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Comparison of the efficacy of H and inverted V anesthetic block techniques: a five-year prospective and multicenter study

Comparación de la eficacia de las técnicas de bloqueo anestésico H y V invertida: un estudio prospectivo y multicéntrico de cinco años

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Keywords:

Onychocryptosis, anesthesia, lidocaine, H technique, V technique, nail, surgery.

Abstract

Introduction: First toe surgery is a common procedure used to treat various conditions, such as onychocryptosis, subungual exostoses, and osteochondromas. A crucial step before surgery is the complete anesthetic block of the affected toe. Currently, the standard technique to achieve this block is the H technique. In this context, our objective is to evaluate the inverted V technique and determine whether it offers advantages compared to Frost's H technique.

Patients and methods: A prospective observational study was conducted in multiple centers between February 2017 and February 2022 with patients requiring surgery for onychocryptosis, subungual exostoses, and osteochondromas. Participants provided informed consent and were randomly assigned to one of two anesthetic block technique groups. Data were collected on demographics, type of block, anesthesia effectiveness at various intervals post-infiltration, and the need for anesthetic reinforcements.

Results: The study included a total of 246 surgical interventions for onychocryptosis, evenly distributed between the two anesthetic block techniques. A total of 123 interventions were randomly assigned to the H technique and 123 to the inverted V technique. The analysis of efficacy times showed that the inverted V technique was 11.4% more effective than the H technique at 20 minutes post-infiltration.

Conclusions: Both methods are safe and effective. However, the inverted V technique demonstrated slightly higher efficacy compared to the H technique.

Palabras clave:

Onicocriptosis, anestesia, lidocaína, técnica H, técnica V, uña, cirugía.

Resumen

Introducción: La cirugía del primer dedo del pie es un procedimiento frecuente para tratar diversas patologías, como onicocriptosis, exóstosis subungueales y osteocondromas. Un paso crucial antes de la intervención quirúrgica es la realización de un bloqueo anestésico completo del dedo afectado. Actualmente, la técnica estándar para lograr este bloqueo es la técnica H. En este contexto, nuestro objetivo es evaluar la técnica en V invertida y determinar si ofrece ventajas en comparación con la técnica H de Frost.

Pacientes y métodos: Se realizó un estudio observacional y prospectivo en varios centros entre febrero de 2017 y febrero de 2022 con pacientes que requerían cirugía por onicocriptosis, exóstosis subungueales y osteocondromas. Los participantes dieron su consentimiento informado y fueron asignados aleatoriamente a uno de los dos grupos de técnicas anestésicas. Se recopilaron datos sobre demografía, tipo de bloqueo, eficacia de la anestesia en intervalos de tiempo posteriores a la infiltración y la necesidad de refuerzos anestésicos.

Resultados: El estudio incluyó un total de 246 intervenciones quirúrgicas para onicocriptosis, distribuidas equitativamente entre las dos técnicas de bloqueo anestésico. De manera aleatoria, se asignaron 123 intervenciones a la técnica H y 123 a la técnica V invertida. El análisis de los tiempos de eficacia mostró que la técnica V invertida fue un 11.4 % más efectiva que la técnica H a los 20 minutos posteriores a la infiltración.

Conclusiones: Ambos métodos son seguros y efectivos. Sin embargo, la técnica V invertida mostró una eficacia ligeramente superior en comparación con la técnica H.

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Introduction

Onychocryptosis is the most common condition affecting the toenail of the first toe, causing inflammation, pain, and even infection[1]. Its causes include improper nail trimming, hereditary factors, and the use of inappropriate footwear[2]. Regarding treatments, if conservative therapy proves ineffective, surgical intervention becomes necessary[3,4]. However, not only onychocryptosis requires surgical treatment; other conditions affecting the first toe, such as subungual exostoses and osteochondromas, also require surgery, requiring an anesthetic block before the procedure[5]. Therefore, it is of interest to develop new and improved anesthetic blocking techniques for toenails and compare them with current techniques to demonstrate their efficacy, thereby enhancing clinical practice in toe surgery.

One of the most widely used techniques is the ring block, with the "H" technique, described by Dr. Frost in 1952, being predominant[6]. This technique involves two infiltrations in the medial and lateral margins of the proximal phalanx. However, complete blocking is not always achieved, which may require additional infiltrations, increasing the dose of anesthetic and postoperative pain. In 2017, the inverted "V" technique was introduced[7], aiming to improve and update the "H" technique by allowing blocking with a single infiltration and two lateralizations.

This study aims to assess the anesthetic efficacy of both techniques by comparing Frost's "H" technique with the inverted "V" technique to determine which is more effective as an anesthetic method in surgery on the first toe.

Patients and methods

Study design

We conducted a 5-year prospective, observational, randomized, and multicentric study from February 2017 through February 2022. The study focused on comparing 2 anesthetic blocking techniques: the "H" technique and the inverted "V" technique. The 2 techniques were performed under homogeneous conditions, using the same consumables, facilities, and drugs to ensure consistency in the procedures.

The study patients were categorized into 2 groups: the "H" group, where the "H" technique was applied, and the "V" group, where the inverted "V" technique was used for anesthetic blocking of the first toe. Group allocation was randomized and based on the last digit of the patients' health record numbers: even numbers were assigned to the "H" group and odd numbers to the "V" group.

The study aimed to compare the efficacy of the blocking techniques 10, 15, and 20 minutes after applying each technique. All patients were asked if they felt numbness in the toe or a cork-like sensation, and using Adson tweezers without teeth, pinches were applied to different areas of the toe to assess whether the patient experienced pain or not, compared to a non-anesthetized toe. These questions and the use of the Adson tweezers were performed at 5, 10, and 20 minutes after the anesthetic infiltration.

Study population

Patients undergoing onychocryptosis surgery from February 2017 through February 2022 were included. The procedures were performed at Hospital Clínic de Barcelona (a public tertiary referral center, Barcelona, Spain) and in 3 private clinics around Barcelona. Patients with a history of hypersensitivity or allergy to local anesthetics of the amide group, as well as those who were pregnant or breastfeeding, were excluded. Patients with neuropathies, cognitive deficits, Raynaud's syndrome, coagulation disorders, or ischemic arteriopathy, which could contraindicate surgery, were also excluded. These criteria were essential to minimize complications and guarantee data validity.

Studied Variables

The comparison between the 2 groups (H and V) regarding technique efficacy at 10, 15, and 20 minutes was used to test the study hypothesis. The variables described were as follows: Age; Sex; Laterality; presence of infection in the nail lesion; presence of granuloma; efficacy of the technique at 10, 15, and 20 minutes; and number of reinforcements (in cases where the block was ineffective).

Data collection was done on both paper and digital health records, including patient medical histories and notes for each anesthetic procedure.

Materials and techniques description

Consumables included sterile, disposable 23 G needles (0.6 mm x 25 mm) for intramuscular use, blue cones, and 5 mL syringes, all sterile and disposable. For aseptic conditions, non-sterile gloves, sterile gauze, antiseptic soap, and 70 % alcohol were used. The anesthetic used was 2 % lidocaine in 10 mL ampoules, always supplied by the same laboratory, with each ampoule containing 200 mg of lidocaine hydrochloride. This anesthetic was chosen based on literature review, as this amide-group local anesthetic is one of the most commonly used in various studies for local anesthesia in the foot and hand, making it suitable for this study.

Procedures were conducted by trained podiatrists following a standardized protocol to ensure consistency and comparability of results. Currently, the most prevalent technique for truncal anesthesia of the first toe is the "H" technique, described by Dr. Frost in 1952[6]. This method involves two punctures on the medial and lateral of the toe, with a lateralization maneuver of the needle in one of them. The first puncture is performed on the dorsal and lateral aspect of the base of the first toe on the fibular margin. One mL of anesthetic is injected at the plantar level, forming wheals toward the dorsum until reaching a total of 2 mL. After injecting the anesthetic, without removing the needle, it is lateralized at a 90-degree angle, and the toe is slightly dorsiflexed. This maneuver allows the anesthetic to infiltrate under the sheath of the extensor hallucis longus, creating a new 1 mL wheal. The second puncture is made on the dorsal and medial side of the first toe, at the tibial margin. Another ml of anesthetic is injected at the plantar level, creating wheals towards the dorsum for a total of 2 mL of anesthetic (Figure 1).

To perform the inverted "V" anesthetic blocking technique, a single puncture site on the dorsal aspect of the toe is used, with 2 lateralization maneuvers (Figure 2). The technique begins with a small pinch on the dorsal side of the first toe, just above the proximal phalanx. The needle is inserted firmly above the extensor tendon for subcutaneous infiltration. Puncture is performed vertically, aspiration

Figure 1. Photographs while performing the technique H.

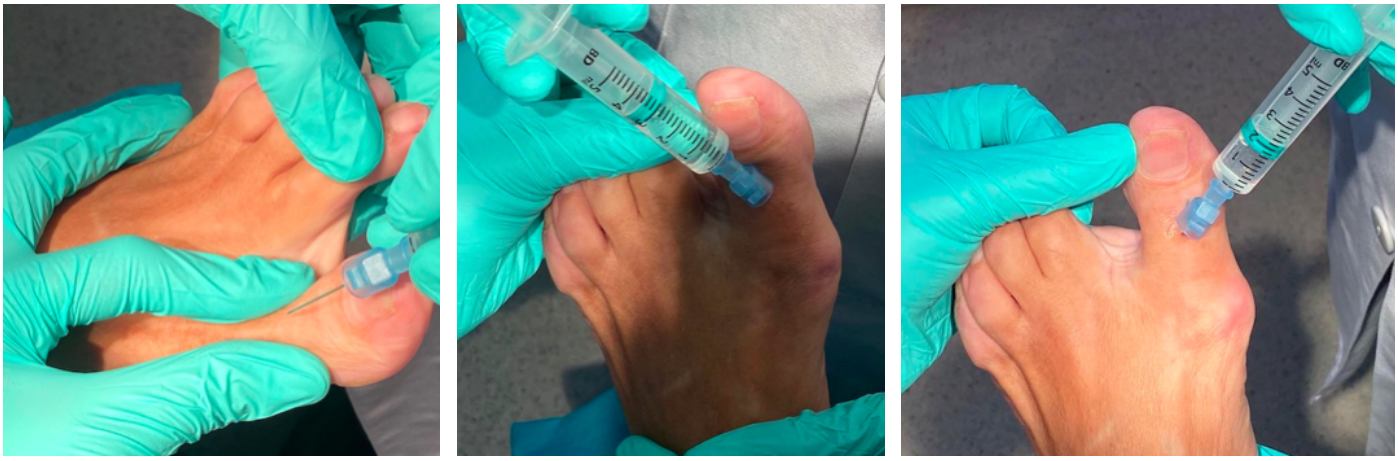


Figure 2. Photographs while performing the inverted technique V.

is performed, and 1 mL of anesthetic is injected, forming a subcutaneous wheal at the injection site. Without removing the needle, it is angled at 45 degrees toward the proximal phalanx in the direction of the plantar side of the toe, blocking the tibial canal of the nail. Another mL of anesthetic solution is injected into the plantar region, then the needle is withdrawn dorsally, creating a wheal with a total volume of 2 mL. Afterwards, the needle is returned to the initial puncture site, and the same maneuver is repeated on the medial/proximal side. The needle is directed at 45 degrees toward the plantar region to anesthetize the nail peroneal canal. One mL of anesthetic solution is injected in the plantar region, and the needle is withdrawn dorsally, creating wheals with a total volume of 2 mL. This technique anesthetizes the four nerve trunks that innervate the first toe, including the 2 dorsal nerves and the 2 plantar nerves.

Statistical analysis

For the statistical analysis, the SPSS software version 24.0 (SPSS, Inc., Chicago, IL, USA) was used. A sociodemographic analysis was performed to evaluate the distribution of results in relation to age and gender. With an alpha risk of 0.05 and a beta risk of 0.2 in a two-sided test, a sample size (NN) of 246 surgeries was required. Group H consisted of 123 surgeries and Group V of 123 surgeries to detect the presence of statistically significant differences between the groups. A 5 % rate of follow-up losses was estimated. After applying the mentioned test, variables were evaluated according to the dependency between them. For this, the chi-square test was used, with statistical significance established at a p-value < 0.05 ($p < 0.05$). Additionally, to analyze the effectiveness of both anesthetic techniques, a comparison of the means of variables between the 2 studied techniques was performed. Quantitative variables for both techniques were also assessed using the Mann-Whitney-Wilcoxon test (to compare both groups), where statistical significance was similarly established at a p-value < 0.05 ($p < 0.05$).

Results

The final sample of the study consisted of 246 anesthesia blocks of the first toe, with 152 MEN and 94 women with a mean age of 44.78 years, and an age range of 12-90 years. In 124 cases,

a block was performed on the right foot, and in 122 cases, on the left foot. Technique V was performed in a total of 123 surgical procedures (68 men and 55 women, with a mean age of 47.81 years), while Technique H was also performed in 123 surgical procedures (84 men and 39 women, with a mean age of 46.61 years). As seen, the mean age between both techniques showed no significant difference ($p > 0.05$). However, significant differences were found regarding gender distribution ($p < 0.05$). Figure 3 shows both conclusions regarding the distribution of age and gender for both techniques.

Figure 4 shows the distributions (in percentages) of the following variables: laterality, infection, granuloma, number of reinforcements, effectiveness at 10 minutes, effectiveness at 15 minutes, and effectiveness at 20 minutes for Techniques V and H.

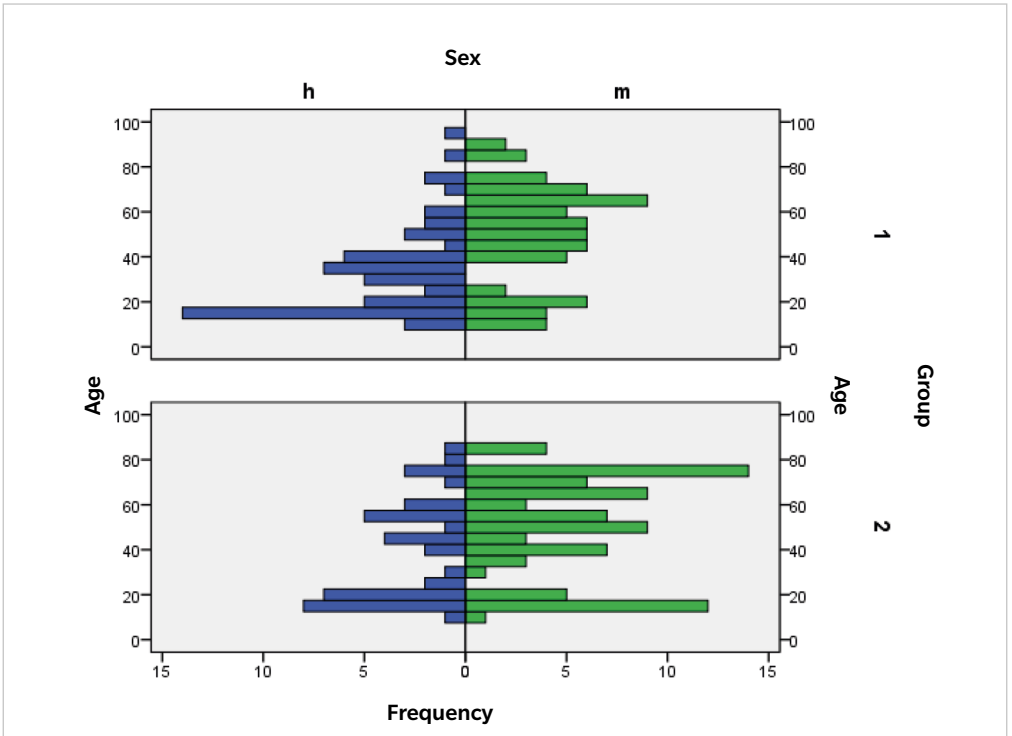
Visually, no substantial differences are observed in the outcomes of the studied variables between both groups, which was corroborated by comparing the means of each variable between the 2 techniques. No statistically significant differences were observed in the variables between Techniques V and H ($p > 0.05$). This would suggest that both anesthetic block techniques in the first toe are quite similar, and either technique (V or H) could be used to achieve an effective block of the target toe for anesthesia.

Nonetheless, the effectiveness times for the anesthetic block were better with Technique V. At 10 minutes post-technique V, 69.9 % of patients experienced complete anesthetic block; at 15 minutes, this rose to 85.4 %, and at 20 minutes, up to 87.8 %. Observing these percentages suggests that the effectiveness of Technique V increases over time. For Technique H, 59.3% had an anesthetic block after 10 minutes, 74.8 % at 15 minutes, and 76.4 % at 20 minutes. As with Technique V, the effectiveness of Technique H also increased over time.

When comparing both techniques at each of the aforementioned times, at 10, 15, and 20 minutes post-injection, Technique V consistently showed slightly superior effectiveness across all time intervals (Figure 5).

The anesthetic failure rate was calculated 20 minutes after the infiltration. If, after 20 minutes, the patient did not report anesthetic sensation, a "cork-like" sensation, or total loss of pain, additional injections, termed bailout injections, were administered. Results showed a failure rate of 12.2 % for Technique V and 23.6 % for Technique H, with two cases requiring two bailout injections. Figure 6 clearly demonstrates that the anesthetic failure rate is significantly higher for Technique H.

Considering the most important variables in the block, the influence and/or association of each variable with the effectiveness achieved at 15 and 20 minutes for both techniques was analyzed. Table I presents the results obtained by applying the chi-square test ($p < 0.05$). A significant dependency was observed between the



h: men. m: women. Group 1: technique V. Group 2: technique H.

Figure 3. Sociodemographic analysis.

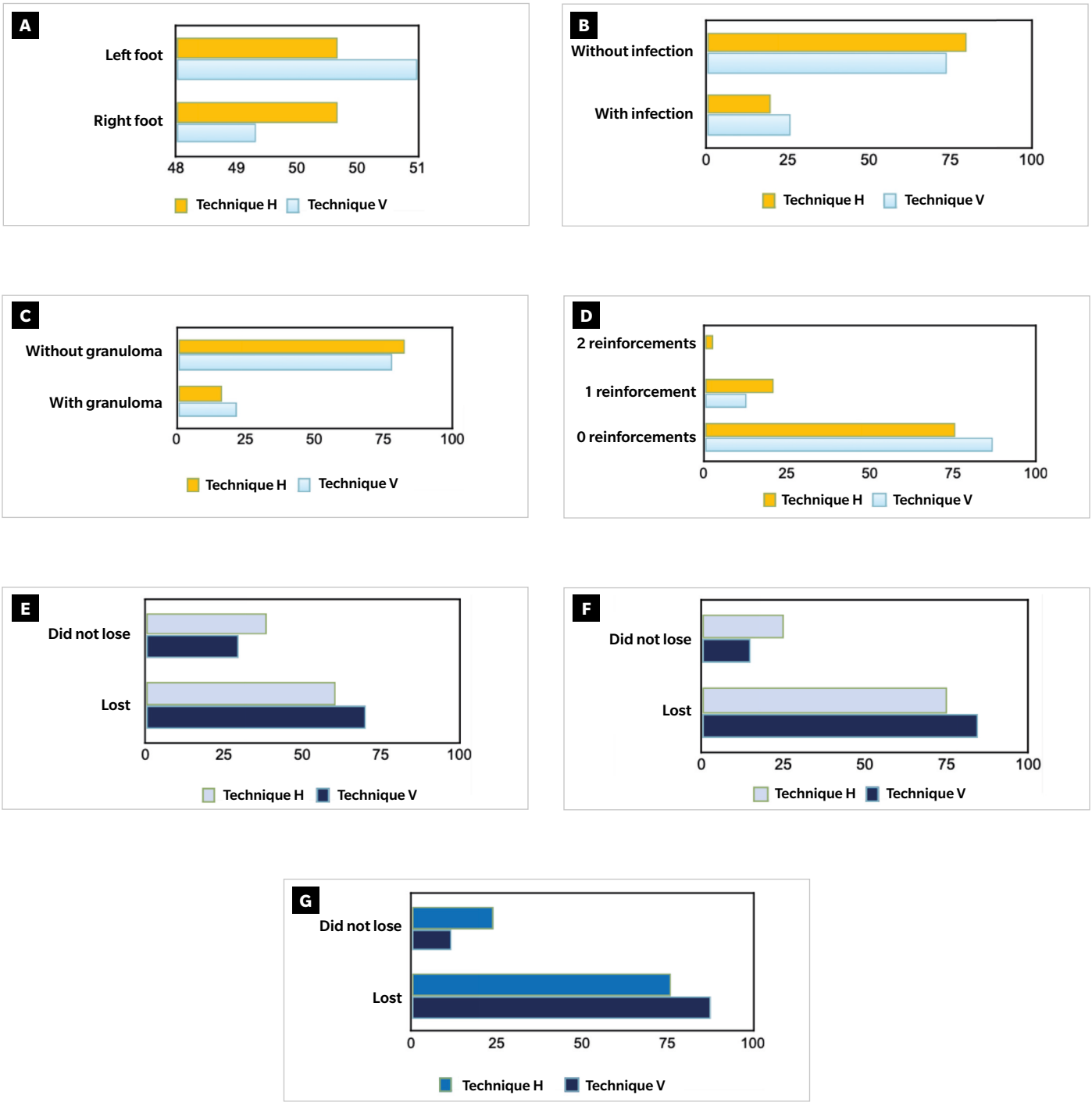


Figure 4. Distribution (percentage) of: A: laterality; B: infection; C: granuloma; D: no. of reinforcements; E: efficacy at 10 minutes; F: efficacy at 15 minutes; G: efficacy at 20 minutes.

number of reinforcements and effectiveness at 15 and 20 minutes for both techniques.

Regarding infection, 57 out of a sample of 246 patients experienced infections, accounting for 23.17 % of the sample. When broken down by technique, 32 of the 123 patients in Technique V experienced infection (26 % of the sample) vs 25 out the 123 patients in Technique H (20.32 %). The effectiveness of Technique V at 20 minutes post-infiltration in infected patients was 75 % (52 % in Technique H).

For granuloma, which often accompanies infection, 44 out of the 246 patients in the sample experienced granuloma, repre-

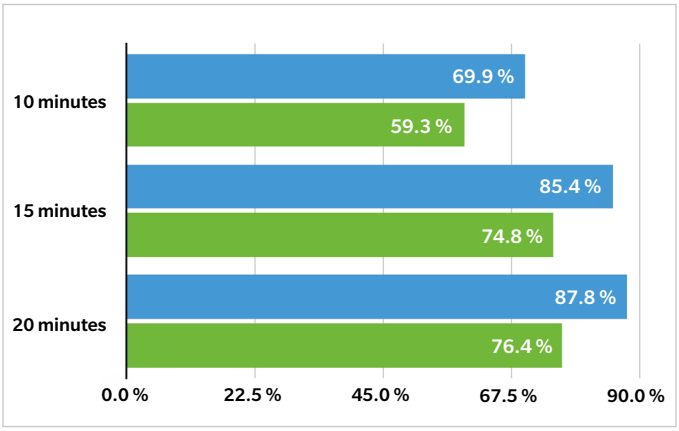


Figure 5. Bar graph for the comparison at 10, 15, and 20 minutes in the percentages between technique V and H.

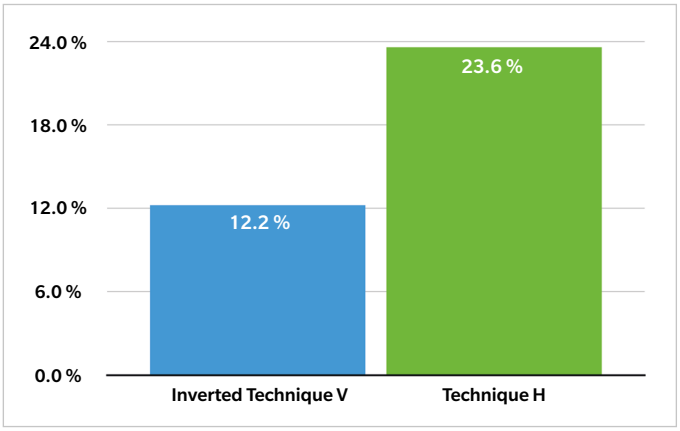


Figure 6. This graph shows the difference in failure or anesthetic failure rate between the 2 techniques under comparison.

Table I. Chi-Square Values.

		Asymptotic Significance (two-tailed)
Technique H	Sex - Efficiency at 15 min	0.043
	Sex - Efficiency at 20 min	0.204
	Number of Reinforcements - Efficiency at 15 min	0.000
	Number of Reinforcements - Efficiency at 20 min	0.000
Technique V	Sex - Efficiency at 15 min	0.657
	Sex - Efficiency at 20 min	0.885
	Number of Reinforcements - Efficiency at 15 min	0.000
	Number of Reinforcements - Efficiency at 20 min	0.000

senting 17.8 % of the sample. When broken down by technique, 24 out og the 123 patients in Technique V developed granuloma (19.51 %), while 20 out the 123 patients in Technique H experienced granuloma (16.26 %). The effectiveness of Technique V at 20 minutes post-infiltration in patients with granuloma was 79% (45 % in Technique H).

Discussion

Conditions of the first toe requiring surgical therapy are common across all ages, with onychocryptosis being the most prevalent[8]. However, there is limited literature on specific local or nerve block anesthesia techniques for these surgical procedures.

Onychocryptosis presents as a painful lesion where the nail lateral edges penetrate the dermal tissue, significantly impacting the patient's quality of life due to pain and functional impairment[1]. While it usually affects the first toe, other toes may also be involved. The prevalence is 2.5 % up to 5 %, with a higher incidence in men[9]. This condition has 2 incidence peaks, around ages 15 and 50[10]. Our study is consistent with these findings, showing incidence peaks between ages 15-20 and 50-60, with higher prevalence in men. Other first toe conditions, such as osteochondromas, subungual exostoses, and verrucous lesions, may also require surgical treatment and anesthesia blocks[11].

An effective block is crucial for a quick onset, pain-free experience, and complete dorsal and plantar anesthesia during surgery. Anesthesia should completely abolish pain, allowing only a light sensation of touch or a cork-like sensation[12,13].

Choosing the appropriate anesthetic technique depends on the patient's needs, surgery duration, and surgeon's preference. Incorrect application of these techniques may cause intense pain and stress for both the patient and surgeon[14]. Currently, the ring block technique is the most widely known[15,16]. This involves 2 injections at

the base of the toe (Technique H). In contrast, Technique V, which involves a single dorsal injection at the base of the first toe[7,16,17], may offer significant advantages.

While lidocaine and mepivacaine are the most widely used local anesthetics, there is no consensus on which is best. Lidocaine, developed in 1943 by Nils Lofgren and Bengt Lundqvist[18], is the most widely used amide-type anesthetic and is considered the "gold standard" in comparative studies. Its action starts within 5-10 minutes, lasting around 1.5 hours[19,20], and it is metabolized in the liver by the enzyme CYP3A4[21]. Its relatively low cost also makes it preferable in economically constrained settings.

Currently, there are controversies regarding various aspects of anesthetic block, such as the volume of anesthetic, latency, and duration of effect. Some studies suggest that volumes > 2-3 mL could cause ischemia due to vascular compression[22-24]. Others advocate for the use of vasoconstrictors to reduce latency time and improve safety[22,25,26]. Existing literature shows variable results regarding the latency time of Lidocaine, with studies reporting times ranging from 4 minutes up to 29 seconds[27]. This variability may be due to anatomical differences between the fingers of the hand and foot, as well as the diameter of the nerve fibers.

Both the H technique and the V technique have theoretical risks of nerve or blood vessel damage due to the proximity of the needle to the neurovascular bundle. However, in our study, no such complications were reported. The use of aspiration prior to injection and the administration of 5 mL of anesthetic did not cause tissue damage or necrosis[7,16,17].

The H technique requires two punctures, whereas the V technique allows for a block with a single puncture. This reduces patient anxiety and the risk of vasovagal reactions, in addition to simplifying the procedure and making it quicker and more comfortable.

Regarding anesthetic effectiveness, our research shows that the inverted V technique exceeds the H technique in terms of success at 10, 15, and 20 minutes, with an effectiveness of 87.8 % vs 76.4 % for the H technique, although not statistically significant. The V technique has a lower rate of anesthetic failure (12.2 % vs 23.6 %) and requires fewer reinforcements. These results suggest that 2 % lidocaine has a latency time of approximately 10 minutes in the first toe. Differences in pH of the medium and anatomical structure may influence the efficacy of the anesthetic.

In our study, the V technique proved to be superior to the H technique, especially in patients with infections or granulomas. We believe that the V technique, by injecting the anesthetic in a region further from the infection, is more effective than the H technique.

Among the limitations of this study, it would be interesting to propose future studies that include some scale to measure pain at the time of puncture to improve the assessment method and make it more effective. Although this aspect was not taken into account in the study design, it would be important for future research. It would also be useful to investigate the number of positive aspirations to reduce or predict complications.

In conclusion, we can generally state that the inverted V technique is an alternative to the H technique for anesthesia in surgeries of the first toe, due to its simplicity, safety and efficacy, and, along with a lower number of punctures. In this study, the V technique showed greater efficacy and a lower failure rate, although not statistically significant. More research is needed to validate these findings in different populations and with other anesthetics.

Etical statement

All patients received a detailed information sheet and signed informed consent before participating in the study. Data collected during the research were handled with utmost confidentiality through coding on record sheets. The study received ethical approval from the Universitat de Barcelona Ethics Committee (IRB Registration No. IRB00003099); Ethics Committee for Drug Research at Hospital Clínic de Barcelona (HCB/2019/0051); and the Drug Research Ethics Committee (CEIm) at Hospital Odontològic Universitat de Barcelona (Registration No. 2007-43).

Conflicts of interest

None declared.

Funding

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