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# Minimally Invasive Anesthesia in Wide Awake Hand Surgery

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## KEYWORDS

• Wide-awake • Epinephrine finger • WALANT • Tourniquet-free • Sedation-free

## KEY POINTS

- The tourniquet is no longer required for hand surgery because of epinephrine hemostasis.
- Epinephrine in the finger is safe.
- Epinephrine vasoconstriction in the finger is reversible with phentolamine.
- Wide-awake flexor tendon repair has decreased tenolysis and rupture rates.
- Patients like the sedation-free approach for carpal tunnel and find it similar to dental surgery.



Videos of how to inject carpal tunnel with minimal pain for wide awake surgery; Field sterility for surgery; surgery; intraoperative patient advice; bandage; and typical patient impression after surgery accompany this article at <http://www.hand.theclinics.com/>

## INTRODUCTION/NATURE OF THE PROBLEM

One of the most significant recent advances in hand surgery has been the movement away from tourniquet surgery, which often requires sedation or general anesthesia. The advent of epinephrine safety in the finger has led many to use this mode of hemostasis. This is providing a patient experience similar to a visit to the dentist; the patient comes in, rolls up his sleeve, gets the local anesthesia, has the hand surgery and goes home without preoperative testing or postoperative recovery time in the hospital or surgery center.

## WHAT IS MINIMALLY INVASIVE ANESTHESIA FOR WIDE-AWAKE HAND SURGERY?

In wide-awake hand surgery, the only medications given to the patient are subcutaneous lidocaine and epinephrine. This mixture is infiltrated wherever surgical dissection, K wire insertion, or

manipulation of fractured bones will occur. The concept behind this technique is that the local anesthetic results in an extravascular Bier block but only where it is needed. The other term that is frequently used to describe this approach is tumescent local anesthesia.

There are several advantages to this minimally invasive technique. If the local anesthesia is administered properly,<sup>1</sup> all that the patient feels is the first needle poke of a 27-gauge needle in the hand for most hand operations. The lack of any sedation means there is no need for preoperative testing, intravenous insertion, intraoperative monitoring, or the postoperative anesthetic care unit. The procedures can be performed without sedation, because epinephrine is used for hemostasis, which obviates the need of a painful tourniquet. Once exposed to this concept, the patients love it.<sup>2</sup> The patient experience of hand surgery using this technique becomes more on par with a visit to the dentist.

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## INDICATIONS/CONTRAINDICATIONS

The author and colleagues believe that nearly every patient should be offered the wide-awake option. Most people who do not want sedation at the dentist are likely to prefer the wide-awake approach, because it is more convenient than going through the time-consuming process associated with sedation: preoperative testing, intravenous insertion, and postsedation recovery period. Patients with pre-existing medical problems such as renal dialysis, morbid obesity, and severe lung problems should be considered for this approach, as it is safer than the sedation/general anesthesia route.

Of course, some patients really are better served having sedation, and it should be given to them. Patients with high anxiety or severe post-traumatic stress disorder may not tolerate a wide-awake procedure. Also take care in offering this technique to non-native English speakers and those with cognitive impairments. Finally, not all surgeons enjoy interactive discussion with patients that can occur during operative procedures. This technique is not for those surgeons.

Epinephrine-induced cardiac ischemia is a possible but extremely rare event; even with high doses (1:1000 epinephrine).<sup>3</sup> The author and colleagues have not had this complication with over 2000 cases. However, if there is concern with epinephrine use because of cardiac disease, lowering the dose of epinephrine to 1:400,000 is an option the author and colleagues occasionally employ. Some have even found epinephrine 1:1,000,000 effective for hemostasis.<sup>4</sup>

## TECHNIQUE

### *Anesthetic*

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It has been shown in liposuction patients that up 35 mg/kg of tumescent lidocaine with epinephrine injection can result in safe blood levels of lidocaine.<sup>5</sup> Nevertheless, the author and colleagues use the conservative upper limit of 7 mg/kg of lidocaine with epinephrine, as their patients are not monitored. In a 70 kg person, this means 49 cc of 1% lidocaine with 1:100,000 epinephrine.

For standard exposures, the author and colleagues inject up to 50 cc of subcutaneous 1% lidocaine with 1:100,000 epinephrine wherever surgical dissection, manipulation of fractured bones, or K wire insertion will occur. If a larger field needs to be anesthetized such as for larger operations such as spaghetti wrist or tendon transfer, the author and colleagues add up to 150 cc of saline to obtain more volume. This results in 0.25% lidocaine with 1:400,000, which is still effective

for local anesthesia and hemostasis. However, this dilution does require a little longer to set up.<sup>6</sup> Even 1 in a million epinephrine provides effective hemostasis if a patient has a greatly unstable heart.<sup>4</sup>

For operations longer than 2 hours, the author and colleagues add up to 10 cc of 0.5% bupivacaine with 1:200,000 epinephrine to the infiltrate to make sure no top ups are required. The author and colleagues consider top ups to be a failure of the initial injection, and they should be avoided.

### *Anesthetic Technique*

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Patients are placed supine and injected in the holding area before entering the operating room. For this technique to be maximally effective, time must be allowed to let the medication take effect. It has been shown that maximal vasoconstriction occurs an average of 26 minutes after injection of 1:100,000 epinephrine beneath human skin.<sup>7</sup>

For short procedures, the patients are instructed at the time of the preoperative consultation that they should bring a book, as they will have to wait at least 30 minutes between the injection of the local anesthesia and the surgery. They are given the analogy of: "putting a cake in the oven and giving it time to bake." The author and colleagues have developed a system to allow for efficient throughput in their surgical center. Their first 3 patients arrive at 8 AM; the surgeon completes their injection and paperwork. It takes an average of 5 minutes to inject a carpal tunnel patient in a consistently almost pain-free manner.<sup>8</sup> While the third patient is being injected, the nurse sets up the first patient in the operating room. After the first case, the nurse brings the second patient into the operating room and sets it up while the surgeon injects the fourth patient, and so on.

More thought is required when injecting larger areas such as multiple flexor tendons in the hand or for forearm cases. The key to success is that enough volume is injected into the most proximal area to be dissected so that the tissues become mildly indurated or blanched with local anesthesia.<sup>9</sup> Care must be taken when injecting near the nerves; eliciting paresthesias is unnecessary, as tumescent local anesthesia is effective without placing the needle so close to the nerve. In addition, the sharp bevel of the needle can lacerate nerve fascicles. With this technique, the local is injected 5 to 10 mm away from major nerves. Then time is given to allow diffusion of the local to the big nerves while epinephrine vasoconstriction sets in. After injection, there should be at least 1 cm of visible or palpable subcutaneous local anesthesia beyond any area of intended dissection.

Attached are several videos that show the use of this technique for an open carpal tunnel release (Videos 1–6).

## HOW TO INJECT MINIMAL PAIN LOCAL ANESTHESIA FOR WIDE-AWAKE HAND SURGERY

There are 2 ways to inject local anesthesia; the traditional method of rapid injection with a 25-gauge needle, or the less painful “blow slow before you go” technique, which hurts patients less. Nine principles of minimal pain local anesthesia are listed in **Box 1**, the details of which have been published elsewhere.<sup>10</sup>

### SPECIFIC AREAS OF IMPACT FOR WIDE-AWAKE ANESTHESIA

#### *Flexor Tendon Repair*

The wide-awake approach has had an impact on reducing rupture and tenolysis rates after flexor tendon repair.<sup>12–14</sup> There are 4 main reasons for this.

First, after each suture, the repair can be tested with full active flexion and extension by the comfortable, cooperative, unседated, tourniquet-free patient. This allows the surgeon to assess for gapping generated by sutures that are too loose, which will increase risk of rupture. Thus

the surgeon can repair the gap before the skin is closed instead of going on to rupture.

Second, the full active flexion and extension shows the surgeon that the repair fits through the pulleys with active movement. If it does not, pulleys can be vented, or repairs can be trimmed or narrowed with sutures. The entire A2 pulley and up to half of the A4 pulley can be divided if necessary. As the surgeon is observing the active movement, only the pulley that needs to be divided is sacrificed.

Third, the tendon can be repaired inside the sheath, with the needles being introduced through sheathotomy incisions that can be repaired at the end of the case. The reason this is possible is that the patient will demonstrate to the surgeon with full active movement that the inside of the sheath has not been caught by the needle and thread.

Finally, if the surgeon sees the patient making a full fist and extending the fingers completely during the surgery, he or she knows that the patient can be allowed to perform true active early protected movement with half a fist after surgery, as opposed to place and hold. The author and colleagues allow patients to make half a fist and 45° active flexion and extension of each of the MP, PIP, and DIP joints beginning 3 to 5 days after surgery.<sup>15</sup> This is the “half a fist/45/45/45” regime.

#### *Tendon Transfer*

One of the most difficult aspects of tendon transfer has been setting the tension of the transfer so it is not too tight or too loose. All surgeons who have done enough transfers understand this.

The ability to watch the comfortable tourniquet-free awake patient flex and extend the involved digits allows for adjustments to be made to the tension before the skin is closed. This technique has taken some of the guesswork out and has improved tensioning during tendon transfer surgery.<sup>16</sup>

#### *Fracture Treatment*

Wide-awake surgery for fracture treatment has several advantages. This technique provides intraoperative assessment of full active movement under low-power C arm fluoroscopy. This motion will demonstrate any malrotation that may be present. The ranging of the fingers also allows the surgeon to see any movement in fracture fragments with active finger flexion and extension. Thus the surgeon can ensure adequate K wire stability is achieved to permit early controlled active movement. The technique for wide-awake fracture treatment is outlined in the article by Gregory and colleagues elsewhere in this issue.

#### **Box 1**

##### **Methods of decreasing the pain of local anesthetic injection**

Step 1. Buffering lidocaine and epinephrine 10:1 with 8.4% bicarbonate<sup>11</sup>

Step 2. Warming the local anesthetic

Step 3. Distracting the patient or the area of injection with touch, pressure, pinching, or ice

Step 4. Using a 27-gauge needle

Step 5. Stabilizing the syringe to avoid needle wobble

Step 6. Injecting 0.5 cc perpendicularly subdermally and pausing until the patient says the needle pain is gone

Step 7. Injecting an additional 2 cc before moving the needle, and then moving antegrade very slowly with 1 cm of local anesthetic always palpable or visible ahead of the needle

Step 8. Reinserting needles within 1 cm of blanched areas

Step 9. Learning from all patients by asking them to score the number of times they felt pain during the injection

## COMPLICATIONS/SAFETY

### *The "Jitters" and Fainting*

There are 2 relatively common problems with tumescent lidocaine and epinephrine injection for wide-awake hand surgery. They are easily dealt with if the surgeon is expecting them and takes defensive action.

The first is the nervous jitter or trembling that can accompany epinephrine injection in anyone. It is wise to forewarn all patients after injection that they may end up feeling a little jittery or shaky after the injection similar to the feeling after consuming too much coffee. The author and colleagues counsel the patient that this is a normal reaction to the adrenaline in the numbing medicine; that the feeling will go away all by itself in 20 to 30 minutes, and that this is not an allergic reaction to the local anesthetic.

The second common problem is a vasovagal episode.<sup>17</sup> This occurs when there is not enough blood going to the brain.<sup>18</sup> The vasovagal response is limited by injecting patients lying down instead of sitting up. Even lying down, some patients may complain that they are not feeling well or that they are going to be sick. They may also get pale between the eyes or in the glabella. These are all signs of imminent fainting, and they are best treated by flexing the hips and knees to get thigh blood to the brain quickly. The head pillow can be removed and placed under the feet. The stretcher can be placed in the Trendelenberg position (head down and feet up). These measures will have the patients feeling much better in a matter of minutes.

### *Safety of Epinephrine in the Finger*

The safety of epinephrine in the finger is now well established.<sup>19,20</sup> The myth of epinephrine danger was generated in the first half of the 20th century when fingers were lost due to procaine acidity.<sup>21</sup> Epinephrine causes vasoconstriction in the human finger, but there is an antidote to this effect: phentolamine. The white finger can be reversed by subcutaneous injection of 1 mg of phentolamine in 20 cc of saline wherever the epinephrine is injected.<sup>22</sup> In reality, most fingertips still have good perfusion even when the proximal finger has vasoconstriction, so phentolamine is rarely required in clinical practice. However, if the fingertip should have poor refill and it is time for patient discharge, the vasoconstriction can be reversed.

There are still no cases of finger death associated with accidental finger injection of high-dose (1:1000) epinephrine in spite of hundreds of case reports.<sup>23,24</sup> Patients who have poor perfusion to fingertips with slow refill before the surgery should

likely not have epinephrine in the finger. However, if there is good perfusion in the fingertip before the surgery, there will likely be good perfusion after the surgery unless the surgeon damages the blood flow with his or her dissection.

### *Safety of No Monitoring for Wide-Awake Hand Surgery*

Injecting lidocaine with epinephrine is safe. For more than 60 years, in the developed world, millions of injections of lidocaine with epinephrine have been administered safely without monitoring in dental offices.<sup>25,26</sup> Most Mohs surgeons do not monitor vital signs in patients who have skin cancers removed, and this practice has been reported to be safe.<sup>27</sup> Everywhere throughout the world, other minor procedures are performed with lidocaine anesthesia without monitoring on a regular basis with only rare adverse reactions reported. The severe adverse reactions of anaphylaxis to lidocaine are extremely rare.<sup>28-31</sup>

Preoperative assessment and intraoperative monitoring are the norm in North America when sedation is given to patients. The issue is about the sedation and not the local anesthesia or the surgery itself.

## OUTCOMES

### *Patient Satisfaction*

There is a popular misconception by many that patients need sedation for minor hand operations such as carpal tunnel surgery. In fact, it has been shown that carpal tunnel patient satisfaction with local anesthetic is high for surgery with or without sedation.<sup>17,32</sup> There is level 3 evidence that patients will choose the anesthetic technique recommended by their surgeon and have equal satisfaction.<sup>2</sup>

Patient satisfaction is high with wide-awake minor procedures such as carpal tunnel surgery and trigger finger release, because the experience is even less cumbersome than a dental visit. The hand surgeon is not operating in the mouth, and patients just hold out their hand for the surgery and do not need to watch. Yet the same in-and-out of the office convenience of dental surgery remains. The tourniquet pain of brief carpal tunnel surgery is twice the pain of the injection of local anesthesia with epinephrine for hemostasis (level 3 evidence).<sup>33</sup> Using epinephrine avoids tourniquet discomfort.

Patients do not have the postoperative nausea and vomiting associated with sedation and narcotic administration. They do not have to take time out of work or get a baby sitter so they can go for preoperative blood work (another needle),

chest radiographs or electrocardiograms. Patients spend far less time at the hospital the day they have their surgery<sup>2</sup> and require no special precautions related to the sedation after the surgery.

### ***Surgeon Satisfaction and Cost Implications***

Removing the need for sedation and the tourniquet removes the need for minor hand surgery to be performed in the setting of the main operating room. Carpal tunnel surgery can be performed with field sterility in the minor procedure room of a clinic or office with the same low infection rate and full sterility of the main operating room.<sup>34</sup> Field sterility means that the masked and gloved surgeon does not wear a gown and only uses towel to drape the hand.<sup>35</sup>

Three carpal tunnels/trigger fingers per hour can be performed in the clinic or office setting with just 1 nurse to help the surgeon.<sup>36</sup> The cost improvements for the surgeon operating in the private sector are massive.<sup>37</sup>

In addition to the greatly decreased expense of the surgery, the surgeon does not need to worry about wasted turnover time. While the nurse turns over the room and brings in the next patient, the surgeon can go and inject the local anesthesia in a waiting patient in the preoperative holding area. By the time he has done that, the next patient in the operating room is ready for surgery.

Talking to the unседated patient during the surgery has many benefits. The personal touch could potentially reduce lawsuit risk. Discussions about return to activities and work can happen while the surgeon is working. Learning a little about the patient can lead to postoperative management advice that can decrease complication risks, which further improves time management for the surgeon.

### **SUMMARY**

Tumescent minimally invasive local anesthesia is eliminating the need for sedation and proximal nerve blocks as well as all of their risks, costs, and inconveniences. It has facilitated advances in procedures such as hand fracture reduction, tendon repair, and tendon transfer by allowing the surgeon to see cooperative patient active movement during the surgery. It has improved the patient experience for simple hand operations such as carpal tunnel release.

### **SUPPLEMENTARY DATA**

Supplementary data related to this article can be found online at <http://dx.doi.org/10.1016/j.hcl.2013.08.015>.

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