CHAPTER **46**

LOCAL ANESTHESIA WITH EPINEPHRINE AND CONCURRENT PNEUMATIC ANKLE TOURNIQUET IN FOREFOOT SURGERY

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INTRODUCTION

Local anesthesia has become a mainstay in lower extremity surgery. Local blocks are often given with sedation as an adjunct in lieu of general anesthesia, so that foot and ankle surgery can be done with as little morbidity to the patient as possible. It is beneficial in most cases to delay the pain associated with the initial insult of surgery as long as possible. In many cases this is accomplished through the addition of dilute epinephrine to the local anesthetic agent. Although prolonged analgesia is a major benefit of adding epinephrine to local anesthetics, the epinephrine also causes a short-term vasoconstriction beneficial in hemostasis.[1-10] It has been shown that the constrictive effects of dilute epinephrine in local anesthetics do not result in complete occlusion of blood flow and are relatively short lived.[1-5] It is for this reason that many surgeons use a combination of local with dilute epinephrine along with an ankle tourniquet for better hemostasis.

Using local anesthesia containing epinephrine in extremities has been discussed at length in the literature. There is a plethora of literature supporting the use of epinephrine in distal extremities. There is only theoretical risk of producing ischemia in extremities cited in many contemporary texts. These are not linked to any studies in the literature because epinephrine dilution techniques have been standardized.[1,4,5,11-13] After extensive literature review it is apparent that in all the reported cases of digital loss secondary to gangrene, none was linked specifically to the use of epinephrine alone.[1,2,4-6]

When many surgeons weigh theoretical risks of tissue damage and loss, they use a tourniquet instead of local anesthetics with epinephrine. However, tourniquets completely occlude blood flow distally during their time of inflation. The physician accepts the loss of prolonged analgesia using plain local anesthesia without epinephrine or injects additional local anesthesia at the end of the surgical case.[14-18] Many surgeons, however, have an appreciation of local anesthesia with epinephrine and use it regularly without the need of a tourniquet.[1,2,4-6] It is known that local anesthetic agents themselves cause vasodilation and increased tissue perfusion. When epinephrine 1:200,000 to 1:400,000 is added, the vasoconstriction is partial and only lasts for 1-3 hours, followed by a reactive hyperemia.[1,2,4] What is not clear is whether the addition use of a tourniquet poses any theoretical or real additive complications when used in combination with local anesthetic containing epinephrine.

Many surgeons use a tourniquet for a predictable and precise bloodless field combined with local anesthesia with epinephrine for prolonged (up to 24 hours) pain control. With the rising rate of medical litigation in seemingly normal complications and the need to practice "good medicineî based on data, we present a retrospective review of all surgeries preformed using a combination of ankle tourniquet and bupivicaine or lidocaine with a dilute epinephrine. For those surgeons that do not use this combination routinely, the data will be useful for those situations when this combination may prove beneficial or necessary.

BACKGROUND

Local anesthesia was first rendered by Karl Koller, to the eye in 1884.[7] Strauss first described digital blocks in 1889 after applying cocaine under an ingrown toenail.[19] Procaine was developed in 1904. Because it caused vasodilatation, unlike cocaine, Braun added epinephrine.[20] Lofgren and Lundquist developed lidocaine in 1943. Lidocaine had many advantages over procaine, mainly decreased allergenicity and faster onset.[21]

When epinephrine was then added to lidocaine there were many reports and warnings of complications. At this time, there existed no set standard preparation, and only a crude dilution drip method was used to mix epinephrine with a local agent.

Neugebaurer and Bunnell reported on a generally crude method for mixing epinephrine and local. Reports of skin slough and necrosis were common in early reports relaying high concentrations of epinephrine greater than 1:20,000.[12,22,23] Since the progression of pharmaceutical standardized solutions of local agents and epinephrine, optimal concentration has been debated. Studies support using 1:100,000 and 1:800,000 strengths of local with epinephrine.[1,2,4-6,8,22-26]

Different local anesthetics have different vasoconstrictive properties with different concentrations of epinephrine. For instance 0.5% bupivacaine has a more profound local vasoconstrictive effect with epinephrine 1:200,000 than 1% lidocaine with epinephrine 1:100,000. In digital blocks, 1% lidocaine with epinephrine 1:100,000, 1:200,000, and 1:300,000 all seemed to initially cause a vascular decrease flow of approximately 50%. Bupivacaine with epinephrine 1:200,000 caused an initial decreased flow of approximately 75% for the same digital block.[1] Furthermore, different local anesthetics have different anesthetic properties with different concentrations of epinephrine. For a tibial nerve block at the ankle level, lidocaine with epinephrine 1:100,000 has a more long lasting anesthetic effect than lidocaine plain. Bupivacaine (0.5%) on the other hand has a longer lasting anesthetic effect without epinephrine than it does with epinephrine 1:200,000 for the same block.[2]

Reports do warn against using epinephrine in patients with underlying systemic diseases with vasospastic or infarct associations.[1,2,4,5,11,12] In states such as pheochromocytoma, hyperthyroidism, severe hypertension, cardiac disease, lupus, scleroderma and peripheral vascular disease, the use of epinephrine is cautioned against.

Pneumatic tourniquet use has become routine since its introduction in medicine in 1904.[9,14-18,26,27] Dangers of tourniquet mainly relating to excessive pressure and prolonged time have been well documented in the literature.[14-18,27-30] Understanding the risks associated with tourniquet use has required the surgeon to appreciate fully any baseline medical condition that could contribute additive risks. Therefore caution should be exercised when using it in patients with peripheral vascular disease, sickle cell, vascular grafts, vasospastic disorders, baseline neuropraxias, trauma, infection, and in patients unable to tolerate tourniquet pressure despite sedation.[9,14-18,26-30]

The optical surgical field is one in which all anatomy is clearly delineated. A tourniquet accomplishes this by completely occluding the blood supply to the structures distal to the tourniquet. When combined with a local anesthetic containing epinephrine, the patient often will perceive a less painful surgical procedure and experience longer postoperative analgesia relief.[1,2,4,5,13] A decrease in narcotic use following local blocks with ambulatory surgeries has also been documented.[3,5,11-13,18] With the literature available for a judicious use of either mode of hemostasis alone (tourniquet or epinephrine), there exists no available medical data on the use of both tourniquet and epinephrine in combination in extremity surgery.

MATERIALS AND METHODS

This study comprises a retrospective review of 362 foot cases performed at Scripps Mercy Hospital, the author's institution between 1992 and 2000. Podiatry surgical residents participated in all included cases. In all cases both a pneumatic ankle tourniquet and a local anesthetic agent with dilute epinephrine were used. The two primary surgeons (WJ and SA) along with the residents provided all follow up care. All patient surgical sites were in the forefoot (distal to tarsal-metatarsal joints). All cases included in the study had local injection sites distal to the tarsal-metatarsal joint.

Patient data and records were accessed through hospital records, office records, and surgical logs. All patient records were reviewed. Charts were reviewed for patient profiles, past medical history, procedure, tourniquet time and pressure, location of block and agent used, and any complications. Data was recorded and stratified according to: 1) type and location of procedure, 2) amount and type of local with epinephrine, 3) location of the block, 4) the tourniquet time and pressure, 6) complications related to any of above.

RESULTS

Review was conducted on 302 patient charts (362 feet; 76 male, 286 female). This included 445 separate procedures (Table 1). The average age of the patient was 48.2 years (range 17-88). Out of 445 total procedures (362 feet), 214 procedures (142

feet) were hammertoe corrections, 173 procedures (173 feet) were bunions or procedures on the first ray, and 58 other procedures (47 feet) including tailor's bunion, neuroma, and lesser metatarsal surgery, were performed (Table 1).

The location of the block corresponded to the locale of surgery i.e. distal verses proximal block in all cases. Included were: 214 digital or distal ray blocks, 173 distal first ray blocks, 58 local blocks confined to surgical site (i.e. 5th ray or interspace blocks).

Local anesthetic agents varied from a 1:1 mixture of 1% lidocaine and 0.5% bupivicaine, or 0.5% bupivicaine with epinephrine concentrations from 1:200,000 to 1:400,000. Local anesthetic amounts averaged 12.7 cc (range 8-25) for first ray procedures, 3-27cc for digital blocks (depending on the number of toes), and 5-24cc for the other distal forefoot procedures. On some feet, multiple procedures were done and in some cases the local was not recorded as a specific amount injected at each site, but as a total amount.

Tourniquet times averaged 38.5 minutes for all hammertoe cases (range 8-81 minutes), 40.6 minutes (range 17-95 minutes) for first ray procedures, and 34.8 minutes for other foot procedures (range 12-90 minutes). All were ankle tourniquets inflated to 250 mm/hg. Many times a tourniquet was inflated while multiple procedures were done.

Past medical history was documented when there was any remote possibility of it contributing to any complication relating to the study. This included hypertension in 83 patients, HIV in 1 patient, hepatitis C in 3 patients, and a positive smoking history in 59 patients. The past medical history was not directly related to any complications.

COMPLICATIONS

Five episodes of immediate ischemia (white toe) were noted; all were in the recovery room and occurred in cases of multiple hammertoes corrected with arthrodesis, Kirschner wires, and interdigital bandage. All cases responded to adjustment of the toe on the pin and loosening of the bandage. No cases of digital loss secondary to ischemia, or cases of necrotic foot or digits were found.

There were 17 cases (17 feet, 4.7%) in which erythema, cellulitis, or infection was noted from 3-28 days postoperative in the chart. In all 17 patients an oral antibiotic was prescribed. Two patients required hospitalization with intravenous antibiotics. None of the 17 patients went on to any long-term problems. In most cases it was not necessarily recorded in the chart as an infection, but as erythema, serous discharge, or early cellulitis. When an antibiotic was given in the postoperative course it was included

Table 1

PATIENT DATA

	Hammertoes	Bunions, 1st Ray Surgery	Other (Neuromas, Tailor's Bunion	Total
# of feet	142 (214 toes)	173	47 (58 procedures)	362 (445 procedures)
Male/female	31/111	35/138	10/37	76/286
Age, average (range) years	52.8 (20-88)	41.4 (18-83)	46.7 (17-78)	48.2 (17-88)
Amount of local, average (range) cc*	10.1 (3-30)	12.7 (8-25)	13.3 (6-26)	12.2 (3-30)
Tourniquet time, average (range) minutes†	38.5 (8-81)	40.6 (17-95)	34.8 (12-90)	38 (8-95)

* On some feet, more than one procedure was performed. Lidocaine 1% with epinephrine 1:200,000; Marcaine 0.5% with epinephrine 1:200,000; or a mixture of 1:1 lidocaine 1% plain and marcaine 0.5% with epinephrine 1:200,000.
† Average ankle tourniquet pressure 250 mm/hg

with these 17 patients. Of note dexamethsone phosphate was injected routinely in nearly all cases about the surgical site.

One case recorded the capital fragment displacing, and in 14 patients pins were noted to be loose or had been removed by the patient. Continued joint pain was recorded in 4 cases. There were 5 cases in which a recurrence of a deformity was specifically noted. Numbness in part or all of a digit was noted specifically in 16 patients.

DISCUSSION

We have presented our review of 362 feet and 445 procedures using the combination of both ankle tourniquet and local bupivacaine or lidocaine with epinephrine 1:200,000-1:400,000. No severe or long-term complications occurred. We have appreciated no evidence of impairment of healing, or increased rate of complications.

Our infection rate of 4.7% may be somewhat higher than reported in the literature. However, questionable infections were also included in this group. Many of these were noted as erythema but were included since they were treated with empiric antibiotics. Because the authors will routinely use a local steroid at the close of the surgery one may query the relationship to infection. It is known that ischemia at a surgical site can have untoward effects on wound healing. However, it is doubtful in this study our patients represent a true increase in postoperative infections linked to the temporary effects of dilute epinephrine and a tourniquet.

A review of the literature does reveal cases of digital ischemia related to excessive volume of local, ring block technique creating a fluid tourniquet, epinephrine, burns from hot soaks to anesthetized digits, and excessive tourniquet pressure. Past literature correlates that epinephrine in the anesthetic was not the specific cause of digital loss in any instance of digital necrosis.[4,6,8,10-12,22-25,31-36] We found only minor transient episodes in five patients of transient ischemia (white toe). In all cases there was a mechanical reason i.e. overstretching the toe or over-compression with dressings that seemed to have been the cause and not necessarily the epinephrine-tourniquet use. In some instances the procedure was so short in duration that the complete effects of the epinephrine had probably not began to wear off until in recovery room and perhaps time itself was enough to let the toe circulation return.

When epinephrine is used in dilute amounts it has been proven to only temporarily cause a decrease in blood flow. In fact, a reflex hyperemia is uniformly noted after the partial constrictive effects of tourniquet wear off. Studies show this may increase blood flow to the limb as the blocked sympathetic effect of the local lasts past that of the epinephrine.[1,2,4] Appreciating this short-lived partial decrease in flow gives further prudence to combined tourniquet use. Realizing the benefit to patients of having longer postoperative analgesia is also key. Patients must be cautious to not over stress the surgical site, which may be numb longer than when using plain local.

It should be noted that the authors rigidly do not use epinephrine containing local in patients with systemic diseases that might contribute to ischemia. Likewise a tourniquet may be limited in those patients with systemic disease, with detailed anatomic dissection used as a standard hemostasis technique.

CONCLUSION

Our results suggest that as long as patients are selected properly, a combination of local anesthetic with a dilute concentration of epinephrine (1:200,000) or less and a concurrent ankle tourniquet may safely provide excellent anatomic visualization and the additive benefit of lengthened analgesia. In 362 feet we have seen no adverse effects to the patient. We again suggest that each surgeon must be familiar with diseases related to vasospastic disorders and this must be part of a preoperative discussion. Using both epinephrine containing local and a concurrent tourniquet should not be routine on all patients and should only be used by surgeons familiar with both modalities. It is not the intent of the authors to persuade foot surgeons to use this combination of epinephrine and tourniquets. It is our goal to provide medical evidence for foot surgeons who have and will continue to use both epinephrine and a tourniquet in their daily practice. This should additionally provide medical evidence for those surgeons who may occasionally find it beneficial to use this combination of techniques.

We as physicians must first "do no harm." Within this constraint we must continue to challenge rituals and hearsay traditions in medicine and replace these with evidence based medicine

for both the optimal benefit to the patient and the further progression of our profession. This implies providing judicious medical and surgical care, giving the patient the very best outcome.

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