



## Original article

# 488 hand surgeries with local anesthesia with epinephrine, without a tourniquet, without sedation, and without an anesthesiologist<sup>☆</sup>



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## ABSTRACT

**Objectives:** Evaluate the incidence of digital infarction and tissue necrosis using local anesthesia with 1% lidocaine and 1:100,000 epinephrine in wrist, hand, and fingers surgeries, without a tourniquet, without sedation, and without an anesthesiologist.

**Methods:** Patients with wrist, hand, and fingers disorders prospectively underwent surgery under local anesthesia with 1% lidocaine and 1:100,000 epinephrine. The primary outcomes evaluated were the presence of digital infarction and tissue loss due to necrosis. As secondary outcomes, the need for the use of sedatives, tourniquet, anesthesiologist assistance, or surgery suspension were evaluated.

**Results:** Fifty-three wrists, 307 hands, and 128 fingers were anesthetized with lidocaine and epinephrine without any complications related to epinephrine. There was no patient that presented with any of the primary or secondary outcomes.

**Conclusions:** Wrist, hand, and fingers surgeries can be safely performed with local anesthesia with 1% lidocaine and 1:100,000 epinephrine, without sedation, without a tourniquet, and without an anesthesiologist.

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<sup>☆</sup> Study conducted at Universidade Estadual Paulista (Unesp), Faculdade de Medicina de Botucatu, Botucatu, SP; Pontifícia Universidade Católica de Campinas (PUC-Campinas), Hospital e Maternidade Celso Pierro; Campinas, SP; and at Associação Beneficente Nossa Senhora do Pari, São Paulo, SP, Brazil.

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## 488 cirurgias da mão com anestesia local com epinefrina, sem torniquete, sem sedação e sem anestesista

### R E S U M O

*Palavras-chave:*  
Epinefrina  
Anestesia local  
Punho  
Mão  
Dedo

**Objetivo:** Avaliar a incidência de infarto digital e necrose tecidual com o uso de anestesia local com lidocaína a 1% e epinefrina a 1:100.000 nas cirurgias do punho, mão e dedos, sem torniquete, sem sedação e sem anestesista.

**Métodos:** Pacientes com afecções do punho, mão e dedos foram prospectivamente operados com anestesia local com lidocaína a 1% e epinefrina a 1:100.000. Os desfechos primários avaliados foram infarto digital e perda tecidual devido a necrose. Os desfechos secundários avaliados foram necessidade de sedação, torniquete, auxílio de anestesista ou suspensão da cirurgia.

**Resultados:** Foram anestesiados 53 punhos, 307 mãos e 128 dedos com lidocaína e epinefrina sem complicação relacionada à epinefrina. Nenhum paciente apresentou desfechos primários ou secundários.

**Conclusão:** Cirurgias do punho, mão e dedos podem ser feitas de forma segura com anestesia local com lidocaína a 1% e epinefrina a 1:100.000, sem sedação, sem torniquete e sem médico anestesista, com segurança.

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## Introduction

The practice of outpatient hand surgery, which aims at reducing costs and increasing the convenience of patients who do not need hospitalization, has stimulated the use of local anesthesia; the method of controlling the discomfort of the most commonly used method, the tourniquet, is sedation.<sup>1</sup> However, safe sedation requires the presence of an anesthesiologist; it hinders the patient's collaboration, mainly in repair surgeries and tendon transfers; it increases the risk of systemic complications, especially in patients over 65 years; and it delays hospital discharge.<sup>2</sup>

To use local anesthesia, obtaining a surgical field with little blood, and avoiding the use of a tourniquet, and also to prevent discomfort and allow the cooperation of a fully conscious patient without use of sedation, the strategy is to associate the local anesthetic with epinephrine, a vasoconstrictor drug. The use of epinephrine in extremities, such the hand and fingers, is formally contraindicated in classical hand surgery textbooks.<sup>3,4</sup> Despite the references to the use of local anesthesia with epinephrine in the upper limb in articles from the 1970s, 1980s, and 1990s,<sup>5-7</sup> only at the beginning of the 21st century did this technique accumulate consistent scientific support to gain favor and win over some surgeons.<sup>8,9</sup>

Although Novais Junior et al.<sup>10</sup> in 2014 and Barros et al.<sup>11</sup> in 2016 published the use of this technique in hand surgery in a Brazilian journal, with highly favorable results, its use is not widespread in the country.

The question of whether the operating conditions of the hospitals and the social and cultural characteristics of the physician and patients in Brazil would allow hand surgeries with local anesthesia using epinephrine, without tourniquet and without the presence of an anesthesiologist remains unanswered.

The present study is aimed at prospectively evaluating the incidence of digital infarction and tissue necrosis with the use of local anesthesia with 1% lidocaine/1:100,000 epinephrine solution in hand surgeries without a tourniquet, without sedation, and without an anesthesiologist, in two teaching hospitals specializing in orthopedics and traumatology and hand surgery.

## Material and methods

The study was previously submitted to and approved by the Research Ethics Committees of the participating institutions.

Patients with traumatic and non-traumatic lesions of the wrist, hand, and fingers requiring surgical treatment were scheduled for surgery with local anesthesia with a 1% lidocaine/1:100,000 epinephrine solution, without a tourniquet, sedation, or anesthesia and without pre-surgical exams, in two teaching hospitals in orthopedics and traumatology and hand surgery.

Inclusion criteria were age above 18 years; surgeries in the wrist, hand, and fingers; no need for surgical access in other places. Exclusion criteria were refusal of the patient in participating of the study; previous finger infarction; sequelae of finger crushing; Buerger's disease; revision of Dupuytren's surgery; clinically evaluated vasospasm and severe ischemia of the fingers and hand; surgeries with probable duration of more than 2 h; and patients who were too nervous to undergo surgery with local anesthesia without sedation, according to the surgeon's evaluation. Tobacco use was not an exclusion criterion.

The patients were anesthetized and operated by surgeons specialized in hand surgery or orthopedics and traumatology, and by residents in these specialties, under supervision.

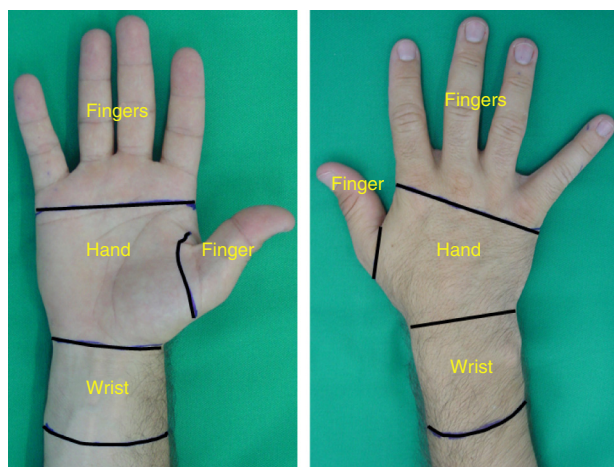
The events assessed were those related to complications arising from the use of epinephrine (primary outcomes) and those from the surgery and anesthesia (secondary outcomes), as described below: (1) digital infarction, defined as intense and persistent ischemia of the finger that evolved to total or partial amputation or functional loss for any reason (loss of movement, cold intolerance, chronic pain, and others); (2) skin necrosis or loss of tissue in any region of the wrist, hand, or fingers; and (3) any change in the surgical or anesthetic strategy characterized by the need to use a tourniquet due to excessive bleeding that would prevent surgery, as well as the need to sedate the patient, request assistance of an anesthesiologist, or discontinue surgery.

The assessments were performed immediately after anesthesia and surgery and at one, two, and six postoperative weeks.

In one of the hospitals, due to clinical and administrative requirements, surgeries were performed in a conventional surgical center (CSC), with intravenous access for antibiotics and cardiac monitoring by a nurse, with patient wearing hospital clothes and the surgeon wearing conventional surgical garments; in turn, in the other hospital, the procedures were performed in an outpatient surgical center (OSC), without venous access or cardiac monitoring, with patients wearing a hospital gown over their clothes and surgeon wearing conventional surgical garments or only sterile gloves, a cap, and a mask.

The regions of anesthesia and surgeries were divided into wrists (5 cm proximal to the styloid processes of the radius and ulna), hand (between the proximal fold of the wrist and the distal fold of the palm or the back of the hand), and fingers (distal to the distal fold of the palm or the back of the hand; Fig. 1).

All patients were discharged on the same day of surgery, without waiting for reversal of the partial ischemia in the surgery site and anesthesia. Patients were advised to return to the hospital if the normal coloration of the skin of the anesthetized region did not return within five and a half hours after the injection of the anesthetic. The dressings were done so as



**Fig. 1 – Local anesthetic injection sites of epinephrine in the wrist, hand, and fingers.**

to allow a visual evaluation by the patient, who was previously oriented regarding the return of the anesthetized region to its normal coloring.

Data regarding comorbidities and medication used by patients were collected.

No preoperative routine exams were performed.

In Brazil, a 1% lidocaine/1:100,000 epinephrine solution is not commercially available. Therefore, this solution was prepared by the surgeon at the time of surgery as follows: 0.2 ml of epinephrine hemitartrate (1.0 mg/ml of the base) was mixed with 20 ml of 1% lidocaine. A 1-ml insulin syringe divided into 100 units was used and 20 units, corresponding to 0.2 ml, were injected into the 20 ml flask of 1% lidocaine. Sodium bicarbonate was not used in the anesthetic solution.

Surgeries were initiated after 30 min of local anesthesia with the 1% lidocaine/1:100,000 epinephrine solution.

The doses of the anesthetic were based on the study by Lalonde and Martin<sup>12</sup> and in a pilot study previously conducted in one of the hospitals of the present study.

In carpal tunnel syndrome and in finger surgeries, the anesthetic solution was not injected into the carpal tunnel or into the digital sheaths, but rather into the subcutaneous tissue around the tunnel and the sheaths.

## Results

During the period studied from 2013 to 2016, 488 wrist, hand, and finger surgeries in 484 patients were performed with local anesthesia with epinephrine, and no complications related to the use of epinephrine were observed. The 1% lidocaine/1:100,000 epinephrine solution was used in 53 wrists, 307 hands, and 128 fingers; no cases of digital infarction or tissue necrosis were observed, and no cases required sedation, tourniquet application, anesthesiologist, or surgery suspension for any reason. No patients needed to return to the hospital prior to the scheduled follow-up consultation due to excessive bleeding or persistence of ischemia caused by epinephrine. No cases required phentolamine to recover the perfusion of the finger injected with epinephrine.

A total of 339 surgeries were performed in a CSC and 149, in an OSC. The mean volume of injected anesthetic was 10.13 ml in the wrist, 13.35 ml in the hand, and 10.4 ml in the fingers, and the mean time of surgery was 23.59 min in the wrist, 32.93 min in the hand, and 24 min in the fingers.

Tables 1–3 detail the surgery sites, type of surgical center (CSC or OSC), volume of anesthetic injected, and surgery duration.

The distribution by gender was 331 women (68.38%) and 153 men (31.61%).

The mean age was 49.37 years, ranging from 18 to 88; 77 (15.9%) were over 65 years.

A total of 57 patients (11.77%) were smokers; 241 (49.79%) presented comorbidities and used medication, mainly anti-hypertensive drugs (17.56%); the other drugs in use were antiplatelet drugs (ASA), antidepressants, anticonvulsants, thyroid hormones, insulin, oral hypoglycemic agents, and statins.

**Table 1 – Wrist surgeries under local anesthesia with a 1% lidocaine/1:100,000 epinephrine solution.**

Surgery	CSC	OSC	Injected volume (ml)			Procedure time (min)			Total
			Mean	Maximum	Minimum	Mean	Maximum	Minimum	
Synovial cyst	4	30	10.88	15	5	20.97	35	8	34
De Quervain's disease	8	4	11.08	20	8	22.5	40	15	12
Flexor tenolysis	0	3	9	10	7	16.66	20	15	3
SCC excision	1	0	5	5	5	40	40	40	1
Lipoma excision	1	0	10	10	10	30	30	30	1
ECU tenolysis	1	0	15	15	15	25	25	25	1
Removal of external fixator	1	0	10	10	10	10	10	10	1
Total	16	37	10.13			23.59			53

OSC, outpatient surgical center; CSC, conventional surgical center; SCC, squamous cell carcinoma; ECU, extensor carpi ulnaris.

**Table 2 – Hand surgeries with local anesthesia with a 1% lidocaine/1:100,000 epinephrine solution.**

Surgery	CSC	OSC	Injected volume (ml)			Procedure time (min)			Total
			Mean	Maximum	Minimum	Mean	Maximum	Minimum	
CTS	183	65	10.26	20	8	20.68	60	10	248
CTS associated with de Quervain's disease or trigger finger	11	0	16.18	26	10	29.45	45	20	11
Benign tumors (nodules, cysts, fibroxanthoma, and others)	5	1	12	17	10	32.5	50	25	6
SCC excision	7	2	8.75	10	4	34	60	20	9
Excision of foreign body granuloma	1	3	8	10	2	17.5	32	10	4
Metacarpal osteosynthesis	0	2	10	10	10	20	15	17.5	2
Extensor tenorrhaphy	15	5	15.4	30	8	32.7	60	17	20
Flexor tenorrhaphy (zones III and IV)	2	0	18	18	18	80	120	40	2
Dupuytren's disease	3	1	15	20	10	32.5	40	29	4
Metacarpal boss	1	0	20	20	20	30	30	30	1
Total	228	79	13.35			32.93			307

CSC, conventional surgical center; OSC, outpatient surgical center; CTS, carpal tunnel syndrome; SCC, squamous cell carcinoma.

**Table 3 – Finger surgery with local anesthesia with a 1% lidocaine/1:100,000 epinephrine solution.**

Surgery	CSC	OSC	Injected volume (ml)			Procedure time (min)			Total
			Mean	Maximum	Minimum	Mean	Maximum	Minimum	
Trigger finger	41	23	7.78	25	3	10.28	40	10	64
Excision of foreign body granuloma	3	0	7.12	10	7	14.5	15	14	3
Benign tumors (tendinous cysts, mucinous cysts, PIP nodule, gouty tophus, and others)	25	0	9.4	18	6	24.2	32	11	25
Removal of synthesis material	4	0	10.25	20	6	27.25	30	20	4
Flexor tenorrhaphy	5	2	14.4	18	8	52.14	120	20	7
Extensor tenorrhaphy	11	4	13.3	20	10	9.13	80	20	15
Extensor tendon transfer	3	1	15	20	10	32.5	40	29	4
Excision of amputation neuroma	1	2	6.8	10	5	20	30	15	3
Digital nerve neuroorrhaphy	2	0	9	10	8	30	30	30	2
Dupuytren's disease (percutaneous)	0	1	10	10	10	20	20	20	1
Total	95	33	10.4			24			128

OSC, outpatient surgical center; CSC, conventional surgical center; PIP, proximal interphalangeal joint.

## Discussion

In the present study, 488 wrist, hand, and finger surgeries were performed under local anesthesia with a 1% lidocaine/1:100,000 epinephrine solution, without a tourniquet, without sedation, and without an anesthesiologist; no cases of digital infarction, tissue necrosis, or surgery suspension for any reason were observed.

Of the surgeries, 149 (30.5%) were made in an OSC, without any intra and postoperative complications.

Anesthesia and surgeries were performed by specialist physicians and residents under supervision, and no complications related to local anesthesia with epinephrine were observed, which adds to the evidence of the efficiency and safety of this practice, even when performed by surgeons with little experience.

The results of the present study were similar to those reported by Lalonde et al.<sup>8</sup> in 2005 (3110 surgeries) and Crowdhry et al.<sup>9</sup> in 2010 (1111 surgeries), as well as to the studies conducted in Brazil by Novais Junior et al.<sup>10</sup> in 2014 (41 surgeries) and Barros et al.<sup>11</sup> in 2016 (16 surgeries).

The most feared complications with the use of epinephrine in hand and finger anesthesia are digital infarction (which can progress to gangrene and amputation) and tissue necrosis. Careful literature reviews of these complications indicate that the use of epinephrine in low concentrations, such as 1:100,000 or 1:200,000, is extremely safe.<sup>13,14</sup> In 2007, Fitzcharles-Browe et al.<sup>15</sup> reviewed literature data on 59 accidental injections of high doses of epinephrine in the fingers (1:1000), which were usually treated with phentolamine, and did not observe digital necrosis.

The literature features four case reports of digital infarction and tissue necrosis associated with the use of local anesthesia with epinephrine in low concentrations.<sup>16-19</sup> A detailed analysis of these cases indicates that the following factors may be associated with complications: previous diseases, such as Raynaud's phenomenon<sup>16</sup> and atherosclerosis with arterial calcifications,<sup>18</sup> and injection of the anesthetic into the digital sheath.<sup>19</sup> The case reported by Ruiter et al.<sup>17</sup> does not allow the conclusion that epinephrine caused tissue necrosis. None of the cases were treated with phentolamine. The aforementioned reports reinforce the need for care in the selection of patients and of the local anesthesia with epinephrine techniques recommended in the literature and adopted in the present study: exclusion of patients with a history of vascular diseases that compromise finger perfusion; presence of digital perfusion compromised by any reason, evaluated clinically by pressing the finger and observing the return of normal coloring; caution regarding the injected volume; and no anesthetic injections within the digital sheaths.<sup>12,19</sup>

The mean volume of anesthetic injected in the present study was 10.1 ml in the wrist, 13.3 ml in the hand, and 10.4 ml in the fingers. The maximum volume injected was 20 ml in the wrist, 30 ml in the hand, and 25 ml in the fingers. Lalonde<sup>20</sup> and Novais Junior et al.<sup>10</sup> recommend that the maximum volume to be used of the 1% lidocaine/1:100,000 epinephrine solution is 50 ml below that used in the present study. Specifically in finger surgeries, in which a higher volume of anesthesia may contribute to local complications, although the present values

were higher than those recommended by Lalonde and Wong,<sup>21</sup> no cases of digital infarction or tissue necrosis were observed. In the present study, for carpal tunnel syndrome surgeries, approximately half of the volume recommended by Kerrigan<sup>22</sup> was used, without surgical difficulties or patient discomfort.

The maximum duration of surgery was 40 min in the wrist (de Quervain's disease), 120 min in the hand (flexor tenorrhaphy), and 120 min in the fingers (flexor tenorrhaphy), due to the specific difficulties of the surgeries (anatomical variations and need to resuture tendons during surgery). This indicates that even in situations with technical difficulties that require more time, the proposed procedure can be performed without complications.

The ischemia obtained with the injection of 1:100,000 epinephrine in the hand and at the finger is not complete, as observed with the use of a tourniquet; however, it is sufficient for safe surgical dissection of the tissues. Nodwell and Lalonde,<sup>23</sup> in an experimental study in humans, found that finger coloration after injection of 1.8 ml of a 2% lidocaine/1:100,000 epinephrine solution returned to normal after a mean of 318.7 min (5.3 h). Therefore, it is not necessary to wait for the total return of the hand or finger perfusion to discharge the patient, a procedure adopted by Lalonde et al.<sup>8</sup> and by the present study without any complications, which facilitates the administration of the ambulatory surgery scheme. However, the patient should be advised to seek medical attention if, within 5.3 h, the anesthetized region does not return to normal color.<sup>8</sup> Patients with completely white fingers without signs of any perfusion in the digital pulp should be treated with phentolamine before hospital discharge.<sup>19</sup>

Lalonde et al.<sup>24</sup> recommend decreasing the acidity of the 1% lidocaine/1:100,000 epinephrine solution (mean pH: 4.2) with the addition of sodium bicarbonate, in order to decrease the burning sensation during the injection. In the present study, the anesthetic solution was prepared by the surgeon, combining lidocaine with epinephrine; the addition of another drug, in this case sodium bicarbonate, would increase the complexity of this operation and increase, in theory, the possibility of errors. Therefore, in the present study, sodium bicarbonate was not used in the anesthetic injection. Although the patient's sensations during anesthetic injection were not systematically studied, the complaint of local burning at the onset of anesthesia was very frequent in the present study.

The waiting time after local anesthesia with epinephrine to start the surgery was precisely 30 min. At the beginning of the authors' experience with this technique, the interval of 10 and 15 min was adopted, failing to achieve adequate ischemia for safe tissue dissection. The clinical experience and experimental studies in humans confirm that the time of 30 min is sufficient to obtain a surgical field with little blood loss, allowing for safe surgery.<sup>25</sup>

In the present sample, 57 (11.7%) patients were smokers and 241 (49.7%) had systemic comorbidities, mainly hypertension, and were using medication. However, no pre-surgical examination (hematological, biochemical, or radiographic) was performed and no complications occurred during or after anesthesia and surgery.

When the surgeon works with the anesthesiologist, the choice of the type of anesthesia, despite the participation of

the surgeon and the patient, is the anesthesiologist's. When using local or regional anesthesia with anesthesiologist participation, the patient is usually sedated. Although postoperative complications in hand surgery are low, the use of local or regional anesthesia without sedation decreases these events, especially in patients over 65 years of age.<sup>2</sup> In the present sample of 488 surgeries, no postoperative systemic complications were observed, and 77 patients (15.9%) were over 65 years.

The present study presents limitations, as the complications and events analyzed were limited to those directly related to the use of local anesthesia with epinephrine, without a tourniquet, without sedation, and without an anesthesiologist, and no comparisons were made with conventional techniques that use sedation, tourniquet, and the assistance of an anesthesiologist. Aspects that may be related to the use of local anesthesia with epinephrine and the surgical environment (CSC and OSC), such as infection, patient discomfort, and cardiovascular alterations, were not evaluated in the present study.

## Conclusions

Wrist, hand, and finger surgeries can be safely performed with local anesthesia with a 1% lidocaine/1:100,000 epinephrine solution, without sedation, without tourniquet, and without an anesthesiologist; a bloodless surgical field is obtained that enhances safer dissection of the tissues, and without risks of digital infarction and tissue necrosis. Careful patient selection and precision in the anesthetic technique are fundamental for the safety in the use of local anesthesia with epinephrine in hand surgery.

## Conflicts of interest

The authors declare no conflicts of interest.

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