

Wide-Awake Surgery With Local Anesthesia and Epinephrine Is Safe

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abstract

Hand and upper extremity surgery performed with the patient wide awake involves the use of a local anesthetic and epinephrine. Controversy persists as to whether epinephrine is safe for use in the hand. The goal of this study was to evaluate the safety of epinephrine in hand and upper extremity surgery. The hypothesis was that epinephrine is safe and can be used for a wide breadth of surgical procedures of the hand and upper extremity. A 4-year retrospective chart review was conducted of consecutive patients undergoing wide-awake surgery performed by 2 surgeons at a single institution. All procedures were performed with local anesthesia and epinephrine. Data collected included patient demographics, procedure volume, procedure type, surgical setting, and complications related to epinephrine use. During the study period, 4054 consecutive patients underwent 4287 wide-awake procedures with local anesthesia and epinephrine. Average patient age was 59 years, and 64% of patients were female. No complications occurred as a result of the use of epinephrine, and no tissue necrosis, phentolamine reversal, anaphylaxis, or readmissions occurred. No patients required conversion to general anesthesia or monitored anesthesia care. This analysis of more than 4000 consecutive patients undergoing wide-awake hand and upper extremity surgery with epinephrine confirmed that epinephrine use is safe, with no reported cases of tissue necrosis, reversal, readmission, anaphylaxis, or anesthetic conversion. Epinephrine is safe for use in the hand and upper extremity for patients undergoing wide-awake hand surgery with a local anesthetic. [*Orthopedics*. 2020;43(6):e529-e532.]

mizes bleeding, which avoids both the need for a tourniquet and the associated pain. Second, it improves the duration of effect of the local anesthesia. Earlier studies showed the safety of epinephrine in the hand and fingers and the effectiveness of phentolamine reversal if needed.^{7,8}

Despite evidence to the contrary, some medical providers believe that the use of epinephrine in the hand may increase the risk of digital necrosis.⁹⁻¹¹ This perception appears to stem from historic complications with procaine that have been erroneously attributed to epinephrine. Procaine acidifies over time, and before 1972, medication did not have expiration dates. As a result, the use of aged procaine resulted in many reported cases of finger necrosis.¹²

Most of the current evidence of the safety of epinephrine with wide-awake hand surgery comes via Canada through the Dalhousie Project, which reported no cases of epinephrine-related complications in 3110 consecutive cases.^{1,10,12,13} To confirm this

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To avoid the risks of general anesthesia, hand surgeons frequently perform outpatient surgery solely with local anesthesia, often referred to as wide-awake hand surgery. Compared with general anesthesia, wide-awake surgery is associated with decreased costs, less perioperative time, fewer postoperative

restrictions, decreased complication rates, and improved ability to perform intraoperative evaluation predicated on patient cooperation.¹⁻⁶ The standard technique for performing wide-awake hand surgery involves the use of both a local anesthetic and epinephrine. The rationale for the use of epinephrine is twofold. First, it mini-

Table 1

Patient Demographics

Characteristic	No.
Patients	4054
Male	1466 (36%)
Female	2588 (64%)
Hypertension	781 (19%)
Active smoker	293 (7%)
Vascular disease	267 (7%)
Diabetes	240 (6%)
Coagulopathy	122 (3%)
Renal disease	85 (2%)
Comorbidities not found	404 (10%)

finding with separate surgeons in a different country, the current authors reviewed their consecutive experience performing wide-awake hand and upper extremity surgery with the routine use of epinephrine. The primary study hypothesis was that epinephrine is safe for use in surgical procedures of the hand and upper extremity. The secondary goal of the study was to elucidate the diversity of procedures that can be performed with wide-awake surgery.

MATERIALS AND METHODS

After institutional review board approval was obtained, a 4-year retrospective chart review was conducted of all surgeries performed under local anesthesia with epinephrine by 2 board-certified orthopedic hand surgeons (A.M.I., J.L.M.) at an outpatient surgical center. Demographic information, medical comorbidities, type of procedure performed as determined by *Current Procedural Terminology* code, and complications related to the anesthetic and/or epinephrine were recorded. All of the patients were available for follow-up to at least the first postoperative visit, typically 7 to 14 days postoperatively.

For both participating surgeons, standard indications for surgery of the hand and upper extremity with only local anesthesia and epinephrine included all procedures

of the fingers, all soft tissue procedures of the hand and wrist, select bony or fracture procedures of the hand and wrist, and select procedures of the forearm and elbow. Contraindications to surgery with only local anesthesia and epinephrine included a history of hand vasospasm (ie, CREST syndrome: calcinosis, Raynaud’s phenomenon, esophageal dysfunction, sclerodactyly, telangiectasias) and a history of allergic reactions to either lidocaine or epinephrine.

Both treating surgeons used a standard protocol for wide-awake procedures. Patients were greeted in the preoperative area, where a mixture of 9 mL of 1% lidocaine with 1:100,000 epinephrine was combined with 1 mL of 8.4% bicarbonate mixed 10 mL:1 mL and injected into the planned surgical site. The details of this technique were described by Lalonde¹ and were adopted by the study surgeons. For safety, the mixture of 1% lidocaine with epinephrine was diluted, based on procedure type and patient weight, as needed to keep the cumulative dose at less than 7 mg/kg.^{14,15} Patients were taken to the operating room, where an initial test for pain sensation was performed after standard sterile preparation and draping. An additional mixture of 1% lidocaine with 1:100,000 epinephrine was available in the operating room to supplement anesthesia if necessary.

At the completion of surgery, sterile dressings were placed and patients were taken to a postoperative area. They received a full set of discharge instructions before departure, including instructions for how to identify signs of prolonged ischemia. There was no routine observation period to monitor the status of the finger or hand before discharge.

RESULTS

A total of 4054 patients who underwent 4287 consecutive wide-awake procedures with local anesthesia performed by the 2 surgeons were reviewed during the course of 4 years. Average patient age was 59 years (range, 6-98 years) and the cohort consisted of 1466 male and 2588 female patients (**Table 1**). Overall, 240 patients

had diabetes (6%), 122 patients had pre-existing coagulopathy (3%), and 267 patients had peripheral vascular disease (7%).

During the collection period, no complications related to the use of epinephrine occurred, including finger or tissue necrosis. No patients required phentolamine reversal or further monitoring with an unplanned admission or early return to the office for concern about epinephrine-induced ischemia. No patients had an allergic reaction or anaphylaxis attributed to lidocaine or epinephrine. **Table 2** shows the diversity and quantity of procedures performed under local anesthesia, including 4062 soft tissue procedures and 225 bony procedures. Finally, no patients required unplanned intraoperative conversion to sedation or general anesthesia.

DISCUSSION

Wide-awake surgery performed under local anesthesia with epinephrine has been adopted successfully both nationally and internationally.^{12,16-19} Mounting evidence shows that wide-awake surgery offers many benefits, such as decreased opioid use, patient convenience, cost savings, improved surgical quality, accelerated rehabilitation, and improved safety for those who are unwilling or unable to undergo general anesthesia.²⁰⁻²⁸

Davison et al²⁰ showed that opioid use after carpal tunnel release was 5% for wide-awake patients compared with 68% for sedated patients. Preoperative laboratory and medical workup was required for only 3% of patients who underwent wide-awake surgery vs 48% of those undergoing sedation. Additionally, preoperative anxiety levels were significantly lower among those undergoing wide-awake surgery. Hustedt et al²¹ performed a comparative study of 4615 patients undergoing hand surgery and reported significantly fewer complications with wide-awake procedures vs general anesthesia, particularly among patients older than 65 years.

Recently, several authors analyzed cost savings with wide-awake surgery. Alter et

al⁵ compared the cost of mini-open carpal tunnel release performed wide awake vs under sedation and found total savings of nearly \$2000 per case with wide-awake surgery. Similarly, Rhee et al³ reported cost savings of 85% and 70% for carpal tunnel release and trigger finger release, respectively, when performed wide awake. Likewise, Codding et al²² examined the cost of trigger finger release surgery and found savings of more than \$100 in anesthesia costs with the use of local anesthesia only, despite an exceedingly short case time.

Beyond cost savings, wide-awake surgery offers benefits in terms of outcomes and rehabilitation. Perhaps most notably, wide-awake flexor tendon repair surgery allows the surgeon to assess repair site integrity and gapping and facilitates venting pulleys as needed by permitting intraoperative active flexion and extension.²³⁻²⁵ With this technique, Higgins et al⁶ showed a reduced rupture rate, with no re-ruptures among patients who followed a prescribed postoperative therapy protocol. Tang²⁶⁻²⁸ found a substantially reduced rate of postoperative tenolysis after wide-awake flexor tendon repair surgery because it allowed judicious pulley venting.

Although wide-awake hand surgery offers many benefits, the fear of tissue ischemia and digital necrosis with the use of epinephrine still exists. However, evidence continues to mount in challenging this dogma. Lalonde et al¹⁰ reported no cases of necrosis or tissue loss in 3110 consecutive injections with epinephrine. Chowdhry et al⁹ and Sardenberg et al¹⁷ found similar results in 1111 and 488 patients, respectively. In the current study, no epinephrine-related complications occurred in more than 4000 consecutive surgical procedures. The current findings reinforce earlier reports of the safety of epinephrine use in the hand and upper extremity.

Interestingly, several case reports recently described digital ischemia after injection with epinephrine. Zhu et al⁸ reported finger ischemia after ipsilateral carpal tunnel and trigger release. Although the patient received twice the recommended

Table 2

Cases and Volume	
Procedure	No.
Trigger finger release	1062
Endoscopic carpal tunnel release	834
Open carpal tunnel release	798
Mass excision, finger	250
De Quervain's release	222
Incision and drainage/foreign body excision	121
Dupuytren's fasciectomy	121
Extensor tendon repair	95
Closed pinning metacarpal/phalanx fracture	68
Volar mass/ganglion excision	57
Local/rotational flap/graft	55
Mucous cyst excision	53
Interphalangeal joint arthrodesis	52
Dorsal mass/ganglion excision	47
Arthrotomy wrist/finger joint	47
Tendon transfer	44
Flexor tendon repair	41
Removal of hardware	35
Nail bed repair/ablation	34
Cubital tunnel release (in situ or transposition)	33
Interphalangeal joint osteophyte excision	32
Flexor tenolysis	27

digital injection dose of epinephrine and had a history of vasospastic disease, phenolamine reversal approximately 14 hours postoperatively was effective.⁸ Similarly, Zhang et al²⁹ reported a patient who had digital necrosis after 3-finger trigger release. Images of the fingers were consistent with a hot water burn injury from submersion rather than ischemia from epinephrine.²⁹ Likewise, Ruiter et al³⁰ reported a case of fingertip necrosis that was attributed to the patient's attempt to regain sensation in the fingertips postoperatively through submersion in hot water. These complications must be interpreted

Table 2 (cont'd)

Cases and Volume	
Procedure	No.
Open reduction and internal fixation metacarpal/phalanx	26
Digital nerve repair	17
Digital neurolysis	17
Extensor tenolysis	16
Amputation, finger	21
Skin neoplasm excision	11
Thumb carpometacarpal arthroplasty	9
Mass excision elbow/shoulder	8
Guyon's canal release	5
Open reduction and internal fixation distal radius	5
Distal ulna resection	4
Posterior interosseous nerve neurectomy	4
Synovectomy	3
Median nerve repair	2
Thumb ulnar collateral ligament repair	2
Finger closed reduction	2
Postaxial polydactyly excision	2
Interphalangeal joint arthroplasty	2
Sagittal band repair	1
Distal radius closed reduction	1
Proximal row carpectomy	1

with care before direct causation can be assigned to the use of epinephrine.

Strengths of this study included the large patient population, the consistent technique for the use of lidocaine with epinephrine, and the consecutive case analysis. Weaknesses included the retrospective nature of the study and the inclusion of only 2 surgeons.

CONCLUSION

In the current cohort of more than 4000 patients, local anesthesia with epinephrine was safe and effective for a diverse range of surgical procedures. Given the many advantages of this technique, surgical ap-

plications in the upper extremity will likely continue to expand. Most of the data on the safety and effectiveness of wide-awake hand surgery come from a small number of international institutions and authors. The current study found no instances of digital necrosis and no need for phentolamine reversal among more than 4000 consecutive patients. These findings further challenge the essentially disproven dogma that epinephrine use in the hand is contraindicated.

REFERENCES

- Lalonde D. Minimally invasive anesthesia in wide awake hand surgery. *Hand Clin.* 2014;30(1):1-6. <https://doi.org/10.1016/j.hcl.2013.08.015> PMID:24286736
- Bismil M, Bismil Q, Harding D, Harris P, Lamyman E, Sansby L. Transition to total one-stop wide-awake hand surgery service-audit: a retrospective review. *JRSM Short Rep.* 2012;3(4):23. <https://doi.org/10.1258/shorts.2012.012019> PMID:22715424
- Rhee PC, Fischer MM, Rhee LS, McMillan H, Johnson AE. Cost savings and patient experiences of a clinic-based, wide-awake hand surgery program at a military medical center: a critical analysis of the first 100 procedures. *J Hand Surg Am.* 2017;42(3):e139-e147. <https://doi.org/10.1016/j.jhsa.2016.11.019> PMID:28011033
- Van Demark RE Jr, Smith VJS, Fiegen A. Lean and green hand surgery. *J Hand Surg Am.* 2018;43(2):179-181. <https://doi.org/10.1016/j.jhsa.2017.11.007> PMID:29421068
- Alter TH, Warrender WJ, Liss FE, Ilyas AM. A cost analysis of carpal tunnel release surgery performed wide awake versus under sedation. *Plast Reconstr Surg.* 2018;142(6):1532-1538. <https://doi.org/10.1097/PRS.0000000000004983> PMID:30188472
- Higgins A, Lalonde DH, Bell M, McKee D, Lalonde JF. Avoiding flexor tendon repair rupture with intraoperative total active movement examination. *Plast Reconstr Surg.* 2010;126(3):941-945. <https://doi.org/10.1097/PRS.0b013e3181e60489> PMID:20463621
- Nodwell T, Lalonde D. How long does it take phentolamine to reverse adrenaline-induced vasoconstriction in the finger and hand? A prospective, randomized, blinded study: the Dalhousie project experimental phase. *Can J Plast Surg.* 2003;11(4):187-190. <https://doi.org/10.1177/229255030301100408> PMID:24009436
- Zhu AF, Hood BR, Morris MS, Ozer K. Delayed-onset digital ischemia after local anesthetic with epinephrine injection requiring phentolamine reversal. *J Hand Surg Am.* 2017;42(6):479.e1-479.e4. <https://doi.org/10.1016/j.jhsa.2017.01.006> PMID:28259566
- Chowdhry S, Seidenstricker L, Cooney DS, Hazani R, Wilhelmi BJ. Do not use epinephrine in digital blocks: myth or truth? Part II. A retrospective review of 1111 cases. *Plast Reconstr Surg.* 2010;126(6):2031-2034. <https://doi.org/10.1097/PRS.0b013e3181f44486> PMID:20697319
- Lalonde D, Bell M, Benoit P, Sparkes G, Denkler K, Chang P. A multicenter prospective study of 3,110 consecutive cases of elective epinephrine use in the fingers and hand: the Dalhousie Project clinical phase. *J Hand Surg Am.* 2005;30(5):1061-1067. <https://doi.org/10.1016/j.jhsa.2005.05.006> PMID:16182068
- Thomson CJ, Lalonde DH, Denkler KA, Feicht AJ. A critical look at the evidence for and against elective epinephrine use in the finger. *Plast Reconstr Surg.* 2007;119(1):260-266. <https://doi.org/10.1097/01.prs.0000237039.71227.11> PMID:17255681
- Lalonde DH. Conceptual origins, current practice, and views of wide awake hand surgery. *J Hand Surg Eur Vol.* 2017;42(9):886-895. <https://doi.org/10.1177/1753193417728427> PMID:28886668
- Lalonde D, Eaton C, Amadio P, Jupiter J. Wide-awake hand and wrist surgery: a new horizon in outpatient surgery. *Instr Course Lect.* 2015;64:249-259. PMID:25745911
- Steiner MM, Calandrucchio JH. Use of wide-awake local anesthesia no tourniquet in hand and wrist surgery. *Orthop Clin North Am.* 2018;49(1):63-68. <https://doi.org/10.1016/j.ocl.2017.08.008> PMID:29145985
- Klein JA. Tumescence technique for regional anesthesia permits lidocaine doses of 35 mg/kg for liposuction. *J Dermatol Surg Oncol.* 1990;16(3):248-263. <https://doi.org/10.1111/j.1524-4725.1990.tb03961.x> PMID:2179348
- Tang JB, Gong KT, Zhu L, Pan ZJ, Xing SG. Performing hand surgery under local anesthesia without a tourniquet in China. *Hand Clin.* 2017;33(3):415-424. <https://doi.org/10.1016/j.hcl.2017.04.013> PMID:28673619
- Sardenberg T, Ribak S, Colenci R, Campos RB, Varanda D, Cortopassi AC. 488 hand surgeries with local anesthesia with epinephrine, without a tourniquet, without sedation, and without an anesthesiologist. *Rev Bras Ortop.* 2018;53(3):281-286. <https://doi.org/10.1016/j.rboe.2018.03.011> PMID:29892577
- Tang JB, Giddins G. Evolution and current status of hand surgery practice in Asia and Europe. *Hand Clin.* 2017;33(3):xiii-xiv. <https://doi.org/10.1016/j.hcl.2017.05.001> PMID:28673633
- Tang JB, Gong KT, Xing SG, Yi L, Xu JH. Wide-awake hand surgery in two centers in China: experience in Nantong and Tianjin with 12,000 patients. *Hand Clin.* 2019;35(1):7-12. <https://doi.org/10.1016/j.hcl.2018.08.011> PMID:30470334
- Davison PG, Cobb T, Lalonde DH. The patient's perspective on carpal tunnel surgery related to the type of anesthesia: a prospective cohort study. *Hand (N Y).* 2013;8(1):47-53. <https://doi.org/10.1007/s11552-012-9474-5> PMID:24426892
- Hustedt JW, Chung A, Bohl DD, Olmschied N, Edwards SG. Comparison of postoperative complications associated with anesthetic choice for surgery of the hand. *J Hand Surg Am.* 2017;42(1):1-8.e5. <https://doi.org/10.1016/j.jhsa.2016.10.007> PMID:27856100
- Codding JL, Bhat SB, Ilyas AM. An economic analysis of MAC versus WALANT: a trigger finger release surgery case study. *Hand (N Y).* 2017;12(4):348-351. <https://doi.org/10.1177/1558944716669693> PMID:28644939
- Lalonde D, Higgins A. Wide awake flexor tendon repair in the finger. *Plast Reconstr Surg Glob Open.* 2016;4(7):e797. <https://doi.org/10.1097/GOX.0000000000000756> PMID:27536476
- Lalonde DH, Martin AL. Wide-awake flexor tendon repair and early tendon mobilization in zones 1 and 2. *Hand Clin.* 2013;29(2):207-213. <https://doi.org/10.1016/j.hcl.2013.02.009> PMID:23660056
- Gibson PD, Sobol GL, Ahmed IH. Zone II flexor tendon repairs in the United States: trends in current management. *J Hand Surg Am.* 2017;42(2):e99-e108. <https://doi.org/10.1016/j.jhsa.2016.11.022> PMID:27964900
- Tang JB. Indications, methods, postoperative motion and outcome evaluation of primary flexor tendon repairs in Zone 2. *J Hand Surg Eur Vol.* 2007;32(2):118-129. <https://doi.org/10.1016/J.JHSB.2006.12.009> PMID:17298858
- Tang JB. Release of the A4 pulley to facilitate zone II flexor tendon repair. *J Hand Surg Am.* 2014;39(11):2300-2307. <https://doi.org/10.1016/j.jhsa.2014.08.025> PMID:25282719
- Tang JB. New Developments are improving flexor tendon repair. *Plast Reconstr Surg.* 2018;141(6):1427-1437. <https://doi.org/10.1097/PRS.0000000000004416> PMID:29579022
- Zhang JX, Gray J, Lalonde DH, Carr N. Digital necrosis after lidocaine and epinephrine injection in the flexor tendon sheath without phentolamine rescue. *J Hand Surg Am.* 2017;42(2):e119-e123. <https://doi.org/10.1016/j.jhsa.2016.10.015> PMID:27955967
- Ruiter T, Harter T, Miladore N, Neafus A, Kasdan M. Finger amputation after injection with lidocaine and epinephrine. *Eplasty.* 2014;14:ic43. PMID:25404956