a false sense of security, especially to an inexperienced operator[9]. In the hospital where we work, we do not have this resource in the surgical unit (ultrasound), hence all blocks were performed seeking the anatomical landmarks of the nerves to be blocked. On the other hand, ultrasound-guided anesthesia has several advantages compared to the conventional 5-in-1 block, including fewer needle punctures with the needles for infiltration, the need for a smaller volume of local anesthetic, less tissue distortion, and consequently a lower risk of systemic toxicity[2].

When compared to general anesthesia, its advantages are: absence of complications involving the airways, as these are not manipulated; fewer postoperative respiratory complications, as there is no mechanical ventilation, and a reduction in postoperative delirium, nausea, and vomiting[2]. In comparison to spinal anesthesia, the technique involves fewer hemodynamic complications (changes in blood pressure and/or heart rate) and neurological complications (neuritis), especially in patients with comorbidities[10].

Some of the disadvantages in comparison to the techniques used for truncal blocks of the ankle described in the literature are: long anesthetic latency time[1,10] (20min); the risk of inadvertent intravascular injection of anesthetic[1]; and the risk of nerve damage caused by the needle. Because it is a superficial and purely sensitive block, it allows the patient to move his/her foot, often hindering the procedure, even under sedation. The nerve block may be incomplete or ineffective in 5% of cases [2,11,12], requiring conversion to spinal anesthesia or general anesthesia in this situation.

We had 3.34% of complications. The seven cases of neuritis progressed with spontaneous resolution, treated only with simple analgesics and neuroprotective drugs. We must emphasize that five of these cases belong to the group of the first 50 patients, in whom we used a conventional 30x0.7mm needle rather than a flexible blunt needle. The percutaneous procedure proved difficult in a patient diagnosed with Parkinson's disease anesthetized with peripheral block, since tremors and involuntary movements did not cease.

The anesthetic technique was effective and the anesthesia was only insufficient in nine procedures (3.76%), which is lower than the percentage encountered in the study presented by Teixeira et al.[2] (5%). Supplementation with local anesthetic was required in four of these cases, conversion to spinal anesthesia in one case, and to general anesthesia in the other four. In one of the cases that switched to general anesthesia, after the patient regained consciousness, we noted that the previously blocked limb was anesthetized, perhaps as a result of the longer latency period presented by the drugs used.

As a limitation of this study, we observed a lack of control groups for a real comparison of the effectiveness of the anesthesia administered, as well as its risks and complications.

The low rate of complications and the success achieved in anesthesia in which we performed peripheral nerve blocks for percutaneous forefoot surgery, encourage us to maintain this anesthetic technique, as it is safe and easy to execute.

## Conclusion

Peripheral nerve blocks used in percutaneous forefoot surgery have proven to be highly effective with low complication rates.

**Authors' contributions:** Each author contributed individually and significantly to the development of this article: CLO *(https://orcid.org/0000-0002-9723-5302) wrote the article, interpreted the results of the study, participated in the review process, approved the final version; LCATF *(https://orcid.org/0000-0002-0778-2506) interpreted the results of the study, participated in the review process, approved the final version; LCRL *(https://orcid.org/0000-0003-1158-2643) conceived and planned the activities that led to the study, wrote the article, participated in the review process, approved the final version; GLFC *(https://orcid.org/0000-0001-5470-8379) interpreted the results of the study, participated in the review process, approved the final version; RNF *(https://orcid.org/000-002-2103-1733) interpreted the results of the study, participated in the review process, approved the final version; LFL *(https://orcid.org/0000-0003-1048-7134) wrote the article, interpreted the results of the study, participated in the review process, approved the final version. *ORCID (Open Researcher and Contributor ID).

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