Wide-Awake Local Anesthesia No Tourniquet (WALANT) versus Regional Anesthesia with Tourniquet for Hand Flexor Tendon Repair Surgeries in Adults

Original Article

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ABSTRACT

Background: A considerable percentage of ER admissions which necessitates operative intervention are related to hand injuries specially flexor tendons. Operations on flexor tendon required perfect bloodless surgical field which can be achieved through using tourniquet under different anesthesia strategy; general anesthesia, Intravenous regional anesthesia brachial plexus block…. etc. Local anesthesia technique through Wide-Awake Local Anesthesia No Tourniquet (WALANT) technique is also an alternative where patient kept awake which allow intraoperative assessment of repaired tendon & hemostasis provided by using adrenaline in the injected local anesthesia mixture.

This study was designed to compare the use of WALANT versus supraclavicular brachial plexus block for flexor tendons repair regarding the intraoperative pain scores, induction time, operating time, blood loss, postoperative pain scores, and patient satisfaction

Materials and Methods: 52 patients enrolled for hand flexor tendon repair were randomly divided into one of two groups (26 in each) either to receive WALANT or SC-BPB with tourniquet.

Results: Intraoperative Wong-Baker Faces scale results for pain assessment were comparable in both groups, except during injection (p = 0.04) was higher in SC-BPB, while tourniquet-related pain was reported in 23% of patients of SC-BPB group (p =0.001).

Induction time was significantly shorter in WALANT (p <0.01), time needed to obtain sufficient hemostasis was significantly longer in WALANT than SC-BPB (p <0.01) while surgical time was comparable in both groups (p = 0.538). higher blood loss was found in WALANT (p <0.01). Patients expressed higher level of satisfaction with WALANT technique (*P value* 0.032) & their wish to have same type of anesthesia if to undergo similar procedure in the future.

Conclusion: WALANT anesthesia was found to be a good alternative to SC-BPB in flexor tendon repair surgeries in adults being technically simple, low cost & efficient technique. BPB still an acceptable technique specially when considerable blood loss is expected like when bone structure involved, or deep aggressive dissection is needed.

Key Words: Flexor tendon repair, hand surgeries, supraclavicular brachial plexus block, tourniquet, WALANT.

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INTRODUCTION

Reports from USA & other countries showing a considerable incidence of hand injuries specially that involves flexor tendons. Although there are no similar statistics in Egypt, the daily practice in emergency theaters showed similar high percentage of such injuries which necessitates surgical repair[1,2].

A bloodless surgical field is essential requirement to conduct hand surgery especially under magnification. The use of arm tourniquet is the traditional tool to achieve sufficient hemostasis while using different anesthetic techniques for example, Intravenous Regional Anesthesia (IVRA), general Anesthetic (GA) or brachial plexus block (BPB)[3].

During COVID-19 pandemic, there was a great need to minimize the use of general anesthesia whenever possible due to risk of infection at time of intubation & limitation of resources so, reconsidering reginal & local techniques specially those requiring lower level of equipment & training has become an inevitable necessity[4].

Currently, the Enhanced Recovery After Surgery (ERAS) approach gaining increasing popularity with

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increasing interest in suitable anesthesia techniques that help faster postoperative hospital discharge & reducing health care related costs[5].

Different anesthesia techniques can be used for fast track orthopedic procedures, for example, total intravenous regional anesthesia which carry problem of tourniquet-associated pain[6], brachial plexus block which is a good choice needs special training, skills & availability of ultrasound machine which is not always available specially in low economic setup[7]. A simple & easily mastered Wide Awake Local Anesthesia with No Tourniquet (WALANT) technique in which mixture of lidocaine and epinephrine is injected for local anesthesia and vasoconstriction respectively, has been increasingly used for hand surgeries in which the patient who is operated on is fully awake[8].

WALANT technique can be used for various hand surgeries; flexor tendon repair, tendon transfers, finger fractures, nerve sutures, …… etc. Epinephrine used with local anesthetics to achieve adequate hemostasis & blood-less surgical field is an important part in this technique without tourniquet. The concerns about safety of peripherally injected epinephrine were assessed in different studies with its safety & efficacy being reported[9].

WALANT technique carried several advantages, being simple, easily learned technique with no special equipment, no tourniquet or sedation is needed[10], avoiding general anesthesia & exposure during airway management (the concern during COVID epidemic), lower cost & intra-operative testing of the repair with active range of motion[11].

Comparing WALANT with other regional techniques as intravenous anesthesia (IVRA), Infraclavicular brachial plexus block (IC-BPB), ……. etc., from different perspectives (fast tracking, cost, efficacy, post-operative pain control,.……etc., was studied in different settings[12,13].

PATIENTS AND METHODS

This prospective randomized study was conducted in orthopedic operating theaters, Ain Shams University Hospitals, Cairo, Egypt, over a period of six months (March to sept., 2022) aiming to compare Wide Awake Local Anesthesia No Tourniquet (WALANT) anesthesia technique to Supra-Clavicular Brachial Plexus Block (SC-BPB) with tourniquet for hand flexor tendons repair.

Patients scheduled for hand flexor tendons repair procedures were recruited if they were over 18 years old & belonging to ASA physical status I or II. patients were excluded if they have compromised peripheral circulation, previous vascular injury, vasculitis, Buerger's disease, scleroderma, evidence of infection at injection site, ischemic heart disease, psychiatric illness, patients with concomitant injuries that needed further operative procedure under general anesthesia or spinal anesthesia and patient with documented hypersensitivity to local anesthetics.

Sample size was calculated based on results of previous studies[3,12], using PASS 11 program for sample size calculation setting power at 80%, alpha error at 5%, and based on their findings and after 10% adjustment for dropout rate a sample size of minimum of 50 patients (25 patients per group) was needed.

After approval of research ethical committee (Faculty of Medicine, Ain-Shams University Research Ethical Committee), fifty-two patients who were fulfilled the inclusion criteria & provided informed written consent of participation after full explanation of the procedure, possible side effects and complications were randomzed by their medical record number (MRN) using "Research Randomizer" (https://www.randomizer.org) which is a closed-source, randomization web service, into one of two groups: WALANT group & ultrasound guided supraclavicular brachial plexus block with tourniquet group.

Patients subjected to the usual preoperative assessment (history, examination & lab investigations).

Intraoperatively, intravenous access was obtained, Antibiotic was given before skin incision as per hospital policy. Standard Monitor was connected in the form of pulse oximetry to measure oxygen saturation (SPO2), baseline non-invasive blood pressure (NIBP) and electrocardiogram (ECG) to measure heart rate (HR) and intravenous fluid (Ringer lactate) was given.

WALANT group: (n=26): patients were submitted to WALANT technique. Doses and method described by Lalonde and Wong[14], 25 ml of lidocaine 2% containing 500 mg which is considered safe for 70 kg patient (as the maximum safe dose of lidocaine with epinephrine 7mg/kg[15] was added to: 19.5 ml normal saline, 0.5 ml of adrenaline (1mg/mL) and 5 ml of 8.4% of sodium bicarbonate to buffer the solution to decrease pain of infiltration and potentiate analgesic effect[16].

Anesthesia mixture of 50 ml (containing 10 mg/ml Lidocaine and epinephrine 1:100,000 conc.) is infiltrated as follow: Infiltration of 15 ml or more per ray (150 mg lidocaine) by 27G needle: 10 ml (or more) in the palm, then 2 ml in the proximal and middle phalanges and 1ml in the distal phalanx (if required).

The maximum needed dose for operating upon 3 fingers was 45 ml (containing 450 mg lidocaine with epinephrine ≈ 6.4 mg/kg for adult weighting 70 kg).

At the end of the injection, there was at least 1 cm of adrenalized skin (pale with palpable local anesthesia) beyond all borders of incision and dissection sites. Incision started at least 15 min. after injection to reach the maximum vasoconstriction/hemostatic effect.

SC-BPB group: (n=26): Patients were enrolled for Ultrasound-Guided Supraclavicular block described by

Chan and Kusre[17,18].15 mL of lidocaine 2% and 15 mL of bupivacaine 0.5% were injected incrementally over 3–5 min. A pneumatic tourniquet was applied on the upper arm with a pressure up to 230 mmHg throughout the procedure. With maximum of 2 hours duration. If the surgery lasted more than 2 hours, tourniquet was deflated for 5 minutes then re-inflated.

All procedures included in this study were performed by same surgical team & anesthesia managements (WALANT & SC-BPB) were provided by same anesthesia team.

The perceived comfort during surgery was quantified and recorded using Wong-Baker Faces pain rating scale which is a valid self-report tool of pain intensity that uses combination of faces, numbers & words providing multiple ways to express pain level[19]. It starts at 0 (no pain) & ends in 10 (it hurts the worst). It was assessed intraoperatively before the anesthetic injection (baseline) (T0), during injections (T1), during the incision (T2), during gentle manipulation (T3), during aggressive manipulation (T4) and during wound closure (T5). In SC-BPPB group, patients were asked to quantify pain in the tourniquet site just before deflation (TT)[20,21].

The amount of blood loss was calculated based upon the number and degree of soaking of swabs used in the operation and the amount in a suction container in the operation room.

The operative time which is time from skin incision till the last suture was recorded.

Post-operative pain in both groups was assessed using numeric pain rating scale (NRS) which is 11-point scale, where 0 indicates no pain and 10 indicates the worst imaginable pain. NRS assessed by blinded investigator at 2, 4, 6, 8, 10, 12 postoperative hours[22,23,24].

The time of 1st call for postoperative analgesia was recorded, patients received 25 mg pethidine IV if the NRS pain exceeds 3 the dose was repeated upon patient's demand with 2 hours minimal time interval between doses. Total analgesic dose that required in the 1st twelve hours postoperatively was recorded.

Patient's satisfaction was measured and recorded using five-point Likert scale[25] (1 = very dissatisfied, 2 = dissatisfied, 3 = neutral, 4 = satisfied, and 5 = very satisfied) with checklist and a closed-ended question "If you were to undergo this surgery again, would you choose the same type of anesthesia? YES or NO " .

End point: 12 hours post- operative.

Data collection

Demographic data (age, weight, physical status), anesthesia induction time, opedrative time, blood loss, intra-operative pain scores, preserved motor power post-operative, first time to call for analgesia in post-operative time, total dose of consumed pethidine for analgesia pain scores and patient satisfaction level.

Statistical Analysis

All data recoded, tabulated, and introduced to a PC using statistical package for social sciences (IBM SPSS 20 for windows). Data will be presented as follow:

1. Descriptive Statistics: mean, Standard deviation (+ SD) and range for parametric numerical data and frequency and percentage of non-numerical data.

2. Analytical Statistics: Independent sample t-test was used to assess the statistical significance of the difference of a parametric variable between two independent means of two study groups, Chi square test was used to examine the relationship between two qualitative variables but when the expected count is less than 5 in more than 20% of the cells; Fisher's Exact Test was used when the expected numbers are small and the confidence interval was set to 95% and the margin of error accepted was set to 5%.

P-value

Level of significance: $P < 0.05$: Significant (S), *P-value* <0.001 was considered as highly significant and *P-value* >0.05 was considered insignificant.

Study outcomes

- Primary: intraoperative pain score
- Secondary: anesthesia induction time, operative time, intraoperative motor power, blood loss, postoperative pain scores and patients' satisfaction.

RESULTS

We compared anesthesia induction time, time to get anesthetic effect to stat surgical incision, time needed till to get adequate hemostasis, intraoperative pain scores, operative procedure time, blood loss, preserved motor power, postoperative pain scores, first time to call for post-operative analgesia, total dose of pethidine consumed for post-operative analgesia and patients' satisfaction in both groups.

Demographic data (age, sex, weight, BMI, ASA status, number of repaired tendons) were comparable in both groups (Table 1)

The anesthesia induction time (time needed to conduct anesthesia block), The mean anesthesia induction time was significantly shorter for WALANT than that needed to perform SC-BPB (Table 2). Longer time was needed to obtain anesthetic and hemostatic effects sufficient to start incision in WALANT group than SC-BPB. (Table 2)

Motor power was preserved in all patients in WALANT group while it was lost in all SC-BPB. (Table 2)

Blood loss despite being minimal, it was significantly higher in WALANT group than the tourniquet group, but that minimal amount of blood did not hinder the surgical procedure with comparable mean surgical time in both groups for almost the same number of tendons. (Table 2).

An inverse relation was detected between time elapse from last injection of anesthetic mixture in WALANT group & amount of blood loss, the more time elapsed the lesser the blood amount lost. (Table 3) But there wasn't such a correlation between the same variables in SC-BPB group as illustrated in (Table 4, Figure 1).

Intraoperative pain score was comparable in both groups except during anesthetic injection (T1) pain scores was significantly higher in the group receiving SC-BPB than the patients of WALANT group (*P- value* = 0.04). Also, just before deflation (TT) was only recorded in some patients of SC-BPB which is considered a highly significant difference (*P- value* = 0.001). (Table 5), (Figure 2) This tourniquet pain was tolerable (maximum pain score of 4) & was just felt before time of tourniquet deflation so, no supplementary pain management was used apart from patient reassurance.

Post-operative pain score was comparable in both groups in the first 6 hours, then the pain perceived was significantly higher in SC-BPB group when measured 8,10 and 12 hours post operatively, P-value 0.004, 0.006 and 0.013 respectively. (Table 6), (Figure 3) Also, the first time to ask for analgesia was comparable in both groups but there was a significant difference in the total doses of pethidine needed to alleviate pain in the 1st twelve hours postoperatively being significantly higher in SC-BPB group than WALANT group (*P-value* < 0.01). (Table 7), (Figures 4,5)

In terms of patient satisfaction, patients who received WALANT was significantly more satisfied than those who received SC-BPB when level of satisfaction assessed using Likert scale (*P-value* = 0.032). Also, more patients who received WALANT would choose the same type of anesthesia if they were to undergo this surgery again, than those who received SC-BPB, with a significant difference (*P-value* = 0.025).

Table (1) shows that the demographic data of both groups was comparable as there was no statistically significant difference between WALANT and SC-BPB group regarding mean age, sex, ASA, weight, BMI, and number of tendons repaired.

Table (2) shows that the statistical analysis of the procedural data revealing that the mean time needed to perform WALANT is significantly shorter than that needed to perform SC-BPB, while the time needed to obtain anesthetic and hemostatic effect sufficient to start incision is significantly longer in WALANT group than SC-BPB.

Motor power was preserved in all WALANT patients studied and lost in all patients of SC-BPB group.

Blood loss despite being minimal, it was significantly higher in WALANT group than the tourniquet group, but that minimal amount of blood did not hinder the surgical procedure with comparable mean surgical time in both groups for almost the same number of tendons.

Table (3) shows that there was an inverse correlation between time passed after the last injection to the first incision and the amount of blood lost in patients received WALANT, the more time elapsed the lesser the blood amount lost. But there wasn't such a correlation between the same variables in SC-BPB group as illustrated in Table (4).

Table (4) shows that there was no correlation between time passed after the last injection to the first incision and the amount of blood lost in patients received SC=BPBB.

Table (5) Shows that the intraoperative pain score was comparable in both groups except during injection (T1) pain scores was significantly higher in the group receiving SCBPB than the patients of WALANT group (*P- value* = 0.04). Also pain at tourniquet site just before deflation (TT) was only recorded in some patients of SC-BPB which is considered a highly significant difference (*P- value* = 0.001).

Table (6) shows that there was no significant difference in the post-operative pain score in both groups in the first 6 hours, then the pain perceived was significantly higher in SC-BPB group when measured 8,10 and 12 hours post operatively, *P-value* 0.004, 0.006 and 0.013 respectively.

Table (7) shows that, the First time to ask for analgesia was comparable in both groups but there was a significant difference in the total doses of pethidine needed to alleviate pain in the 1st twelve hours postoperatively being significantly higher in SC-BPB group than WALANT group (*P-value* < 0.01).

In terms of patient satisfaction, patients who received WALANT was significantly more satisfied than those who received SC-BPB when level of satisfaction assessed using Likert scale (*P-value* = 0.032). Also, more patients who received WALANT would choose the same type of anesthesia If they were to undergo this surgery again, than those who received SC-BPB, with a significant difference (*P-value* = 0.025).

Table 1: Demographic data in both groups.

No.= 26		WALANT group No.= 26	SC-BPB group	Test value	*P-value*	Sig.
Age (years)	Mean ± SD	28.11 ± 7.03	31.51 ± 8.93	-1.528*	0.133	NS
	Range	19 – 53	18 – 63			
Sex	Female	12 (46.2%)	13 (50.0%)	0.077*	0.781	NS
	Male	14 (53.8%)	13 (50.0%)			
ASA	I	18 (69.2%)	17 (65.4%)	0.087*	0.768	NS
	II	8 (30.8%)	9 (34.6%)			
Weight (kg)	Mean ± SD	77.42 ± 8.33	77.04 ± 6.46	0.186•	0.853	NS
	Range	66 – 95	66 – 92			
BMI Weight/(Hight)^2	Mean ± SD	23.77 ± 2.35	24.38 ± 2.42	-0.930•	0.357	NS
	Range	18 – 28	19 – 31			
Number of tendons repaired	1	7 (26.9%)	7 (26.9%)	2.632*	0.268	NS
	2	12 (46.2%)	7 (26.9%)			
	3	7 (26.9%)	12 (46.2%)			

p -value > 0.05: Nonsignificant; *p -value* < 0.05: Significant; *p -value* < 0.01: Highly significant *: Chi-square test; •: Independent t-test

Table 2: Comparison between WALANT group and SC-BPB group regarding procedural data.

No.= 26		WALANT group No.= 26	SC-BPB group	Test value	*P- value*	Sig.
Anesthesia induction Time (min)	Mean ± SD	10.73 ± 1.8	16.5 ± 2.1	-10.626	.000	HS
	Range	9 – 16	13 – 21			
Duration of surgery (min)	Mean ± SD	71.74 ± 13.21	69.50 ± 15.87	0.553•	0.583	NS
	Range	47 – 99	37 – 89			
Preserved motor power	No	0 (0.0%)	26 (100.0%)	52.000*	0.000	HS
	Yes	26 (100.0%)	0 (0.0%)			
Time from last injection to skin incision (min)	Mean ± SD	18.12 ± 3.89	12.50 ± 3.24	5.654•	0.000	HS
	Range	15 – 27	8 – 19			
Blood Loss (ml)	Median (IQR)	12.5 (5 – 15)	0 (0 – 5)			
	Mean ± SD	12.5 ± 6.04	2.88 ± 3.51	-5.210≠	0.000	HS
	Range	5 – 25	0 – 10			

p -value > 0.05: Non significant; *p -value* < 0.05: Significant; *p -value* < 0.01: Highly significant *: Chi-square test; •: Independent t-test; ≠: Mann-Whitney test

Table 3: Correlation between time from last injection to skin incision and amount of blood lost in WALANT group.

WALANT group	Time from last injection to skin incision	
	r	*P-value*
Blood Loss ml	-0.808**	0.000

P-value > 0.05: Nonsignificant; *P-value* < 0.05: Significant; *P-value* < 0.01: Highly significant r Spearman correlation coefficient

Table 4: Correlation between time from last injection to skin incision and amount of blood lost in SC-BPB group.

SC-BPB group	Time from last injection to skin incision	
	r	*P-value*
Blood Loss ml	0.084	0.685

p -value > 0.05: Nonsignificant; *p -value* < 0.05: Significant; *p -value* < 0.01: Highly significant r Spearman correlation coefficient

Table 5: Comparison between WALANT group and SC-BPB group regarding the perceived comfort during surgery that was quantified using Wong-Baker Faces pain rating scale intraoperatively.

Wong-Baker Faces pain rating scale No.= 26		WALANT group No.= 26	SC-BPB group	Test value≠	P- value	Sig.
T0	Mean ± SD	0.23 ± 0.65	0.31 ± 0.74	-0.402	0.687	NS
	Median (IQR)	0 (0 – 0)	0 (0 – 0)			
	Range	0 – 2	0 – 2			
T1	Mean ± SD	0.69 ± 1.12	1.46 ± 1.45	-2.056	0.040	S
	Median (IQR)	0 (0 – 2)	2 (0 – 2)			
	Range	0 – 4	0 – 4			
T2	Mean ± SD	0.00 ± 0.00	0.00 ± 0.00	0.000	1.000	NS
	Median (IQR)	0 (0 – 0)	0 (0 – 0)			
	Range	0 – 0	0 – 0			
T3	Mean ± SD	0.00 ± 0.00	0.00 ± 0.00	0.000	1.000	NS
	Median (IQR)	0 (0 – 0)	0 (0 – 0)			
	Range	0 – 0	0 – 0			
T4	Mean ± SD	0.54 ± 0.90	0.15 ± 0.54	-1.815	0.070	NS
	Median (IQR)	0 (0 – 2)	0 (0 – 0)			
	Range	0 – 2	0 – 2			
T5	Mean ± SD	0.08 ± 0.39	0.15 ± 0.54	-0.589	0.556	NS
	Median (IQR)	0 (0 – 0)	0 (0 – 0)			
	Range	0 – 2	0 – 2			
TT	Median (IQR)	0 (0 – 0)	0 (0 – 2)	-3.261	0.001	HS
	Range	0 – 0	0 – 4			

p -value > 0.05: Non significant; *p -value* < 0.05: Significant; *p -value* < 0.01: Highly significant ≠: Mann-Whitney test. Time before the injection (baseline) (T0), during injections (T1), during the incision (T2), during gentle manipulation (T3), during aggressive manipulation (T4) and during wound closure (T5), pain in the tourniquet site just before deflation (TT).

Table 6: Comparison between WALANT group and SC-BPB group regarding post-operative pain score using Numeric Rating Scale for pain (NRS pain) recorded every 2 hours.

Post-Operative NRS No.= 26		WALANT group No.= 26	SC-BPB group	Test value≠	*P- value*	Sig.
2 hrs. post op.	Mean ± SD	0.19 ± 0.40	0.12 ± 0.33	-0.761	0.446	NS
	Median (IQR)	0 (0 – 0)	0 (0 – 0)			
	Range	0 – 1	0 – 1			
4 hrs. post op.	Mean ± SD	0.46 ± 0.81	0.69 ± 0.84	-1.274	0.203	NS
	Median (IQR)	0 (0 – 1)	0.5 (0 – 1)			
	Range	0 – 3	0 – 3			
6 hrs. post op.	Mean ± SD	2.42 ± 0.86	3 ± 1.06	-1.834	0.067	NS
	Median (IQR)	2 (2 – 3)	3 (2 – 4)			
	Range	1 – 4	2 – 5			
8 hrs. post op.	Mean ± SD	3.31 ± 1.12	4.27 ± 1.25	-2.844	0.004	HS
	Median (IQR)	3 (3 – 4)	4 (3 – 5)			
	Range	2 – 7	2 – 7			
10 hrs. post op.	Mean ± SD	3.88 ± 1.28	4.85 ± 1.12	-2.768	0.006	HS
	Median (IQR)	4 (3 – 5)	5 (4 – 6)			
	Range	2 – 7	3 – 7			
12 hrs. post op.	Mean ± SD	3.85 ± 1.16	4.69 ± 1.12	-2.484	0.013	S
	Median (IQR)	4 (3 – 5)	5 (4 – 5)			
	Range	2 – 6	2 – 7			

p -value > 0.05: Non significant; *p -value* < 0.05: Significant; *p -value* < 0.01: Highly significant ≠: Mann-Whitney test

Table 7: Comparison between WALANT group and SC-BPB group regards post-operative analgesia and patient's satisfaction.

No.= 26		WALANT group No.= 26	SC-BPB group	Test value	*P- value*	Sig.
First time to ask for analgesia (hrs.)	Mean ± SD	7.50 ± 1.45	6.96 ± 1.31	1.405•	0.166	NS
	Range	4 – 10	5 – 10			
Total dose Pethidine given (mg) in 12 hours post op.	Mean ± SD	40.38 ± 18.81	59.62 ± 17.43	-3.824•	0.000	HS
	Range	25 – 100	25 – 100			
Level of patient's satisfaction using Likert scale	Mean ± SD	3.65 ± 0.94	3.12 ± 0.82	2.211•	0.032	S
	Range	2 – 5	2 – 5			
Closed-ended question "If you were to undergo this surgery again, would you choose the same type of anesthesia? YES or NO "	No	3 (11.5%)	10 (38.5%)	5.026*	0.025	S
	Yes	23 (88.5%)	16 (61.5%)			

P-value > 0.05: Non significant;*P-value* < 0.05: Significant; *P-value* < 0.01: Highly significant *: Chi-square test; •: Independent t-test

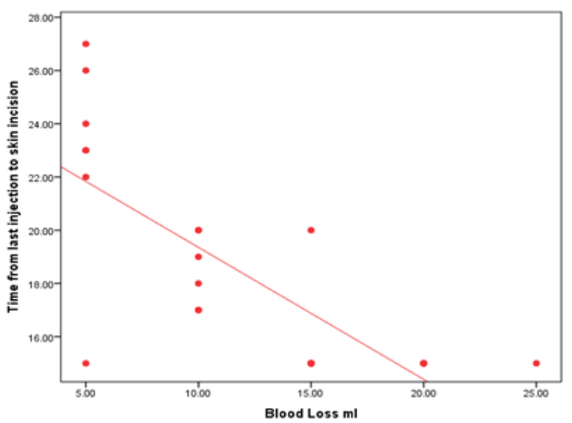

Fig. 1: Graphic representation of the relation between time from last injection to skin incision and amount of blood lost in WALANT group

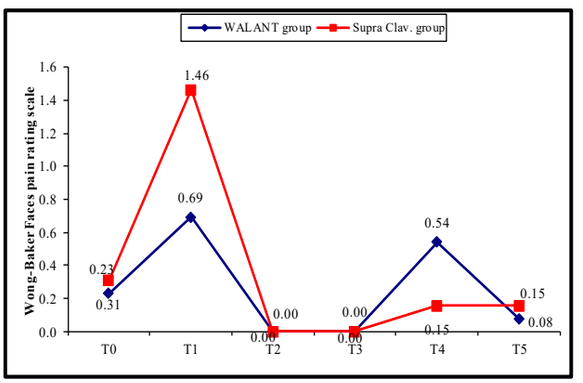

Fig. 2: Comparison between WALANT and SC-BPB group regarding the intraoperative pain score before the injection (baseline) (T0), during injections (T1), during the incision (T2), during gentle manipulation (T3), during aggressive manipulation (T4) and during wound closure (T5)

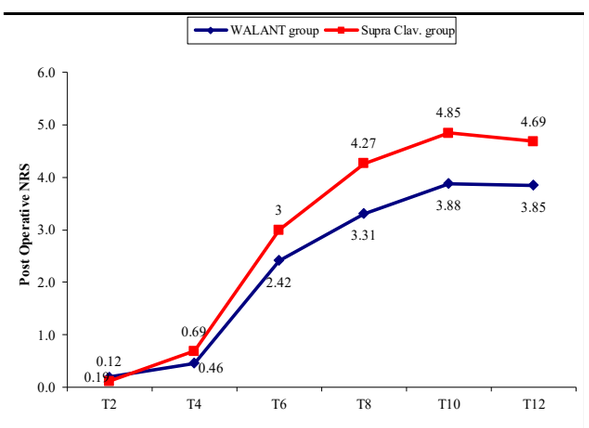

Fig. 3: Graphic representation of the post-operative pain score recorded in WALANT and SC-BPB groups using Numeric Rating Scale for pain (NRS pain) recorded every 2 hours

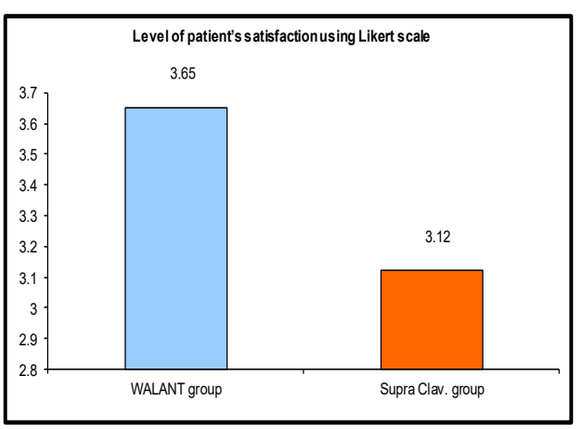

Fig. 4: Comparison between WALANT group and SC-BPB group regards level of patient satisfaction assessed using Likert scale

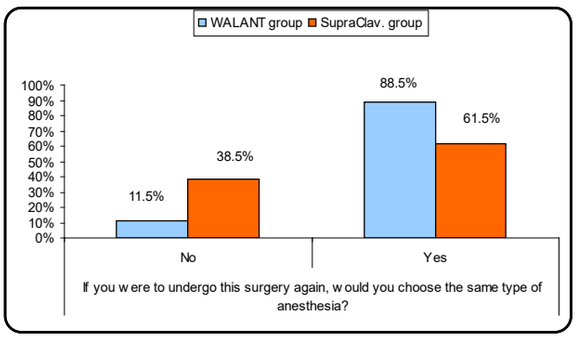

Fig. 5: Comparison between WALANT group and SC-BPB group regards tolerability to the same anesthetic technique

DISCUSSION

This study was designed to investigate the most suitable regional anesthetic technique for surgical procedures involving flexor tendons of the hand in adults which is considered one of the frequent surgical interventions in our hospitals, comparing the use of WALANT technique with the standard anesthetic technique which is BPB (Brachial Plexus Block). Supraclavicular approach was chosen for BPB in our study.

Flexor tendons repair surgeries can be performed under BPB both supra & infra-clavicular approaches with similar performance time, procedural-related pain scores, and success rates. BPB have been shown to be efficient anesthesia technique with benefits of fast onset, and low complication rates[26]. choosing between the two approaches depends on anesthetist's preferences & skill level. Anyway, each approach carries some problems, meta-analysis demonstrated that IC-BPB showed a significantly high incidence of incomplete radial nerve sensory block, which may be avoided by double or triple injection. Furthermore, IC-BPB with multiple injection technique is needed to lower incidence of incomplete ulnar block than SC-BPB[27]. The supraclavicular level is an ideal site to achieve anesthesia of the entire upper extremity just distal to the shoulder as the plexus remains relatively tightly packed at this level, resulting in a rapid and high-quality block[24].

A bloodless surgical field and hemostasis in hand surgery is ultimately necessary so traditionally a pneumatic tourniquet is applied to the arm to provide clear visualization during operation,[28] Tourniquet-related pain experienced by patients received SC-BPB is believed to be due to scape of intercostobrachial nerve which supplies skin strip along the medial aspect of the upper arm & cause pain with tourniquet inflation. This nerve derived from T2 and therefore is not a part of the brachial plexus & not blocked when using SC-BPB[29].

The intercostobrachial nerve can be blocked by direct local anesthetic infiltration either by using anatomic landmarks (from the upper border of the biceps to the lower border of the triceps at the anterior axillary line) or under ultrasound guidance[30].

In this study no additional blocks were used in SC-BPB group despite hat 6 out of 26 patients (23%) reported pain and discomfort in the tourniquet site as this was mild (maximum recorded pain score was 4 & it was just before deflation of the tourniquet, so it was managed by reassuring the patient only.

Orman compared the effects of WALANT, IVRA and IC-BPB as regards the cost and clinical pain scores of patients underwent hand surgery, reported tourniquet pain in seven patients (15%) in the IVRA group, and five (11.3%) patients in the IC-BPB group in patient underwent various hand procedure[12].

On the other hand, in WALANT group the bloodless field was achieved without using tourniquet through optimizing the vasoconstrictive effect of locally injected epinephrine-local anesthetic mixture, which cause no pain felt outside the surgical field (tourniquet site) with statistically significant difference in this point *P-value* <0.01.

The intraoperative pain scores at different points of time were assessed using Wong-Baker Faces & were set as the primary outcome of this study. It was found that, pain score at time of injection of local anesthetics was significantly higher in group received SC-BPB than that in those received WALANT group (*P- value* < 0.05) which agreed with reports of several studies[31,32] This could be explained by size of stimulating insulated needles that we used for the SC-BPB compared to the 27G needle used in applying WALANT in addition to other maneuvers that used to minimize pain during local anesthetic injection as the addition of sodium bicarbonate, numbing skin with intradermal injection of local anesthetic before advancing the needle 7 many other injection tips that[31].

During rough manipulation & dissection (T4), pain score was higher in WALANT group compared to SC-BPB group yet, it did not reach a statistically significant level (*P*>0.05).

The mean time consumed in conducting WALANT (10.73 min) was shorter than that needed for SC-BPB (16.5 min) with *P-value* <0.01, this may be attributed to the fact that SC-BPB is more complex procedure that need higher level of preparations, precautions & skill Similar results reported by Orman[12] and Turcotte[33].

According to the technique of WALANT described by Lalonde and Wong[14] that was followed in our study, the minimal time needed to obtain a sufficient anesthetic and hemostatic effect is 15 min., but the time of 1st incision was variable and unintentionally longer in some patients due to surgical preparation, scrubbing and draping. Also in the SC-BPB Incision was planned to start once the block is effective and the arm tourniquet applied, taking

into consideration time delay due to surgical preparation, scrubbing and draping.

We recorded the time elapsed from the last injection to the moment when 1st incision was done, it was longer in WALANT group with mean time (18.12 min.) than in SC-BPB (12.5 min.) with *P-value* <0.01. Studies compared WALANT to local anesthesia with tourniquet reported similar results[3] while when WALANT compared to IC-BPB, this time difference was in favor to WALANT[34] This could be explained by the longer time needed to get effect in IC-BPB compared to SC-BPB.

In this study blood loss was minimal in both groups, but it was significantly higher in WALANT group than group of SC-BPB with tourniquet with *P-value* <0.01. This matches previous reports[12] that reported more blood loss with WALANT up to describing surgical field to be "bloody" in some patients under WALANT. This was never happening while conducting this stud as the overall blood loss was minimal & did not affect surgical procedures with comparable mean surgical time in WALANT (72min) and SC-BPB (69 min) for almost the same number of tendons. Any way blood loss is varying with nature of surgical procedure, level of deep tissue dissection &involvement of bone.

Epinephrine's vasoconstriction intensity differs depending on vessel type (arteries, arterioles, precapillary sphincters, capillaries, venules, and veins). Usually, epinephrine's arterial vasoconstriction effect occurs at 7 - 10 minutes[35]. McKee investigated the optimal time delay between epinephrine injection and incision to minimize bleeding by comparing mean relative hemoglobin index in extremity versus time after infiltration, the optimal time delay was found to be 25 minutes to achieve adequate vasoconstriction to provide the best surgical field exposure & less blood loss[36]. Different time delay reported by other researchers[3].

Analyzing data obtained in his study showed inverse correlation between time delay between last injection of local anesthetic/epinephrin mixture to the first incision and the amount of blood lost in patients received WALANT, the more the time waited after injection the more the epinephrine vasoconstrictive effect and hemostasis and the less the amount of blood loss (r- value = -0.808 and p <0.05) no such a relation was found when analyzing the data of SC-BPB group as the hemostatic effect depends on application of the pneumatic tourniquet not the dynamic pharmacological effect of adrenaline.

The ability to assess range of movement intraoperatively is of great value to get the best results of tendon's repair which is well provided when using WALANT anesthesia strategy keeping the patient awake & preserving motor power to allow for this assessment. The functional outcome value of intraoperative assessment of range of movement was being investigated[37].

Post-operative pain score was comparable in both groups during the first six post-operative hours, after that the perceived pain score was higher in SC-BPB at eights, tenth & twelfth post-operative hours. Our study was continued for 12 post-operative hours.

This was different from reports from other study[38] that was conducted to compare WALANT & BPB for post osteotomy of lower end radius in which studied continued for 24 post-operative hours & pain score was higher in WALANT compared to BPB at 12th & 14th postoperative hours. The different results could be explained by different type of surgical procedures specially bone involvement & different technique of BPB

Patients received WALANT called for rescue analgesia for the first time (NRS>=4) after mean of 7,50 hrs. compared to mean of 6,96 hrs. in group of SC-BPB with total doses of rescue analgesia (pethidine) needed to control pain in the 1st twelve hours postoperatively being significantly higher in SC-BPB group than WALANT group (*P-value* < 0.01). Similar results reported by different investigators [31,34].

Patients expressed higher level of satisfaction with WALANT (*P-value* = 0.032). Also, more patients who received WALANT would choose the same type of anesthesia If they were to undergo this surgery again, than those who received SC-BPB, with a significant difference (*P-value* = 0.025)

In terms of patient satisfaction, patients who received WALANT was significantly more satisfied than those who received SC-BPB when level of satisfaction assessed using Likert scale (*P-value* = 0.032). Also, more patients in WALANT group would choose the same type of anesthesia If they were to undergo this surgery again, than those who received SC-BPB, with a significant difference (*P-value* = 0.025).

As patient impression about anesthetia anagment is greatly affected by any perceived discomfort or even minor pain so, we can assume that tourniquet pain/discomfort[39] is an important factor for patient satisfaction and the chance to accept or refuse similar anesthetic management in the future. Anyway, other many factors play a role in this issue as personal experiences, preferences, number of injections & site of injection being at operative site like in WALANT or away at root of the neck as in case of BPB. This may explain the difference results reported by different investigators[3,31,34].

In our study of flexor tendons repair surgeries, WALANT anesthesia was found to be suitable alternative to SC-BPB while having the advantages of being simple technique and no need for special equipment or skills, less time needed in induction and less injection pain also it avoids discomfort of tourniquet, intraoperative active motion of the hand is preserved, that can help optimize the surgical technique, better effect on post-operative analgesia and more patient satisfaction. The SC-BPB

group had the longer induction time but surgical procedure can start as soon as tourniquet applied without significant delay and less bleeding intraoperative so it would be a better choice in patient subjected to more bleeding if there is no contraindication to regional block. There was no statistically significant difference among the groups in terms of surgical time and 1st time to call for analgesia.

The study is limited by its small sample size, restricting the inclusion to flexor tendon repair, conducted in one center & restricting comparison to one approach of brachial plexus block. So, further multicenter studies including larger number of participants & comparing different techniques for variety of hand procedures will add better understanding & evaluation.

CONCLUSION

WALANT anesthesia was found to good alternative to SC-BPB in flexor tendon repair surgeries in adults being simple technique with no need for special equipment or skills, less time consumed in induction, associated with less pain at time of injection, no tourniquet related pain, & providing a good post-operative analgesia. Also keeping patient awake with preserved motor power of the fingers allowed for intraoperative assessment of active motion of flexors &repair efficacy. All these benefits making this technique very suitable to low economic settings or minor procedures with no expected significant bleeding & when rapid turn over of cases & fast tracking is a target.

Brachial plexus block either infra- or- supra clavicular approaches is still a very good choice in upper extremities specially n a complex procedure with intense dissection & possibly higher blood loss as those involving bony structures specially with the availability of needed facilities & skills.

CONFLICT OF INTERESTS

There are no conflicts of interest.

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