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.1 Most occurred before 1950 and all used procaine, which may have been expired and thus may have had a toxically low pH.2 The effects of epinephrine can be easily and expediently reversed with the use of phentolamine.3–5

THE EVIDENCE
In the world literature, no cases of finger necrosis have been reported after the use of lidocaine with epinephrine.2 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.3–4,6

Denkler1 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 al2 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.7

Krunic et al8 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.9–19 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 al3 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 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 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, phenolamine, 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. To document the timeline of phentolamine reversal, Nodwell et al 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 epinephrine for hand and finger blocks. This resulted in over 1,300 cases of digital blocks reported in the Journal of Hand Surgery in 2005. 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 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 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 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 fasciectomies. 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.

**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...
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 affect the perfusion of the digits.

**REFERENCES**

3. 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.