

# Epinephrine and Hand Surgery

Tobias Mann, MD, Warren C. Hammert, MD



## THE PATIENT

A 45-year-old man injured his dominant hand at work, with zone II flexor tendon injuries to the index and middle fingers. He states he has severe nausea after general anesthesia and would prefer local anesthesia for repair of the injuries.

## THE QUESTION

Is lidocaine with epinephrine safe for use in digits of the upper extremity, potentially allowing surgery with no sedation or tourniquet?

## CURRENT OPINION

Traditional concern regarding the use of epinephrine in the fingers is based on 21 reported cases of digital necrosis after being injected with a local anesthetic with epinephrine.<sup>1</sup> Most occurred before 1950 and all used procaine, which may have been expired and thus may have had a toxically low pH.<sup>2</sup> The effects of epinephrine can be easily and expediently reversed with the use of phentolamine.<sup>3–5</sup>

## THE EVIDENCE

In the world literature, no cases of finger necrosis have been reported after the use of lidocaine with epinephrine.<sup>2</sup> Furthermore, as epinephrine auto-injectors are becoming commonplace, there have been several case reports and case series of patients who accidentally injected their fingers with epinephrine 100 times more concentrated than what is found in the commercially available lidocaine and epinephrine mixtures. In some of these cases, the patients went untreated, and still there were no reports of digital necrosis or other permanent harmful sequelae from these cases.<sup>3,4,6</sup>

*From the Department of Orthopaedic Surgery, University of Rochester Medical Center, Rochester, NY.*

The authors acknowledge Dr. Don Lalonde for work on this topic and efforts to make hand surgeons aware of the safety regarding epinephrine in the hand and fingers.

Received for publication November 7, 2011; accepted in revised form November 21, 2011.

No benefits in any form have been received or will be received related directly or indirectly to the subject of this article.

**Corresponding author:** Warren C. Hammert, MD, Department of Orthopaedic Surgery, University of Rochester Medical Center, 601 Elmwood Avenue, Box 665, Rochester, NY 14642; e-mail: warren\_hammert@urmc.rochester.edu.

0363-5023/12/37A06-0029\$36.00/0  
doi:10.1016/j.jhsa.2011.11.022

Denkler<sup>1</sup> did not identify a single reported case of digital gangrene from lidocaine and epinephrine in a search of Index Medicus from 1880 to 1966, the National Library of Medicine database from 1966 to 2000, and selected textbooks from 1900 to 2000. Among 48 cases of digital gangrene, all but 6 occurred over 50 years ago; the anesthetics used were procaine and cocaine with epinephrine and only 44% (21 cases) had epinephrine mixed with the local anesthetic. In 17 of those cases, the anesthetic was manually diluted, creating an unknown concentration of epinephrine. In the remaining 4 cases, epinephrine concentrations ranged from 1:160,000 to 1:400,000. There were several complicating factors such as presence of infection, tourniquets, and use of hot soaks. Thomson et al<sup>2</sup> reviewed evidence showing that as procaine ages it becomes more acidic. Given that expiration dates on injectable medications were not mandated until 1978, the authors argued that aged procaine, rather than epinephrine, was the likely culprit in the reported cases of digital necrosis.<sup>7</sup>

Kronic et al<sup>8</sup> found 2 additional cases of finger necrosis after digital blocks with plain lidocaine. One case involved laser ablation of warts on an index finger that developed postprocedure swelling and an infection necessitating surgical debridement; necrosis developed after the debridement. The second case involved surgical debridement of a finger infection in a patient with scleroderma and Raynaud phenomenon and the authors concluded that the necrosis was likely caused by the infection, pre-existing microvascular damage, or excessive necrosis caused by the laser ablation rather than the lidocaine.

Several case reports have been published on accidental injection of high-concentration (1:1,000) epinephrine into the hand and fingers.<sup>9–19</sup> In most of these cases, the effect of epinephrine was reversed using phentolamine. All of these patients made a full recovery. In 2007, Fitzcharles-Bowe et al<sup>3</sup> published a review of the documented cases of high-dose finger epinephrine injections. They searched the literature from 1900 to 2005 and found 59 cases that matched their inclusion criteria. Of these 59 cases, 32 received no treatment. The remaining 27 were treated with phentolamine reversal, transdermal nitroglycerin ointment,



heat, terbutaline, nifedipine, iloprost, or some combination of these; no cases of finger necrosis were reported. The most notable adverse effects noted were reperfusion pain that lasted up to 4 hours and neurapraxia that lasted up to 10 weeks.

Simons et al<sup>20</sup> published another literature review of unintentional injections of high-dose epinephrine in 2009. They identified 69 cases over the past 20 years, 63 of which involved injection into a finger. No treatment was undertaken in 13% of these 69 cases; the remaining patients were treated pharmacologically or with heat, or with a combination of both. There were no permanent sequelae reported.

A retrospective cohort study by Muck et al<sup>4</sup> published in the *Annals of Emergency Medicine* lends further credence to the notion that high-dose epinephrine injections into the digits do not cause digital necrosis. They found 365 cases of accidental epinephrine injections from auto-injectors over a 4-year period. Of those, 127 involved injections into the fingers and had follow-up. Only 29 patients received pharmacologic treatment in the form of transdermal nitroglycerin ointment, phentolamine, or terbutaline. Again, no cases of digital necrosis were reported. Furthermore, no patients required hospitalization or involvement of a hand surgeon, and all had complete resolution of symptoms.

Phentolamine injections have been successfully used to reverse the effects of epinephrine in the digits.<sup>3,4,9–20</sup> To document the timeline of phentolamine reversal, Nodwell et al<sup>5</sup> designed a randomized, blinded study in which they injected volunteers with a lidocaine-epinephrine mixture. A total of 18 board-certified hand surgeons, 2 residents, 1 hand therapist, and 1 nurse underwent a digital block on each hand using lidocaine with 1:100,000 epinephrine. After 1 hour, the block on 1 hand was reversed with phentolamine and the other received a sham reversal. On average, phentolamine reversed the clinically apparent effects of epinephrine after 85 minutes, whereas it took an average of 320 minutes for the effects of epinephrine to wear off on the sham reversal side. All subjects retained capillary refill in the nail beds during the period when the epinephrine was in effect. No subjects experienced permanent sequelae as a result of this experiment.

Between 2002 and 2004, 9 hand surgeons in 6 cities prospectively recorded the use of lidocaine with epi-

nephrine for hand and finger blocks. This resulted in over 1,300 cases of digital blocks reported in the *Journal of Hand Surgery* in 2005.<sup>6</sup> The authors reported no incidence of digital necrosis. There was no need for phentolamine rescue and no long-term ill effects were noted. Chowdhry et al<sup>21</sup> reported 1,111 cases of finger surgery in which over half received digital blocks with

epinephrine. As in the prior studies discussed here, there were no cases of digital gangrene or other permanent deleterious sequelae.

Sönmez et al<sup>22</sup> published a randomized, controlled study comparing fingertip blood gas parameters in patients receiving digital anesthesia with or without epinephrine augmentation. The authors measured capillary blood gas parameters before performing the digital block, and again 15 minutes

after the block. They also recorded the time to return of sensation in the blocked digit in the 2 groups. In the plain lidocaine group, they saw an increase in the partial pressure of oxygen and pulse oximeter oxygen saturation after the block. Return of sensation in this group occurred after an average of almost 5 hours. In the lidocaine with epinephrine group, there was no statistically significant change in the blood gas partial pressures after the block. The effects of the block wore off at an average of 8 hours in this group.

Wilhelmi et al<sup>23</sup> published a double-blinded, randomized, controlled trial examining the effect of digital block with or without epinephrine. They performed a total of 60 digital blocks, 29 without and 31 with epinephrine. There were no complications reported in the lidocaine with epinephrine group. Denkler retrospectively compared patients with Dupuytren surgery treated with palmar and digital fasciectomy. One cohort consisted of 42 digits treated in the hospital with an upper arm tourniquet. The second cohort consisted of 60 digits treated in the office with local anesthetic with epinephrine without a tourniquet. Complications were similar in each group. There were no cases of digital necrosis, but there was one arterial transection in the local anesthesia group.<sup>24</sup>

## SHORTCOMINGS OF THE EVIDENCE

Several large cohorts and a few randomized trials support the safety of using epinephrine to augment local anesthetic in digital blocks. On the other hand, to date

### EDUCATIONAL OBJECTIVES

- State when expiration dates on injectable medications were mandated.
- Discuss what happens to procaine as it ages.
- Discuss the treatment measures following accidental injection of high-concentration (1:1,000) epinephrine into the hand and finger.
- State the role of phentolamine injections to reverse the effects of epinephrine in the digits.
- List the benefits of epinephrine in hand surgery with respect to tourniquet use, sedation, and cost.

Earn up to 2 hours of CME credit per *JHS* issue when you read the related articles and take the online test. To pay the \$20 fee and take this month's test, visit <http://www.jhandsurg.org/CME/home>.

there is little evidence that augmentation of digital blocks with epinephrine leads to better outcomes.

### DIRECTIONS FOR FUTURE RESEARCH

As the use of epinephrine with local anesthesia becomes more commonplace in the hand, serious adverse events should be reported publicly. Clinical trials measuring patient satisfaction, complications, and cost with and without epinephrine would be helpful.

### OUR CURRENT CONCEPTS FOR THIS PATIENT

We use commercially available lidocaine with epinephrine because evidence has established its safety and because we believe it improves hemostasis and decreases the need for tourniquet use and sedation, which should lower costs. When the patient is not sedated, intraoperative assessment of active range of motion can be performed, which may be beneficial in flexor tendon repair, tenolysis, and tendon transfer. The use of epinephrine also increases the duration of the analgesic effect, which may delay or decrease the need for opiates in the postoperative period. We recommend caution in patients with known peripheral vascular disease; diabetes; Raynaud phenomenon; Berger's disease; calcinosis, Raynaud phenomenon, esophageal dysmotility, sclerodactyly, and telangiectasia syndrome; or other conditions that may adversely effect the perfusion of the digits.

### REFERENCES

- Denkler K. A comprehensive review of epinephrine in the finger: to do or not to do. *Plast Reconstr Surg* 2001;108:114–124.
- 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;119:260–266.
- 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* 2007;2:5–11.
- Muck AE, Bebart VS, Borys DJ, Morgan DL. Six years of epinephrine digital injections: absence of significant local or systemic effects. *Ann Emerg Med* 2010;56:270–274.
- Nodwell T, Lalonde D. 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. *Can J Plast Surg* 2003;11:187–190.
- Lalonde D, 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* 2005;30A:1061–1067.
- Food and Drug Administration. Warning—procaine solution. *JAMA* 1948;138:599.
- Kronic AL, Wang LC, Soltano K, Weitzel S, Taylor RS. Digital anesthesia with epinephrine: an old myth revisited. *J Am Acad Dermatol* 2004;51:755–759.
- Hinterberger JW, Kintzi HE. Phentolamine reversal of epinephrine-induced digital vasospasm. How to save an ischemic finger. *Arch Fam Med* 1994;3:193–195.
- Mathez C, Favrat B, Staeger P. Management options for accidental injection of epinephrine from an autoinjector: a case report. *J Med Case Reports* 2009;3:7268.
- Greenberg MI, Riviello RJ. Local effects after inadvertent digital injection with an epinephrine auto-injector. *Clin Toxicol (Phila)* 2010;48:1179–1180.
- Jordan LK. An unusual case of digital ischemia. *NC Med J* 1969;30:418–419.
- Maguire WM, Reisdorff EJ, Smith D, Wiegenstein JG. Epinephrine-induced vasospasm reversed by phentolamine digital block. *Am J Emerg Med* 1990;8:46–47.
- Markovchick V, Burkhardt KK. The reversal of the ischemic effects of epinephrine on a finger with local injections of phentolamine. *J Emerg Med* 1991;9:323–324.
- Burkhardt KK. The reversal of the ischemic effects of epinephrine on a finger with local injections of phentolamine. *J Emerg Med* 1992;10:496.
- McCauley WA, Gerace RV, Scilley C. Treatment of accidental digital injection of epinephrine. *Ann Emerg Med* 1991;20:665–668.
- McGovern SJ. Treatment of accidental digital injection of adrenaline from an auto-injector device. *J Accid Emerg Med* 1997;14:379–380.
- Murali KS, Nayeem N. Accidental digital injection of adrenaline from an autoinjector device. *J Accid Emerg Med* 1998;15:287.
- Barkhordarian AR, Wakelin SH, Paes TR. Accidental digital injection of adrenaline from an autoinjector device. *Br J Dermatol* 2000;143:1359.
- Simons FE, Lieberman PL, Read EJ Jr, Edwards ES. Hazards of unintentional injection of epinephrine from autoinjectors: a systematic review. *Ann Allergy Asthma Immunol* 2009;102:282–287.
- 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;126:2031–2034.
- 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* 2008;33B:515–518.
- Wilhelmi BJ, Blackwell SJ, Miller JH, Mancoll JS, Dardano T, Tran A, et al. Do not use epinephrine in digital blocks: myth or truth? *Plast Reconstr Surg* 2001;107:393–397.
- Denkler K. Dupuytren's fasciectomy in 60 consecutive digits using lidocaine with epinephrine and no tourniquet. *Plast Reconstr Surg* 2005;115:802–810.

