

Current Concepts

Wide Awake Hand Surgery : Principles, Pain Management, and Outcomes

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Wide Awake Local Anesthesia No Tourniquet (WALANT) hand surgery is safe, efficacious, and evolving to address expanding demands and indications. WALANT Surgery has demonstrated consistent and reproducible advantages for patients and providers alike. Over the past several years, WALANT techniques have been further honed and implemented throughout the hand and upper extremity surgery field. These advances have improved patient pre-, intra-, and postoperative pain during routine hand surgery procedures. These improvements and the elimination of intraoperative tourniquet pain and unpleasant general anesthetic sequelae have increased overall patient satisfaction. Additionally, the WALANT surgical technique has helped mitigate patient postoperative opiate needs and prescriptions. Regarding surgical outcomes, data is emerging to support the non-inferiority of WALANT versus conventional surgical techniques when applied to many procedures. The prospective growth of WALANT hand and upper extremity surgery is immense, with progressing indications and applications.

INTRODUCTION

The “Wide Awake Local Anesthesia No Tourniquet” (WALANT) technical approach to hand and upper extremity surgery has undergone rapid expansion in its utilization over the past several years.¹⁻⁵ The key tenet of WALANT surgery is the tumescent infiltration of lidocaine with epinephrine at the surgical site, which, when done appropriately, can achieve both pain control and hemostasis, thereby obviating the need for a general anesthetic agent or tourniquet.^{3,6-11} Previous investigations have demonstrated the efficacy and safety of this strategy, which has fueled its continued adoption and growing applications.^{3,4,7-10,12}

This approach offers countless advantages for both patients and surgeons alike.¹⁻⁴ For patients, WALANT surgery offers increased convenience, decreased preoperative testing and clearance, and the ability to continue home medications (such as anticoagulants) perioperatively while removing the unpleasant sequelae inherent to fasting and general or intravenous anesthesia postoperatively.^{3,4,10} For surgeons, WALANT surgery imparts the flexibility of performing a large variety of common hand surgeries in the of-

fice, ambulatory surgical center, or main operating room. Moreover, WALANT surgery affords surgeons the ability to appraise and adjust repaired tendons and finger fractures based on the active patient’s range of motion, expand patient access to care to those who may otherwise not qualify for surgical anesthesia due to health or weight, better allocate staff and economic resources, and reduce one’s environmental footprint and medical waste.^{1,3,4,9,10} Furthermore, intraoperative patient consciousness and attentiveness offer the distinctive advantage of real-time intraoperative education toward postoperative instruction.^{2,3,6,10}

Warrender *et al.* previously outlined and reviewed the principles and techniques of WALANT hand surgery,³ which has since been augmented by subsequent reviews, analyses, technique guides, and textbooks dedicated to exploring its surgical potential.^{2,4,9,10} As WALANT hand surgery continues to evolve, evidence is mounting supporting its beneficial impact on both patient experiences and surgical outcomes. The goal of this review is to explore the evidence on pain control and surgical outcomes in the WALANT surgical setting,

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PAIN CONTROL

Pain control in WALANT surgery is executed through preoperative tumescent local anesthesia. High-volume and low-concentration formulations are preferred and should be injected to achieve a visible, palpable subcutaneous collection 1-2 centimeters beyond the relevant operative field.^{2,3,10} Surgeons must be familiar with the pharmacokinetics of the various local anesthetics they employ to meet the analgesic demands of each case and be prepared for any prospective adverse reactions that may arise. Local anesthetics are commonly divided into two groups, amides and esters, which carry distinct properties.¹³ Amides, such as lidocaine and bupivacaine, are commonly utilized in WALANT surgery and function by inhibiting sodium ion influx through membrane channels or ionophores.¹³ To garner patient satisfaction and trust during a WALANT surgery, pain needs to be proficiently controlled in the preoperative, intraoperative, and postoperative periods.

PREOPERATIVE

INJECTION AGENT

Dr. Lalonde, a pioneer in the WALANT surgical technique for the hand and upper extremities, has published extensively on advantageous preoperative injection techniques and strategies to minimize patient discomfort.^{7,8,12,14,15} The recommended injection volumes of local anesthetic vary with the intended operation, with 1% lidocaine with 1:100,000 epinephrine typically recommended when utilizing less than 50 cc of local anesthetic.^{12,15} epinephrine is indicated to deliver surgical site hemostasis precluding the need for a tourniquet intraoperatively. However, historically, there have been reservations against the use of epinephrine in the hand. However, the safety of epinephrine with lidocaine in the hand for WALANT hand surgery has been confirmed in two separate large series by Lalonde *et al.* as well as Ilyas *et al.*^{12,16}

Lidocaine is typically encouraged in favor of bupivacaine,¹⁵ despite bupivacaine's more prolonged duration of activity.¹³ Lalonde & Wong have substantiated this decision due to bupivacaine's cardiotoxicity, diminished duration of pain relief relative to touch and pressure sensory deprivation, and lidocaine's proven clinical track record in the setting of unmonitored dental procedures.^{15,17} However, Diaz-Abele *et al.* performed a randomized prospective study investigating postoperative pain and oral analgesic consumption between patients injected with lidocaine versus bupivacaine before WALANT carpal tunnel release (CTR) surgery.¹⁸ Interestingly, their investigation detected a significant decrease in early pain perception and acetaminophen consumption (at 12 and 24 hours) in the bupivacaine group. However, opioid consumption was similar between groups, with both groups consuming less than 10% of that which was prescribed.¹⁸

TIMING

Preoperative injection is recommended to be placed before transport to the operating room setting.^{14,15} This serves to combat any potential vasovagal episodes that may arise while allowing for the optimal epinephrine effect to promote vasoconstriction, limit bleeding, and improve intraoperative visibility.^{3,11,15,19} McKee *et al.*, in two separate investigations, have shown that maximal vasoconstriction after injection of lidocaine with epinephrine occurs after roughly 25-30 minutes,^{11,19} which further supports this workflow.

TECHNIQUE

Given advances in technique and experiential knowledge, a near-pain-free injection of lidocaine with epinephrine is an obtainable reality. Recommended principles to reduce pain are solution-, patient-, and provider-driven.^{1,14,20,21}

Regarding the lidocaine-epinephrine solution, due to its acidity (pH of 4.2), buffering with 8.4% sodium bicarbonate at a concentration of 1:10 is recommended.^{1,21,22} Furthermore, prior investigations have found that warming the injection solution can lead to a less painful injection.^{21,23,24} A 27- or 30-gauge, sharp needle should be used as this is less painful than larger-diameter alternatives.^{1,21} Needles with these gauges also inherently promote slower injection speeds, which further alleviates patient pain.^{1,20,21,25}

Patient distraction through audio-, visual-, or tactile stimuli has been shown to decrease injection-associated anxiety and pain.^{1,21} Additionally, injections perpendicular to the skin with stabilized needles (minimizing needle movement) are both proven technical skills that limit patient pain.^{1,21} Injections should be placed subdermally after pushing the skin into the needle, and needle progression should only occur after an initial, slow injection bolus to provide a wheal for the needle to advance behind.^{1,21} Lalonde has also advocated for the routine incorporation of real-time patient feedback following injection as a means of self-improvement and skillset refinement.^{1,21}

INTRAOPERATIVE

LACK OF TOURNIQUET

The intraoperative advantages from a pain perspective of WALANT surgery are well documented.^{2-5,10} A major intrinsic benefit of this technique is eliminating the need for a tourniquet and its corresponding pain and discomfort. Several prospective randomized trials have directly examined pain outcomes between cohorts with and without using an intraoperative tourniquet.²⁶⁻²⁸ Iqbal *et al.* conducted a prospective randomized controlled trial of 73 patients undergoing carpal tunnel release, in which they found that patients allocated to the "no-tourniquet" group had half the median intraoperative pain score (2.5 versus 5) compared to their counterparts randomized to the "tourniquet" cohort, which was statistically significant.²⁸ These results are corroborated throughout the literature by several additional randomized prospective studies, including but not

limited to those by Ralte *et al.*, Gunasagaran *et al.*, and Lee *et al.*^{26,27,29}

PATIENT PERCEPTION OF PAIN

The evidence illuminating pain tolerance of WALANT hand surgery continues to grow. Several previous investigations have found that WALANT patients report no intraoperative surgical site pain, which has matched the outcomes of their intravenous anesthetic study counterparts.²⁶⁻³² Overall, evidence has shown that patients tolerate these procedures exceedingly well, with multiple investigations concluding that over 90% of patients find the discomfort akin to or less than that of a dental procedure.^{30,32} A second hurdle, intensified in wide-awake surgery, is the patient psychological tolerance of these procedures. Interestingly, Ford *et al.* recently carried out a retrospective review to assess whether the WALANT surgical technique was endured similarly by patients with and without pre-existing psychiatric diagnoses, including generalized anxiety disorder (GAD), major depressive disorder (MDD), or bipolar disorder.³³ Their findings supported that intraoperative pain, postoperative pain, and overall patient satisfaction were similar between those with and without pre-existing comorbid psychiatric conditions.³³ However, in the setting of patient anxiety, readily available distracting modalities during WALANT hand surgery, including noise-canceling headphones and virtual reality, can be used.^{34,35} In a prospective randomized trial, Townsend *et al.* identified that using noise-cancelling headphones during WALANT hand surgery statistically decreased intraoperative patient anxiety.³⁴ Similarly, Hoxhallari *et al.* noted in a single-blinded randomized prospective trial that virtual reality during office-based WALANT hand surgery decreased patient anxiety.³⁵

POSTOPERATIVE

SURGEON PRESCRIBING

Given the current prevalence of opioid misuse, abuse, and dependence, adequate postoperative pain control is of pivotal importance.^{36,37} Previous hand surgery literature has found that patients are often overprescribed opioids in the postoperative period at a rate of approximately five times more than consumed.^{36,38-40} Further highlighting this discrepancy between supply and demand, Ilyas *et al.*, as well as Weinheimer *et al.*, found acetaminophen and ibuprofen to be a non-inferior efficacious alternative to opioids in postoperative pain control in prospective, randomized, double-blinded controlled trial after common hand surgeries.^{41,42} However, despite these data, patient demands may ultimately restrict the ability of a provider to modify their prescriber habits.

A speculative concern surrounding the incorporation of WALANT hand surgery is the repercussions it may have on postoperative opioid demands. However, these initial concerns have proven to be conjectural and are largely unsubstantiated.^{29,36,39} Miller *et al.* conducted a prospective investigation evaluating postoperative opiate consumption

of CTR and trigger finger release (TFR) cases performed WALANT versus monitored anesthesia care (MAC).³⁶ Total opioid consumption and days of use were similar between both groups, with the average overall opioid consumption of roughly four pills.³⁶ Dar *et al.* tested this idea even further in their prospective investigation wherein postoperative WALANT and MAC hand and upper extremity surgical patients were not prescribed opioids but instead instructed to take only over-the-counter analgesic agents.³⁹ They found 97.9 percent of patients in the WALANT technique group to have their pain controlled without any prescribed postoperative opiates, which was a higher percentage than that of the MAC cohort (80.6%).³⁹ Despite the demonstration of a decreased need for opioids after hand surgery, when indicated, Ilyas *et al.* identified that the use of multimodal pain management after hand surgery emphasizing the use of acetaminophen and non-steroidal anti-inflammatory drugs (NSAIDs) as first-line postoperative pain management with opioids reserved for severe breakthrough pain.⁴³

PATIENT SATISFACTION

Early evidence regarding postoperative patient satisfaction following WALANT surgery versus conventional surgical methods has further bolstered the case for its widespread adoption.^{5,6,14,20,30,44} Davison *et al.* found that 93% of patients undergoing WALANT CTR would choose it again, and these patients had lower preoperative anxiety compared to their intravenous sedation plus tourniquet study counterparts.⁵ In a prospective, randomized controlled trial, Lee *et al.* found increased surgical satisfaction and decreased postoperative pain in those undergoing WALANT- versus local anesthesia with tourniquet technique for patients undergoing A1 pulley release, 1st extensor retinacular release, and carpal tunnel release.²⁹

OUTCOMES

WALANT surgery offers numerous prospective operative advantages in addition to the tangible patient, economic, and environmental benefits previously elucidated in the literature.⁴⁵⁻⁴⁸ Although the evidence surrounding the efficiency, reproducibility, safety, and utility of WALANT surgery is robust, literature investigating surgical outcomes remains an emerging area of investigation. As the applications and indications of this technique continue to grow, so does the body of evidence highlighting and cataloging surgical outcomes.

CARPAL TUNNEL RELEASE

Saleh *et al.* performed a randomized controlled trial of WALANT carpal tunnel release versus conventional technique with a tourniquet assessing patients' subjective perioperative experience and postoperative outcomes.⁴⁹ In addition to a statistically significant decrease in intraoperative patient discomfort, they found non-inferior results in the WALANT cohort regarding operative time and postop-

erative complications.⁴⁹ These results substantiated those found by Tulipan *et al.*, who found no differences in reoperation nor postoperative patient-reported disability and pain outcome measures between individuals undergoing open carpal tunnel releases with WALANT or MAC technique.⁴⁴ Furthermore, Olaiya *et al.* performed a systematic review and meta-analysis to compare patient satisfaction, perceived operative difficulty, and overall surgical outcomes of patients who underwent awake open carpal tunnel release with and without a tourniquet.⁵⁰ In their investigation, including eight studies and 765 patients, they concluded that the use of a conventional tourniquet approach generates significantly more pain without any clinically improved outcomes as compared to using a wide awake, no tourniquet approach in carpal tunnel release.⁵⁰

FLEXOR TENDON REPAIR

In tendon repair, the patient's distinct ability to test active tendon motion can impact intraoperative decision-making, providing opportunities for improved outcomes.^{2,8,51} As described previously by Lalonde, wide-awake tendon repair has two major advantages: first, intraoperative assessment of tendon tracking through pulleys helps ensure the repair glides unabated, theoretically reducing the need for subsequent tenolysis.^{8,51} Secondly, cooperative, intraoperative patient testing helps identify gaps in tendon repairs, thereby mitigating re-rupture incidence.^{8,51,52} Higgins *et al.* reported a detection rate of intraoperative gapping in flexor tendon repairs at 7%, highlighting the substantial opportunity for improvements in outcomes and re-rupture rate utilizing WALANT techniques.^{4,52} Lalonde and Martin have reported that the WALANT tendon repair technique has not only decreased postoperative tenolysis and re-rupture rates but also has allowed for an increasingly aggressive and liberal approach regarding postoperative rehabilitative protocols secondary to increased confidence in their repairs.^{4,53} Duru *et al.* retrospectively reviewed 94 zone 1 and zone 2 wide-awake flexor tendon repairs at a single institution from 2018-2020, describing excellent or good results in 100% of zone 1 fingers, 88% of zone 2 fingers, and 77.8% of all thumb repairs.⁵⁴ Although their overall described functional outcomes, tenolysis, and re-rupture rates were commensurate with those in the literature performed with conventional modes of anesthesia, they highlight the need for future, large-scale clinical trials.⁵⁴

FLEXOR TENOLYSIS

In a recent systematic review and meta-analysis performed by Levit *et al.*, the authors sought to assess whether the WALANT technique was superior to local anesthesia with a tourniquet (LAWT) for trigger finger release (TFR) regarding but not limited to cost, operative time, functional outcomes, and adverse events.⁵⁵ Postoperative time and cost were both significantly decreased in the WALANT patients, while functional outcomes, rates of adverse events, and overall operative time remained similar between groups.⁵⁵ Regarding patient satisfaction following TFR, Rabinowitz *et al.* performed a retrospective investigation, which found

that 100% of WALANT patients would opt for the same technique. In comparison, 68% of LAWT patients prefer WALANT-style surgery for subsequent prospective procedures.^{55,56} Similarly, in a prospective cohort study carried out by Rhee *et al.*, it was found that 94% of patients undergoing trigger finger release would choose the WALANT technique if they were to have the same procedure again.^{48,57}

FRACTURE MANAGEMENT

As the WALANT surgical technique has continued to demonstrate clinical success, its indications and utilization have broadened considerably. Fracture management is one domain undergoing rapid integration into the WALANT surgical sphere. From a technical perspective, WALANT offers several broad advantages throughout fracture care. During the reduction and fixation of a distal radius fracture, the intraoperative patient's active range of motion permits the opportunity to observe and evade tendon irritation as they may glide over the plate during physiologic motion.^{4,58} In a systematic review and meta-analysis performed by Rigney *et al.*, no differences were found in postoperative functional and radiographic outcomes between distal radius fractures fixed under WALANT compared to traditional anesthesia techniques.⁵⁹ However, their review was consistent with only six eligible studies, with only two being randomized controlled trials.⁵⁹ However, their conclusions were further supported by a 2024 systematic review by Gouveia *et al.*, wherein the WALANT technique for managing distal radius fractures led to comparable operative times and blood loss, with low postoperative pain scores and compelling functional outcomes.⁶⁰

Fixation of phalanges and metacarpal fractures utilizing the WALANT methodology is well described and validated in the literature.⁶¹⁻⁶⁴ Similar to WALANT practices across other upper extremity surgery disciplines, finger fracture management in the awake patient allows for the unparalleled chance to test arc of motion, Kirschner wire (K-wire) placement, and construct stability intraoperatively.⁶² In ten patients, Feldman *et al.* demonstrated improved functional outcomes in the WALANT management of metacarpal fractures without increased complications or morbidity.⁶³ These promising results built off the earlier accounts from Xing *et al.*, which highlighted the successful use of WALANT for metacarpal plating in a series of four patients.⁶⁵ Further empirical support for using the WALANT technique in managing metacarpal and phalangeal fractures came directly from the restrictions and limitations in access incited by the coronavirus disease (COVID-19) pandemic.⁶⁴ In a single center study out of France between 2020 and 2021, Ruterana *et al.* found similar functional outcomes, complication rates, reoperation frequencies, and patient satisfaction between WALANT and LAWT approaches for the management of metacarpal and phalangeal fractures.⁶⁴ Notably, Gillis *et al.* have demonstrated that K-wire fixation management of closed hand fractures under field sterility alone (as opposed to full sterility in the operating room) does not lead to increased infectious complications.⁶¹

DUPUYTREN'S DISEASE

The outcomes surrounding the wide-awake approach to Dupuytren patients have been examined in several studies throughout the literature.^{15,66,67} Despite the successful application of this approach towards the operative management of Dupuytren's since the early 2000s, its widespread adoption has been relatively limited.^{67,68} Although the majority of the outcome data on WALANT Dupuytren's surgery is positive,^{67,68} Nelson *et al.* found that pooled total active motion postoperative results favored general anesthesia versus WALANT technique in a retrospective analysis of 111 cases, although the difference was not significant.⁶⁶

The boundaries of WALANT hand surgery continued to be pushed. Although the data is preliminary and sample sizes limit overreaching takeaways, wide-awake surgical approaches have been described in navigating scaphoid fractures, distal radius fractures, forearm diaphyseal fractures, finger and hand arthritis necessitating arthroplasty, arthroscopy, and even fusions.^{1,69-72} Future prospective investigations into these emerging WALANT applications will be invaluable towards appropriately evaluating its efficacy and prospective future directions.

CONCLUSION

Wide-awake, local anesthesia, no tourniquet hand, and upper extremity surgery is an ever-evolving technique that has proven advantageous to patients, providers, health systems, and the environment. The WALANT technique has proven non-inferior to conventional anesthesia regarding numerous hand procedural outcomes while demonstrating increased patient satisfaction. Furthermore, the opportunity WALANT surgery affords for intraoperative adjustments and real-time patient education are particularly ad-

vantageous. The potential growth of WALANT hand and upper extremity surgery is immeasurable, with progressing indications and applications. As surgeons continue to integrate this approach into their expertise, improved results concerning patient pain, procedural tolerance, postoperative function, and radiographic outcomes can be expected.

DECLARATION OF CONFLICT OF INTEREST

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There is no information (names, initials, hospital identification numbers, or photographs / images) in the submitted manuscript that can be used to identify any patients.

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REFERENCES

1. Lalonde DH. Latest Advances in Wide Awake Hand Surgery. *Hand Clinics*. 2019;35(1):1-6. doi:[10.1016/j.hcl.2018.08.002](https://doi.org/10.1016/j.hcl.2018.08.002)
2. 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.
3. Warrender WJ, Lucasti CJ, Ilyas AM. Wide-Awake Hand Surgery: Principles and Techniques. *JBJS Rev*. 2018;6(5):e8-e8. doi:[10.2106/JBJS.RVW.17.00142](https://doi.org/10.2106/JBJS.RVW.17.00142)
4. Kurtzman JS, Etcheson JI, Koehler SM. Wide-awake Local Anesthesia with No Tourniquet: An Updated Review. *Plast Reconstr Surg Glob Open*. 2021;9(3):e3507. doi:[10.1097/GOX.0000000000003507](https://doi.org/10.1097/GOX.0000000000003507)
5. 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. doi:[10.1007/s11552-012-9474-5](https://doi.org/10.1007/s11552-012-9474-5)
6. Lalonde DH. Effective Things Surgeons Can Tell Patients During Wide-Awake Local Anesthesia No Tourniquet Surgery to Decrease Complications and Improve Outcomes. *Journal of Hand Surgery Global Online*. 2022;4(6):464-466. doi:[10.1016/j.jhsg.2022.04.009](https://doi.org/10.1016/j.jhsg.2022.04.009)
7. Lalonde D, Martin A. Epinephrine in local anesthesia in finger and hand surgery: the case for wide-awake anesthesia. *J Am Acad Orthop Surg*. 2013;21(8):443-447. doi:[10.5435/JAAOS-21-08-443](https://doi.org/10.5435/JAAOS-21-08-443)
8. Lalonde D, Martin A. Tumescent local anesthesia for hand surgery: improved results, cost effectiveness, and wide-awake patient satisfaction. *Arch Plast Surg*. 2014;41(4):312-316. doi:[10.5999/aps.2014.41.4.312](https://doi.org/10.5999/aps.2014.41.4.312)
9. Degreef I, Lalonde DH. WALANT surgery of the hand: state of the art. *EFORT Open Rev*. 2024;9(5):349-356. doi:[10.1530/EOR-24-0033](https://doi.org/10.1530/EOR-24-0033)
10. Hearon BF, Isaacs-Pullins SR, Lalonde DH. Adoption of the Wide-Awake Local Anesthesia No Tourniquet Technique in Hand Surgery. *JBJS Rev*. 2023;11(7). doi:[10.2106/JBJS.RVW.23.00068](https://doi.org/10.2106/JBJS.RVW.23.00068)
11. McKee DE, Lalonde DH, Thoma A, Glennie DL, Hayward JE. Optimal time delay between epinephrine injection and incision to minimize bleeding. *Plast Reconstr Surg*. 2013;131(4):811-814. doi:[10.1097/PRS.0b013e3182818ced](https://doi.org/10.1097/PRS.0b013e3182818ced)
12. 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. doi:[10.1016/j.jhsa.2005.05.006](https://doi.org/10.1016/j.jhsa.2005.05.006)
13. Becker DE, Reed KL. Local Anesthetics: Review of Pharmacological Considerations. *Anesth Prog*. 2012;59(2):90-102. doi:[10.2344/0003-3006-59.2.90](https://doi.org/10.2344/0003-3006-59.2.90)
14. Lalonde DH. "Hole-in-one" local anesthesia for wide-awake carpal tunnel surgery. *Plast Reconstr Surg*. 2010;126(5):1642-1644. doi:[10.1097/PRS.0b013e3181f1c0ef](https://doi.org/10.1097/PRS.0b013e3181f1c0ef)
15. Lalonde DH, Wong A. Dosage of local anesthesia in wide awake hand surgery. *J Hand Surg Am*. 2013;38(10):2025-2028. doi:[10.1016/j.jhsa.2013.07.017](https://doi.org/10.1016/j.jhsa.2013.07.017)
16. Ilyas AM, Jennings JD, Banner L, Matzon JL. Wide-Awake Surgery With Local Anesthesia and Epinephrine Is Safe. *Orthopedics*. 2020;43(6):e529-e532. doi:[10.3928/01477447-20200827-03](https://doi.org/10.3928/01477447-20200827-03)
17. Calder K, Chung B, O'Brien C, Lalonde DH. Bupivacaine digital blocks: how long is the pain relief and temperature elevation? *Plast Reconstr Surg*. 2013;131(5):1098-1104. doi:[10.1097/PRS.0b013e3182865dbb](https://doi.org/10.1097/PRS.0b013e3182865dbb)
18. Diaz-Abele J, Luc M, Dyachenko A, Aldekhayel S, Ciampi A, McCusker J. Lidocaine With Epinephrine Versus Bupivacaine With Epinephrine as Local Anesthetic Agents in Wide-Awake Hand Surgery: A Pilot Outcome Study of Patient's Pain Perception. *J Hand Surg Glob Online*. 2020;2(1):1-6. doi:[10.1016/j.jhsg.2019.09.004](https://doi.org/10.1016/j.jhsg.2019.09.004)
19. McKee DE, Lalonde DH, Thoma A, Dickson L. Achieving the optimal epinephrine effect in wide awake hand surgery using local anesthesia without a tourniquet. *Hand (N Y)*. 2015;10(4):613-615. doi:[10.1007/s11552-015-9759-6](https://doi.org/10.1007/s11552-015-9759-6)
20. Joukhadar N, Lalonde D. How to Minimize the Pain of Local Anesthetic Injection for Wide Awake Surgery. *Plast Reconstr Surg Glob Open*. 2021;9(8):e3730. doi:[10.1097/GOX.0000000000003730](https://doi.org/10.1097/GOX.0000000000003730)
21. Strazar AR, Leynes PG, Lalonde DH. Minimizing the pain of local anesthesia injection. *Plast Reconstr Surg*. 2013;132(3):675-684. doi:[10.1097/PRS.0b013e31829ad1e2](https://doi.org/10.1097/PRS.0b013e31829ad1e2)

22. Frank SG, Lalonde DH. How acidic is the lidocaine we are injecting, and how much bicarbonate should we add? *Can J Plast Surg.* 2012;20(2):71-73. doi:[10.1177/229255031202000207](https://doi.org/10.1177/229255031202000207)
23. Yang CH, Hsu HC, Shen SC, Juan WH, Hong HS, Chen CH. Warm and neutral tumescent anesthetic solutions are essential factors for a less painful injection. *Dermatol Surg.* 2006;32(9):1119-1123. doi:[10.1111/j.1524-4725.2006.32254.x](https://doi.org/10.1111/j.1524-4725.2006.32254.x)
24. Hogan ME, vanderVaart S, Perampaladas K, Machado M, Einarson TR, Taddio A. Systematic review and meta-analysis of the effect of warming local anesthetics on injection pain. *Ann Emerg Med.* 2011;58(1):86-98.e1. doi:[10.1016/j.annemergmed.2010.12.001](https://doi.org/10.1016/j.annemergmed.2010.12.001)
25. Zilinsky I, Bar-Meir E, Zaslansky R, Mendes D, Winkler E, Orenstein A. Ten commandments for minimal pain during administration of local anesthetics. *J Drugs Dermatol.* 2005;4(2):212-216.
26. Ralte P, Selvan D, Morapudi S, Kumar G, Waseem M. Haemostasis in Open Carpal Tunnel Release: Tourniquet vs Local Anaesthetic and Adrenaline. *Open Orthop J.* 2010;4:234-236. doi:[10.2174/1874325001004010234](https://doi.org/10.2174/1874325001004010234)
27. Gunasagaran J, Sean ES, Shivdas S, Amir S, Ahmad TS. Perceived comfort during minor hand surgeries with wide awake local anaesthesia no tourniquet (WALANT) versus local anaesthesia (LA)/tourniquet. *J Orthop Surg (Hong Kong).* 2017;25(3):2309499017739499. doi:[10.1177/2309499017739499](https://doi.org/10.1177/2309499017739499)
28. Iqbal HJ, Doorgakant A, Rehmatullah NNT, Ramavath AL, Pidikiti P, Lipscombe S. Pain and outcomes of carpal tunnel release under local anaesthetic with or without a tourniquet: a randomized controlled trial. *J Hand Surg Eur Vol.* 2018;43(8):808-812. doi:[10.1177/1753193418778999](https://doi.org/10.1177/1753193418778999)
29. Ki Lee S, Gul Kim S, Sik Choy W. A randomized controlled trial of minor hand surgeries comparing wide awake local anesthesia no tourniquet and local anesthesia with tourniquet. *Orthop Traumatol Surg Res.* 2020;106(8):1645-1651. doi:[10.1016/j.otsr.2020.03.013](https://doi.org/10.1016/j.otsr.2020.03.013)
30. Ayhan E, Akaslan F. Patients' Perspective on Carpal Tunnel Release with WALANT or Intravenous Regional Anesthesia. *Plastic and Reconstructive Surgery.* 2020;145(5):1197. doi:[10.1097/PRS.0000000000006741](https://doi.org/10.1097/PRS.0000000000006741)
31. Tomaino MM, Ulizio D, Vogt MT. CARPAL TUNNEL RELEASE UNDER INTRAVENOUS REGIONAL OR LOCAL INFILTRATION ANAESTHESIA. *The Journal of Hand Surgery: British & European Volume.* 2001;26(1):67-68. doi:[10.1054/jhsb.2000.0426](https://doi.org/10.1054/jhsb.2000.0426)
32. Teo I, Lam W, Muthayya P, Steele K, Alexander S, Miller G. Patients' perspective of wide-awake hand surgery--100 consecutive cases. *J Hand Surg Eur Vol.* 2013;38(9):992-999. doi:[10.1177/1753193412475241](https://doi.org/10.1177/1753193412475241)
33. Ford B, Neumann D, Pina M, Olivieri-Ortiz R, Ferreira J, Parrino A. The Influence of Mental Health Diagnoses on Patient Experiences and Outcomes in Patients Undergoing WALANT Hand Surgery. *J Hand Surg Glob Online.* 2024;6(3):303-307. doi:[10.1016/j.jhsg.2023.12.012](https://doi.org/10.1016/j.jhsg.2023.12.012)
34. Townsend CB, Bravo D, Jones C, Matzon JL, Ilyas AM. Noise-Canceling Headphones and Music Decrease Intraoperative Patient Anxiety During Wide-Awake Hand Surgery: A Randomized Controlled Trial. *J Hand Surg Glob Online.* 2021;3(5):254-259. doi:[10.1016/j.jhsg.2021.05.008](https://doi.org/10.1016/j.jhsg.2021.05.008)
35. Hoxhallari E, Behr IJ, Bradshaw JS, et al. Virtual Reality Improves the Patient Experience during Wide-Awake Local Anesthesia No Tourniquet Hand Surgery: A Single-Blind, Randomized, Prospective Study. *Plast Reconstr Surg.* 2019;144(2):408-414. doi:[10.1097/PRS.0000000000005831](https://doi.org/10.1097/PRS.0000000000005831)
36. Miller A, Kim N, Ilyas AM. Prospective Evaluation of Opioid Consumption Following Hand Surgery Performed Wide Awake Versus With Sedation. *Hand (N Y).* 2017;12(6):606-609. doi:[10.1177/1558944716677536](https://doi.org/10.1177/1558944716677536)
37. Morris BJ, Mir HR. The opioid epidemic: impact on orthopaedic surgery. *J Am Acad Orthop Surg.* 2015;23(5):267-271. doi:[10.5435/JAAOS-D-14-00163](https://doi.org/10.5435/JAAOS-D-14-00163)
38. Chapman T, Kim N, Maltenfort M, Ilyas AM. Prospective Evaluation of Opioid Consumption Following Carpal Tunnel Release Surgery. *Hand (N Y).* 2017;12(1):39-42. doi:[10.1177/1558944716646765](https://doi.org/10.1177/1558944716646765)
39. Dar QA, Avoricani A, Rompala A, et al. WALANT Hand Surgery Does Not Require Postoperative Opioid Pain Management. *Plastic and Reconstructive Surgery.* 2021;148(1):121. doi:[10.1097/PRS.0000000000008053](https://doi.org/10.1097/PRS.0000000000008053)
40. Kim N, Matzon JL, Abboudi J, et al. A Prospective Evaluation of Opioid Utilization After Upper-Extremity Surgical Procedures: Identifying Consumption Patterns and Determining Prescribing Guidelines. *J Bone Joint Surg Am.* 2016;98(20):e89. doi:[10.2106/JBJS.15.00614](https://doi.org/10.2106/JBJS.15.00614)

41. Weinheimer K, Michelotti B, Silver J, Taylor K, Payatakes A. A Prospective, Randomized, Double-Blinded Controlled Trial Comparing Ibuprofen and Acetaminophen Versus Hydrocodone and Acetaminophen for Soft Tissue Hand Procedures. *J Hand Surg Am.* 2019;44(5):387-393. doi:[10.1016/j.jhsa.2018.10.014](https://doi.org/10.1016/j.jhsa.2018.10.014)
42. Ilyas AM, Miller AJ, Graham JG, Matzon JL. Pain Management After Carpal Tunnel Release Surgery: A Prospective Randomized Double-Blinded Trial Comparing Acetaminophen, Ibuprofen, and Oxycodone. *J Hand Surg Am.* 2018;43(10):913-919. doi:[10.1016/j.jhsa.2018.08.011](https://doi.org/10.1016/j.jhsa.2018.08.011)
43. Ilyas AM, Sundaram P, Plusch K, Kasper A, Jones CM. Multimodal Pain Management After Outpatient Orthopedic Hand Surgery: A Prospective Randomized Trial. *J Hand Surg Glob Online.* 2024;6(1):16-20. doi:[10.1016/j.jhsg.2023.07.021](https://doi.org/10.1016/j.jhsg.2023.07.021)
44. Tulipan JE, Kim N, Abboudi J, et al. Open Carpal Tunnel Release Outcomes: Performed Wide Awake versus with Sedation. *J Hand Microsurg.* 2017;9(2):74-79. doi:[10.1055/s-0037-1603200](https://doi.org/10.1055/s-0037-1603200)
45. Coddling 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. doi:[10.1177/1558944716669693](https://doi.org/10.1177/1558944716669693)
46. Leblanc MR, Lalonde J, Lalonde DH. A Detailed Cost and Efficiency Analysis of Performing Carpal Tunnel Surgery in the Main Operating Room versus the Ambulatory Setting in Canada. *Hand.* 2007;2(4):173-178. doi:[10.1007/s11552-007-9043-5](https://doi.org/10.1007/s11552-007-9043-5)
47. Leblanc MR, Lalonde DH, Thoma A, et al. Is main operating room sterility really necessary in carpal tunnel surgery? A multicenter prospective study of minor procedure room field sterility surgery. *Hand (N Y).* 2011;6(1):60-63. doi:[10.1007/s11552-010-9301-9](https://doi.org/10.1007/s11552-010-9301-9)
48. 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. doi:[10.1016/j.jhsa.2016.11.019](https://doi.org/10.1016/j.jhsa.2016.11.019)
49. Saleh E, Saleh J, Govshievich A, Ferland-Caron G, Lin JC, Tremblay DM. Comparing Minor Hand Procedures Performed with or without the Use of a Tourniquet: A Randomized Controlled Trial. *Plast Reconstr Surg Glob Open.* 2021;9(4):e3513. doi:[10.1097/GOX.0000000000003513](https://doi.org/10.1097/GOX.0000000000003513)
50. Olaiya OR, Alagabi AM, Mbuagbaw L, McRae MH. Carpal Tunnel Release without a Tourniquet: A Systematic Review and Meta-Analysis. *Plastic & Reconstructive Surgery.* 2020;145(3):737-744. doi:[10.1097/PRS.0000000000006549](https://doi.org/10.1097/PRS.0000000000006549)
51. Lalonde DH. Wide-awake flexor tendon repair. *Plast Reconstr Surg.* 2009;123(2):623-625. doi:[10.1097/PRS.0b013e318195664c](https://doi.org/10.1097/PRS.0b013e318195664c)
52. 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. doi:[10.1097/PRS.0b013e3181e60489](https://doi.org/10.1097/PRS.0b013e3181e60489)
53. 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. doi:[10.1016/j.hcl.2013.02.009](https://doi.org/10.1016/j.hcl.2013.02.009)
54. Duru Ç, Yaşar B, Ergani HM, Acicbe O, Utku Ö, Ünlü RE. Outcomes of Wide-Awake Flexor Tendon Repairs in 58 Fingers and 9 Thumbs. *J Hand Surg Am.* 2023;48(7):734.e1-734.e8. doi:[10.1016/j.jhsa.2022.01.015](https://doi.org/10.1016/j.jhsa.2022.01.015)
55. Levit T, Lavoie DCT, Dunn E, Gallo L, Thoma A. Trigger Finger Release Using Wide-Awake Local Anesthesia No Tourniquet Versus Local Anesthesia With a Tourniquet: A Systematic Review and Meta-analysis. *Hand (New York, N.Y.).* Published online January 20, 2024;15589447231222517. doi:[10.1177/15589447231222517](https://doi.org/10.1177/15589447231222517)
56. Rabinowitz J, Kelly T, Peterson A, Angermeier E, Kokko K. In-office wide-awake hand surgery versus traditional surgery in the operating room: a comparison of clinical outcomes and healthcare costs at an academic institution. *Current Orthopaedic Practice.* 2019;30(5):429. doi:[10.1097/BCO.0000000000000785](https://doi.org/10.1097/BCO.0000000000000785)
57. Gil JA, Hresko AM, Weiss APC. Current Concepts in the Management of Trigger Finger in Adults. *JAAOS - Journal of the American Academy of Orthopaedic Surgeons.* 2020;28(15):e642. doi:[10.5435/JAAOS-D-19-00614](https://doi.org/10.5435/JAAOS-D-19-00614)
58. Huang YC, Hsu CJ, Renn JH, et al. WALANT for distal radius fracture: open reduction with plating fixation via wide-awake local anesthesia with no tourniquet. *J Orthop Surg Res.* 2018;13(1):195. doi:[10.1186/s13018-018-0903-1](https://doi.org/10.1186/s13018-018-0903-1)
59. Rigney B, Casey C, McDonald C, Pomeroy E, Cleary MS. Distal radius fracture fixation using WALANT versus general and regional anesthesia: A systematic review and meta-analysis. *The Surgeon.* 2023;21(1):e13-e22. doi:[10.1016/j.surge.2022.01.006](https://doi.org/10.1016/j.surge.2022.01.006)
60. Gouveia K, Harbour E, Gazendam A, Bhandari M. Fixation of Distal Radius Fractures Under Wide-Awake Local Anesthesia: A Systematic Review. *Hand (N Y).* 2024;19(1):58-67. doi:[10.1177/15589447221109632](https://doi.org/10.1177/15589447221109632)

61. Gillis JA, Lalonde J, Alagar D, Azzi A, Lalonde DH. K-wire Fixation of Closed Hand Fractures Outside the Main Operating Room Does Not Increase Infections. *Plast Reconstr Surg Glob Open*. 2022;10(11):e4679. doi:[10.1097/GOX.0000000000004679](https://doi.org/10.1097/GOX.0000000000004679)
62. Gregory S, Lalonde DH, Fung Leung LT. Minimally invasive finger fracture management: wide-awake closed reduction, K-wire fixation, and early protected movement. *Hand Clin*. 2014;30(1):7-15. doi:[10.1016/j.hcl.2013.08.014](https://doi.org/10.1016/j.hcl.2013.08.014)
63. Feldman G, Orbach H, Rinat B, Rozen N, Rubin G. Internal fixation of metacarpal fractures using wide awake local anesthesia and no tourniquet. *Hand Surg Rehabil*. 2020;39(3):214-217. doi:[10.1016/j.hansur.2020.01.003](https://doi.org/10.1016/j.hansur.2020.01.003)
64. Ruterana P, Abitbol A, Castel LC, Gregory T. WALANT technique versus locoregional anesthesia in the surgical management of metacarpal and phalangeal fractures: Lessons from the Covid-19 crisis. *Hand Surg Rehabil*. 2022;41(2):220-225. doi:[10.1016/j.hansur.2021.12.002](https://doi.org/10.1016/j.hansur.2021.12.002)
65. Xing SG, Tang JB. Surgical treatment, hardware removal, and the wide-awake approach for metacarpal fractures. *Clin Plast Surg*. 2014;41(3):463-480. doi:[10.1016/j.cps.2014.03.005](https://doi.org/10.1016/j.cps.2014.03.005)
66. Nelson R, Higgins A, Conrad J, Bell M, Lalonde D. The Wide-Awake Approach to Dupuytren's Disease: Fasciectomy under Local Anesthetic with Epinephrine. *Hand (N Y)*. 2010;5(2):117-124. doi:[10.1007/s11552-009-9239-y](https://doi.org/10.1007/s11552-009-9239-y)
67. Denkler K. Dupuytren's fasciectomy in 60 consecutive digits using lidocaine with epinephrine and no tourniquet. *Plast Reconstr Surg*. 2005;115(3):802-810. doi:[10.1097/01.prs.0000152420.64842.b6](https://doi.org/10.1097/01.prs.0000152420.64842.b6)
68. Barone N, Lalonde DH, Brutus JP. Tips, Tricks, and Pearls for a Superior Patient and Surgeon Experience for Wide-awake Dupuytren Surgery. *Plast Reconstr Surg Glob Open*. 2024;12(2):e5570. doi:[10.1097/GOX.0000000000005570](https://doi.org/10.1097/GOX.0000000000005570)
69. How HM, Khoo BLJ, Ayeop MAS, Ahmad AR, Bahaudin N, Ahmad AA. Application of WALANT in Diaphyseal Plating of Forearm Fractures: An Observational Study. *J Hand Surg Glob Online*. 2022;4(6):399-407. doi:[10.1016/j.jhsg.2022.02.004](https://doi.org/10.1016/j.jhsg.2022.02.004)
70. Folberg CR, Alves JA de O, Pereira FMS, Pedrozo VB. WALANT Technique in Percutaneous Scaphoid Osteosynthesis. *Rev Bras Ortop (Sao Paulo)*. 2022;57(6):1070-1073. doi:[10.1055/s-0041-1726070](https://doi.org/10.1055/s-0041-1726070)
71. Liu B, Ng CY, Arshad MS, Edwards DS, Hayton MJ. Wide-Awake Wrist and Small Joints Arthroscopy of the Hand. *Hand Clin*. 2019;35(1):85-92. doi:[10.1016/j.hcl.2018.08.010](https://doi.org/10.1016/j.hcl.2018.08.010)
72. Sharma S, Ong J, Putti A. Proximal Interphalangeal Joint Arthroplasty Using the Wide-Awake Local Anesthesia No Tourniquet Technique. *Hand (N Y)*. 2023;18(4):612-615. doi:[10.1177/15589447211063545](https://doi.org/10.1177/15589447211063545)