

A Comprehensive Review of Epinephrine in the Finger: To Do or Not to Do

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The prohibition against the use of local anesthetics with epinephrine for digital blocks or infiltration is an established surgical tradition. The present article provides a comprehensive review of all reported digital necrotic and ischemic complications with epinephrine in the digits in an effort to understand whether the current prohibition is based on documented reports. A comprehensive review of articles showing the successful use of local anesthetic with epinephrine in the digits is presented.

A review of Index Medicus from 1880 to 1966 and a computer review of the National Library of Medicine database from 1966 to 2000 were performed using multiple keywords. Selected major textbooks from 1900 to 2000 were also reviewed.

A total of 48 cases of digital gangrene after anesthetic blocks (mostly using cocaine or procaine) have been reported in the world literature. Only 21 cases involved the use of epinephrine; 17 involved an unknown concentration based on manual dilution. Multiple other concurrent conditions (hot soaks, tight tourniquets, and infection) existed in these case reports, making it difficult to determine the exact cause of the tissue insult. There have been no case reports of digital gangrene using commercial lidocaine with epinephrine (introduced in 1948). Multiple studies involving thousands of patients support the premise that the use of lidocaine with epinephrine is safe in the digits.

An extensive literature review failed to provide consistent evidence that our current preparations of local anesthesia with epinephrine cause digital necrosis, although not all complications are necessarily reported. However, as with all techniques, caution is necessary to balance the risks of this technique with the dangers of mechanical tourniquets and upper extremity block anesthesia. (*Plast. Reconstr. Surg.* 108: 114, 2001.)tk;1

One of the strongest admonitions given to medical students and residents is not to inject local anesthetics with epinephrine into the digits. This prohibition is promulgated by essentially all surgical, hand, plastic, and dermatological texts. A review of the world's literature from the past 120 years documents 48 cases of

digital necrosis from local anesthetics. None of these cases involved the use of Xylocaine (lidocaine), and only 21 entailed the use of epinephrine. The majority of cases occurred more than 50 years ago. At that time, epinephrine was diluted by hand.¹

The recent literature reports 15 cases of digital ischemia resulting from anesthetics with epinephrine,^{2,3} epinephrine solutions,⁴ or EpiPen injections.⁵⁻¹⁷ All were reversed, even those involving concentrated epinephrine (1:1000), if treated up to 13 hours after injury.⁸

Digits have a great ability to withstand ischemic insults due to their structure, which has skin, tendons, ligaments, and bone, but no muscle. There are reports of finger replantation after 42 hours of warm ischemia.¹⁸

Although a bloodless field is necessary for hand surgery, the mechanical tourniquet is the only current recommendation. However, mechanical tourniquets have their own complications.¹⁹

The present article provides (1) a comprehensive review of all reported necrotic and ischemic complications with epinephrine in the digits to understand whether the current prohibition is reasonable and (2) a comprehensive review of articles showing successful use of local anesthetic with epinephrine in the digits.

MATERIALS AND METHODS

A review by hand of Index Medicus from 1880 to 1966 was performed using the following headings: adrenal preparations, anesthesia, anesthetic complications, cocaine, lidocaine, local anesthesia, local anesthetics, and procaine. In addition, a review of major textbooks of anesthesia, orthopedics, and surgery was

performed. National Library of Medicine computer searches from 1966 to 2000 were done using the following key words: chemically induced gangrene, epinephrine, epinephrine/adverse effects, finger injuries/drug therapy, finger injuries/surgery, injections/subcutaneous, ischemia/chemically induced, lidocaine/adverse effects, local anesthesia, local anesthetics/adverse effects, procaine, vasoconstriction, vasoconstrictor agents, sickle cell disease, and Raynaud's, history.

Journal Review

The first use of local anesthesia in the West was reported by Karl Koller in his 1884 presentation on the use of cocaine in the eye.²⁰ Subsequently, Burke²¹ performed the first digital nerve block, and Halsted reported the first major nerve block.²² Schleich introduced the concept of using dilute solutions of local anesthetics in an effort to reduce toxic complications.²³ Klein²⁴ recently popularized this technique.

Epinephrine was first isolated from the adrenal medulla in 1897 by Abel, who named it. Takamine²⁵ isolated it in crystalline form and patented it as "Adrenalin" (epinephrine) in 1901.

Cocaine was the only local anesthetic available until the introduction of procaine by Einhorn in 1904.²⁶ Despite the fact that cocaine is a vasoconstrictor, there are few reported cases of digital necrosis²⁷⁻³² with cocaine use.

In 1903, Braun³³ popularized the addition of epinephrine (suprarenin or suprarenal extracts) to solutions of cocaine. He described the epinephrine effect as that of a "chemical tourniquet," retarding the absorption of the cocaine and prolonging its effect. His first article documented three cases of finger anesthesia using a cocaine/epinephrine solution. Braun expressed mixed feelings about using epinephrine in the digits^{27,28,34}: "if the action of suprarenin be too intense or long continued, gangrene of the tissues can occur, particularly if the nutrition of the part is already interfered with, as, for instance in arteriosclerosis of the extremities, wounds, or plastic flaps. Siebert³⁵ has collected cases of this kind." However, Braun did use epinephrine near the base of the finger "where the blood supply is more abundant"²⁷ and recommended injecting "only a small amount."³⁶

Numerous authors began to address the problem of necrosis after local anesthesia in

the 1920s. Ruben³⁷ and Riccio and La Rossa³⁸ concluded the causes were overdistension of tissues, poor surgical technique, or use of too much epinephrine.

In 1928, Moulouguet³⁹ reported a case of total gangrene of the index finger after an injection of plain procaine. However, hot soaks were used after surgery. Halla⁴⁰ reported the first case of a digital block with epinephrine developing gangrene. He emphasized that the injury occurred from hot soaks after surgery.

In 1931, Garlock⁴¹ reported four cases of gangrene after digital blocks; however, none involved epinephrine. He considered the gangrene secondary to a tight tourniquet.

In 1933, Lambert and Snyers²⁹ described two cases of procaine with epinephrine causing digital necrosis. They also tabulated 23 cases of digital necrosis after local anesthetics. Many of these cases are known only through their citations.^{32,35,42-47}

In 1936, Hanke⁴⁸ reported a case of digital necrosis after the resection of severe Dupuytren's contracture. He injected 40 cc of procaine with epinephrine into the palm before surgery. No tourniquet was necessary.

In 1941, Kaufman³⁰ reported a case of burns to a finger anesthetized with procaine and epinephrine. Kaufman collected cases of digital necrosis from the European and American literature. He thought contributing factors included peripheral arteriosclerosis, allergic reaction, injection of excessive amounts of solution, vasoconstriction due to epinephrine, vascular trauma from the tourniquet, and burns from hot soaks postoperatively.

In 1942, Pelner⁴⁹ described a case of gangrene after the injection of procaine with epinephrine 1:50,000 into an ingrown toenail. He noted that commercial vials of anesthetics could contain epinephrine solutions as strong as 1:20,000. In his review, he opined that epinephrine was the cause of the tissue sloughs. However, a review of the articles he cited does not support this conclusion.

Also in 1942, McLaughlin⁵⁰ reported on a patient who received digital block anesthesia with epinephrine (concentration unspecified). After surgery, the patient used hot soaks, which caused digital necrosis.

In 1944, O'Neil and Byrne⁵¹ reported eight cases of digital gangrene after digital nerve block anesthesia. In six cases epinephrine use was assumed, and seven of the cases involved hot soaks.

In 1947, Debeyre and Mattei⁵² reported two cases of digital gangrene after injections of local anesthetic. They recommended that general anesthetic be used in most cases.

De Rougemont and Carcassone,⁵³ in a 1948 review of digital blocks, noted several reports of gangrene. Pointing out that gangrene of the finger could occur without epinephrine being used in digital blocks, they reported their own series of more than 1500 digital blocks using epinephrine 1:100,000 without digital necrosis.

In 1958, Burnham⁵⁴ reported on his use of local anesthetics with 1:200,000 epinephrine in 93 digital blocks without complications. He recommended injecting small amounts of anesthetic at the area of the metacarpal heads and dorsally in the hand.

In 1963, Bradfield⁵⁵ reviewed digital block anesthesia and its complications. He noted that there were 41 cases of gangrene after digital blocks. He added three cases of his own found by survey, although it is not known if epinephrine was used.

In 1967, Johnson⁵⁶ reported his experiences using lidocaine with epinephrine in the hand and fingers. He documented 421 cases, without any incidence of digital gangrene. Most cases involved the hand rather than the finger, but at least 98 involved the finger. Johnson emphasized that this technique avoided the need for general anesthesia and a tourniquet.

Rank et al.,⁵⁷ in their 1968 book, strongly warned against the use of epinephrine in the finger. They presented a photograph of a necrotic finger after local anesthesia; however, no details were provided in any edition.

In 1971, two articles advocated using epinephrine in local anesthetics for podiatry. Steinberg and Block⁵⁸ used lidocaine with epinephrine in more than 200,000 injections into the foot, forefoot, and toes without seeing any necrosis or gangrene. They noted that digital tourniquets were unnecessary with the use of epinephrine. Kaplan and Kashuk⁵⁹ also advocated using anesthetics with vasoconstrictors in the digits.

In 1974, Sandzen⁶⁰ strongly condemned digital blocks. He presented a photograph of a necrotic finger after local anesthetic block, but no details.

In 1979, McGlamry⁶¹ recommended injecting lidocaine with epinephrine 1:100,000 for digital blocks. Gross⁶² questioned this recommendation; however, he considered a rubber-

band tourniquet safer practice than the use of epinephrine.⁶³

In 1985, Earle and Blanchard⁶⁴ used lidocaine with epinephrine for finger blocks at the level of the metacarpals.

In 1996, Farmer³ reported a case of partial digital necrosis in which the patient had local anesthetic with epinephrine injected into the finger by an ophthalmologist. Concentrations, type, and amounts of epinephrine or local anesthetic were not mentioned.

In 1998, Sylaidis and Logan⁶⁵ described using 1:80,000 epinephrine in 100 consecutive cases. They reported no ischemic necrosis or gangrene.

In 1998, Wilhelmi et al.⁶⁶ used epinephrine in 23 digital surgeries. They experienced no complications. After a literature review, they noted "no case has been reported in which epinephrine alone caused the complication of finger gangrene." They pointed out that hot soaks were the cause of digital gangrene in most cases.

Textbook Review

Bunnell's *Surgery of the Hand*, which first appeared in 1944, went through six editions. Bunnell preferred the use mechanical tourniquets instead of chemical tourniquets, although he was aware of severe complications from mechanical tourniquets and he documented no specific complications using epinephrine. The first edition⁶⁷ contained several admonitions regarding the use of epinephrine in the fingers. Bunnell stated that "Adrenalin should never be injected into a digit, because from this gangrene has often resulted." He referenced the work of McLaughlin⁵⁰ and Kaufman,³⁰ although Bunnell made no mention of the dangers of hot soaks. Bunnell's second and third editions^{68,69} contained the same recommendations regarding epinephrine and added the reference by O'Neil and Byrne.⁵¹ Joseph Boyes, who authored the final two editions,^{70,71} kept Bunnell's recommendations and references unchanged. Boyes acknowledged the dangers of using rubber-band tourniquets.

Frederick Christopher's *Minor Surgery* encompassed eight editions between 1929 and 1967. The first edition⁷² recommended using procaine with epinephrine 1:200,000 for digital blocks. No mention was made of potential necrosis from the epinephrine, although he noted that fingers were "end arteries." The

TABLE I
Digital Gangrene and Necrosis after Local Anesthesia in the Digits

Case	Reference and Year	Clinical Problem	Surgery	Anesthetic and Quantity	Epinephrine Use	Tourniquet	Hot Soaks	Infection Present	Gangrene Extent	Remarks
1	Strauss, 1889 ¹²²	Ingrown toenail	Removal of nail	20% cocaine, unknown quantity	None	No	Unknown	Yes	Entire digit	Citation only
2	Marcinowski, ¹²⁰ 1902	Paronychia	I&D	3 cc of Eukain B	None	No	Unknown	Yes	Mid-distal phalanx	Outdated anesthetic
3	Dejardin, ⁴³ 1917	Paronychia?	I&D	1% cocaine, unknown quantity	None	No	Unknown	Yes	Entire digit	Citation only
4	Siebert, ³⁵ 1910	Infected wound?	I&D	Cocaine and Eukain B, unknown quantity	None	Yes	Unknown	Yes	Entire digit	Citation only
5	Siebert, ³⁵ 1910	Needle fragment?	Removal of needle	Cocaine and Eukain B, unknown quantity	None	No	Unknown	Yes	Distal two phalanges	Citation only
6	Dejardin, ⁴³ 1917	Felon	I&D	Sterile water, unknown quantity	None	No	Unknown	Yes	Entire digit	Citation only
7	Dejardin, ⁴³ 1917	Traumatic amputation	Removal of phalanx	Procaine, unknown quantity	None	No	Unknown	No	Entire digit	Citation only
8	Chevrier, ⁴⁴ 1927	Severed extensor tendon	Repair of tendon	Procaine-epinephrine, unknown quantity	Yes, unknown concentration	No	Unknown	Unknown	Middle/distal phalanx	Citation only
9	Dinanian, ^{47,125} 1928	Ingrown toenail	Removal of nail	Procaine-epinephrine, unknown quantity	Yes, 1:200,000	No	No	Yes	Entire toe and metatarsal	Citation only
10	Moulounguet, ³⁰ 1928	Embedded needle	Removal of foreign body	3-4 cc of 0.5% procaine	None	No	Yes, warm soaks after surgery	Unknown	Entire digit	
11	Toupet, 1928 ¹²⁶	Trophic nail disturbance	Excision	Procaine-epinephrine, unknown quantity	Yes, unknown concentration	Unknown	Unknown	Unknown	Entire toe	Possible vascular disease
12	Halla, ⁴⁰ 1928	Paronychia	I&D	1-2 cc of 2% procaine-epinephrine	Yes, unknown concentration	No	Yes, digit soaked in boiling water for 30 minutes	Yes	Most of finger	Cautions against hot soaks
13	Wolfsohn, ⁴⁵ 1928	Unknown	Unknown	8-10 cc of procaine-epinephrine	Yes, unknown concentration	Unknown	Unknown	Unknown	Terminal phalanx	
14	Costantini et al, ³² 1930	Unknown	Unknown	Cocaine-epinephrine, unknown quantity	Yes, unknown concentration	Unknown	Unknown	Unknown	Entire digit	Citation only phalanx
15	Costantini et al, ³² 1930	Unknown	Unknown	Cocaine-epinephrine, unknown quantity	Yes, unknown concentration	No	Unknown	Unknown	Entire digit	Citation only
16	Makai, ¹²⁷ 1932	Paronychia	I&D	2 cc of 1% procaine-epinephrine	Yes, 1:200,000	Yes, for 2 minutes	Yes	Yes	Small slough at distal phalanx	Citation only

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17	Makai, ²⁷ 1932	Ingrown toenail	Resection of nail	2-3 cc of 1% procaine at the base	Yes, unknown concentration	No	Unknown	Yes	Small slough at injection site	Advised checking circulation postoperatively
18	Garlock, ⁴¹ 1931	Embedded needle	Removal of needle	Unknown quantity of 1% procaine distal to tourniquet	None	Yes, rubber band 30 minutes	Unknown	Unknown	Gangrene started 2 days later	Marked delay in gangrene
19	Garlock, ⁴¹ 1931	Paronychia	I&D	Unknown quantity of 1% procaine distal to tourniquet	None	Yes, tight rubber band for 15 minutes	Unknown	Yes	Amputation at the PIP joint from thrombosed vessels	No epinephrine; blue/cold finger noted next day
20	Garlock, ⁴¹ 1931	Felon from wood splinter	I&D	Unknown quantity of procaine	None	Yes, thin tourniquet	Yes, warm soaks	Yes, chronic infection	Gangrene to MCP dorsal and DIP volar	No epinephrine, tight tourniquet
21	Garlock, ⁴¹ 1931	Embedded needle fragment	Removal of needle	6 cc of 1% procaine distal to tourniquet	None	Yes catheter for 1 hour	Unknown	Infection present	IP joint amputation	Thumb bled at conclusion of case
22	Heinicke, ²¹ 1932	Melanoma of great toe	Wide excision	25-30 cc of 0.5% procaine-epinephrine	Yes, unknown concentration	No	Unknown	No	Tip of toe	Advised pancreatic extract injections
23	Kirchbach, ¹²⁸ 1932	Ingrown toenail	Nail avulsion and curettage	8 cc of 0.25% procaine, unknown quantity	Yes, 1:400,000	No	Unknown	Yes	Localized gangrene in area of infiltration	Gangrene started 2 days later
24	Rupp, ¹²⁹ 1932	Paronychia	I&D	10-15 cc of 0.5% procaine-epinephrine	Yes, unknown concentration	No	Unknown	Yes	Entire digit	Not in Lambert and Snyers ²⁹
25	Rupp, ¹²⁹ 1932	Ingrown toenail	I&D	Unknown quantity of anesthetic	Unknown	Unknown	Unknown	Yes	Unknown	Not in Lambert and Snyers ²⁹
26	Delgoffe, ³⁰ 1933	Chronic osteitis of terminal phalanx	Removal of chronic osteitis of nail	5-8 cc of 1% procaine	None	No	Unknown	Yes	Amputation 50 days later	Citation only
27	Lambert and Snyers, ²⁹ 1933	Embedded foreign body	3 cc of 2% procaine-epinephrine	Yes, unknown concentration	No	Unknown	Yes	Gangrene to level of injection	Unknown	Amputation 50 days later
28	Lambert and Snyers, ²⁹ 1933	Paronychia	I&D	2.5 cc of procaine-epinephrine	Yes, unknown concentration	Yes	Unknown	Yes	Gangrene to level of proximal injection	
29	Hanke, ⁴⁸ 1936	Dupuytren's contracture	Total fasciectomy	40 cc of procaine	Yes, unknown concentration	No	Unknown	No	Gangrene distal to DIP in long and ring fingertips	Huge volume of anesthetic
30	Kaufman, ³⁰ 1941	Felon	I&D	4 cc of 2% procaine-epinephrine	Yes, unknown concentration	No	Finger soaked in hot boiling water	Yes	IP joint amputation	Third-degree burns
31	McLaughlin, ⁵⁰ 1942	Paronychia of middle finger	I&D	3 ml of procaine-epinephrine	Yes, unknown concentration	Unknown	Yes	Yes, boric acid hot soaks	Mid phalanx	
32	Gutler, ¹²² 1942	Paronychia	I&D	Unknown	Unknown	Yes	Unknown	Unknown	Distal phalanx	Photograph only
33	O'Neil and Byrne, ⁵¹ 1944	Abscess on tip of finger	I&D	Unknown anesthetic for digital block	Unknown	Unknown	Yes, hot water soaks	Yes	Gangrene and amputation	A burn under digital block

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34	O'Neil and Byrne, ³¹ 1944	Paronychia	I&D	Procaine, unknown concentration and amount	Unknown	No	Yes, warm water soaks	Yes	Distal third gangrene/amputation	A burn under digital block
35	O'Neil and Byrne, ³¹ 1944	Traumatic fracture middle phalanx	Repair of laceration and fracture	15 cc of 2% procaine without epinephrine	No	Unknown	Unknown	Unknown	Amputated at proximal phalanx	
36	O'Neil and Byrne, ³¹ 1944	Chronic paronychia	Removal of nail	Unknown type and amount of anesthetic	Unknown	Unknown	Yes, hot water soaks	Yes	Gangrene of distal portion	A burn under digital block
37	O'Neil and Byrne, ³¹ 1944	Infected finger	Unknown	Unknown type and amount of anesthetic	Unknown	Yes, elastic for 45 minutes	Yes, temperature unknown	Yes	Middle phalanx amputation	A burn from hot soaks
38	O'Neil and Byrne, ³¹ 1944	Paronychia	I&D	4 cc of procaine-epinephrine solution	Yes, unknown concentration	No	Yes, very warm water	Yes	Amputation at the middle phalanx	
39	O'Neil and Byrne, ³¹ 1944	Paronychia	I&D	Unknown quantity of procaine-epinephrine	Yes, unknown concentration	No	Yes, soaks as hot as patient could stand	Yes	Entire finger burned	Stiff finger
40	O'Neil and Byrne, ³¹ 1944	Subungual hematoma	Incision	Unknown quantity of procaine	Unknown	Unknown	Yes, hot soaks	No	Amputation of distal phalanx	Burned finger from hot soaks
41	Debeyre and Mattei, ³² 1947	Paronychia	I&D	5 ml of plain procaine	None	Unknown	Unknown	Yes	Entire digit	
42	Debeyre and Mattei, ³² 1947	Ingrown nail	Debridement	3 ml of plain procaine	Yes, 1:160,000	Unknown	Yes, warm soaks	Yes	Epidermal slough	
43	Rank et al., ³² 1968	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Entire finger	Photograph only; no specifics
44	Bradfield, ³⁵ 1963	Infected finger	Incision?	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Second-hand report, poor details
45	Bradfield, ³⁵ 1963	Laceration and fracture of middle phalanx	Repair of fracture and laceration	15 ml of 2% procaine	Unknown	No	Unknown	Unknown	Required amputation at proximal phalanx	Presumption of epinephrine use
46	Bradfield, ³⁵ 1963	Unknown	Unknown	4 ml of 0.5% procaine	Unknown	No	Unknown	Unknown	Gangrene of finger	Presumption of epinephrine use
47	Sandzen, ^{60,123} 1974	Unknown	Unknown	Unknown	Unknown	Yes	Unknown	Unknown	Entire finger	Photograph only
48	Farmer, ³ 1996	Unknown	Unknown	Unknown anesthetic	Yes, unknown concentration	Unknown	Unknown	Unknown	Dermal necrosis and skin slough	

I&D, incision and drainage; PIP, proximal interphalangeal; MCP, metacarpophalangeal; DIP, distal interphalangeal; IP, interphalangeal.

second edition⁷³ also recommended epinephrine use in the finger. However, in the section on local anesthesia, there were multiple warnings regarding the use of epinephrine with anesthetics in the finger. In the third through sixth editions,⁷⁴⁻⁷⁷ Christopher provided discussions and citations regarding the potential dangers of using epinephrine in the digits. Ochsner and DeBakey,⁷⁸ in 1955, were the first to warn about epinephrine injections into the ears: "Solutions containing epinephrine should not be injected into the appendages such as the fingers, toes, ears, or the penis of certain patients, notably those with peripheral vascular disease. Gangrene and slough have occurred." They gave no specific references or examples.

Frederick Christopher's *Textbook of Surgery* appeared between 1936 and 1997. The first three editions⁷⁹⁻⁸¹ contained no specific precautions regarding the use of epinephrine in the finger. However, the fourth and fifth editions^{82,83} contained a warning against infiltrating too much fluid into the fingers and the dangers of epinephrine causing ischemic necrosis, without specific citations. The sixth edition in 1956⁸⁴ carried warnings in the sections on hand surgery and local anesthesia about local anesthetics with epinephrine, especially in infected fingers. The only specific citation for this reasoning was the article by O'Neil and Byrne,⁵¹ although their cases were descriptions of burns suffered under local anesthesia. The following editions⁸⁵⁻⁹³ did not warn about digital blocks with epinephrine.

Schwartz's *Principles of Surgery*⁹⁴⁻⁹⁷ did not mention any possible dangers of using epinephrine in digital blocks until 1984. Between 1984 and 1999, the chapters on surgery of the hand cautioned that epinephrine should not be included in digital or wrist blocks due to potential irreversible vascular spasm.⁹⁸⁻¹⁰⁰

The first three editions of Campbell's *Operative Orthopedics*¹⁰¹⁻¹⁰³ made no mention of the dangers of epinephrine use in local anesthetics. The fourth through eighth editions all stated that the use of epinephrine in digital blocks could lead to potential finger gangrene,¹⁰⁴⁻¹⁰⁹ although no specific citations were provided.

All editions of Green's *Operative Hand Surgery*¹¹⁰⁻¹¹³ have cautioned against using epinephrine in digital blocks. In the current edition, Johnson's 1967 article⁵⁶ advocating

epinephrine use in the digits is cited, in error, as a reason not to use it.¹¹⁴

The first edition of the *Physicians' Desk Reference*, which was published in 1946,¹¹⁵ contained no specific precautions regarding epinephrine in the digits. At that time, procaine with epinephrine was available in concentrations ranging from 1:20,000 to 1:100,000. The entry on Xylocaine (lidocaine), which was introduced in America in 1951,¹¹⁶ came with a warning that epinephrine should not be used for digital block anesthesia, although the same edition gave no similar precautions for procaine. In 1962,¹¹⁷ the precaution against using Xylocaine with epinephrine in digital blocks vanished. In 1973,¹¹⁸ a new warning appeared: "The use of any vasoconstrictor drug is not recommended in surgery involving the digits, nose, ear, or penis." In 1980,¹¹⁹ this statement appeared: "Solutions containing a vasoconstrictor should be used cautiously and in carefully circumscribed quantities in areas of the body supplied by end arteries or having otherwise compromised blood supply." This warning remains in the current edition.¹²⁰

DISCUSSION

This article reviews all 48 cases of digital gangrene and necrosis after local anesthesia in the digits (Table I). Much of the information is incomplete regarding the use and concentrations of epinephrine, hot soaks, tourniquets, tight dressings, or preexisting medical conditions. Only 21 of the 48 cases involved the use of epinephrine, and in only four is the concentration of epinephrine even known. None of the cases involved Xylocaine with epinephrine. There are no associations with Raynaud's phenomenon, cryoglobulinemia, or sickle cell disease.

Major factors causing necrosis included the use of older anesthetics such as cocaine, Eukain, or water (seven cases).^{35,42,43,121} Hot soaks caused postoperative burns in 14 cases.^{30,39,40,50-52} Two cases, those of Heinicke¹²² and Hanke,⁴⁸ involved injecting excessive amounts of anesthetic. The cases of Cutler,¹²³ Rank et al.,⁵⁷ and Sandzen^{60,124} are photographs only. The cases of DeJardin,⁴³ Chevrier,⁴⁴ Wolfsohn,⁴⁵ Bradfield,⁵⁵ and Farmer³ provide insufficient information to allow for an analysis. Of the last 14 cases, only seven involved the use of epinephrine. Four of these 14 cases involved the use of a tourniquet; tourniquet use is unknown in the others. Eleven of

these 14 cases also involved infections. Therefore, an analysis of all documented cases of necrosis after digital blocks does not support the conclusion that epinephrine use causes the necrosis. The cases documented are too incomplete in the information outlined to make firm conclusions. Obviously, the causes are multifactorial, and not just due to epinephrine.

Five articles involving 93,⁵⁴ 98,⁵⁶ 100⁶⁵ 23,⁶⁶ and 200,000⁵⁸ patients support the premise that the use of lidocaine with epinephrine is safe in the digits and foot. The current recommendation is to avoid its use, although epinephrine has short-lived effects at extremely dilute solutions.¹²⁵ A review of the history of epinephrine's use shows that it does not deserve its dangerous reputation. All techniques are fraught with potential complications.

The recommendations to take away from this study include the following:

1. Small amounts of local anesthetics with dilute epinephrine are probably safe for digital infiltration or blocks.
2. Use dilute solutions such as 1:200,000 or less.
3. Do not do a circumferential block of the digits.
4. Block preferentially at the level of the metacarpal heads rather than the digit.
5. Use small needles to avoid injuring the vessels.
6. Avoid postoperative hot soaks.
7. Buffer the anesthetic to avoid acidic solutions.
8. Bandages should not be constrictive or excessively tight.
9. Patients should be followed regarding prolonged ischemia, which could require reversal with phentolamine injections or nitroglycerin ointment.
10. Avoid using epinephrine in patients with vasospastic, thrombotic, or extreme medical conditions.
11. If you know of specific complications, report them and the details.

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