Do Not Use Epinephrine in Digital Blocks: Myth or Truth?

Bradon J. Wilhelmi, M.D., Steven J. Blackwell, M.D., John H. Miller, M.D., John S. Mancoll, M.D., Tony Dardano, D.O., Alan Tran, M.D., and Linda G. Phillips, M.D.

Galveston, Texas

The purpose of this study was to examine the role for epinephrine augmentation of digital block anesthesia by safely prolonging its duration of action and providing a temporary hemostatic effect. After obtaining approval from the review board of the authors’ institution, 60 digital block procedures were performed in a prospective randomized double-blinded study. The digital blocks were performed using the dorsal approach. All anesthetics were delivered to treat either posttraumatic injuries or elective conditions. Of the 60 digital block procedures, 31 were randomized to lidocaine with epinephrine and 29 to plain lidocaine. Of the procedures performed using lidocaine with epinephrine, one patient required an additional injection versus five of the patients who were given plain lidocaine (p = 0.098). The need for control of bleeding required digital tourniquet use in 20 of 29 block procedures with plain lidocaine and in 9 of 31 procedures using lidocaine with epinephrine (p < 0.002). Two patients experienced complications after plain lidocaine blocks, while no complications occurred after lidocaine with epinephrine blocks (p = 0.23). By prolonging lidocaine’s duration of action, epinephrine may prevent the need for an additional injection and prolong post-procedure pain relief. This study demonstrated that the temporary hemostatic effect of epinephrine decreased the need for, and thus the potential risk of, using a digital tourniquet (p < 0.002). As the temporary vasoconstrictor effect is reversible, the threat of complication from vasoconstrictor-induced ischemia is theoretical.

From the Divisions of Plastic Surgery, University of Texas Medical Branch and Southern Illinois University School of Medicine. Received for publication February 25, 2000; revised April 18, 2000.


Lidocaine, an amide, has a reduced allergenicity, improved efficacy, rapid onset, and 1- to 2-hour duration. Procaine, an ester, has a slower onset and a 30- to 40-minute duration of action.8,17-21 The mechanism of these local analgesics involves the inhibition of nerve con-
duction by interfering with the increase in sodium concentration normally caused by depolarization.17–19,21

Before describing the addition of epinephrine to procaine, Braun reported using it alone to create a "chemical tourniquet."21 When epinephrine binds to alpha-1 and alpha-2 receptors, vasoconstriction results through the activation of the phosphatidylinositol system and adenylate cyclase, respectively.26–29 This vasoconstrictive response has been measured in digital vessels using the Doppler laser flowmeter.30–32 In fact, injection of a sympathetic agonist resulted in a 37 percent decreased blood flow in digits and a 50 percent decreased flow for 5 minutes, normalizing in 60 minutes in another study.30,32 Accordingly, augmenting the local anesthetic with epinephrine has many advantages, including prolonging the effect, decreasing the amount needed, reducing the risk of toxicity, and decreasing bleeding at the operative site.10,15,20,33–35 Other vasopressive agents, such as phenylephrine and norepinephrine, have been found ineffective at producing adjunctive hemostasis and a prolonged effect of lidocaine.20,35

Neugebauer36 warned against the use of epinephrine in high concentrations. Moreover, the measurement of epinephrine concentration was imprecise, as Bunnell1 advised the addition of three drops of epinephrine per ounce. Furthermore, in 1928, Serafin37 described tissue sloughing following the use of local anesthetic containing 1:20,000 epinephrine. Since then, the optimal concentration of epinephrine has been debated; studies support using between 1:100,000 and 1:800,000.15,38–40 Generally, the maximum dose of epinephrine injected in normal individuals should not exceed 1 mg (100 ml of 1:100,000). Hypertension does not usually occur with less than 0.5 mg of epinephrine (50 ml of 1:100,000).15,35 Because digital blocks require just 5 ml of agent, systemic effects are infrequent. However, lower quantities of epinephrine can precipitate adverse systemic effects for patients with certain underlying diseases.15,35 Therefore, the use of epinephrine is cautioned for patients with pheochromocytoma, hyperthyroidism, severe hypertension, cardiac disease, and peripheral vascular disease.10,15,41

Materials and Methods

After obtaining approval from our institutional review board, 60 digital blocks were performed in a prospective randomized double-blinded study. Patients were randomized to a control group to receive plain lidocaine or to a treatment group to receive lidocaine with epinephrine. The institute’s pharmacy prepared 7-ml vials of 1% lidocaine or 1% lidocaine with 1:200,000 epinephrine. Physicians and patients were blinded, as these vials were labeled only with study drug protocol and numbers that were assigned by a statistician to randomize patient selection. These vials were placed in an emergency room Pyxis drug dispenser and administered in numerical order as ascribed by the statistician. Specialized informed consent was obtained by all patients enrolling in the study. The anesthetics were delivered to treat either posttraumatic injuries or elective conditions. The digital blocks were performed with 3-ml syringes and 1.5-cm 30-gauge needles. Of the several digital block techniques described, the dorsal approach was uniformly employed.

Results

Of the 60 digital blocks, 31 were randomized into the treatment group receiving lidocaine with epinephrine and 29 to the control group receiving plain lidocaine. Of the patients given digital blocks with epinephrine, one required an additional injection versus five of the patients given digital blocks without epinephrine (p = 0.098). The additional injection was needed after the effects of the first anesthetic procedure diminished (35 to 65 minutes). The need for control of bleeding required digital tourniquet use in 20 of 29 blocks with plain lidocaine, while 9 of 31 blocks using lidocaine with epinephrine required a tourniquet (p = 0.002). Following the procedures using plain lidocaine blocks, two patients experienced complications requiring additional procedures, including the loss of a cross-finger flap in one patient and infection progression following incision and debridement of a felon, obviously unrelated to the use of plain lidocaine. No complications occurred in the group that received lidocaine with epinephrine blocks (p = 0.23).

Discussion

Excessive tourniquet pressure, ring block technique, epinephrine, injection of excessive volume, and burn from hot soaks to anesthetized fingers have all been implicated as contributors to gangrene formation after digital blocks.42–48 In reviewing prior reports of gan-
Following digital blocks, Garlock claimed to be the first to report this complication in 1931. Garlock’s technique involved injecting undocumented amounts of plain procaine distal to tightly applied tourniquets; he attributed the complications in his study to a vascular injury from the digital tourniquet. Other than this, the complication of finger gangrene has not been reported following the practical use of digital tourniquets in the absence of other risk factors (e.g., excess volume of injection or hot soaks). Dove and Clifford described an episode of digital ischemia that completely resolved within 12 hours after the use of a digital tourniquet. Although studied exhaustively, tourniquets have only been proven to cause nerve and muscle injury in animal models, when pressures exceeded 500 mmHg. The allegation by Garlock of endothelial injury being caused by a tourniquet has not been proven.

Local asphyxia distal to tourniquets is well tolerated for several hours by humans, provided that the skin under the tourniquet is anesthetized. The local changes of acidosis and hyperkalemia that occur in tissues distal to tourniquets are generally not adverse, since dilution prevents systemic acidosis and hyperkalemia, even with tourniquet deflation. Moreover, several digital tourniquet techniques have been described and safely used.

Kaufman and McLaughlin each implicated epinephrine to play a role in a patient with finger gangrene after digital blocks. However, both authors acknowledged the actual cause to be scald burns acquired by immediate soaking of still anesthetized fingers in boiling hot solutions of boric acid. In fact, those patients did not feel the burn until the solution reached their palms. Moreover, thermal injuries are known to cause vessel thrombosis. Thus, epinephrine may have facilitated the burn injuries only by prolonging the effect of the anesthetic.

In 1944, O’Neill and Byrne reported seven cases of finger gangrene after digital blocks, probably as a result of thermal injuries, as all of these patients received hot soaks. To date, the only common factor in all cited cases of finger gangrene is hot soaks. O’Neill and Byrne postulated that the increased metabolism caused by hot soaks contributed to the gangrene formation. Accordingly, they reported that soaks should be contraindicated for at least 24 hours following digital blocks. However, direct thermal injury is another possibility. In 1958, Burnham published his experience of no complications following 93 digital blocks using 2% procaine and 1:200,000 epinephrine. Discouraging the circular block, Burnham attributed his success to the technique of injecting proximal to the metacarpal heads.

In 1963, Bradfield reported three patients with finger gangrene after digital blocks without epinephrine. Since Bradfield used the ring technique, this was implicated to cause gangrene, as well as the injection of excessive volume, as one patient was injected with 15 ml of a local anesthetic. Recently, Sylaidis and Logan reported no complications after performing 100 consecutive digital blocks with lidocaine and epinephrine. Of the several techniques described, the volar and dorsal approaches are the most common. The dorsal approach, which involves only one injection site, over the less painful dorsum of the finger is favored by the authors; recently, their experience of no complications with this technique using lidocaine with epinephrine in a retrospective series was published.

In summary, several cases of finger gangrene reported after digital blocks have one common factor, hot soaks; these cases were, in fact, thermal injuries. Irreversible injury to digital vessels can occur with digital blocks. The risk for bilateral digital vessel injury may be increased with the circular technique or injection of excessive volume of a local anesthetic. Furthermore, Garlock’s allegation that the tourniquet causes gangrene has not been proven. Finally, there exists no reported case of finger gangrene resulting from the use of epinephrine in the digital block.

**CONCLUSIONS**

After performing a retrospective review of digital blocks with epinephrine, this prospective randomized double-blinded study was designed, which demonstrated that the temporary hemostatic effect of epinephrine decreased the need for, and thus the potential risk of, using a digital tourniquet. Also, by prolonging the duration of action of lidocaine fourfold, epinephrine may prevent an additional injection, as is often required with lengthier procedures, and may prolong pain relief following the procedure. Given the results of this study, we began administering lidocaine with epinephrine digital...
blocks routinely for posttraumatic and elective conditions. To date, 121 digital blocks using lidocaine with epinephrine have been performed without the complication of finger gangrene. Again, it is important to carefully perform the digital block procedure with a small-caliber needle and an appropriate volume of local anesthetic to minimize the risk of bilateral digital vessel injury. The digital block is discouraged for patients with disease processes potentially involving the digital vessels at the base of the proximal phalanx (i.e., infection or trauma). Furthermore, the use of epinephrine is cautioned for patients with pheochromocytoma, hyperthyroidism, severe hypertension, cardiac disease, and peripheral vascular disease.\(^{10,15,41}\) This experience demonstrates that the potential risk of finger gangrene with epinephrine augmentation of the digital block is theoretical, thus disproving the dogma or long-time medical dictum that proscribes its use despite the lack of scientific data to support this.

Steven J. Blackwell, M.D.
Division of Plastic Surgery
University of Texas Medical Branch
301 University Blvd.
Galveston, Texas 77555-0724

REFERENCES


PLASTIC AND RECONSTRUCTIVE SURGERY, February 2001