

Study on Epinephrine Used in Local Anesthesia

Controversy and certainty

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Epinephrine (adrenaline) - C₉H₁₃NO₃ - was synthesized for the first time by Fredrich Stelz in 1904 from phenylalanine. After a hydrolysis and decarboxylation process, active dopamine is obtained. Following the pathway of other hydroxylation followed by N-methylation, epinephrine synthesis is achieved. Epinephrine has initially been administrated together with procaine in local anesthesia in hand surgery. Epinephrine has been considered to be one of causes of ischemia and necrosis in hand and especially fingers surgery. Over time, studies have shown the efficacy and safety of using lidocaine-associated epinephrine in local hand surgery anesthesia. Numerous advantages regarding the use of lidocaine 1% with epinephrine, solution at a concentration of 1:100,000 have been reported, starting with increasing the duration of anesthesia, avoiding the use of tourniquet, leading to increased patient comfort and to the advantage of a much lower cost in terms of surgery as a whole. Our study group consisted of fifty patients with hand and fingers different pathologies. In all cases surgery was performed under local anesthesia using lidocaine 1% with epinephrine, solution at a concentration of 1:100,000. The decrease of doses mentioned in the literature was attempted and in some cases the decrease was up to 30%. There have not been reported any ischemic or necrosis complication in the immediate postoperative period.

Keywords: lidocaine, epinephrine, local anesthesia, hand surgery

Local anaesthetics are synthetic pharmacological agents that cause reversible loss of sensitivity at the level of the area where they are injected. Chemically, they have a cocaine-like formula, which was the first local anaesthetic described by Nieman and first used by the austrian ophthalmologist Koller in 1884 [1]. Procaine was the first synthetic anesthetic to be used on a large scale since 1905, and later in 1947 lidocaine was synthesized. Lidocaine, with the chemical structure of alpha-diethylamino-2,6-dimethylacetanilide, was the first local amine-amide anaesthetic synthesized by Nils Lofgren [2, 3]. Being water-soluble and temperature stable, it can be sterilized without changing its properties. Lidocaine is the most commonly used topical anaesthetic and is also used as an antiarrhythmic agent [1]. However, lidocaine, also known as xylocaine, does not have the effects of cocaine: euphoria and addiction [4]. The maximal doses of lidocaine may be doubled by the addition of adrenaline. In hand surgery the need of a bloodless operation field led to the idea of association of adrenaline (epinephrine) to local anesthetics for its vasoconstrictor effect [1]. In 1956, S. Bunnell postulates that adrenaline is not to be injected at the fingertips because of the high risk of ischemia and necrosis that can occur at this level, aspects mentioned by De Freitas Novais Jr., et al. in 2014 [5]. Such mechanism was described as a toxic effect of substances like contrast media on living tissues [6]. Over time it has been shown that adrenaline was not the cause of digital necrosis, but procaine was, used as a local anaesthetic at that time [7]. Thomson shows in his studies that the use of epinephrine in the hands and fingers is safe [8]. The need for the bloodless operation field in hand surgery, longer anesthesia time, avoiding sedation and tourniquet use has led to the study of the association of lidocaine with epinephrine (adrenaline), thus demonstrating the utility of using this

combination in hand surgery and its advantages. Our study was conducted on a group of 50 patients with various diseases or injuries in the hand where surgery was performed without sedation and tourniquet (WALLANT technique-Wide Awake Local Anaesthesia No Tourniquet), using local anaesthesia with lidocaine 1% and epinephrine (adrenaline), following the concentrations and the injection points indicated by literature and even trying to reduce the amount of anesthetic used.

Experimental part

A group of 50 patients with various pathologies of the hands was studied: 18 patients with carpal tunnel syndrome, 19 patients with Stage II and III Dupuytren disease, 7 patients with trigger thumb and 6 patients with finger posttraumatic sequelae for which tenolysis and/or neurolysis was indicated. In all cases local anaesthesia was used with lidocaine 1% with epinephrine, solution at a concentration of 1:100,000. The 18 patients with carpal tunnel syndrome, aged between 24 and 64 years, were 8 men and 10 women, 8 of whom were at the left hand and 10 at the right one (table 1).

Nineteen patients of the 50 studied cases presented stage II and III Dupuytren disease with one or two digital rays affected, in all cases the 4th and the 5th fingers were involved. The group consisted of 15 men and 4 women between the ages of 42 and 76 years, of whom 6 had a history of cardiovascular disease and two cases of noninsulin dependent diabetes. The amount of anesthetic solution injected was between 11 and 20 mL, (2 mL on each volar aspect of proximal phalange and 10 mL in the palm). In our study group, there were also 7 cases with trigger finger pathology at D1 level (Title 2) and 6 cases of posttraumatic or postoperative sequelae for which neurolysis and/or tenolysis was required, all at the long

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Carpal carpien syndrome	Male	Female	Age	Anesthetic solution (mL)	Hand
1	x	-	64	6	right
2	x	-	24	8	right
3	x	-	61	18	right
4	-	x	32	12	right
5	-	x	62	8	left
6	x	-	62	18	left
7	x	-	64	10	left
8	-	x	35	10	right
9	-	x	54	15	left
10	-	x	54	20	right
11	x	-	60	14	left
12	-	x	58	10	left
13	x	-	63	20	right
14	-	x	56	20	right
15	x	-	48	20	left
16	-	x	42	20	left
17	-	x	68	20	right
18	-	x	39	20	right

Table 1
STUDY GROUP FORMED BY PATIENTS WITH CARPAL TUNNEL SYNDROME

Trigger finger (thumb)	Male	Female	Age	Anesthetic solution (mL)	Hand
1	-	x	58	3	right
2	-	x	51	10	left
3	x	-	43	3	left
4	-	x	50	8	right
5	x	-	45	4	left
6	-	x	56	7	left
7	x	-	47	5	left

Table 2
STUDY GROUP FORMED BY PATIENTS WITH TRIGGER FINGER PATHOLOGY AT D1 LEVEL

Sequelaes of the hand	Male	Female	Age	Anesthetic solution (mL)	Hand
1	-	x	62	3	left
2	x	-	58	15	right
3	x	-	46	15	left
4	x	-	30	10	left
5	x	-	42	8	left
6	-	x	56	8	right

Table 3
STUDY GROUP FORMED BY PATIENTS WITH SEQUELAES OF THE HAND

fingers (table 3). In the case of the trigger thumb, for all the patients the anesthetic solution used was lidocaine 1%:adrenaline = 1:100,000. The waiting time for anesthesia to set in was between 7 and 15 min.

In the study group we used lower volumes of anesthetics than those described in the literature for carpal tunnel syndrome and Dupuytren's disease, but higher in the case of the trigger fingers. We mention once again that all the trigger finger cases were located at the level of the thumb.

Results and discussions

In all cases, regardless of pathology, the surgical intervention went well, without accidents or intraoperative incidents, without the need to supplement anesthesia or with intravenous sedation, providing a minimal bleeding field (in none of the cases it was necessary to apply the tourniquet). The comfort of the patients was good, their satisfaction at discharge being full. This type of anesthesia allowed for short-term hospitalization from a few hours to 24 h (for those with cardiovascular disease requiring a longer postoperative follow-up) at low cost. No distal digital necrosis, bleeding, hematoma or other postoperative complications have been reported.

The action of local anesthetics is based on their chemical structure namely their aromatic group. This is the first component of the chemical formula of local

anaesthetics which is lipophilic and able to cross neural membranes [1]. The second component of the chemical formula of this type of anesthetic is represented by the intermediate chain which may have an amide linkage in its structure and are aminoamides (lidocaine, bupivacaine, mepivacaine, ropivacaine, etc.) or an ester linkage and are aminoesters (cocaine, procaine, tetracaine, benzocaine, etc.) [1]. Over time, an ideal anesthetic has been sought, which has high efficiency at low concentrations, with a short time to take effect, with a long-lasting action time, which has small systemic toxicity and is water soluble, stable in solution and easily sterilizable [1]. It has been found that the use of vasoconstrictors in a concentration of 1:200,000 increases the anesthetic time of action by decreasing the blood flow and the rate of anesthetic absorption. The maximum allowed local anesthetic doses may be doubled when associated with adrenaline because absorption is slower and reaching toxic plasma concentrations is avoided [1, 9]. After S. Bunnell showed and demonstrated in 1956 the risks of using adrenaline in hand surgery, especially in the fingers, this association lidocaine - adrenaline was avoided [10]. Also, Green in Operative Hand surgery-5th Edition contraindicates the use of adrenaline in local anesthesia in the hand, returning in the next edition (Operative Hand Surgery-6th edition) by showing that this type of anesthesia

is safe [11]. Over time, studies have shown that there are no postoperative complications when using the solution lidocaine 1% with 1:200,000 adrenaline even at the fingertips [12]. Lalonde in 2005 did an extensive, multicentric study, which was attended by nine hand surgeons on a group of 3110 cases with different pathologies of the hands and fingers [13]. In all cases, the WALLANT (wide awake local anaesthesia no tourniquet) technique was used to show the advantages and disadvantages of the technique. He also set the injection points for the various pathologies in the hand as well as the indicated amounts. Lalonde recommended the use of a 1:100,000 lidocaine:adrenaline concentration and 7 mg/kg as the maximum acceptable dose so that for a person of about 70 kg can be used 50 mL of 1% lidocaine solution with epinephrine in a concentration of 1:100,000 [11]. In order to reduce the pain of anesthetic injection, it is proposed to add to the anesthetic solution an 8.4% bicarbonate solution in the ratio of 10:1 (lidocaine:bicarbonate) [1]. No postoperative complications such as necrosis, ischemia, hematoma, and the need to use phentolamine as an antidote for the vasoconstrictor effect of adrenaline have been reported in any of these cases [14]. Using local anesthesia with epinephrine-associated lidocaine the tourniquet is avoided, so Lalonde introduces the notion of wide-awake local anaesthesia no tourniquet (WALLANT) [7, 15]. The technique can be used not only for carpal tunnel syndrome, Dupuytren's disease, trigger finger, but also for metacarpian fractures, trapeziectomy, or even in serious trauma and flexor tendon sections at the wrist. Lalonde, also describes tendon transfers operated with this type of anesthesia, highlighting the advantage of being able to collaborate with the patient and to assess tendon tension correctly. In these cases, larger volumes of anesthetic being needed, a solution of 0.5% lidocaine and epinephrine 1:200,000 may be used. To increase the amount of anaesthetic, lidocaine ¼% with epinephrine 1:400,000 is recommended [15]. In 2007, Fitzchales-Bowe et al. by injecting adrenaline into different concentrations into their own fingers showed that there were no necrosis complications even when using concentrations of 1:100,000 or 1:10,000 and not even 1:1,000 [16]. In 2012, Mann and Hammert report a study in which tenorrhaphy and tenolysis surgeries are routinely done with local anaesthesia (1% lidocaine with adrenaline) emphasizing the safety of the method, the absence of the need to use the tourniquet and the possibility of correct assessment of the length of the tendon as a result of a good intraoperative collaboration with the patient, in none of these cases sedation being required [17]. In our study, we used adrenaline associated with the local anaesthetic, respecting the injection points and decreasing in some cases the indicated amounts, with no postoperative complication. The waiting time from the injection of the anaesthetic to full anaesthesia in four cases was only 4 minutes, the average being 8-10 min. Only in two cases dilution of 1:200,000 was used due to cardiac comorbidities of the patients [18, 19]. As far as patient satisfaction is concerned, it was maximum in terms of both intraoperative comfort and length of hospital stay that was reduced to a few hours [19-22].

Conclusions

The use of epinephrine in combination with local anaesthetics, at a concentration of 1:100,000 in hand surgery does not involve any risk, and provides multiple advantages: avoids tourniquet use, avoids drug administration for patient sedation, extended time of action of the anaesthetics, the possibility of full collaboration with the patient throughout the surgical procedure, lower hospitalization costs. The WALLANT technique proved to be safe and highly efficient with no postoperative complications such as digital necrosis.

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