Acta Orthop. Belg., 2022, **88**, 359-367

ORIGINAL STUDY

doi.org/ 10.52628/88.2.8351

Comparison of the WALANT and the PFNB techniques in the surgical treatment of unimalleolar fractures: a prospective study

Ceyhun Çağlar, Ali Said Nazligül, Yasemin Akçaalan, Mehmet Asiltürk, Mahmut Uğurlu

From the Department of Orthopedics and Traumatology, Ankara City Hospital, Ankara, Turkey

The popliteal fossa nerve block (PFNB) technique is one of the most popular anesthesia method in the foot and ankle surgery. The wide awake local anesthesia no tourniquet (WALANT) technique is an local anesthetic method and it has been gaining popularity in orthopedic surgery in recent years. Our aim is to compare the efficacy of the WALANT and the PFNB techniques in pain management. This prospective study included 40 patients with lateral malleolar and medial malleolar fractures. The first group was anesthetized using the WALANT technique; in the second group, PFNB was performed. All patients were evaluated for intrasurgical bleeding amounts, mean arterial pressure, surgery time and VAS scores for presurgical pain, pain during the local anesthetic injection sequence, mean intrasurgical pain, mean postsurgical pain. A total of 40 patients in both groups were successfully operated on with the WALANT and the PFNB techniques. When the two groups were compared, statistically significant differences were observed for mean intrasurgical VAS (p = 0.033), mean postsurgical VAS (p = 0.038) and intrasurgical bleeding (p = 0.006). No significant difference was found in pain scores during anesthetic injection (p = 0.529), mean arterial pressure (p = 0.583) and surgery time (p = 0.277). The PFNB technique is more successful in pain management in the treatment of the unimalleolar fractures. Intrasurgical bleeding amounts were less detected in the WALANT technique. The both techniques are a reliable and suitable anesthetic method in the surgical treatment of unimalleolar fractures.

Keywords: WALANT; popliteal fossa nerve block; malleolar fracture; visual analog scale; ORIF.

INTRODUCTION

Malleolar fractures constitute approximately 10% of all fractures presented to the emergency department and the average age of these patients is 45 years *(1)*. Malleolar fractures are usually surgically treated to maintain stability, correct alignment, and prevent posttraumatic osteoarthritis, because even a 1-millimeter displacement of the talus reduces the contact surface by 42% in the ankle joint *(2)*. Open reduction and internal fixation (ORIF) is generally preferred as the surgical method.

■ Ceyhun Çağlar[1],
■ Ali Said Nazlıgül[1],
■ Yasemin Akçaalan[2],
■ Mehmet Asiltürk[1],
■ Mahmut Uğurlu[3]

[1]*Department of Orthopedics and Traumatology, Ankara City Hospital, Ankara, Turkey.*

[2]*Department of Anesthesiology and Reanimation, Ankara City Hospital, Ankara, Turkey.*

[3]*Department of Orthopedics and Traumatology, Ankara Yıldırım Beyazıt University, Ankara, Turkey.*

Correspondence : Ceyhun Çağlar, Department of Orthopedics and Traumatology, Ankara City Hospital, Ankara, Turkey. Fax: 00903125526000.
Email : ceyhun.caglar@hotmail.com

No benefits or funds were received in support of this study.
None of the authors have a conflict of interest.

In the surgical treatment of malleolar fractures, the use of a tourniquet is often preferred, both to reduce blood loss and to provide a clean surgical field. However, when the duration of surgery is prolonged, complications such as tourniquet-related thigh pain and postsurgical swelling in the foot and ankle may arise.

Many different anesthesia methods are used during surgery. Current methods in the literature include general anesthesia, spinal and epidural anesthesia, peripheral nerve block, and local anesthesia with IV sedation *(3)*.

Popliteal fossa nerve block (PFNB), which is a type of sciatic nerve block, has recently started to be preferred in foot and ankle surgery *(4)*. Despite large numbers of cases, low complication rates have been reported *(5)*. It is a more reliable method for the cardiovascular and pulmonary system, although it poses a risk of neuropathic pain in the early postoperative period *(3)*.

The "wide awake local anesthesia no tourniquet" (WALANT) technique was first described by Dr. Donald H. Lalonde in 2005 *(6)*. Lidocaine and epinephrine are injected subcutaneously into the area to be operated on. Thus, local anesthesia and vasoconstriction are obtained in the surgical field. This technique also removes the need to use a tourniquet and thus prevents possible complications of tourniquet usage *(7)*. The WALANT technique was first used for phalanx and metacarpal fractures, tendon ruptures, and simple wrist surgeries *(8)*. Recently, this technique was extended to the treatment of distal radius and olecranon fractures, many soft tissue procedures, and the treatment of joint arthritis *(9,10)*. Patient satisfaction is high with this technique because it eliminates the risks of the anesthesia, especially in patients with comorbidities, and it reduces hospital stay and cost *(11)*.

When the literature on the WALANT technique was examined, it was seen that a single study has been performed about the application of this technique for ankle fractures *(12)*. The aims of our study; to prove the reliability and effectiveness of the WALANT technique in the surgical treatment of unimalleolar fractures, to compare the efficacy of the WALANT and the PFNB techniques in pain management.

MATERIALS AND METHODS

Our research was approved by the research ethics committee of our institution and we received signed informed consent regarding the WALANT or the PFNB anesthesia techniques to be applied from all patients. All patients in the study were operated on by the same surgeon, and the study comprised patients with the diagnosis of ankle fracture in our institution from January 2019 to December 2019. Inclusion criteria of the study; patients with isolated lateral or medial malleolar fractures and patients who agreed to be operated with the WALANT or the PFNB method. Posterior malleolar fractures, bimalleolar and trimalleolar fractures, pilon fractures, open fractures, patients using antiaggregant or anticoagulant drugs, alcohol or drug abuse, severe peripheral neuropathy and patients with very low or very high pain threshold were the exclusion criteria of the study. During this period, 40 patients (23 males and 17 females, age range 21-75 years, mean age 43.17) with unimalleolar fractures were operated using the WALANT or the PFNB techniques, respectively (one patient WALANT, one patient PFNB). The lateral malleolar fractures of 21 patients and the medial malleolar fractures of 19 patients were fixed by ORIF. No patients were given an antiaggregant or anticoagulant drug before surgery to prevent the amount of intrasurgical bleeding. Patients' demographic characteristics, fracture types, presurgical VAS scores, VAS scores during anesthetic injection, mean intrasurgical VAS scores, mean postsurgical VAS scores, intrasurgical bleeding amount, duration of surgery, and mean arterial pressure were recorded.

We used 2% lidocaine (Aritmal®, Osel Company, Turkey), epinephrine (1/1000; Galen Company, Turkey), and 8.4% $NaHCO_3$ (Onfarma Company, Turkey) in the WALANT procedures according to the patients' group assignments. First, we mixed 20 mL of 2% lidocaine, 1 mL (1/1000) of epinephrine, and 4 mL of 8.4% $NaHCO_3$. By adding saline to this mixture, we completed the volume to a total of 40 mL. First we administered 10 mL of the local anesthetic to the fracture site for haematoma block (Figure 1a), followed by 10 mL of local anesthetic subcutaneously 1 cm under the skin from the proxi-

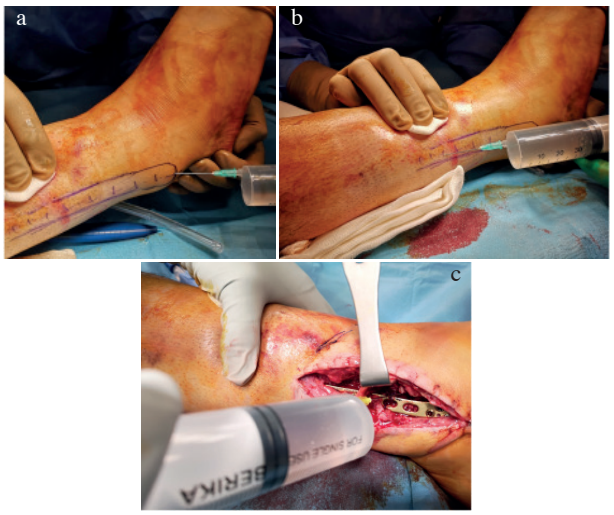

Figure 1. *— **a.*** Application of local anesthetic for haematoma block into fracture site. ***b.*** Application of local anesthetic sub-cutaneously on the incision line. ***c.*** Application of local anesthetic into the syndesmosis space when a syndesmotic screw was required.

mal to the distal of the incision line (Figure 1b), and finally 10 mL of the local anesthetic to the fracture site (Figure 1c). During the injection, 22-G needles, were used for patient comfort. Since the lateral and medial malleolar are subcutaneous bones, we did not need to receive ultrasound guide to prevent possible nerve damage during injection. VAS scores were recorded during the injections. We kept an additional 10 mL of the local anesthetic ready in case it might be needed during surgery. We waited mean 18 minutes after the injections for adequate anesthesia and vasoconstriction. Before starting the surgery, we checked the anesthesia effect by palpating the fracture line. We applied an additional 5 mL of local anesthetic to the syndesmosis space for the 11 patients who had a syndesmosis injury to be fixed with a syndesmotic screw.

The PFNB technique was performed for all patients by the same anesthesiologist in the block room 30 minutes before surgery. It was performed with ultrasound guidance (LOGIQ P6; GE Healthcare) using a high-frequency linear transducer (3.4-10.8 MHz) (Figure 2a). After introducing a 22-G needle, approximately 2 mL of saline was administered to evaluate the proximity to the target nerve (Figure 2b). After confirming that the needle was in the right

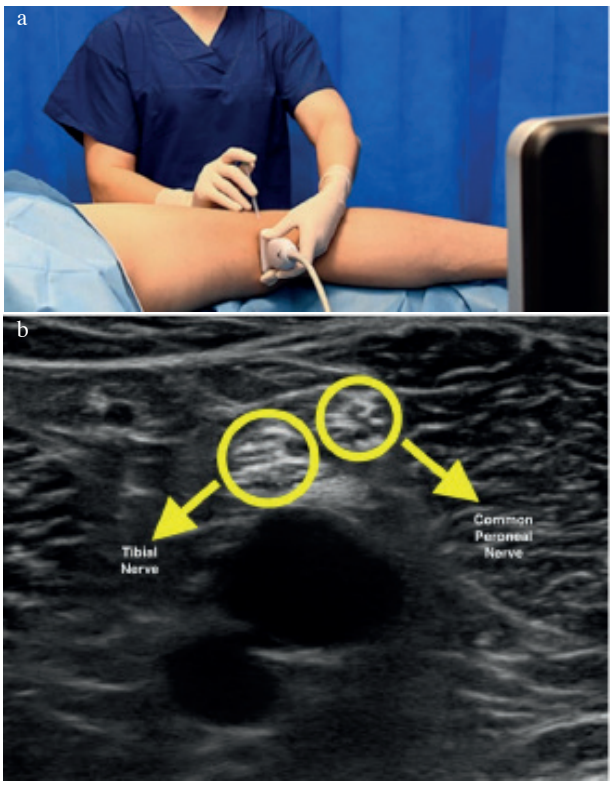

Figure 2. *— **a.*** Application of ultrasound guided PFNB technique. ***b.*** Tibial and common peroneal nerve in popliteal fossa on ultrasound image.

place, approximately 10 mL of a mixture of 0.50% bupivacaine (Marcain®, AstraZeneca Company, UK) and 2% lidocaine (Aritmal®, Osel Company, Turkey) prepared in a ratio of 1:1 was injected as a bolus through the needle. We waited mean 22 minutes after the injections for adequate anesthesia. Before starting the surgery, we checked the effect of the anesthesia by palpating the fracture line as in the WALANT group. The patient was taken to the operating room after the PFNB effect was controlled. No patients needed additional doses of medication or sedation intrasurgically.

ORIF was performed as a standard surgical procedure for all patients. Syndesmosis injury was evaluated by applying Cotton test intrasurgically. All patients were monitored by an anesthesiologist assistant. Mean arterial pressure was kept in the range of 80-100 mmHg throughout the surgery in order not to affect the amount of bleeding. Patients with a mean arterial pressure of more than 100 mmHg

Table 1. — Recorded data of patients undergoing the WALANT technique

Case	Gender	Age	Fracture Type	Presurgical VAS	VAS During Anesthetic Injection	Mean Intrasurgical VAS	Mean Postsurgical VAS	Intrasurgical Bleeding (ml)	Surgery Time (Minutes)	Mean Arterial Pressure (mmHg)
1	M	57	LAT	4	3	0	0	6	30	91
2	M	35	MED	5	3	1	0	6	25	94
3	F	63	LAT	2	2	2	1	12	35	83
4	F	28	LAT	6	2	1	0	9	30	97
5	M	34	MED	4	2	0	0	6	25	81
6	F	41	LAT	4	3	1	0	6	30	90
7	F	27	MED	7	4	2	1	12	30	82
8	M	32	LAT	5	2	1	0	21	35	85
9	M	64	LAT	4	4	3	2	18	35	88
10	M	49	MED	3	2	2	1	15	35	84
11	F	31	MED	5	3	1	0	6	25	93
12	M	55	LAT	6	1	0	0	12	20	86
13	M	75	LAT	3	2	2	1	9	25	95
14	F	33	MED	5	4	1	0	6	30	92
15	M	38	LAT	4	1	1	0	15	25	83
16	F	29	MED	7	4	3	2	12	30	99
17	M	38	LAT	5	3	2	1	18	40	94
18	F	36	LAT	6	2	1	1	12	35	81
19	F	47	MED	3	2	0	0	9	30	95
20	M	59	MED	2	1	0	0	12	25	92

M : Male, F : Female, LAT : Lateral malleolus, MED : Medial malleolus,, VAS : Vısual analog scale.

were given antihypertensive drug before surgery and mean arterial pressure remained between 80-100 mmHg. In both methods, the pain felt by the patient was recorded as a VAS score every 10 minutes. The VAS scores recorded during surgery were averaged and recorded as the intrasurgical VAS score. There was no need for an additional dose of the local anesthetic in any patient for severe pain. The amount of bleeding was recorded during surgery, calculated based on the total number of surgical gauzes that absorbed blood in the surgical area during operation. Based on a previous study with the estimation of the blood loss, the amount of bleeding was calculated considering that there is approximately 3 mL of blood in the surgical gauze (10×10 cm) that has reached 25% saturation *(13)*.

Patients were not given splints or casts to start early postoperative movement to maintain fracture fixation. The patients were followed in our clinic for approximately 4-6 hours in terms of postsurgical vital signs and VAS scores. A total of 5 VAS scores were taken every hour after the operation and the average was recorded as the postsurgical VAS score. All patients were discharged one day after the operation when no complications were observed.

Upon collection, all data were categorized with Microsoft Office Excel 365 software. Data are presented as mean ± standard deviation (SD) and median (minimum-maximum). The power analysis of the study was performed by department of biostatistics and the sample size was found to be sufficient. Independent samples t-tests were used to

evaluate parametric statistics and Mann-Whitney U tests were used to evaluate non-parametric statistics. Values of $p < 0.05$ were accepted as statistically significant.

RESULTS

The data recorded for patients treated with the WALANT technique are shown in Table 1. This group included 11 male and 9 female patients. 11 of these patients had lateral malleolus and 9 had medial malleolus fractures. In this group, 5 patients needed a syndesmosis screw and therefore received an additional syndesmosis injection.

The data recorded for patients treated with the PFNB technique are shown in Table 2. This group included 12 male and 8 female patients. 10 patients had lateral malleolus and 10 had medial malleolus fractures. 4 of the patients in this group required a syndesmosis screw.

Demographic characteristics and types of fractures of patients undergoing surgery are presented in Table 3. In terms of these features, the values in both groups were determined close to each other.

Statistical comparison of the two groups is shown in Table 4. When the groups were compared, the mean intrasurgical and mean postsurgical VAS score was statistically significantly lower in the PFNB group ($p = 0.033$, $p = 0.038$). As stated before, the total bleeding amount was calculated by multiplying the number of surgical gauze collected until the end of surgery. The amount of intrasurgical bleeding was statistically significantly less calculated in the WALANT group ($p = 0.006$). Although, VAS score of during anesthetic injection and mean arterial pressure were less detected in the WALANT group

Table 2. — Recorded data of patients undergoing the PFNB technique

Case	Gender	Age	Fracture Type	Presurgical VAS	VAS During Anesthetic Injection	Mean Intrasurgical VAS	Mean Postsurgical VAS	Intrasurgical Bleeding (ml)	Surgery Time (Minutes)	Mean Arterial Pressure (mmHg)
1	M	56	MED	4	2	1	1	12	25	94
2	F	38	LAT	5	4	0	0	18	35	89
3	M	21	MED	3	3	0	0	21	25	83
4	M	33	LAT	6	2	1	1	15	30	88
5	F	46	LAT	6	2	0	0	12	40	92
6	M	68	MED	5	3	0	0	12	30	98
7	F	43	LAT	4	3	1	0	9	35	94
8	M	36	LAT	5	2	0	1	6	30	90
9	F	48	MED	4	4	2	1	21	25	93
10	F	34	LAT	3	1	1	0	24	40	87
11	M	30	MED	5	2	0	0	18	30	82
12	M	73	MED	6	3	1	0	15	25	99
13	M	39	LAT	7	2	0	0	18	35	90
14	M	27	MED	5	3	0	1	15	35	84
15	F	25	MED	7	4	1	0	9	30	86
16	M	39	LAT	5	3	0	0	12	45	91
17	M	46	MED	4	3	0	0	18	35	92
18	F	37	LAT	6	4	1	0	15	30	96
19	M	59	MED	4	2	2	1	24	25	88
20	F	58	LAT	5	2	0	2	21	35	93

M : Male, F : Female, LAT : Lateral malleolus, MED : Medial malleolus,, VAS : Visual analog scale, PFNB : Popliteal fossa nerve block.

Table 3. — Demographic characteristics and fracture types of the patients

Characteristics	WALANT Technique	PFNB Technique
Gender, n (%)		
Male	11 (55%)	12 (60%)
Female	9 (45%)	8 (40%)
Age, year		
Mean ± SD	43.550 ± 14.136	42.800 ± 14.092
Median (min-max)	38 (27-75)	39 (21-73)
Fracture type, n (%)		
Lateral	11 (55%)	10 (50%)
Medial	9 (45%)	10 (50%)

WALANT : Wide awake local anesthesia no tourniquet, PFNB : Popliteal fossa nerve block, SD : Standard deviation

(p = 0.529, p = 0.583), they were not statistically significant.

In first group, the safe anesthetic limit of 7 mg/kg for the WALANT technique was not exceeded *(14)*. No local or systemic complications of medication were observed in any patients after surgery. Superficial infection of the incision area occurred in only 1 patient in the first group and was treated with wound debridement and oral ampicillin and ciprofloxacin. In one patient described numbness in the medial side of the foot and gave overreacted to painful stimuli. Oral pregabalin was applied for treatment at 150 mg/day. In the 6th month of follow-up, the complaint of neuropathic pain was completely resolved and drug treatment was discontinued.

DISCUSSION

The PFNB technique has gained particular popularity in foot and ankle surgery in recent years *(15)*. It is a more selective regional anesthesia method compared to spinal anesthesia and it has less risk of headache after surgery *(16)*. Compared with general anesthesia, PFNB does not have side effects of nausea and vomiting. Moreover, it is extremely safe for the cardiopulmonary system *(17)*. However, complications such as postsurgical neuropathic pain may occur after PFNB. In a study conducted by Gartke et al., 147 patients undergoing foot

Table 4. — Statistical comparison of both techniques

Parameters	WALANT Technique	PFNB Technique	p Value
Presurgical VAS			0.341
Mean ± SD	4.500 ± 1.468	4.950 ± 1.145	
Median (min-max)	4-5 (2-7)	5 (3-7)	
VAS During Anesthetic Injection			0.529
Mean ± SD	2.500 ± 1.000	2.700 ± 0.864	
Median (min-max)	2 (1-4)	3 (1-4)	
Mean Intrasurgical VAS			0.033*
Mean ± SD	1.200 ± 0.951	0.550 ± 0.686	
Median (min-max)	1 (0-3)	0 (0-2)	
Mean Postsurgical VAS			0.038*
Mean ± SD	0.500 ± 0.688	0.400 ± 0.598	
Median (min-max)	0 (0-2)	0 (0-2)	
Intrasurgical Bleeding, ml			0.006*
Mean ± SD	11.100 ± 4.575	15.750 ± 5.045	
Median (min-max)	12 (6-21)	15 (6-24)	
Surgery Time, minute			0.277
Mean ± SD	29.750 ± 4.993	32.000 ± 5.712	
Median (min-max)	30 (20-40)	30 (25-45)	
Mean Arterial Pressure, mmHg			0.583
Mean ± SD	89.250 ± 5.729	90.450 ± 4.695	
Median (min-max)	90-91 (81-99)	90-91 (82-99)	

WALANT : Wide awake local anesthesia no tourniquet, PFNB : Popliteal fossa nerve block, SD : Standard deviation, VAS : Visual analog scale, * : Statistically significant

and ankle surgery received PFNB and were then followed for 8 months after surgery. The prevalence of neuropathic symptoms was 41% at 2 weeks, decreasing to 24% at 34 weeks. The prevalence of severe neuropathy was 4% *(18)*. In our study, only 1 (5%) of 20 patients who underwent PFNB developed postoperative neuropathic pain; that patient had completely recovered in the sixth month after surgery with medical treatment. The PFNB technique is extremely safe and comfortable in foot and ankle surgery if applied by an experienced anesthesiologist. In addition, it provides long-term anesthesia with a single injection and does not require additional doses.

The patients in both the WALANT and PFNB groups were discharged from the hospital the day after surgery. Since spinal, epidural, or general anesthesia was not applied, there was no need to keep them in the hospital to follow possible complications. As a result, the hospitalization costs were dramatically reduced and orthopedic service circulation was provided more comfortably *(19)*.

It was waited for the effectiveness of the anesthesia for a mean of 18 minutes in the WALANT group and 22 minutes in the PFNB group. We measured in the study that the anesthetic effect started sooner in the WALANT group.

One of the parameters that we considered in our research was the amount of bleeding. In a study by Jha et al., measurements was made by weighing bloody gauze to estimate the amount of bleeding *(20)*. However, since there was not a lot of blood loss in our research, we preferred the method we described earlier *(13)*. We had a lower bleeding amount than expected in both of our groups, and the mean amount of bleeding was less in the WALANT group, which was found to be significant. We kept the mean arterial pressure of the patients in both groups between 80 and 100 mmHg intrasurgically to prevent increased amounts of bleeding. We think that the vasoconstrictive effect of the epinephrine used in the WALANT technique facilitated this result.

When VAS scores were evaluated between the groups, the mean intrasurgical and mean postsurgical VAS score was statistically significantly lower in the PFNB group. Although the mean intrasurgical pain score in WALANT technique has been found to be higher than the PFNB technique, the patients who were applied the WALANT technique also tolerated the pain comfortably during surgery. In addition, the VAS scores measured during anesthetic injection and presurgically were not statistically significant but similar values were obtained in the two groups. The PFNB technique has been shown to provide prolonged analgesia for up to 18 hours in the postoperative period *(21)*. Based on this, we can say that the PFNB technique is also comfortable in terms of postoperative pain control. On the other hand, postoperative pain control is not that long in the WALANT technique. In a study by Kang et al., although the WALANT were applied in patients with carpal and cubital tunnel release and it was seen to be effective in controlling pain in the early postoperative period, this efficacy is not as long as PFNB *(22)*. In our study, the mean postsurgical pain was higher in the WALANT group and the feeling of rebound pain started in a shorter time.

In a previous study, different rates of $NaHCO_3$ were added to the lidocaine-epinephrine mixture and these anesthetics with different pH levels were applied *(23)*. For this reason in our research, we added $NaHCO_3$ to the lidocaine-epinephrine mixture in the WALANT technique so the pH value of the WALANT will be closer to the physiological pH value of the human body, the pain intensity will be decreased.

Some studies have shown that lidocaine is chondrotoxic and increases the possibility of joint cartilage damage *(24)*. Furthermore, the chondrotoxic effect of 2% lidocaine is higher than that of 1% lidocaine. Therefore, we diluted 20 mL of 2% lidocaine with saline to 40 mL and reduced the lidocaine concentration to 1% in WALANT group. In this way, we aimed to have less cartilage damage in joint-related fractures. As there is no risk of joint cartilage damage in the PFNB group, it has an important advantage in this regard.

The present comparison of the WALANT and the PFNB techniques in unimalleolar fractures is the first such analysis in the literature and we believe that the WALANT technique will become more widespread, especially in lower limb surgeries, as it is increasingly learned and developed. Moreover,

since there is no need to use a tourniquet, risks such as tourniquet pain and ischemia after surgery are avoided *(25)*. One of the most important features, while an experienced anesthesiologist is needed for the PFNB method, the WALANT can easily be applied directly by orthopedic surgeons directly in the surgery of subcutaneous bones such as the lateral and medial malleolus.

Our research has some limitations. First of all, the VAS scores that we used to evaluate the patients were based entirely on patients' statements. Pain sensitivities and the degree of injury to which patients are exposed may differ from each other. Therefore, our measurements of pain were not objective. Secondly, the amount of intrasurgical bleeding was not measured with precision; it was estimated based on the number of bloody sponges. Amounts may vary due to not having equal amounts of blood in each surgical gauze. Thirdly, our patient follow-up time was not long enough and longer follow-up times are needed for late complications. Another limitation is that there was no correlation between the groups in terms of comparisons for gender, age, and type of fracture.

CONCLUSION

It has been determined that the PFNB technique, which has gained an important place in ankle surgery in recent years, is more advantageous than the WALANT technique in terms of pain management. On the other hand, less blood loss was seen with the WALANT technique. We think that the WALANT technique will become popular in ankle ankle surgery in the future due to its ease of application, cost and practicality.

REFERENCES

1. Court-Brown CM, McBirnie J, Wilson G. Adult ankle fractures – an increasing problem? Acta Orthop Scand. 1998;69:43-47.
2. Ramsey PL, Hamilton W. Changes in tibiotalar area of contact caused by lateral talar shift. J Bone Joint Surg Am. 1976;58:356-357.
3. Anderson JG, Bohay DR, Maskill JD, et al. Complications after popliteal block for foot and ankle surgery. Foot Ankle Int. 2015;36:1138-1143.
4. McPhail SM, Dunstan J, Canning J, Haines TP. Life impact of ankle fractures: qualitative analysis of patient and clinician experiences. BMC Musculoskelet Disord. 201221;13:224.
5. Fredrickson MJ, Kilfoyle DH. Neurological complication analysis of 1000 ultrasound guided peripheral nerve blocks for elective orthopaedic surgery: a prospective study. Anaesthesia. 2009;64:836-44.
6. 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;30:1061-1067.
7. Maliha SG, Cohen O, Jacoby A, Sharma S. A cost and efficiency analysis of the WALANT technique for the management of trigger finger in a procedure room of a major city hospital. Plast Reconstr Surg Glob Open. 2019;7:e2509.
8. 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.
9. Tahir M, Mehboob G, R Jamali A, Phillips AM. Use of the wide-awake local anaesthetic no tourniquet in the management of distal radius fractures. J Pak Med Assoc. 2020;70:S42-S48.
10. Far-Riera AM, Pérez-Uribarri C, Sánchez Jiménez M, Esteras Serrano MJ, Rapariz González JM, Ruiz Hernández IM. Prospective study on the application of a WALANT circuit for surgery of tunnel carpal syndrome and trigger finger. Rev Esp Cir Ortop Traumatol. 2019;63:400-407.
11. Steiner MM, Calandruccio JH. Use of wide-awake local anesthesia no tourniquet in hand and wrist surgery. Orthop Clin North Am. 2018;49:63-68.
12. Li YS, Chen CY, Lin KC, Tarng YW, Hsu CJ, Chang WN. Open reduction and internal fixation of ankle fracture using wide-awake local anaesthesia no tourniquet technique. Injury. 2019;50:990-994.
13. Algadiem EA, Aleisa AA, Alsubaie HI, Buhlaiqah NR, Algadeeb JB, Alsneini HA. Blood loss estimation using gauze visual analogue. Trauma Mon. 2016;21:e34131.
14. Pires Neto PJ, Moreira LA, Las Casas PP. Is it safe to use local anesthesia with adrenaline in hand surgery? WALANT technique. Rev Bras Ortop. 2017;52:383-389.
15. He M, Ling DD, Cai GY, Zou TX, Yu B. Two different placement paths in popliteal fossa with a novel nerve block needle for postoperative analgesia after foot and ankle surgery. Minerva Anestesiol. 2018;84:582-589.
16. Ma HH, Chou TA, Tsai SW, Chen CF, Wu PK, Chen WM. The efficacy and safety of continuous versus single-injection popliteal sciatic nerve block in outpatient foot and ankle surgery: a systematic review and meta-analysis. BMC Musculoskelet Disord. 2019;20:441.
17. YaDeau JT, Fields KG, Kahn RL, et al. Readiness for discharge after foot and ankle surgery using peripheral nerve blocks: a randomized controlled trial comparing spinal and general anesthesia as supplements to nerve blocks. Anesth Analg. 2018;127:759-766.

18. Gartke K, Portner O, Taljaard M. Neuropathic symptoms following continuous popliteal block after foot and ankle surgery. Foot Ankle Int. 2012;33:267-274.
19. 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;30:7-15.
20. Jha R, Sharma R, Rastogi S, Khan SA, Jayaswal A, Gamanagatti S. Preoperative embolization of primary bone tumors: A case control study. World J Radiol. 2016;8:378-389.
21. Provenzano DA, Viscusi ER, Adams SB Jr, Kerner MB, Torjman MC, Abidi NA. Safety and efficacy of the popliteal fossa nerve block when utilized for foot and ankle surgery. Foot Ankle Int. 2002;23:394-399.
22. Kang SW, Park HM, Park JK, et al. Open cubital and carpal tunnel release using wide-awake technique: reduction of postoperative pain. J Pain Res. 2019;12:2725-2731.
23. Vent A, Surber C, Graf Johansen NT, et al. Buffered lidocaine 1%, epinephrine 1: 100'000 with sodium bicarbonate (hydrogen carbonate) in a 3: 1 ratio is less painful than a 9: 1 ratio: a double-blind, randomized, placebo-controlled, crossover trial. J Am Acad Dermatol. 2020;83:159-165.
24. Jayaram P, Kennedy DJ, Yeh P, Dragoo J. Chondrotoxic effects of local anesthetics on human knee articular cartilage: a systematic review. PM R. 2019;11:379-400.
25. Stimpson J, Gill DF, Memarzadeh A, et al. Reducing the hypertensive effects of the prolonged surgical tourniquet using a dual-cuff strategy: a prospective randomized controlled trial. J Foot Ankle Surg. 2019;58:1177-1186.