Is Wide-Awake Local Anesthesia No Tourniquet Technique in Distal Radius Plating Surgery a Comfortable Procedure? A Prospective Case-Control Study

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Abstract

Background: Wide-awake local anesthesia no tourniquet (WALANT) is a promising technique for bony procedure in recent years. During distal radius surgery via WALANT technique, surgeons may concern about intraoperative pain. This prospective case-control study was aimed to compare the intraoperative hemodynamic changes between WALANT technique and general anesthesia (GA) in patients undergoing distal radius plating surgery.

Methods: We recruited 40 adults with distal radius fracture underwent plating using the WALANT technique (group A) or general anesthesia (group B). Each group comprised 20 patients with similar demographics. Mean arterial pressure (MAP) and heart rate were recorded in both groups. Intraoperative pain intensity was measured by numeric rating scale (NRS) for pain in group A.

Results: The NRS decreased significantly compared with preoperative status in group A for most of the intraoperative period. The intraoperative MAP in group A showed no significant change among each peri-operatively period. In addition, group A showed less peri-operative MAP fluctuation than group B ($p < 0.05$). The intraoperative changes in HR showed significant changes between group A and B during reduction, plating and skin closure. The reduction and plating quality were similar between each group.

Conclusions: Patients undergoing distal radius plating surgery via WALANT technique has a lower MAP changes. Distal radius plating surgery using the WALANT technique is a well-tolerated surgical procedure and showing the similar reduction and plating quality to through GA.

Introduction

Wide-awake local anesthesia no tourniquet (WALANT) is a promising technique for performing various hand surgeries^{1 2}. This technique employs a large amount of local anesthetic with epinephrine over the surgical site. Under the haemostatic effect of epinephrine, a relatively bloodless surgical field can be created without the use of a tourniquet. Because of the nature of tumescent local anesthesia, local anesthetic injections around the nerve are unnecessary and increase the risk of nerve injury³. WALANT offers technical simplicity, and the whole procedure can be performed by a surgeon without the use of sedation. In recent few years, the WALANT technique has been employed for bony procedures, such as open reduction plating for distal radius fracture⁴⁻⁷, olecranon fracture⁸, and ankle fracture⁹. Because of no major complications, previous studies^{6,8} have concluded that WALANT is a safe and simple option for patients with a high-grade anesthesia or sedation risk.

Concerning intraoperative pain during WALANT distal radius plating surgery, surgeons still hesitated in adopting this technique in bony procedure, such as distal radius plating surgery. However, no study provided the intraoperative data of subjective and objective outcomes of patient receiving distal radius plating surgery through WALANT technique.

Our primary outcome was the patient's mean arterial pressure (MAP) and heart rate (HR), and the secondary outcome was intraoperative numeric rating scale for pain (NRS) when using the WALANT technique. We also compared the quality of plating perioperatively in each group. The objective physical response to pain appeared on changes in the changes in MAP and HR¹⁰. We hypothesised that changes in MAP and HR may be smaller in WALANT group. The aim of the study was to testify that WALANT technique, comparing with GA, in patients undergoing distal radius plating surgery may be a well-tolerated procedure.

Methods

From January 2019 to February 2020, forty adults with DRF undergoing open reduction and plating surgery at a standard operation theater of a university-affiliated hospital were recruited. This prospective observational study was approved by the Institutional Review Board of Kaohsiung Medical University Hospital (KMUHIRB-F(I)-20180116). The mean age of the patient was 61 ± 14 years old. Eleven patients had diabetes mellitus, 13 patients had hypertension, three patients had history of cerebral vascular accident, two patients had chronic kidney disease and one patient had chronic heart failure, and two patients had evidence of vascular calcification in wrist and hand vessels. Regarding the anesthetic risk of the included patients, 25 patients were classified as American Society of Anesthesiologists physical status (ASA) 2, 14 patients were classified as ASA 3, and one patient was classified as ASA 4. Patients with multiple injuries, an open fracture, or a pathological fracture were excluded. The indication for undergoing WALANT or general GA depended on the patients' preference. Patients in group A underwent surgery using the WALANT technique, and all surgical procedures and administration of local anesthetics were performed by the same surgeon.

In group A (WALANT), 1% lidocaine with 1:100,000 epinephrine was used. Patients' forearms were placed in a supine position. Local anesthetic injection began with employing the Henry approach to make an incision at the proximal end with a 26-G needle. After 2–3 mL had been injected into the subcutaneous fat, the 26-G needle was exchanged with a 22-G long needle, and the local anesthetic was slowly injected along the volar incision wound from the same entry point. Typically, 15 mL is enough to cover all the volar surface of the subcutaneous area for Henry approach incisions. A 24 G needle was then used through the pronator quadratus and touched the volar surface of the radius; 10 mL of local anesthetic was injected into the fracture site and along the distal radius volar periosteum. Patients pronated their forearm, and 10 mL of local anesthetic was injected along the dorsal periosteum. Finally, 2–3 mL was injected over the radial styloid to prepare for preliminary K-wire fixation. The local anesthetic injection procedure generally took 5–10 minutes to perform. We prepped after the injection of local anesthetic. Surgery was performed 20 minutes after local anesthetic injection, once the haemostatic effect of epinephrine was observed.

In group B (GA), patients underwent surgery using GA with ultrasound-guided brachial plexus block (BPB) at the supraclavicular level. GA was induced with 1 mcg/kg fentanyl and 2 mg/kg propofol and maintained with 2–4% sevoflurane. The anesthesiologist identified the ultrasound image of brachial

plexus at the supraclavicular level. Under real-time ultrasound guidance, the anesthesiologist performed supraclavicular block with 25 mL of 0.25% bupivacaine. Thereafter, a tourniquet was applied to the patient's upper arm. After exsanguinating the forearm blood with an Esmach bandage, the tourniquet was set up at 250 mmHg and the surgery for DRF was performed.

GA was induced by two experienced anesthesiologists, and the surgical procedure was performed by three surgeons. All surgeons performing the surgical procedures were classified as having level 3 expertise¹¹. Different volar locking plates (ACU-LOC plate, ACUMED, LLC., USA; Anatomic Volar Plate System, Depuy Synthes, Johnson & Johnson Co., USA; Distal R.A.F. Locking plate, APLUS Co., Taiwan) were used for internal fixation in all cases. A standard volar approach was used to expose the fractured side. The fracture was approached from the radial side of the flexor carpi radialis, and the quadratus pronator muscle was incised to reduce the fracture.

In group A, MAP, HR, and NRS were measured by nursing staff in the operation theatre seven times perioperatively, namely before surgery (T0) and at the time of injection of local anesthesia (T1), skin incision (T2), fracture reduction (T3), plating and screwing (T4), skin closure (T5), surgery completion (T6). In group B, the anesthesia team continuously monitored patients' intraoperative physiological status. MAP and HR in group B were marked after induction (T1) and at the other six same time points as in group A.

We recorded the operative time of each group, from skin incision to wound closure. The blood loss was recorded in each group. In GA group, the blood loss was recorded after wound closure and before tourniquet deflation. The radiographic parameters to examine the preoperative and postoperative quality of reduction and plating including radial height, radial inclination, volar tilt, ulnar variance and articular step-offs were compared between each group. Anesthesia-related (and surgery-related) risk within 30 days of surgery was also recorded.

The data in this study were examined by an independent operator using descriptive statistics. Continuous variables were expressed as the mean and standard deviation, and categorical variables were expressed as the total number of events. Fisher's exact test was used to analyse the categorical data. After assessing normal distribution, repeated measures ANOVA were used for comparing MAP and HR within and between treatment groups, and the means of absolute changes in MAP and HR among treatment groups. Paired t-tests were used to compare radial inclination, radial height, and ulnar variance. Depending on the nonnormal distribution, the Wilcoxon signed-rank test was used for comparing NRS from T1 to T6 and T0. The Mann-Whitney U test was used to compare the articular step-offs. A two-tailed $p < 0.05$ or an adjusted p-value (false discovery rate) < 0.05 after accounting for multiple testing was considered statistically significant.

Results

The demographic information, comorbidity, DRF pattern, surgical time, and amount of blood loss are presented in Table 1. The intraoperative NRS score in group A demonstrated a statistically significant decrease from T0 to T2, T4, T5, and T6 ($p < 0.05$). However, there was no significant difference between T0 versus T1 (2.30 ± 2.43 versus 1.90 ± 2.38 , $p = 0.514$) and T0 versus T3 (2.30 ± 2.43 versus 1.80 ± 2.35 , $p = 0.567$) (Table 2).

Table 1
Demographic data

	WALANT	GA	<i>p</i> -value
Patient number	20	20	
Age (year)	62.2 (13.5)	59.9 (14.6)	0.718
Sex			
Male	3	6	0.256
Female	17	14	
ASA physical status			
2	12	13	0.595
3	7	7	
4	1	0	
Comorbidity			
Diabetes Mellitus	6	5	0.723
Hypertension	5	8	0.311
Cerebral vascular accident	1	2	0.548
Chronic kidney disease	0	2	0.147
Chronic heart failure	1	0	0.311
Forearm and wrist vascular calcification	1	1	1.000
Fracture classification			
AO 2R3A	14	11	0.606
AO 2R3B	3	5	
AO 2R3C	3	4	
Blood loss (ml)	14.2 (13.1)	6.6 (5.9)	0.008
Operation time (minute)	57.8 (16.4)	63.8 (20.6)	0.512
Complication			
Infection	0	0	-
Neuropraxia	0	0	-

WALANT, wide-awake local anaesthesia no tourniquet; GA, general anaesthesia; ASA, American Society of Anesthesiologists' classification

	WALANT	GA	<i>p</i> -value
Compartment syndrome	0	0	-
Perioperative cardiovascular event	0	0	-
Hand vascular compromise event	1	0	0.331
WALANT, wide-awake local anaesthesia no tourniquet; GA, general anaesthesia; ASA, American Society of Anesthesiologists' classification			

Table 2
Perioperative absolute change in mean arterial pressure and heart rate

	WALANT		GA		<i>p</i> -value
	Mean	SD	Mean	SD	
ΔMAP					
T1	7.80	6.14	20.58	13.87	0.002
T2	8.42	6.40	25.37	18.94	< 0.001
T3	9.28	6.70	22.87	19.01	0.001
T4	9.95	8.85	23.83	13.70	0.001
T5	9.10	7.85	25.12	16.37	< 0.001
T6	9.13	8.36	25.77	18.62	< 0.001
ΔHR					
T1	4.80	6.88	7.45	8.50	0.256
T2	7.65	7.45	10.35	7.07	0.247
T3	8.40	8.19	13.55	7.16	0.029
T4	8.30	7.13	14.65	8.50	0.007
T5	8.10	6.91	13.30	7.64	0.027
T6	8.30	5.66	12.90	7.28	0.050
WALANT, wide-awake local anaesthesia no tourniquet; GA, general anaesthesia; SD, standard deviation; ΔMAP, absolute change in mean arterial pressure; ΔHR, absolute change in heart rate					

The perioperative MAP and HR are displayed in Fig. 1. The preoperative MAP and HR exhibited no statistically significant differences between the groups. The absolute change of MAP in group A was

significantly lower than that in group B at all time points relative to T0 (all $p < 0.05$). Group A demonstrated no significant differences in the absolute changes of HR from T0 with 4.80 ± 6.88 beats per minute (bpm) at T1 ($p = 0.256$) and 7.65 ± 7.45 bpm at T2 ($p = 0.247$). However, group A exhibited statistical significant difference of absolute changes in HR from T0, to 8.40 ± 8.19 bpm at T3 ($p = 0.029$), 8.30 ± 7.13 bpm at T4 ($p = 0.007$), 8.10 ± 6.91 bpm at T5, ($p = 0.027$) and 8.30 ± 5.66 bpm at T6 ($p = 0.050$) (Table 3).

Table 3
Perioperative numeric rating scale

	Mean	SD	<i>p</i> -value
T0	2.30	2.43	
T1	1.90	2.38	0.514
T2	0.60	0.88	0.011
T3	1.80	2.35	0.567
T4	0.85	1.18	0.033
T5	0.40	0.75	0.003
T6	0.40	0.75	0.003
SD, standard deviation			

The MAP showed no statistically significant difference ($p = 0.068$) among group. A but statistically significant difference among group B ($p < 0.001$). Further analyses with post-hoc pairwise comparisons, the MAP among group A showed no significant difference at T0 than that at T1 to T6. However, the MAP among group B showed significant greater at T0 than that at T1 to T6 (Appendix).

The reduction and plating quality were similar between each group in preoperative and postoperative radiograph (Table 4). There were no perioperative cardiovascular events or postoperative events of infection, neuropraxia, or compartment syndrome. A transient bluish appearance distal to the inject area was frequently noted in Group A. It may be the result of a mechanical block of venous return by tumescent local anesthetic. However, a 39-year-old woman had histories of psoriasis vulgaris and cold sensitivity in the hands. No vascular calcification was noted in her hand and wrist vessels. After the injections of local anesthetic, a transient vascular compromise event occurred. However, no permanent complications were noted during follow-up.¹²

Table 4

Radiologic measurements comparing the WALANT group to GA group preoperative and postoperative values

	Preoperatively				Postoperatively			
	WALANT	GA	p-value	adjusted p-value	WALANT	GA	p-value	adjusted p-value
RI (degree)	20.78 (5.11)	17.04 (7.20)	0.840 ^a	0.983	23.06 (3.40)	19.88 (4.49)	0.023 ^a	0.092
UV (degree)	3.53 (2.08)	2.54 (3.48)	0.314 ^a	0.785	0.58 (1.73)	-0.42 (2.27)	0.153 ^a	0.306
RH (mm)	8.46 (2.45)	8.38 (3.70)	0.940 ^a	0.983	10.47 (1.56)	10.14 (2.61)	0.649 ^a	0.649
ASO (mm)	0.38 (0.73)	0.29 (0.52)	0.983 ^b	0.983	0 (0)	0.05 (0.23)	0.344 ^b	0.459
VT (degree)	-11.96 (18.42)	-5.98 (15.38)	0.296 ^a	0.785	7.38 (6.03)	4.81 (6.33)	0.221 ^a	0.368
RI, radial inclination; UV, ulnar variance; RH, radial height; ASO, articular step-off; VT, volar tilt; a: paired t-test; b: the Mann–Whitney U test								

Discussion

WALANT is a promising approach that hand surgeons can adopt to perform different types of soft tissue and bony procedures. Relevant studies^{5 6} have reported its safety as well as favourable postoperative outcomes when used for open reduction and plating for DRF. The results of our study indicate that relatively stable intraoperative physiological status was noted in patients undergoing surgery using WALANT than those undergoing GA.

Pain is an unpleasant sensory and emotional experience associated with actual and potential tissue damage. The NRS was the most frequently used method to describe pain severity. NRS ranges from “0” representing no pain to “10” representing the worst pain imaginable. An objective pathophysiological response to nociceptive stimuli, which also called nociception. Lots of commercial monitoring has been proposed and analgesia nociception index (ANI) is one of the parameter based on the high frequency component of heart rate variability¹³. In addition, changes in ANI parallel the changes in HR and MAP¹⁰. Because the ANI monitor is not available everywhere, we could indirectly testify the patient’s nociception level by the changes in MAP and HR.

When we injected local anesthetic in a broken forearm, administration of 40 mL of local anesthetic around the wrist led to patient discomfort due to wrist swelling. We informed all patients the bulging is normal and should not be painful. Some patients could tolerate this effect, but others could not. However, patients always felt bulging relief after skin incision. The NRS at T1 was not significantly different from

that at T0 in WALANT group and the MAP between T0 and T1 showed no significant difference. The significant drop in mean MAP from T0 to T1 using GA obviously caused by the pharmacological effect of anesthetics. Since the blood loss in both groups was small, we could attribute the better intraoperative haemodynamic control to fewer systemic effect of the local anesthetic and less physical response to noxious stimuli.

The timepoint that may have frightened patients was the reduction period. The technique that surgeons adopted to perform this step smoothly was to provide adequate hematoma block (i.e. appropriate amount of local anesthetic) to the fracture site to infiltrate the periosteum surrounding the dorsal and volar cortex. We always inserted the needle radial to flexor carpi radialis to prevent injury to the median nerve. Patients occasionally felt uncomfortable during the reduction, as indicated by the insignificant reduction in NRS. However, the absolute change in MAP was significantly lower than that observed when applying with GA. In addition, no statistically significant difference among WALANT group. We hypothesised that this subjective discomfort was not a real painful sensation and the small hemodynamic variability indicated little stimulation of patients' sympathetic tone in a minor surgery with small blood loss.

Despite the amount of intraoperative blood loss being higher in the WALANT group than in the GA group (14.15 mL vs. 6.55 mL, $p = 0.008$), we considered that the total amount of blood loss might be similar or lower in the WALANT group. This difference might be caused by the amount of blood loss was calculated before deflation of the pneumatic tourniquet. It was difficult to calculate the total amount of blood loss postoperatively because most of the patients in the WALANT group were from outpatient surgery departments. Under the local haemostatic effect of epinephrine, the amount of blood loss was very limited and did not interfere with the surgical procedure. Without the use of a tourniquet, we could feel and see the pulsation of the radial artery, which enabled us to coagulate some small vessels more confidently by using WALANT.

There were several limitations in our study. First, although there were 20 patients in each group, which is sufficient according to a previous study ¹⁴, this was still a small sample size. Second, this was a nonrandomised control prospective observational study. Some selection bias might exist; however, most of the patient preoperative demographics, including fracture pattern, demonstrated no significant differences between two groups. Finally, every anesthesiologist had personal preferences regarding the mode of administration (inhaled and intravenous) of anesthetics for GA and the quality of ultrasound-guided BPB might vary among anesthesiologists.

Conclusion

Patients undergoing distal radius plating surgery via WALANT technique showed stable intraoperative haemodynamic status, low intraoperative pain intensity and low nociception. Distal radius plating surgery using the WALANT technique is a well-tolerated surgical procedure. WALANT could be an alternative when general anesthesia was high-risk or unavailable.

Abbreviations

ANI: Analgesia Nociception Index

ASA: American Society of Anesthesiologists physical status

BPB: Brachial plexus block

GA: General anesthesia

HR: Heart rate

MAP: Mean arterial pressure

NRS: Numeric rating scale for pain

WALANT: Wide-awake local anesthesia no tourniquet

Declarations

Ethics approval and consent to participate

This prospective observational study was approved by the Institutional Review Board of Kaohsiung Medical University Hospital (KMUHIRB-F(I)-20180116).

Consent for publication

Not applicable

Availability of data and materials

The datasets used/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Authors' contributions

Each author is expected to have made substantial contributions to the conception. WCL and ICL designed of the work; CCC and CLS made the acquisition, analysis, CLS made the data interpretation; CKL and WCL have drafted the work or YCF and JBJ substantively revised it

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Figures

Figure 1

Graphs showing the perioperative changes in mean arterial pressure (MAP) and heart rate (HR). (A) Preoperative MAP (T0) exhibited no statistically significant differences between the wide-awake local anesthesia no tourniquet (WALANT) group and general anesthesia (GA) group. MAP in the GA group dropped after the induction of anesthesia. (B) The preoperative HR showed no statistically significant differences between the two groups. HR exhibited a mild increase in the WALANT group and a greater decrease in the GA group. * indicates $p < 0.05$.

Supplementary Files

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