

Epinephrine in Local Anesthesia in Finger and Hand Surgery: The Case for Wide-awake Anesthesia

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Abstract

Traditionally, surgeons were taught that local anesthesia containing epinephrine should not be injected into fingers. This idea has since been refuted in many basic and clinical scientific studies, and today, injection of lidocaine plus epinephrine is widely used for digital and hand anesthesia in Canada. The key advantages of the wide-awake technique include the creation of a bloodless field without the use of an arm tourniquet, which in turn reduces the need for conscious sedation. The use of local anesthesia permits active motion intraoperatively, which is particularly helpful in tenolysis, flexor tendon repairs, and setting the tension on tendon transfers. Additional benefits of wide-awake anesthesia include efficiencies and cost savings in outpatient surgical case flow due to the absence of conscious sedation.

Basic and clinical scientific studies have shown that epinephrine can be injected safely into the finger and hand. Lidocaine plus epinephrine for local anesthesia provides anesthesia and a bloodless field through vasoconstriction, which can eliminate the need for a pneumatic tourniquet during hand surgery. Lack of an arm tourniquet typically makes intravenous sedation unnecessary and allows the use of wide-awake anesthesia, so that patients can voluntarily move their fingers intraoperatively, thereby enabling the surgeon to make fine adjustments to repaired tendons, joints, and bones before closing the skin. Eliminating sedation has many benefits for patients and surgeons.

Safety of Epinephrine in the Finger

The idea that epinephrine should never be injected into fingers origi-

nated sometime between 1920 and 1940, when procaine was used with and without epinephrine, with resulting reports of finger necrosis. Nearly all of the 48 reported cases of finger necrosis attributable to procaine local anesthesia occurred before 1950, with most implicating procaine injected without epinephrine.¹ Procaine is quite acidic, with a pH of 3.6, and it further acidifies to a pH as low as 1 with prolonged storage; this acidity, not the addition of epinephrine, is likely responsible for the historical reports of finger necrosis.² Lidocaine, by contrast, has been used safely both with and without epinephrine. An extensive review of the literature from 1880 to 2000 revealed no documented cases of finger necrosis resulting from local anesthesia with lidocaine plus epinephrine.¹

Clinical evidence demonstrating the safety of lidocaine mixed with epinephrine is extensive and was well

summarized by Mann and Hammett.³ In 2001, Wilhelmi et al⁴ reported that epinephrine plus lidocaine injection was safe in all 29 fingers injected with it. In 2010, Chowdhry et al⁵ reported no epinephrine-induced complications in a clinical series of 1,111 consecutive cases of digital block anesthesia with lidocaine plus epinephrine. A multicenter trial known as the Dalhousie project prospectively reviewed 3,110 consecutive cases of lidocaine with epinephrine $\leq 1:100,000$ injected electively into fingers and hands.⁶ No cases of digital necrosis or need for phentolamine rescue were reported.

Accidental High-dose Epinephrine Injection

In a review of the world literature published between 1990 and 2005, Fitzcharles-Bowe et al⁷ found 54 cases of accidental injection of high-dose epinephrine (1:1,000) into patients' own fingers and added 5 cases of their own. This dose is 100 times more potent than the commercially available 1% lidocaine with epinephrine (1:100,000) used in elective local anesthetic finger injections today. None of the 59 total cases of accidental injection resulted in finger necrosis, although phentolamine treatment was provided in only 13 cases.

In 2010, Muck et al⁸ identified 365 cases of accidental injection of epinephrine 1:1,000 into the hand from six poison centers in Texas. Of these, 213 were in the digits; 127 had complete follow-up. None of the fingers exhibited signs of necrosis. Given that high-dose accidental epinephrine finger injection has never been associated with finger necrosis, it is extremely unlikely that the use of more dilute epinephrine in local anesthetic would result in finger necrosis.

Phentolamine Antidote to Epinephrine Vasoconstriction

Phentolamine, an alpha antagonist, is the antidote to epinephrine-induced vasoconstriction in the finger. In 2003, phentolamine was proven to reliably reverse epinephrine vasoconstriction in the human finger.⁹ In this study, 18 volunteers associated with the Dalhousie University hand surgery program had both long fingers injected in three places with lidocaine with epinephrine. It took an average of 85 minutes to completely reverse finger epinephrine vasoconstriction following phentolamine injection.

Injection Technique

Dilution

Although there is evidence that up to 35 mg per kg lidocaine with epinephrine can be safely injected,¹⁰ the senior author (D.L.) prefers to use the conservative traditional upper limit of 7 mg per kg. For a person weighing 70 kg (154.3 lb), this equates to 490 mg or 49 mL of 1% lidocaine with epinephrine 1:100,000. If >50 mL of volume is required, saline is added to make up the difference. Up to 150 mL of saline can be added to 50 mL of lidocaine and epinephrine 1:100,000 to make up to 200 mL of 0.25% lidocaine with epinephrine 1:400,000, which is effective for hemostasis and anesthesia.

Injection Location

When hemostasis is required, the senior author (D.L.) recommends injecting approximately 2 mL of 1% lidocaine with epinephrine 1:100,000 into the palmar and dorsal subcutaneous tissues of each proximal and middle phalanx where dissection will occur (Figure 1). For the distal phalanges, no more than 1 mL is needed.

If only a sensory block is required, the single subcutaneous injection in the midline of the proximal phalanx with lidocaine and epinephrine (SIMPLE) technique is sufficient. In the SIMPLE block, 2 mL of 1% lidocaine and epinephrine 1:100,000 is injected into the subcutaneous fat located between both digital nerves (Figure 1, A).

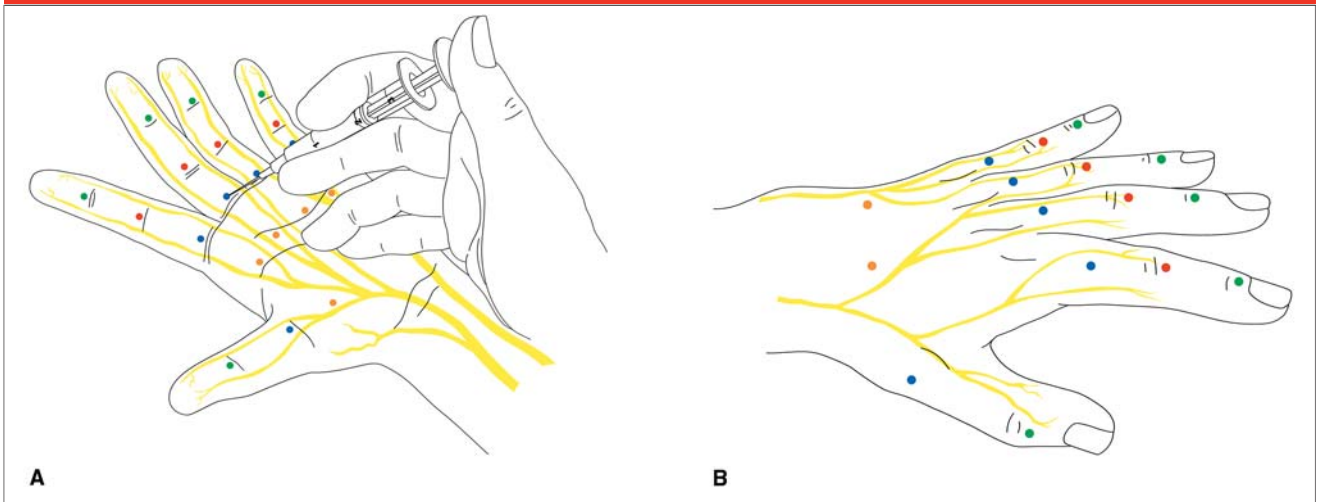
Evidence demonstrates that patients prefer the SIMPLE block to the two-injection dorsal block.¹¹ SIMPLE blocks with epinephrine provide digital anesthesia for an average of 10.4 hours, whereas those without epinephrine last an average of 4.9 hours.¹²

The White Finger

Typically, the fingertip is not blanched following injection of epinephrine 1:100,000 into the proximal or middle phalanges, which is where most injections are performed. In most cases, the finger is blanched only where the epinephrine is injected. Capillary fingertip blood gas parameters pO_2 and SaO_2 have been shown not to decrease significantly with lidocaine-epinephrine blocks injected at the base of the finger.¹³

In the setting of complete, sustained blanching of the fingertip, the blanched portion of the finger takes an average of 380 minutes to return to normal color.⁹ For a fingertip that remains white longer than expected, 1 mg of phentolamine diluted in 5 mL of saline can be injected wherever the epinephrine was injected. This will reverse the vasoconstriction within 85 minutes. The senior author (D.L.) has never had to use phentolamine rescue injection in >2,000 finger injections containing epinephrine. Most fingers do not require prolonged monitoring by health professionals because usually some capillary refill is present at the conclusion of surgery, and patients are

Figure 1



A, Illustration of the sites of volar injection of local anesthesia in finger and hand surgery. When only a sensory block of the finger is required, 2 mL is injected into the areas designated by the blue dots. This finger block is called the SIMPLE (single subcutaneous injection in the middle of the proximal phalanx with lidocaine and epinephrine) block. To achieve hemostasis and local anesthesia for palmar finger surgery, 1% lidocaine with epinephrine 1:100,000 is injected into the midline subcutaneous fat between the digital nerves in each area designated by a dot. **B**, Illustration of the sites of dorsal injection. To achieve hemostasis and local anesthesia, 1% lidocaine with epinephrine 1:100,000 is injected into the midline subcutaneous fat in each area designated by a dot. In each illustration, 2 mL is injected at the site of the blue and red dots, 1 mL into the site of the green dots, and 5 mL into the site of the orange dots.

instructed to return to the clinic or emergency department if the fingertip is not pink within 6 hours.

Contraindications and Complications

Caution is advised in all low-flow finger perfusion states, such as Buerger disease, as well as in patients with renal failure or connective tissue diseases, such as severe scleroderma. In general, however, if the finger is well-perfused before injection, excellent capillary refill will be seen after the epinephrine has worn off, unless the surgery itself damages finger blood flow, as can occur in surgical procedures such as Dupuytren contracture release.

Two minor adverse events are common following epinephrine injection. The first is the jitters or shakes. Prior to injection, patients should be advised that they may feel a little jittery or shaky following injection and that this

sensation usually dissipates within 15 to 20 minutes. Epinephrine has an intravascular half-life of 1.7 minutes.¹⁴ The second adverse event, vasovagal fainting, can occur following any injection or procedure. Injecting patients while they are supine reduces the risk of injury from fainting. Fainting is best managed by lowering the head and flexing the hips and knees to increase cerebral blood flow.¹⁵

Digital necrosis is the greatest potential complication of injecting epinephrine into the finger. However, no finger loss has been reported in association with the injection of lidocaine and epinephrine into fingers.¹⁶

The Wide-awake Approach for Specific Surgical Procedures

Flexor Tendon Repair

A recent study of 102 consecutive patients treated with wide-awake

flexor tendon repair noted no tendon ruptures when the postoperative active motion protocol was followed.¹⁷ The authors attributed the low rupture rate to the ability to identify and re-suture tendon repair gaps seen when the awake patients actively fully flexed and extended their fingers intraoperatively. Methods of local anesthetic injection for flexor tendon repair have been published, along with video illustration.¹⁸

Tendon Transfer

One of the most challenging aspects of tendon transfer surgery is setting the appropriate tension on the repair. Postoperative evaluation of seven patients who underwent extensor indicis proprius to extensor pollicis longus tendon transfer with the wide-awake technique demonstrated that proper tension had been set in all transfers.¹⁹ Several patients required intraoperative adjustments for repairs that were either too

loose or too tight, as demonstrated by the active movement of the awake patients.

Elective Surgery

In Canada, most carpal tunnel operations are now performed in minor procedure rooms outside the main operating room with locally injected lidocaine with epinephrine anesthesia, using field sterility.²⁰ Dispensing with the tourniquet eliminates the need for sedation, monitoring, and intravenous insertion, all of which are required when the procedure is performed in the main operating room. The same applies to trigger finger release and other common hand procedures, such as flexor tendon ganglion excision, de Quervain release, and soft-tissue mass excision.

In the field sterility setting, the hand is square-draped with four sterile towels, and the surgeon wears only a mask and sterile gloves. The patient is not fully draped, and the surgeon does not wear a gown. In a prospective multicenter study of 1,504 consecutive cases of carpal tunnel releases performed with field sterility outside the main operating room, the superficial infection rate was only 0.4%.²¹ No deep infections occurred.

Among hand surgeons, the wide-awake approach is frequently referred to as the wide-awake local anesthesia technique (WALANT). In addition to the aforementioned indications, WALANT has also been used in conjunction with hand fractures,²² trapeziectomy,²³ Dupuytren contracture,²⁴ and wrist arthroscopy/triangularfibrocartilage complex repair.²⁵

Cost Savings

A Canadian study found that twice as many carpal tunnel releases could be performed at one quarter the cost

by performing the surgery in minor procedure rooms with field sterility rather than in the main operating room with full sterility.²⁰ Similar data have been published in the United States.²⁶ In the senior author's (D.L.) practice, three carpal tunnel releases can be performed per hour in minor procedure rooms with only one surgeon and one nurse assistant. In the main operating room, 2 hours and three nurses are needed to perform three carpal tunnel releases, as well as the addition of the nursing staff required in the post-anesthetic care unit. A British hand surgery team calculated that they had saved the National Health Service £750,000 (\$1,160,000) for the 1,000 wide-awake hand surgery cases reported on in their study.²⁷

Summary

The wide-awake approach, using local anesthesia and epinephrine, offers the advantages of convenience, time and cost savings, and enhanced quality of surgery for both patient and surgeon. Unlike many changes in medicine, this one requires less technology and less expense. The evidence for the safety of epinephrine in hand surgery is favorable.

References

Evidence-based Medicine: Levels of evidence are described in the table of contents. In this article, reference 9 is a level I study. References 6 and 11-13 are level II studies. References 5, 7, 17, 19, 21, and 25 are level IV studies. References printed in **bold type** are those published within the past 5 years.

1. Denkler KA: A comprehensive review of epinephrine in the finger: To do or not to do. *Plast Reconstr Surg* 2001;108(1):114-124.
2. Thomson CJ, Lalonde DH, Denkler KA,

- Feicht AJ: A critical look at the evidence for and against elective epinephrine use in the finger. *Plast Reconstr Surg* 2007; 119(1):260-266.
3. Mann T, Hammert WC: Epinephrine and hand surgery. *J Hand Surg Am* 2012;37(6):1254-1256, quiz 1257.
4. Wilhelmi BJ, Blackwell SJ, Miller JH, et al: Do not use epinephrine in digital blocks: Myth or truth? *Plast Reconstr Surg* 2001;107(2):393-397.
5. Chowdhry S, Seidenstricker L, Cooney DS, Hazani R, Wilhelmi BJ: Do not use epinephrine in digital blocks: Myth or truth? Part II. A retrospective review of 1111 cases. *Plast Reconstr Surg* 2010; 126(6):2031-2034.
6. Lalonde DH, Bell M, Benoit P, Sparkes G, Denkler K, Chang P: A multicenter prospective study of 3,110 consecutive cases of elective epinephrine use in the fingers and hand: The Dalhousie Project clinical phase. *J Hand Surg Am* 2005; 30(5):1061-1067.
7. Fitzcharles-Bowe C, Denkler K, Lalonde D: Finger injection with high-dose (1:1,000) epinephrine: Does it cause finger necrosis and should it be treated? *Hand (N Y)* 2007;2(1):5-11.
8. Muck AE, Bebarta VS, Borys DJ, Morgan DL: Six years of epinephrine digital injections: Absence of significant local or systemic effects. *Ann Emerg Med* 2010;56(3):270-274.
9. Nodwell T, Lalonde DH: How long does it take phentolamine to reverse adrenaline-induced vasoconstriction in the finger and hand? A prospective randomized blinded study. The Dalhousie project experimental phase. *Canadian Journal of Plastic Surgery* 2003;11(4):187-190.
10. Klein JA: Tumescence technique for regional anesthesia permits lidocaine doses of 35 mg/kg for liposuction. *J Dermatol Surg Oncol* 1990;16(3):248-263.
11. Williams JG, Lalonde DH: Randomized comparison of the single-injection volar subcutaneous block and the two-injection dorsal block for digital anesthesia. *Plast Reconstr Surg* 2006; 118(5):1195-1200.
12. Thomson CJ, Lalonde DH: Randomized double-blind comparison of duration of anesthesia among three commonly used agents in digital nerve block. *Plast Reconstr Surg* 2006;118(2):429-432.
13. Sönmez A, Yaman M, Ersoy B, Numanodlu A: Digital blocks with and without adrenalin: A randomised-controlled study of capillary blood parameters. *J Hand Surg Eur Vol* 2008; 33(4):515-518.
14. Rosen SG, Linares OA, Sanfield JA,

- Zech LA, Lizzio VP, Halter JB: Epinephrine kinetics in humans: Radiotracer methodology. *J Clin Endocrinol Metab* 1989;69(4):753-761.
15. Raj SR, Coffin ST: Medical therapy and physical maneuvers in the treatment of the vasovagal syncope and orthostatic hypotension. *Prog Cardiovasc Dis* 2013; 55(4):425-433.
 16. Kronic AL, Wang LC, Soltani K, Weitzul S, Taylor RS: Digital anesthesia with epinephrine: An old myth revisited. *J Am Acad Dermatol* 2004;51(5):755-759.
 17. Higgins A, Lalonde DH, Bell M, McKee D, Lalonde JF: Avoiding flexor tendon repair rupture with intraoperative total active movement examination. *Plast Reconstr Surg* 2010;126(3):941-945.
 18. Lalonde DH, Kozin S: Tendon disorders of the hand. *Plast Reconstr Surg* 2011; 128(1):1e-14e.
 19. Bezuhly M, Sparkes GL, Higgins A, Neumeister MW, Lalonde DH: Immediate thumb extension following extensor indicis proprius-to-extensor pollicis longus tendon transfer using the wide-awake approach. *Plast Reconstr Surg* 2007;119(5):1507-1512.
 20. Leblanc MR, Lalonde J, Lalonde DH: A detailed cost and efficiency analysis of performing carpal tunnel surgery in the main operating room versus the ambulatory setting in Canada. *Hand (N Y)* 2007;2(4):173-178.
 21. Leblanc MR, Lalonde DH, Thoma A, et al: Is main operating room sterility really necessary in carpal tunnel surgery? A multicenter prospective study of minor procedure room field sterility surgery. *Hand (N Y)* 2011;6(1):60-63.
 22. Jones NF, Jupiter JB, Lalonde DH: Common fractures and dislocations of the hand. *Plast Reconstr Surg* 2012; 130(5):722e-736e.
 23. Farhangkhoe H, Lalonde J, Lalonde DH: Wide-awake trapeziectomy: Video detailing local anesthetic injection and surgery. *Hand (N Y)* 2011;6(4):466-467.
 24. Denkler K: Dupuytren's fasciectomy in 60 consecutive digits using lidocaine with epinephrine and no tourniquet. *Plast Reconstr Surg* 2005;115(3):802-810.
 25. Hagert E, Lalonde DH: Wide-awake wrist arthroscopy and open TFCC repair. *Journal of Wrist Surgery* 2012; 1(1):55-60.
 26. Chatterjee A, McCarthy JE, Montagne SA, Leong K, Kerrigan CL: A cost, profit, and efficiency analysis of performing carpal tunnel surgery in the operating room versus the clinic setting in the United States. *Ann Plast Surg* 2011;66(3):245-248.
 27. Bismil MS, Bismil QM, Harding D, Harris P, Lamyman E, Sansby L: Transition to total one-stop wide-awake hand surgery service-audit: A retrospective review. *JRSM Short Rep* 2012;3(4):23.