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Original article

Wide -Awake Local Anesthesia No Tourniquet (WALANT) Procedure for Primary Repair of Traumatic Rupture of Flexor Tendon of the Hand: A Single Center Experience

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Abstract

Reconstruction of flexor tendons of the hand injuries is performed under general or regional anesthesia and tourniquet, in general. During the Covid-19 pandemic period the insufficiency of anesthesiologists created the need to find alternative methods of anesthesia with similar results of the existing ones. Wide awake, local anaesthetic, no-tourniquet technique (WALANT) started to be more popular, and based on the advantages (low cost, no tourniquet, no access of anaesthetic support, intraoperative collaboration to control active motion of flexor tendon reparation) gradually appeared to be a safe technique. Combination of lidocaine and adrenaline allows to ensure local anesthesia and at the same time vasoconstriction. The aim of this study is to estimate the evidence of effectiveness and secure of the WALANT technique in a case series from our hand reconstruction unit according to patient's satisfaction, complications, and functional outcomes. ***Material & Method:*** During the period from April 2021 to September 2022, 34 patients with traumatic lesion of flexor tendon of the hand were treated with tenorrhaphy under WALANT procedure. The flexor tendon zone of traumatic injury was I,II,III, and T1,T2,T3. All patients were operated within 24 hours from the injury and were able to be discharged on the same day. The majority of the operations were performed in a second operative theatre and all performed without anaesthetic support. ***Results:*** Overall, Visual Analogue Scores were 0/10, mean rate of patient's satisfaction was very satisfied in 82.3%, while mean Quick DASH score was 1.38. There were no cases with peri-postoperative complication during the WALANT technique. In all cases there was no need to administrate phentolamine as antidote to adrenaline vasoconstriction or other procedure of anesthesia. ***Conclusions:*** WALANT procedure is a safe method in which you can control pain and blood loss from the combination of lidocaine and adrenaline. The absence of tourniquet avoid the intra- postoperative discomfort of the patient, while intraoperative collaboration of the patient offers immediate restoration of active motion of flexor tendon and avoid postoperative complications from tenorrhaphy. Furthermore, patients satisfaction continues to exist high and rate of postoperative complication nonentity.

Keywords: ***WALANT, Wide - awake local anesthesia no tourniquet, flexor tendon injuries, hand injuries, complications flexor tendons.***

Introduction

The incidence of traumatic injury of flexor tendon of the hand varied from 7.0 to 41/100.000 person per year, with the proportion to be higher in men, inversely related to age [1,2]. According to etiology the most common cause is related to work and household injury followed by the road accidents [2]. Flexor tendons injuries have a great and considerable incidence of morbidity which in most of the time leads to poor functional outcomes and influences livelihoods [3]. Anatomically in the hand, motion of the flexion is activated by flexor pollicis longus (FPL) for the thumb and flexor digitorum superficialis (FDS) and flexor digitorum profundus (FDP) for the other digits. Thumb appears with two annular and one cruciate pulley with scope to avoid bowstringing of the tendon, while in other fingers, flexor tendons are environed by five annular pulleys to retain the tendons to the bone and three cruciate pulleys which permit flexion of the digits [4].

Therapy of flexor tendons injury, is the surgical finding of the two ends of tendon (in majority of cases the proximal end of tendon regresses into palm or carpal tunnel area) and sutured together. Two main factors presuppose this surgical procedure: anesthesia and tourniquet for a bloodless surgical field. In general, traumatic flexor tendons reparation is executed under general or regional anesthesia and intraoperative control of sutured tendon

(extension-flexion test) performed by surgeon [5]. Most of the times repair of flexor tendon may have a prolonged duration of time, especially if an extension of the incision is needed to recapture the proximal end of the tendon. In this situation general anesthesia is compulsory as tourniquet becomes intolerable after a mean of twenty minutes (varied from 19.4 to 24,1min) [6]. Bennett et al (1964) suggested that tourniquet tolerance is not equal painless, and an operation with short duration does not exclude non anesthetic arm's pain [7].

The COVID-19 pandemic period enforced an alteration according to functionality of the staff (anesthesiologist) and health facilities for the treatment of the affected patients with virus. This new situation inducted to hand surgeon to find alternative methods of anesthesia with similar results of the existing ones. Lalonde et al (2005) examinates the theory that injected adrenaline in the finger produced digital ischemia and necrosis in 3110 cases and concluded that the true incidence of finger infarction in elective low-dose epinephrine injection into the hand and finger is likely to be remoted, particularly with the possible rescue with phentolamine, and introduced the Wide-awake Local Anesthesia No Tourniquet (WALANT) [8,9].

Term Wide awake anesthesia is described as local injection of anesthetic agent(lidocaine) and epinephrine without other sedation and without tourniquet [10]. During pandemic period the WALANT procedure starting to be more popular in hand surgeons because is performed without anesthetic support and is accessed to general surgical theatre [11]. British Society for Hand Surgery during period of COVID -19 proposed the use of WALANT procedure [12]. Main advantage of the procedure is that the combination of lidocaine and adrenaline allows to ensure local anesthesia and at the same time hemostasis, ensures patients comfort convenience since there is not exist tourniquet. In addition, intraoperative collaboration of patient to execute flexion -extension test of involvement flexor tendon enables the surgeon to avoid complications of suturing (gapping, rupture) [13-15].

The aim of this research is to estimate the evidence of effectiveness and secure of the WALANT technique in a case series from our hand reconstruction unit who underwent primary repair of flexor tendon injuries of the hand according patient's satisfaction, complications, and functional outcomes.

Material & Methods

This study was performed at the Hand Reconstruction Unit of Orthopaedic department of General Hospital of Heraklion "Venizeleio-Pananeio" from April 2021 to July 2020. The Institutional Ethical Committee approved the study. Inclusion criteria were: I. age>20 years old, II. primary surgical repair of flexor tendon, III. surgical repair with only WALANT technique. Exclusion criteria were: I. age younger than 18 years old, II. patients who received regional or general anesthesia, III. polytrauma patients, IV. vascular hand injuries. Thirty-four patients (21 men and 13 female) with an average age of 39.5 years old (range from 23-54 yrs) underwent for primary repair of traumatic injury of flexor tendon of the hand. Main causes were industrial accidents (35,3%), agriculturally (29,4%) household (23,5%), and road accidents (11,8%). Distribution according to the digit affects, appear mostly in ring finger (35,3%) and the thumb (29,4%). Right hand was affected in 26 cases and left in 8 cases while dominant hand was involved in 26 cases. (Table I) Three cases presented with injury of flexor tendons of ring and small fingers and two cases with flexor tendons of middle and ring finger. According to classifications of Verdan, flexor injury in thumb were in zone T1 in 2(20%) cases, T2 in 6(60%) cases and T3 in 2(20%) cases. In last two cases, the proximal end of FPL was found in carpal tunnel area. Referring to the other digits the injury were in zone I in 4(16.7%) cases, zone II in 17(70,9%) cases and in zone III in three (12,4%) cases. In last cases distal end of FDP found over A1 pulley, while both FDS and FDP were ruptured in 13 cases. (Table II) Majority of patients were operated within 24-48 hours from the injury, and all were discharged on the same day three hours after operation. Operations in proportion of 79,4% were performed in the second operative theatre, 11,7% in emergency department and 8,9% in main operative theatre. All patients were operated from the author.

Table I: Demographic characteristics of patients

Gender (male/female)	**21/13(61,8%/38,2%)**
Mean Age	39,5(23-54)
Hand Involved (Right/Left)	26/8(76,5%/23,5%)
Hand Dominance (Right/Left)	21/5(80,8%/19,2%)
Cause	**Patients %**
Industrial accident	35.3%
Agriculturally Accident	29,4%
Household Accident	23,5%
Road Traffic Accident	11,8%

Table II: Distribution according to digit location and Zone of laceration be Verdan

Digit	Patients %	Zone by Verdan Number Pt/%		
Thumb	10(29,4%)	T1:2(20%)	T2:6(60%)	T3:2(20%)
Index	2(5,9%)	I:0	II: 2(8,4%)	
Middle	4(11,7%)	I:1(4,1%)	II:3(12,5%)	
Ring	12(35,3%)	I:2(8,4%)	II:8(33,3%)	III:2(8,4%)
Small Finger	6(17,7%)	I:1(4,1%)	II:4(16,6%)	III:1(4,1%)

Surgical Technique

We prepared an analgesic-hemostasis mixture of 10cc of premixed 1% lidocaine with 1:100.000 adrenaline and 1ml of bicarbonate sodium 8.4% according to Lalonde technique [9]. The first injection of 4cc was performed in the most proximal area of the dissection, and after 15 minutes we continue with the second injection of 2cc over subcutaneous fat between digital nerves in metacarpal-phalangeal joint. Third injection of 2cc was over proximal phalange - phalangeal joint and the last of 2cc over distal phalange. (Fig1(a)-(b)-(c)-(d)) After a mean of 20 minutes from the first injection the patient is pain free, the surgical field is bloodless and performed the process of finding the two ends of flexor tendon from the initial skin trauma and sutured them. Except in three cases with ruptures of the FPL (T1 zone) and FDP (I zone) which we repaired with pull- out Bunnell technique, in other cases we performed four strand cruciate

technique as core suture with prolene 4.0 and epitendinous repair with 6.0 running suture around the cut tendon ends. After suturing the tendon, we asked from the patient to execute the flexion-extension test (active range of motion) and we controlled eventual gap between the tendon end, or trigger of the tendon in pulley. We closed the skin, and we applied an extension block (half plaster of Paris cast) with the wrist in 20˚-30˚ palmar flexion, metacarpophalangeal joint in flexion and interphalangeal joints in extension. After perioperative intravenous administration of cephalosporin and an analgesic we checked the circulation status of the finger and three hours after operation the patient discharged from hospital. Postoperatively the patients were able to perform active range of motion (extension flexion) of the involved finger and to follow the rehabilitation protocol which included passive flexion-extension as tendon gliding exercises and active flexion-extension of all digits in pain-free range initially. Patients were trained to follow a home-based exercise program to enhance full functional recovery.

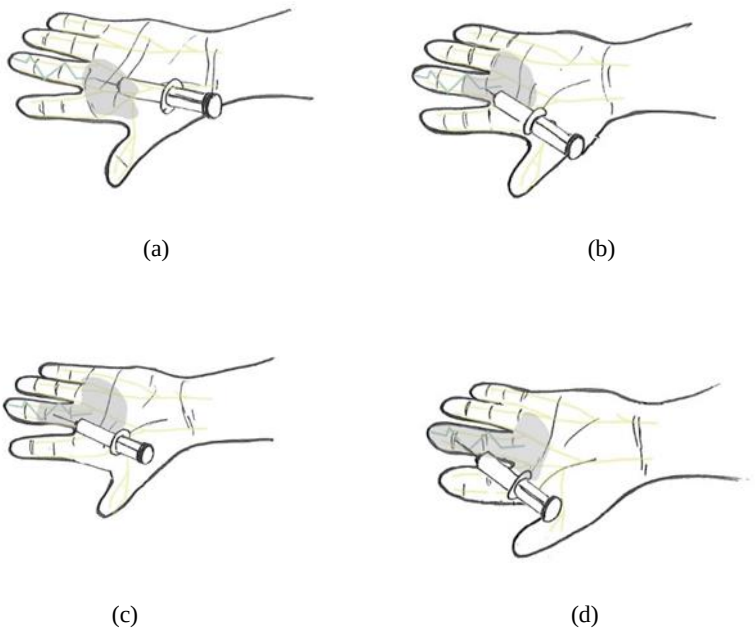

Figure 1: Started from the proximal area of grey line (incision line) of the injury finger first injection (a) of the mixture (10cc of premixed 1% lidocaine with 1:100.000 adrenaline and 1ml of bicarbonate sodium 8,4%). Fifteen minutes after the first injection we continued with second injection with 2cc over subcutaneous fat between digital nerve in MCP joint (b). Third injection is over PIP joint(c) while the last 2cc of mixture over distal phalanx (d). Artist's rendition of schematic presentation of injections area at the palmar surface of the hand.(Compliments of Kastani Evangelia).

Results

Results based on patients̀ satisfaction (Patient satisfaction rating scale), complication, and functional outcomes (Quick Dash Score) [17]. All cases were examined at a follow up of two, four and twelve weeks postoperatively. According to complications we distinguished them in two categories: first category of complications concerned the type of anesthesia (pain, change method of anesthesia), bleeding and second category of complications concerned suturing method (tendon ruptures, adhesions required tenolysis) or from trauma (infection). From the first category of complications all the patients underwent WALANT procedure, and no patients required additional other anaesthetic method to control pain. Nine cases were anxious about WALANT procedure, and mean VAS score 24 hours after operation was 1.2, while final Visual Analogue Score were 0/10 in 27 patients and in 7 cases minor to 4/10 at two weeks. Regarding bleeding at the surgical field only in four cases we used electrocautery but there was no need of application of tourniquet in all cases. Measuring the quantitative assessment of bleeding (used the net weight of blood with the gauze) the amount of blood loss was 1.30 ±1.1 grams). The mean time to perform surgery was 15.12± 8.32 min while the average surgical time was 43.4 min (range from 28- 62 min). In all the cases they no need to administrate phentolamine as antidote to adrenaline vasoconstriction.

From the second category of complications, we didn't have any wound complication and at final control (twelve weeks postoperatively) we didn't have any rerupture of the flexor tendons and only three cases (one thump, one small finger and one index) presented adhesions. In cases of thumb and index we decided to continue physiotherapy program and at six months the range of motion was unsatisfactory for daily and worked activities. In case of small finger, we suggested tenolysis, but the patient was satisfied from the functional result.

Intra-operatively in seven cases after core suture procedure and during active range of motion we discovered a gap in tendon ends and we revised the suture procedure, while in three cases we found a trigger of FDS in A2 pulley and in two cases trigger of FDP in A4 pulley from the sutures. In these cases, we performed partial sheathotomies impairment the functionality of pulleys. All patients were discharged in the same day.

The Quick dash score was used to assess the retrieval status of patients after the surgical repaired of flexor tendons of the hand and for the control final outcomes. At the final follow up the main score was 1.38(varied from 0.0- 6.8). The majority of the patients were capable to perform the previous daily and worker activities without pain or restriction. Based on the results we concluded that when patients followed prescribed control postoperative rehabilitation program, the use of involved fingers and the risk of reruptures or adhesions of flexor tendon were diminished to zero.

Finally, all patients' response to major question referred to the satisfaction rating scale with five elements (very satisfied, satisfied, neutral, unsatisfied, very unsatisfied) from the WALANT procedure. From thirty-four patients twenty-eight were very

satisfied (82.3%), and six satisfied (17.7%). We didn't have any patient to respond that Wide-awake Local Anesthesia No Tourniquet procedure is unsatisfied.

Discussion

Despite the progress in various surgical techniques the flexor tendon injuries of the hand remain a difficult problem and a challenge from the side of the surgeon, but from the patient too, due to unsatisfactory postoperative functional results. Poor functional outcomes usually affect subjects of working age which increases the percentage of morbidity and incapacity of the hand after these injuries [3]. In hand surgery, two main factors presuppose this surgical procedure: tourniquet with scope to create a bloodless surgical field to perform a surgery under magnification and anesthesia (general or brachial block) to eliminate the discomfort of tourniquet application [14].

Hutchinson et al(1993) in a comparative study between arm and forearm tourniquet, concluded that the tolerance of arm tourniquet were less tolerable compared with forearm, and respective maximum tolerance of forearm tourniquet varied from 13 to 25 minutes [17,18]. Extension of tourniquet application(250mmHg) use after 20 minutes present discomfort from patient, pain at tourniquet area, ulnar nerve distribution paresthesia, numbness in median nerve distribution and finally complete paralysis occurred 7 minutes later in forearm tourniquet [18,20]. Prolonged application of tourniquet leads to transient neurological deficit [23].

Old theory that epinephrine must be not injected into fingers because it causes finger ischemia and necrosis (vasoconstriction effect) was reported between 1920-1940, and 48 cases have been reported in literature, but local anesthesia was performed with procaine [21]. Denker (2001) suggested that combination of lidocaine with epinephrine is safe in the digits without risk of digital necrosis while Lalonde et al (2005) reported his experience using local anesthesia and epinephrine and reported the advantage (save anesthetic method, saving time and cost of surgery, enhanced quality of surgery) of the wide-awake approach and also suggested the efficacy of the local anesthetic method in hand surgery [8,22]. Chowdhry et al(2010) referred that the main advantages of epinephrine are prolonging duration of anesthetic agent and temporary hemostasis. With this benefit of the epinephrine (hemostasis), hand surgery can be executed without application of tourniquet devise.

Lalonde (2009) introduced Wide -awake local anesthesia no tourniquet (WALANT) procedure and described that term: Tumescent means the injection of large enough volumes of dilute local anesthetic solution containing epinephrine so that all tissues to be dissected are slightly firm to the touch [9]. Additional suggesting the areas of injection, volume and contains of mixture anesthetic for flexor tendons repair, also introduced the active flexion of flexor tendons repair by the patients as a part of surgical technique with scope to decrease the risk of rerupture and to avoid the trigger in the sheath of tendons [9]. This technique offers patient's convenience to eliminate pain from tourniquet and decrease the risk associated with general anesthesia [10,15,24]. The contraindications of the procedure are considered in small children, polytrauma patients, and in individual mentally challenged [9].

Comparative reports presented in literature between Wide-awake local anesthesia no tourniquet versus local anesthesia for minor hand operations (Carpal tunnel syndrome, Trigger finger, De Quervain's) support that WALANT is an alternative anesthetic technique that, provides better comfort for the patient, decreased pain during surgical procedure, creates bloodless surgical field, provides patient safety and efficacious anesthesia [14,15].

WALANT procedure was not initially accepted by hand surgeons until the pandemic period of COVID-19, with the lack of anesthesiologists to cover other areas of health, brought back to the fore and the good outcomes from its application began to be published slowly [12,25,26]. Sutcliffe et al(2022) reported that in pandemic Covid -19 period British Society for Hand Surgery encourage and suggest the use of WALANT technique and propose that the use of respective procedure of anesthesia for hand surgery injury should continue and increase beyond the current pandemic based the advantages which offers.12 Rutereana et al(2022) reported that during Covid-19 period WALANT was a safe and effective anesthetic method in hand surgery and must be included in surgical training with scope to optimize day to day operative care and confrontation future crises, while Alves et al(2012) suggested that with WALANT technique the post-surgical hospitalization time is shorter generating greater benefits to patients' health and in future hand surgery service must be able to perform this anesthetic procedure, in their daily surgery routine, due to its benefits [25,26].

Advantages of the procedure have been described in many reports in literature and include patient safety and comfort because of the lack of tourniquet so there are no risks for potential nerve damage and pain from limb ischemia [27]. Patients are not required to preoperative examination, fasting before procedures, and halting of their medications [28]. There is also a decrease of the risks of monitored anesthesia care especially in older or overweight patients with comorbidities [29]. Moreover hand operation is not needed to be implemented to the main operative theatre, the support staff is no needed and there is reduced equipment use (decreased sterile equipment needs or equipment for alternative general/regional anaesthesia), resulting in the diminution of the cost of interventions and the saving of health system resources [10,30,31,33]. Intraoperative collaboration between patient and surgeon and intraoperative active range of motion, evaluated the function of flexor repair (tendon repair gapping or sheaths triggering) and the decreased rate of postoperative flexor ruptures or adhensions [3,9,13,27]. In our case series the intraoperative active range of motion help us to diagnose the gap in core suture and to revise the procedure while in cases with triggering in A2, A4 pulley the partial sheathotomies restore the range of finger motion. Finally postoperative recovery time is optimized to avoid the complications which accompany general anesthesia or regional block, and postoperative anesthesia care unit is not needed [27,32].

Conclusion

The final purpose of flexor tendon reconstruction, are optimized functional outcomes with decreased risk of complications (adhesions, tendon gapping and postoperative ruptures). Wide-awake local anesthesia no tourniquet technique offer numerous advantages compared to other anesthetic techniques. The main technical advantage is intraoperative control of repair of flexion tendon during active range of motion from patient which decreases the rate of postoperative rupture or tenolysis. Based on the reported advantages, we concluded that WALANT anesthesia offers many positive benefits in relation to traditional anesthetic techniques.

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Conflict of interest

The authors declare that they had no conflict of interest.

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References

[1] Manninen M, Karjalainen T, J Määttä, Flinkkilä T. Epidemiology of flexor tendon injuries of the hand in a

Northern Finnish Population. Scand J Surg. 2017,106(3):278-282. doi:10.1177/1457496916665544.
[2] Clayton RA, Court-Brown CM. The epidemiology of musculoskeletal tendinous and ligamentous injuries. Injury. 2008;39(12):1338–44. doi: 10.1016/j.injury.2008.06.021.
[3] Nolan GS, Kiely AL, Madura T, Karantana A. Wide-awake local anaesthesia no tourniquet (WALANT) versus regional or general anaesthesia for flexor tendon repair in adults: protocol for a systematic review and meta-analysis. BMC, 2020,9(1):264, doi:10.1186/s13643-020-01532-1.
[4] Maw J, Wong KY, Gillespie P. Hand Anatomy. Br J Hosp Med (Lond) 2016;77(3):C34-3, C38-40, doi:10.12968/hmed.2016.77.3.C34.
[5] Fulchignoni C, Bonetti MA, Rovere G, Ziranu A, Maccauro G, Pataia E. Wide awake surgery for flexor tendon primary repair: A literature review. Orthop Rev (Pavia) 2020,25(Suppl 1):8668, doi:10.4081/or.2020.8668.
[6] Tanpowpong T, Kitidumrongsook P, Patradul A. The deleterious effects of exsanguination with a tight bandage on tourniquet tolerance in the upper arm. J Hand Surg Eur Vol 2012; 37(9): 839-41, doi:10.1177/1753193412442288.
[7] Bennett JE, Mohler L. Arm tourniquet tolerance in unanesthetized adults. Surg Forum 1964; 15: 463-5.
[8] Lalonde DH, 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):1061–7, doi: 10.1016/j.jhsa. 2005.05.006.
[9] Lalonde DH. Wide-awake flexor tendon repair. Plast Reconstr Surg 2009; 123(2):623-5. doi: 10.1097/PRS.0b013e318195664c.
[10] 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): 312-6, doi:10.5999/aps.2014.41.4.312.
[11] Hobday D, Welman T, O'Neill N, Pahal GS. A protocol for wide awake local anesthetic no tourniquet (WALANT) hand surgery in the context of coronavirus disease 2019(COVID-19) pandemic. Surgeon 2020,18(6):e67-e71, doi:10.1016/j.surge.2020-06.015.
[12] Sutcliffe A, Khera B, Khashaba H. Wide awake local anesthesia no tourniquet (WALANT) procedures during COVID: a single center experience. Acta Biomed. 2022;93(1): e2022013, doi:10.23750/abm.v93i1.12134.
[13] Higgins A, Lalonde D, Bell M, McKee D, Lalonde JH. Avoiding flexor tendon repair rupture with intraoperative total active movement examination. Plast Reconstr Surg 2010; 126(3): 941-945. doi:10.1097/PRS. 0b013e 3181e60489.
[14] Gunasagaran J, Sean E, Shivdas S, Amir S, Ahmad T. Perceived comfort during minor hand surgeries with wide awake local anaesthesia no tourniquet (WALANT) versus local anaesthesia (LA)/tourniquet. Journal Orthopaedic Surgery (Hong Kong) 2017; 2593):1-4 30949. doi: 10.1177/2309499017739499.
[15] Ruxasagulwong S, Kraisarin J, Sananpanich K. Wide awake technique versus local anesthesia with tourniquet application for minor orthopedic hand surgery: a prospective clinical trial. J Med Assoc Thai. 2015,98(1);106-10.
[16] Kleinert HE, Verdan C. Report of the committee on tendon injuries (International Federation of Society for Surgery of the Hand). J Hand Surg Am 1983;8(5Pt2):794-8, doi:10.1016/s0363-5023(83)80275-5.
[17] McKinley RK. Manku-Scott T, Hastings AM, French DP, Baker R. Reliability, and validity of a mew measure of patient's satisfaction with out of hours primary medical care in the United Kingdom: Development of a patient's questionnaire. BMJ,1997;314(7075):193-198, doi:10.1136/bmj.314.7075.193.
[18] Hutchinson DT and McClinton MA. Upper extremity tourniquet tolerance. J Hand Surg 1993; 18(2): 206–210, doi:10.1016/0363-5023(93)90347-6.
[19] Maury A and Roy W. A prospective, randomized, controlled trial of forearm versus upper arm tourniquet tolerance. J Hand Surg Br, 2002; 27(4): 359–360, doi:10.1054/jhsb.2002.0787.
[20] Edwards SA, Harper GD, Giddins GE. Efficacy of forearm versus upper arm tourniquet for local anaesthetic surgery of the hand. J. Hand Surg Br, 2000;25(6):573-4, doi:10.1054/jhsb.2000.0420.
[21] 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):443-7, doi: 10.5435/JAAOS-21-08-443.
[22] Denkler KA: A comprehensive review of epinephrine in the finger: To do or not to do. Plast Reconstr Surg 2001;108(1):114-124, doi:10.1097/00006534-200107000-00017.
[23] Flatt AE. Tourniquet time in hand surgery. Arch Surg 1972; 104(2): 190–192, doi:10.1001/archsurg.1972.04180020070013.
[24] 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): 2031-4, doi:10.1097/RPS.0b013e3181f44486.
[25] Alves RS, Corsoni DAP, Fernandes PHO, Sasaki SU, Zaia IM, Dos Santos SB, Sato MA. Benefits of the walant technique against the Covid-19 pandemic. Acta Orthop Bras, 2021;29(5):274-276, doi:10.1590/1413-785220212905244505.
[26] Rutereana P, Abitbol A, Castel L-C, Gregory T. WALANT technique versus locoregional anesthesia in the surgical management of the metacarpal and phalangeal fractures: Lessons from the Covid-19 crisis. Hand Surg Rehab. 2022;41(2):220-225, doi: 10.1016/j.hansur.2012.12.002.
[27] Kurtzman JS, Etcheson LI, Koehler SM. Wide – awake local anesthesia with no tourniquet: an updated review. Plast Reconstruct Surg Glob Open, 20121;26(9):e357, doi:10.1097/GOX.0000000000003507.
[28] 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– 147, doi:10.1016/j.jhsa.2016.11.019.
[29] Li G, Warner M, Lang BH, Huang L, Sun LS. Epidemiology of anesthesia related mortality in the United States, 1999–2005. Anesthesiology.2009;110(4):759–765, doi:10.1097/aln. 0b013e31819b5bdc.
[30] 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, doi:10.1177/1558944716669693.
[31] 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 (N Y). 2007;2(4):173–178, doi:10.1007/s11552-007-9043-5.

[32] Hustedt J, Chung A, Bohl D, Olmschied N, Edwards S. Comparison of Postoperative Complications Associated with Anesthetic Choice for Surgery of the Hand. Journal Hand Surgery 2017; 42(1): 1-8. doi: 10.1016/j.jhsa.2016.10.007.

[33] Caggiano N, Avery D, Matullo K. The effect of anesthesia type on nonsurgical operating room time. Journal Hand Surgery 2015; 40(6): 1202-1209. doi 10.1016/j.jhsa.2015.01.037