# Evaluation of the applicability of the LANT (Local Anesthesia No Tourniquet) technique in the osteosynthesis of distal radius fractures (DRF)

## *Evaluación de la aplicabilidad de la técnica LANT (Local Anesthesia No Tourniquet) en la osteosíntesis de fracturas del radio distal (FRD)*

Ana Scott-Tennent De Rivas[1,2] Carla Albert Minguell[3] Laura Prats Gispert[1,2,4]
Amer Mustafa Gondolbeu[1,2,4,5] Marta Bonjorn Martí[1,2,4] Pau Forcada Calvet[1,2,4,5]

[1] Hospital Arnau de Vilanova, Lleida, Spain
[2] Hospital Santa Maria, Lleida, Spain
[3] Hospital Arnau de Vilanova, Lleida, Spain
[4] Department of Anatomy and Embryology, Universitat de Lleida (UdL), Lleida, Spain
[5] Laboratory of Macro and Microdissection and Surgical Anatomy, Department of Human Anatomy, University of Barcelona (UB), Barcelona, Spain

**Address for correspondence** Ana Scott-Tennent De Rivas, MD, Secretaria de Traumatologia, 4ª planta. Av. Alcalde Rovira Roure, 80, 25198 Lleida, Spain (e-mail: residenciacotarnau@gmail.com).

Rev Iberam Cir Mano 2024;52(2):e93–e106.

**Abstract**

To evaluate the applicability of the LANT (Local Anesthesia No Tourniquet) technique in the osteosynthesis of distal radius fractures (DRF), a randomized clinical trial was designed that compared the short-term results between patients treated with local anesthesia without ischemia (LANT) and those operated on with locoregional anesthesia (RA) and ischemia cuff. The main variables of the study were pain, swelling, and patient satisfaction. Bleeding from the surgical wound, mobility, technical difficulty perceived by the surgeon, anesthetic insufficiency, and complications were also analyzed.

Between December 2020 and 2021, 27 patients were included. Those treated with LANT had less pain between days 10 and 15 after surgery, as well as less bleeding during the immediate postoperative period. 22 of the 27 patients in the study required sedation, and 67% of the LANT group needed additional doses of local anesthesia. We conclude that LANT is a viable technique for DRF osteosynthesis and may offer certain benefits by avoiding the use of the ischemia cuff in selected cases. However, the authors of the study recommend adding local anesthesia around the distal radioulnar

**Keywords**

- distal radius fractures
- Wide Awake Local Anesthesia No Tourniquet (WALANT)
- tourniquet
- locoregional anesthesia
- osteosynthesis

**received**
February 3, 2024
**accepted**
September 6, 2024

**DOI** https://doi.org/10.1055/s-0044-1793922.
**ISSN** 1698-8396.



Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

joint (DRUJ) to improve pain management during reduction maneuvers and emphasize that collaboration with an anesthesiologist was essential during their study.
**Level of evidence** 1/Therapeutic II.

## Resumen

Para evaluar la aplicabilidad de la técnica LANT (Local Anesthesia No Tourniquet) en la osteosíntesis de fracturas del radio distal (FRD), se diseñó un ensayo clínico aleatorizado que comparó los resultados a corto plazo entre pacientes tratados con anestesia local sin isquemia (LANT) y aquellos operados con anestesia locorregional (AR) y manguito de isquemia. Las principales variables del estudio fueron el dolor, la tumefacción y la satisfacción del paciente. También se analizaron el sangrado de la herida quirúrgica, la movilidad, la dificultad técnica percibida por el cirujano, la insuficiencia anestésica y las complicaciones.

Entre diciembre de 2020 y 2021, se incluyeron 27 pacientes. Aquellos tratados con LANT presentaron menos dolor entre los días 10 y 15 tras la cirugía, así como menos sangrado durante el posoperatorio inmediato. 22 de los 27 pacientes del estudio requirieron sedación, y el 67% del grupo LANT necesitó dosis adicionales de anestesia local. Concluimos que LANT es una técnica viable para la osteosíntesis de FRD y podría ofrecer ciertos beneficios al evitar el uso del manguito de isquemia en casos seleccionados. Sin embargo, los autores del estudio recomiendan añadir anestesia local alrededor de la articulación radiocubital distal (ARCD) para mejorar el manejo del dolor durante las maniobras de reducción y destacan que la colaboración con un anestesiólogo fue imprescindible durante su estudio.

**Nivel de evidencia** 1/Terapéutico II.

**Palabras clave**
- fracturas distales del radio
- Anestesia Local em Estado de Vigilia Sin Torniquete (WALANT)
- torniquete
- anestesia locorregional
- osteosíntesis

## Introduction

WALANT (Wide Awake Local Anesthesia No Tourniquet) is an anesthetic technique that uses low doses of local anesthetic (lidocaine) combined with adrenaline to create a bleeding-free surgical field, avoiding the use of an ischemia cuff. This technique has demonstrated multiple benefits, including high patient satisfaction rates and a safety profile widely supported by the literature. Its use is currently becoming more widespread. Today, WALANT is not only used in outpatient soft tissue surgery of the hand and foot, but also in more complex procedures such as fracture osteosynthesis.

Although WALANT has been previously described for distal radius fracture (DRF) osteosynthesis, its exclusive application can be challenging for surgeons unfamiliar with the technique. In this context, the use of local anesthesia without ischemia (LANT) could be an intermediate alternative, avoiding the adverse effects associated with the use of the cuff, but allowing its combination with other anesthetic techniques such as sedation and/or general anesthesia.

The aim of this study was to evaluate the feasibility and assess whether there is any benefit derived from the use of LANT anesthesia compared to locoregional anesthesia with ischemia for DRF osteosynthesis.

## Materials and Methods

This randomized clinical trial was registered at ClinicalTrials.gov (ID: NCT05421000) and approved by the hospital's ethics committee in November 2020, complying with the legal requirements established in Spanish Law 14/2007 and Royal Decree 1716/2011.

## Inclusion and exclusion criteria

Patients treated between December 2020 and 2021 with distal radius fractures (DRF) requiring surgical treatment were included, provided they had signed the informed consent and did not present any of the exclusion conditions detailed in the ►**Table 1**.

After signing the consent, an external observer collected personal and demographic data in a coded manner to ensure confidentiality.

### Random assignment

Patients were randomly assigned to two groups:

- **Group A:** underwent WALANT or LANT.
- **Group B:** treated with locoregional anesthesia (RA) and tourniquet.

 

**Table 1** Exclusion criteria

| |
|---|
| a. Unsigned informed consent |
| b. 17 years old or younger |
| c. Associated fractures in which additional definitive osteosynthesis was required: scaphoid fracture, ulnar fracture (ulnar styloid osteosynthesis included), bifocal radius fractures, etc |
| d. Open fractures |
| e. Polytrauma patients |
| f. Requiring more than a standard volar DRF approach and/or other than a volar plate. |
| g. DRF with >30 days or DRF malunions |
| Contraindications to the use of ischemia |
| a. Peripheral vascular disease |
| b. Extensive soft tissue injury |
| c. Peripheral neuropathy |
| d. Severe infection |
| e. Thromboembolic disease in the extremity |
| f. Poor skin conditions |
| g. Arteriovenous fistula |
| h. Sickle cell hemoglobinopathy |
| Contraindications for proximal blocking: |
| a. Existence of previous trauma or anatomical distortion of the area that prevents the abduction of the arm |
| b. Active presence of infection at the locoregional anesthesia puncture site |
| c. Previous axillary lymphadenopathy |
| d. Previous history of local anesthetic allergy |
| e. Severe coagulopathy |
| f. Severe pre-existing neurological diseases in the upper extremity |
| Contraindications for WALANT anesthetic technique |
| g. Documented hypersensitivity to lidocaine |
| h. Compromised peripheral circulation |
| i. Patients with previous vascular pathology, a history of vasculitis, Buerger's disease, and scleroderma |
| j. Patients with infection of the area surrounding the injection |

Randomization was performed in blocks of 10 using *Study Randomizer*.[18]

Blinding was not possible due to obvious differences between anesthetic techniques. However, neither patients nor the surgical team were aware of the allocation until the time of surgery.

All patients were offered optional sedation based on their level of anxiety or tolerance.

## Anesthetic technique

All patients received the same antibiotic prophylaxis according to hospital protocol.

**Group A (WALANT or Sedation + LANT):**

The doses proposed by Lalonde were followed,[19] using 1% lidocaine with adrenaline (1:100,000) buffered with 8.4% sodium bicarbonate to minimize injection pain. To avoid exceeding the maximum dose of 7 mg/kg, lidocaine was diluted to 0.5%. In patients with cardiovascular disease, adrenaline was used at a concentration of 1:400,000 for greater safety.

The anesthetic was administered by the surgeon under sterile conditions, allowing 15-30 minutes for the adrenaline to reach its maximum vasoconstrictive effect before starting surgery. The technique described by Ahmad[9] was used, infiltrating 40 ml of local anesthetic into the subcutaneous tissue. Subsequently, 30 ml was administered in deeper planes divided into 3 points, from proximal to distal, distributed in 4 ml around the volar periosteum, 2 ml radially and 4 ml in the dorsal periosteum. This was done through a lateral entry, introducing the needle on the radial side, avoiding the radial artery (►**Fig. 1**). The technique that Ahmad initially described[9] and used in this study did not contemplate anesthesia in the distal radioulnar joint (DRUJ) region.

In addition, 10 ml was systematically introduced into the intra-articular region, using conventional dorsal radiocarpal arthroscopic approaches 3-4 and/or 6R in all cases. As long as toxic doses were not exceeded, a consensus was reached that up to 50 ml of additional administration was allowed (completing the 100 ml available in the preparation) when the surgeon or patient considered it necessary. This could be done before or during surgery.

**Group B (AR + tourniquet):**

Locoregional anesthesia consisted, in all cases, of an axillary block performed by the anesthesiologist in the operating room. The same ischemic cuff (18.0 × 4.0 inches (46 × 10 cm) Stryker Instruments®, USA) as well as the same ischemic pressure (250 mmHg) were applied in all patients.

## Surgical technique

All surgeries were performed by level 2, 3, or 4 surgeons.[20] The surgical procedure was similar for all participants: DRF osteosynthesis using a conventional volar approach and fixation using a specific plate. Arthroscopic assistance was performed in some cases at the surgeon's discretion through conventional dorsal radiocarpal portals (3-4 and 6R). The wound was covered with 3 gauze pads and immobilized with a dorsal plaster splint.

 

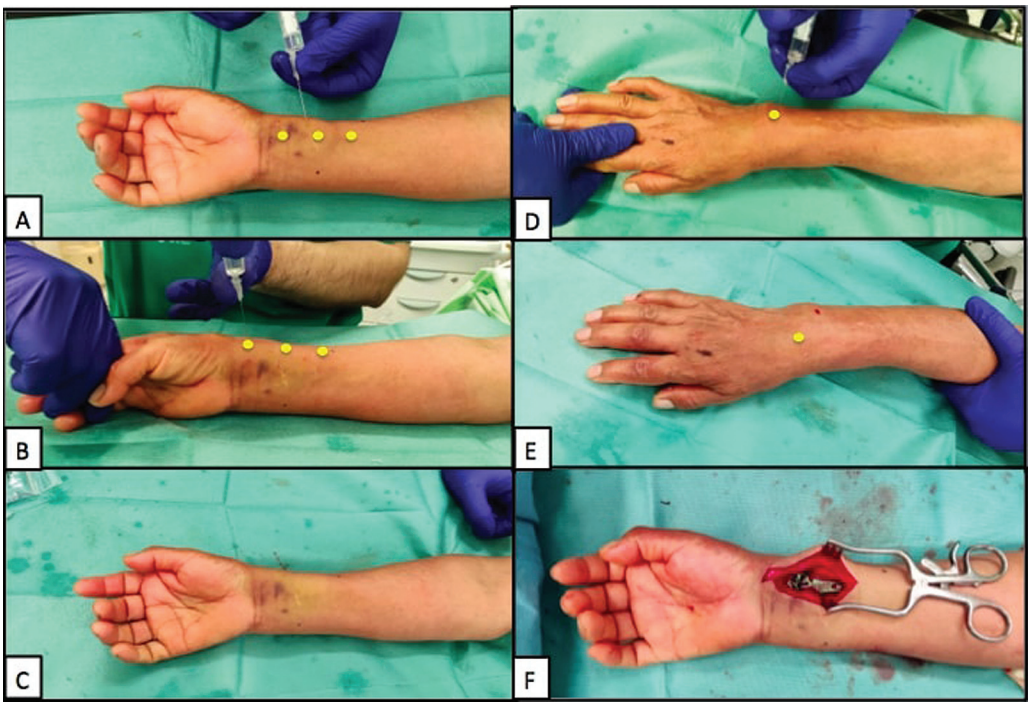


**Fig. 1** WALANT's anesthesia administration technique in a patient. (**A**) Injection of 10ml to the subcutaneous tissue along the volar approach. Yellow dots mark where the injections should be done, from proximal to distal. (**B**) Injection of 30 ml to deeper planes, introducing the needle from the radial side avoiding puncture through the radial artery. Yellow dots mark where the injections should be done, from proximal to distal, applying 4 ml around the volar periosteum, 2 ml radially, and 4 ml in the dorsal periosteum. (**C**) Aspect of the volar region after infiltration according to our reference technique,[10] before adding extra doses of WALANT. (**D**) Injection of 10 ml in DRUJ. Yellow dot marks the place where injection was usually done (**E**) Injection of 10 ml intra-articular, through the conventional radiocarpal atroscopic portals 3-4. (**F**) Demonstration of what a surgical field looks like after DRF osteosynthesis with WALANT.

## Follow-up and data collection

All data were collected by an external observer. After surgery, patients were hospitalized for one night. All patients had their casts changed and their wounds were reviewed the next day by the attending surgeon, together with the external observer. Upon discharge, they were given a form with early mobilization guidelines and a record of pain medication that they had to follow and complete until their first outpatient visit.

Follow-up was performed in two visits:

1. **First visit (10–15 days):** wound review and cast removal if indicated.
2. **Second visit (30 days):** assessment of postoperative progress and final data collection.

## Study variables

The main variables of the study were pain (VAS scale), swelling (►**Fig. 2**) and patient satisfaction. The following were included as secondary variables:

Surgical bleeding.
Wrist and finger mobility (►**Fig. 3**).
Technical difficulty perceived by the surgeon.
Anesthetic insufficiency.
Postoperative complications.

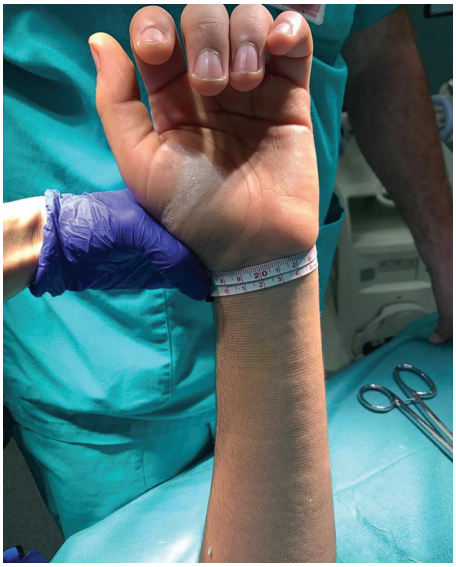

**Fig. 2** Preoperative injured wrist swelling using the proximal wrist crease perimeter as reference (cm).

(►**Table 2**) explains how the study variables were measured.

 

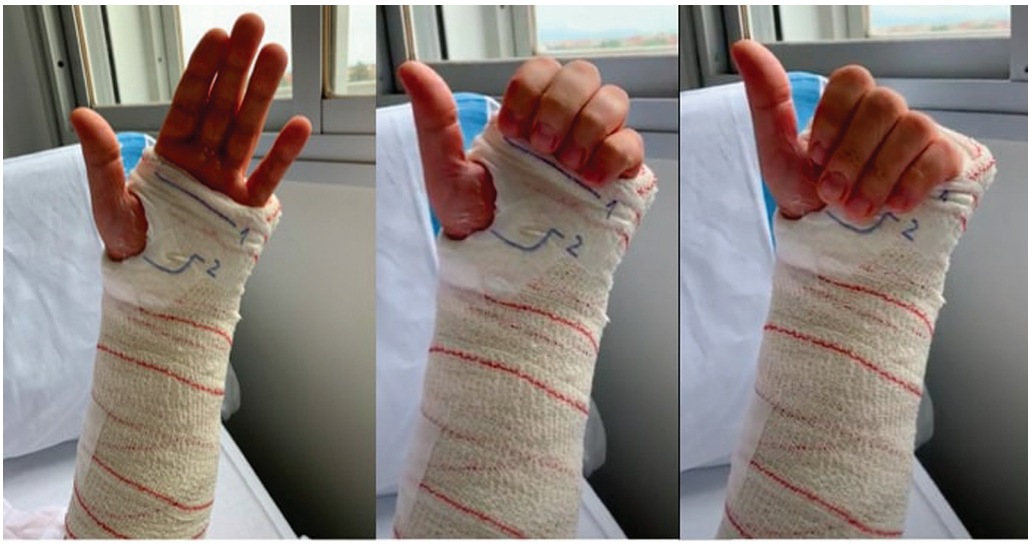

**Fig. 3** Finger mobility the day after surgery, measured by the capability to reach the distal and the proximal palmar crease with the tip of the fingers, named after Line 1 and Line 2 respectively.

## Statistical analysis

The quantitative variables were described as mean and standard deviation or median and interquartile range depending on their distribution. Qualitative variables were expressed as absolute and relative frequencies. For comparisons, Student's t-test, Mann-Whitney U test, Pearson's chi-square test, or Fisher's exact test were used as appropriate. Analyses were performed with R statistical software, considering a significance level of 5%.

## Results

Between December 2020 and December 2021, a total of 27 patients were included in the study (►**Fig. 4**). One patient (P17) was excluded from the final analysis due to fracture redisplacement requiring immediate re-surgical intervention, so the results were based on 26 patients. However, the patient was followed up until final discharge.

## Demographic and clinical characteristics

The demographic and clinical data of participants were similar between groups (►**Table 3**). No significant differences were observed in terms of age, sex, hand dominance, or AO/OTA classification of fractures.

### Pain

Pain analysis, measured by visual analogue scale (VAS), showed significant differences at the first visit (10–15 days). Patients in the WALANT or LANT group reported less pain compared to the AR and ischemia group (median VAS: 3 [1.75–4] vs 5 [3–6], $p = 0.019$). However, no relevant differences were observed in preoperative pain, immediate postoperative pain or at one-month follow-up (►**Tables 4** and **5**).

### Swelling

The increase in the circumference of the injured wrist was similar between the groups during the follow-up period (►**Table 6**). Although the AR group showed a tendency to greater swelling immediately after surgery, this difference did not reach statistical significance ($p = 0.081$).

## Patient satisfaction

Both groups showed high satisfaction rates. 100% of patients in the WALANT or LANT group and 93.3% in the AR group would repeat the procedure with the same anesthesia. In addition, 83.3% and 93.3%, respectively, would recommend the anesthetic technique received (►**Table 7**).

## Surgical bleeding

The AR group had higher rates of active bleeding at the surgical wound during the first 24 hours compared with the WALANT or LANT group (86.7% vs. 16.7%, $p = 0.001$). There were also differences in the amount of blood observed on the dressings, with more patients in the AR group having stained dressings (►**Table 8**).

## Postoperative mobility

Patients in the WALANT or LANT group had improved wrist mobility on the day after surgery, especially in flexion (30° vs. 20°, $p = 0.006$) and ulnar deviation (13° vs. 5°, $p = 0.033$). These differences were maintained at 1-month follow-up, with greater flexion in the WALANT or LANT group (35° vs. 20°, $p = 0.018$). No significant differences were observed in finger mobility or thumb opposition as measured by Kapandji (►**Tables 9** and **10**).

 

**Table 2** Outcome measures

| Outcome | Definition | Method of measurement | Moment of measurement |
|---|---|---|---|
| Pain | Difference between preoperative and postoperative pain | VAS scale | 24 hours, first outpatient visit, 1 month follow up. |
| | Intraoperative and postoperative analgesic needs | Description of the use of painkillers, doses, posology and days of use | Intraoperative, hospitalisation, first outpatient visit |
| Swelling | Difference between preoperative and postoperative swelling. Healthy wrist was also measured to allow comparison. (►**Fig. 2**) | Proximal wrist crease perimeter (cm) | 24 hours, first outpatient visit, 1 month follow up |
| Patient satisfaction | Index of satisfaction, willingness to repeat and recommend the anesthetic technique. | Personal designed "Satisfaction" scale (1 no satisfied- 5 very satisfied); 2 questions about whether he/she would repeat and recommend the anesthesia received (Yes/No answer) | Written down in a questionnaire form delivered and answered by the patient during the first outpatient visit. |
| Evolution of the surgical wound | Presence of active bleeding through the surgical wound | External observer and surgeon during wound cure (Yes/No) | 24 hours, first outpatient visit, 1 month follow up |
| | Amount of blood found in the dressings (3 non bended dressings) | External observer and surgeon during wound cure, measured as:<br>- ⅓ dressing<br>- ⅔ dressing<br>- > ⅔ dressing blood-stained | 24 hours, first outpatient visit, 1 month follow up |
| Mobility | Thumb opposition | Kapandji Scale | 24 hours, first outpatient visit, 1 month follow up |
| | Finger mobility (►**Fig. 3**) | Capability to reach the distal and the proximal palmar crease with the tip of the fingers, named after 1st line and 2nd line respectively (according to intrinsic and extrinsic movement). If not arrived, the number of the observer's finger widths left to arrive each crease was used (i.e. 1 finger widths, 2 fingers widths). | 24 hours, first outpatient visit, 1 month follow up |
| | Wrist mobility | Flexion, extension, radial and ulnar deviations and pronosupination using a goniometer (°). | 24 hours, first outpatient visit, 1 month follow up |
| Difficulty in visualisation of surgical field | | Numeric scale (1 easy- 5 very difficult) | Asked by the external observer right after the surgery had finished. |
| Stress during surgery | | (Yes/No question) and description of the reason | Asked by the external observer right after the surgery had finished. |
| Anesthesia insufficiency | Need of extra anesthesia | Description of technique used (sedation or local anesthesia reinforcement)<br>Description of the reason for change or reinforcement | Asked by the external observer right after the surgery had finished. |
| | Reconversion to General Anesthesia (GA) | | |
| Postoperative complications | | | Collected at the end of follow up (1 month) |

## Technical difficulties and complications

Surgeons' perceived stress was low in both groups. In the WALANT or LANT group, the surgeon was most concerned when the patient complained of pain with reduction maneuvers, whereas in the AR group, the greatest concern was exceeding the recommended ischemia time limit (►**Table 11**).

 

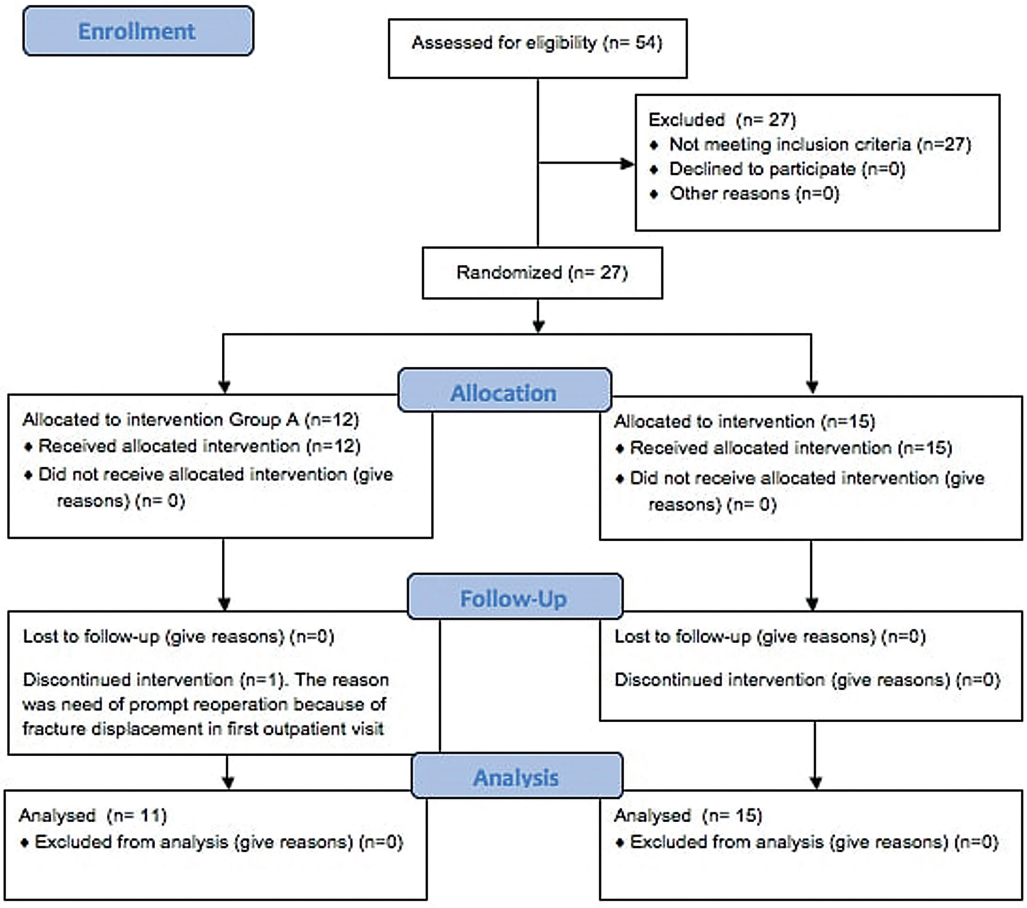


**Fig. 4** The CONSORT flow diagram showing subjects at each stage of the clinical trial. CONSORT, Consolidated Standards of Reporting Trials.

**Table 3** Patients' demographic data

| Demographic and clinical data | WALANT or LANT (A) | Locoregional Anesthesia and tourniquet (B) |
|---|---|---|
| Number of patients | 12 | 15 |
| Age | 55.2 (9.53) | 55.3 (16.9) |
| Gender | 9 (75%) ♀ | 12 (80%) ♀ |
| Right injured wrist | 5 (42%) | 10 (67%) |
| Right dominant hand | 12 (100%) | 13 (87%) |
| AO/OTA classification: B1 | 0 (0%) | 1 (7%) |
| B3 | 3 (25%) | 3 (20%) |
| C1 | 1 (8%) | 3 (20%) |
| C2 | 0 (0%) | 2 (13%) |
| C3 | 8 (67%) | 6 (40%) |
| Ulnar styloid fracture | 8 (67%) | 6 (40%) |
| Time from fracture-surgery (days) | 12.2 (6.75) | 11.9 (5.95) |
| Time of hospitalization (h) | 18.5 [16.2;19.5] | 17.0 [13.8;20.5] |
| Time from surgery-first visit (days)* | 12.5 (3.62) | 11.4 (4.63) |
| Time from surgery-first month visit (days)* | 39.6 (2.69) | 28.5 (6.32) |
| Time of rehabilitation at final follow up (days)* | 4 (SD) | 2 (SD) |
| Time of immobilization (days)* | 16 (SD) | 20 (SD) |

Numerical variables are described as mean (standard deviation) unless they are not normally distributed, in which case they are described as median [first quartile, third quartile].
*Missing for the loss of follow-up patient (N = 26).

 

**Table 4** Pain (VAS scale 1-10)

| Moment of measure | WALANT or LANT (A) | Locoregional Anesthesia and tourniquet (B) | P value |
|---|---|---|---|
| Preoperative | 4.00 [3.75;7.00] | 5.00 [3.50;6.00] | 0,98 |
| Day after surgery | 5.00 [5.00;6.25] | 6.00 [4.50;7.00] | 0,921 |
| First visit (10-15 days) | 3.00 [1.75;4.00] | 5.00 [3.00;6.00] | **0,019** |
| First month visit* | 3.00 [1.50;3.50] | 2.00 [2.00;4.00] | 0,491 |
| Evolution of pain (day after surgery-preoperative) | 1.00 [-0.50;2.50] | 1.00 [-0.50;2.50] | 0,825 |
| Evolution of pain (day after surgery-First visit (10-15 days)) | -2.00 [-3.25;0.00] | 0.00 [-1.00;1.00] | **0,049** |
| Evolution of pain (day after surgery-First month visit)* | -2.00 [-3.00;0.00] | -1.00 [-3.00;0.00] | 0,875 |

Numerical variables are described as median [first quartile, third quartile]. Since they are not normally distributed and Mann-Whitney test p-value for differences between groups is reported.
*Missing for the loss of follow-up patient. (N = 26)

**Table 5** Comparison of analgesic intake between both groups

| Moment of use Analgesic drug | WALANT or LANT (A) | Locoregional Anesthesia and tourniquet (B) | P value |
|---|---|---|---|
| Intraoperative corticosteroids | 7 (58.3%) | 10 (66.7%) | 0,706 |
| Intraoperative paracetamol | 8 (66.7%) | 11 (73.3%) | 1 |
| Intraoperative metamizol | 0 (0.00%) | 1 (6.67%) | 1 |
| Intraoperative dexketoprofen | 6 (50.0%) | 7 (46.7%) | 1 |
| Intraoperative opioids | 8 (66.7%) | 11 (73.3%) | 1 |
| Hospitalization paracetamol | 12 (100%) | 15 (100%) | . |
| Hospitalization metamizoll | 8 (66.7%) | 8 (53.3%) | 0,696 |
| Hospitalization ibuprofen | 2 (16.7%) | 1 (6.67%) | 0,569 |
| Hospitalization dexketoprofen | 5 (41.7%) | 5 (33.3%) | 0,706 |
| Hospitalization opioids | 2 (16.7%) | 7 (46.7%) | 0,217 |
| After hospital discharge paracetamol (1g) | 12 (100%) | 12 (80.0%) | 0,231 |
| Days of use after hospital discharge-paracetamol(1g) | 10.5 [6.25;15.0] | 15.0 [10.0;15.2] | 0,25 |
| After hospital discharge-metamizol (575mg) | 6 (50.0%) | 7 (46.7%) | 1 |
| Days of use after hospital discharge-metamizol | 10.0 [10.0;10.0] | 7.00 [6.00;15.0] | 1 |
| After hospital discharge-ibuporfen (600mg) | 0 (0.00%) | 4 (26.7%) | 0,106 |
| Days of use after hospital discharge-ibuprofen | | 19.5 [11.8;26.2] | . |
| After hospital discharge-dexketoprofen (25mg) | 3 (25.0%) | 2 (13.3%) | 0,628 |
| Days of use after hospital discharge-dexketoprofen | 14.0 [8.50;14.5] | 6.50 [4.75;8.25] | 0,374 |
| Total days us analgesic use | 12.5 [8.50;15.0] | 15.0 [11.5;15.5] | 0,212 |

Quantitative numerical variables are described as median [first quartile, third quartile]. Since they are not normally distributed and the Mann-Whitney test p-value for differences between groups is reported.
Qualitative variables are described as whole numbers (%). For differences between groups in qualitative variables the Pearson's chi-squared test p-value or the Fisher's exact test p-value (if any expected frequency lower than 5) is reported.

 

**Table 6** Comparison of postoperative swelling* (cm)

| Moment of measurement | WALANT or LANT (A) | Locoregional Anesthesia and tourniquet (B) | P value |
|---|---|---|---|
| Preoperative | 17.2 (1.03) | 17.1 (1.10) | 0,69 |
| Day after surgery | 18.1 (1.15) | 18.5 (1.20) | 0,308 |
| First outpatient visit (10–15 days) | 17.6 (1.16) | 17.6 (1.06) | 0,939 |
| First month visit** | 17.5 (1.15) | 17.2 (1.34) | 0,483 |
| Day after surgery - preoperative | 0.82 (0.62) | 1.47 (1.17) | 0,081 |
| First outpatient visit (10–15 days) - preoperative | 0.33 (0.46) | 0.53 (0.70) | 0,382 |
| First month visit – preoperative** | 0.37 (0.66) | 0.12 (0.74) | 0,368 |

*Proximal wrist perimeter used as reference
Numerical variables are described as mean (standard deviation) and The Student's T test is reported.
**Missing for the lost of follow-up patient (N = 26)

**Table 7** Patient's satisfaction

| | WALANT or LANT (A) | Locoregional Anesthesia and tourniquet (B) | P value |
|---|---|---|---|
| Level of satisfaction (1–5) | 5.00 [4.75;5.00] | 5.00 [5.00;5.00] | 0,737 |
| Would the patient repeat the same anesthesia? Yes | 12 (100%) | 14 (93.3%) | 1 |
| Would the patient recommend the same anesthesia? Yes | 10 (83.3%) | 14 (93.3%) | 0,569 |

Quantitative numerical variables are described as median [first quartile, third quartile] . Since they are not normally distributed and Mann-Whitney test p-value for differences between groups is reported.
Qualitative variables are described as whole numbers (%). For differences between groups in qualitative variables the Pearson's chi-squared test p-value or the Fisher's exact test p-value (if any expected frequency lower than 5) is reported.

**Table 8** Comparison of postoperative bleeding through surgical wound

| Moment of measurement | Postoperative bleeding through surgical wound | WALANT or LANT (A) | Locoregional Anesthesia and tourniquet (B) | P value |
|---|---|---|---|---|
| Day after surgery | Active bleeding through surgical wound: Minimal active bleeding (isolated drops) | 2 (16.7%) | 13 (86.7%) | 0,001 |
| | Active bleeding through surgical wound: No | 10 (83.3%) | 2 (13.3%) | |
| | Presence of blood in dressing: 1/3 blood-stained dressing | 8 (66.7%) | 3 (20.0%) | 0,05 |
| | Presence of blood in dressing: 2/3 blood-stained dressing | 3 (25.0%) | 9 (60.0%) | |
| | Presence of blood in dressing: >2/3 blood-stained dressing | 1 (8.33%) | 3 (20.0%) | |
| First visit (10–15 days) | Presence of blood in dressing: 1/3 blood-stained dressing | 1 (8.33%) | 4 (26.7%) | 0,342 |
| | Presence of blood in dressing: No | 11 (91.7%) | 11 (73.3%) | |

Qualitative variables are described as whole numbers (%). For differences between groups in qualitative variables the Pearson's chi-squared test p-value or the Fisher's exact test p-value (if any expected frequency lower than 5) is reported

 

**Table 9** Comparison of wrist mobility between both groups

| Moment of measurement | Wrist movement | WALANT or LANT (A) | Locoregional Anesthesia and tourniquet (B) | P value |
|---|---|---|---|---|
| Day after surgery | Flexion (F) | 30 [28.8;40.0] | 20 [10.0;20.0] | **0,006** |
| | Extension (E) | 30 [17.5;30.0] | 10 [6.25;27.5] | 0,175 |
| | Pronation (P) | 75 [45.0;81.2] | 43 [12.5;67.5] | 0,138 |
| | Supination (S) | 60 [22.5;80.0] | 25 [0.00;60.0] | 0,258 |
| | Ulnar deviation (UD) | 13 [5.00;20.5] | 5 [0.00;10.0] | **0,033** |
| | Radial deviation (RD) | 5 [0.00;12.5] | 5 [0.00;10.0] | 0,748 |
| First visit (10-15 days) ** | Flexion (F) | 30 [15.0;30.0] | 20 [10.0;30.0] | 0,649 |
| | Extension (E) | 10 [10.0;25.0] | 20 [12.5;35.0] | 0,225 |
| | Pronation (P) | 50 [40.0;70.0] | 70 [30.0;80.0] | 0,528 |
| | Supination (S) | 50 [42.5;60.0] | 50 [12.5;80.0] | 0,875 |
| | Ulnar deviation (UD) | 10 [5.00;15.0] | 20 [5.00;20.0] | 0,507 |
| | Radial deviation (RD) | 5 [5.00;17.5] | 10 [0.00;20.0] | 0,73 |
| First month visit** | Flexion (F) | 35 [22.5;40.0] | 20 [12.5;30.0] | 0,018 |
| | Extension (E) | 40[22.5;50.0] | 25 [20.0;40.0] | 0,24 |
| | Pronation (P) | 80 [55.0;90.0] | 90 [55.0;90.0] | 0,806 |
| | Supination (S) | 80 [50.0;90.0] | 70 [47.5;85.0] | 0,32 |
| | Ulnar deviation (UD) | 25 [17.5;37.5] | 15 [12.5;25.0] | 0,122 |
| | Radial deviation (RD) | 15 [7.50;20.0] | 15 [7.50;25.0] | 0,733 |

Numerical variables are described as median [first quartile, third quartile]. Since they are not normally distributed and Mann-Whitney test p-value for differences between groups is reported).
**Missing for the lost of follow-up patient (N = 26)

**Table 10** Comparison of finger mobility between both groups; (*)

| Moment of measurement | Place where finger is headed to reach | WALANT or LANT (A) | | Locoregional Anesthesia and tourniquet (B) | | P value |
|---|---|---|---|---|---|---|
| | | TOTAL (*) | % (*) | TOTAL (*) | % (*) | |
| Day after surgery | Line 1 | 6(1); 4(2); 2(3) | 50(1); 36,6(2); 18,18(3) | 10(1); 2(2); 3(3) | 66,67(1); 13,3(2); 20(3) | 0,492 |
| | Line 2 | 4(1); 6(2); 2(3) | 33,3(1); 54,54(2); 18,18(3) | 5(1); 5(2); 5(3) | 33,33(1); 33,33(2); 33,33(3) | 0,876 |
| | Kapandji score | 6 [5.00;7.25] | | 5 [4.00;5.50] | | 0,191 |
| First visit | Line 1 | 5(1); 4(2); 2(3) | 45,45(1); 36,6(2); 18,18(3) | 8(1); 4(2); 3(3) | 53,33(1); 26,67(2); 20(3) | 0,876 |
| (10-15 days) ** | Line 2 | 7(1); 3(2); 1(3) | 63,63(1); 27,27(2); 9,09(3) | 9(1); 2(2); 4(3) | 60(1); 13,13(2); 26,67(3) | 0,478 |
| | Kapandji score | 7.00 [6.00;8.00] | | 6.00 [5.00;7.50] | | 0,215 |
| First month visit** | Line 1 | 8 (1); 2(2); 1(3) | 72,72(1); 18,18(2); 9,09(3) | 11(1); 4(2); 0(3) | 73,33(1); 13,3(2); 0(3) | 0,625 |
| | Line 2 | 11(1) | 100(1) | 11(1); 4(2); 0(3) | 73,33 (1); 13,3(2); 0(3) | 0,113 |
| | Kapandji score | 8.00 [7.00;10.0] | | 8.00 [6.50;9.50] | | 0,573 |

Numerical variables are described as median [first quartile, third quartile]. Since they are not normally distributed and Mann-Whitney test p-value for differences between groups is reported. For differences between groups in qualitative variables the Pearson's chi-squared test p-value or the Fisher's exact test p-value (if any expected frequency lower than 5) is reported.
**Missing for the loss of follow-up patient (N = 26)

 

**Table 11** Description of anesthetic requirements

| Group | Patient's code | AO/OTA Classification | Additional anesthesia required? | Cause of need of extra anesthesia | Type of extra anesthesia |
|---|---|---|---|---|---|
| A | 4 | C3 | Yes | Insufficient anesthesia | Sedation + WALANT lateral region (5ml) |
| | 5 | C3 | Yes | Insufficient anesthesia | Sedation + WALANT DRUJ (20 ml) |
| | 8 | B3 | No | – | – |
| | 9 | C3 | Yes | Patient's preference (feeling nervous) + Insufficient anesthesia | Sedation + WALANT DRUJ (20 ml) |
| | 10 | B3 | Yes | Patient's preference (feeling nervous) + Insufficient anesthesia | Sedation + WALANT lateral region (5ml) |
| | 11 | C3 | Yes | Patient's preference (feeling nervous) + Insufficient anesthesia | Sedation + reconversion to LRA + GA |
| | 15 | C3 | Yes | Insufficient anesthesia | Sedation + WALANT DRUJ (10 ml) |
| | 18 | C3 | Yes | Patient's preference (feeling nervous) | Sedation + WALANT DRUJ (10 ml) and articular (10 ml) |
| | 20 | C1 | Yes | Patient's preference (feeling nervous) + Insufficient anesthesia | Sedation + WALANT DRUJ (10 ml) and ulnar styloid (10 ml) |
| | 23 | C3 | Yes | Insufficient anesthesia | Sedation + WALANT DRUJ (10 ml) |
| | 25 | B3 | Yes | Patient's preference (feeling nervous) + Insufficient anesthesia | Sedation + WALANT DRUJ (10 ml), articular (10 ml) and ulnar styloid (10 ml) + reconversion to GA |
| B | 1 | C3 | Yes | Patient's preference (feeling nervous) | Sedation |
| | 2 | C1 | Yes | Patient's preference (feeling nervous) | Sedation |
| | 3 | C3 | Yes | Patient's preference (feeling nervous) | GA |
| | 6 | B1 | Yes | Patient's preference (feeling nervous) | GA |
| | 7 | C1 | No | Patient's preference (feeling nervous) | Sedation |
| | 12 | C1 | Yes | Patient's preference (feeling nervous) + Insufficient anesthesia | Sedation + GA |
| | 13 | C3 | Yes | Patient's preference (feeling nervous) | Sedation |
| | 14 | C2 | Yes | Patient's preference (feeling nervous) | Sedation |
| | 16 | B3 | Yes | Patient's preference (feeling nervous) | Sedation |
| | 19 | C3 | Yes | Patient's preference (feeling nervous) | Sedation |
| | 21 | C2 | No | – | – |
| | 22 | C3 | Yes | Patient's preference (feeling nervous) | Sedation |
| | 24 | C3 | Yes | Lumbosciatic pain (patient in treatment before DRF) | Sedation |
| | 26 | B3 | Yes | Patient's preference (feeling nervous) | Sedation |
| | 27 | B3 | Yes | Patient's preference (feeling nervous) | Sedation |

 

Complications included one case of complex regional pain syndrome (CRPS) diagnosed according to Budapest criteria in the WALANT or LANT group and two cases in the AR group. No other major complications were reported.

## Discussion

The results of this study show that the WALANT or LANT technique is applicable in the osteosynthesis of DRF, and may offer some specific benefits in the population of this study related to pain and mobility.

## Comparison with the literature

Excessive postoperative hand swelling is known to be detrimental, which is why hand surgeons must make every effort to try to decrease postoperative swelling as much as possible.[21,22]

Since the beginning of the use of WALANT, the authors have had the subjective perception that avoiding the ischemia cuff reduces swelling after surgery. For this reason, swelling has been included as one of the main variables to be studied. Although no statistical differences were found, the results obtained are in line with this perception. The relationship between WALANT and postoperative swelling may be interesting to consider in future analyses.

Satisfaction was high in patients in both groups, which is in agreement with the reviewed studies.

The findings of reduced pain in the WALANT or LANT group at 10–15 days are consistent with previous studies that have reported reduced pain at 24 hours and during the early postoperative period.[11,13] However, in this study, no significant differences were observed from the first month onwards, suggesting that the early analgesic effect might not have a prolonged impact on clinical outcome.

The active bleeding observed in the AR group is consistent with studies describing increased bleeding after release of the ischemia cuff.[16,17] Some authors describe that intraoperative bleeding with the use of WALANT in DRF is greater compared to other anesthetic techniques.[11,12,15] Similar to L.M. Yi et al., (2020) the authors failed to find a reliable and reproducible way to assess bleeding during surgery.[15] Patients operated on with an ischemia cuff tourniquet had more active bleeding from the surgical wound the day after surgery, being statistically significant with a relative risk of 5.2 CI 95%1/4.[1.4, 18.7] They also had a greater amount of blood on the dressings at 24 hours and at the first outpatient visit. A reasonable explanation could be that the use of the LANT allowed for better intraoperative homeostasis. In addition, the use of a tourniquet may mask real intraoperative bleeding and therefore may influence the findings of previous studies.[11,12,15]

Apart from wrist flexion and ulnar deviation on the day after surgery, wrist or finger mobility and thumb opposition did not differ between groups or over time. Other studies have shown that long-term wrist mobility does not seem to be influenced by the anesthetic technique.[11–15]

The median difficulty with visualization of the surgical field as perceived by the surgeon was similar between groups. The WALANT has been shown to be applicable in wrist arthroscopy before.[23,24] In seven of the patients in the LANT group, we were able to use dry arthroscopy to rule out associated ligament injuries and to check the final reduction. Therefore, we believe that, with patience, LANT is not only applicable in cases of elective surgery requiring the use of arthroscopy, but also in traumatic injuries if necessary.

Surgeons reported experiencing intraoperative stress in some cases, regardless of the intervention group. When using WALANT or LANT, the surgeon was concerned about patient discomfort, whereas when using the tourniquet, ischemia time seemed to act as a counterbalance.

Most patients required additional anesthesia, regardless of the intervention group, with sedation being the most frequently required technique. However, the reason for requiring it was different. In the LANT group it was due to discomfort or because the patient was complaining of pain, while in the AR group this was mainly due to anxiety (see ►**Table 11**).

Anxiety has already been described as a cause of the need for sedation or even conversion to general anesthesia in DRF.[11,15] However, collaboration with the anesthesia service and the use of LANT may still provide some of the benefits of WALANT, such as not having to use extremity tourniquets in patients where their use may be contraindicated (see ►**Table 1**) or discouraged, such as in patients with upper extremity lymphedema following breast cancer.

Most patients in the LANT group required at least one additional injection of local anesthesia beyond that described in the first published technique by Adham Ahmad (2018)[9] that was used as a reference in the study (see ►**Table 11**). Typically, these additional doses were administered already in the operating room after performing reduction maneuvers under scopic control, before making the first incision. Durkan et al. (2020)[14] also described that they had to add additional WALANT intraoperatively in 3 of 15 patients for the same reason.

We observed that intraoperative pain occurred mainly during pronation-supination during fracture reduction, and this improved after infiltrating the ARCD with 10-15ml of local anesthetic. Before this study was conducted, only Orbach et al. (2018)[10] had described the need to infiltrate the ARCD in a patient due to pain during reduction maneuvers. After completion of this study, the reference technique was updated, describing two new injection regions including the dorsal area of the distal radius and around the ARCD in the Lalonde manual (Wide Awake Hand Surgery and Therapy Tips, 2nd Edition, November 2021).[25] This was also emphasized by Koehler SM MD in the webinar (Advanced Applications of WALANT in Hand Surgery, April 2022, ASSH). The authors are aware that it may not be easy to identify the ARCD itself, as in most cases of DRF it may be dislocated. However, adding WALANT around this region resolved most cases where patients perceived some intraoperative pain. Consequently, it is recommended to systematically infiltrate around the ARCD when administering WALANT in DRF.

 

No major complications have been described in the literature using this technique.[10,15] Neither during the performance of this study.

During the study, one patient experienced a loss of fracture reduction in the immediate postoperative period. However, the surgeon's visualization difficulty was scored as 2 on a scale of 5 and he responded "no" when asked about intraoperative stress, so this complication does not seem to be directly related to the anesthesia technique.

### Limitations of the study

Limitations of this study include the small sample size and the impossibility of completely blinding participants and the surgical team due to the nature of the anesthetic techniques. Furthermore, the results do not include long-term follow-up, which would be necessary to assess the functional impact and complication rates over a longer period of time.

## Conclusions and clinical implications

The WALANT or LANT could be a viable alternative technique for DRF osteosynthesis, and could be used in selected cases where the use of an ischemia cuff is not advisable.

The technique that was initially described and used in this study did not contemplate anesthesia in the region of the distal radioulnar joint (DRUJ). In cases in the WALANT or LANT group where anesthesia was insufficient, the incorporation of local anesthesia around the DRUJ proved to be a useful strategy for pain control during reduction maneuvers, and could be considered an improvement on the standard application of WALANT or LANT in DRF osteosynthesis.

Despite the extensive experience and familiarity of using the WALANT technique, the authors of the study emphasize that collaboration with the anesthesia service was essential during the performance of the study, so they advise their collaboration for complex cases such as osteosynthesis of distal radius fractures.

#### Informed Consent

Written informed consent was obtained from all subjects before the study.

#### Ethical Approval

Ethical approval for this study was obtained from ethics committee of our hospital "Comitè Ètic d'Investigació Clínica (CEIC) of Hospital Universitari Arnau de Vilanova de la Gerència Territorial Lleida – GSS (CEIC-2360), ensuring this study accomplishes the basic requirements needed for the Spanish law of 3rd July 14/2007 and the Biomedical Research Royal Decree-Law 18th November 1716/201 to be applied.

#### Trial Registration

ClinicalTrials.gov ID: NCT05421000.

#### Author's contribution

All of the contributors listed above have made a substantial contribution to the concept or resolved, the article; or the acquisition, analysis, or interpretation of data for the article; wrote the article or critically reviewed it for important intellectual content; approved the version to be published and agreed to be responsible for all aspects of the work to ensure that questions related to accuracy or the integrity of any part of the work are properly investigated and resolved., as stated in the *Authorship Declaration Form.*

#### Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

#### Conflicting Interests

The author(s) declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

#### Acknowledgments

First, we would like to thank Montserrat Martínez from Institut de Recerca Biomètica Lleida (IRB) and Pablo Peman Rodriguez for his patience and invaluable help with statistics and data analysis. Secondly, we would like to show our acknowledgment to the Service of Anesthesia of Hospital Arnau de Vilanova, as this work would not have been possible without their collaboration. Thirdly, we are grateful to Maria Antonia Minguell Pamies and Montserrat Rubinat Ponsoda who have helped us with bureaucracy during the study and our daily practice. Finally, we would like to thank Mireia Esplugas Mimó, who has inspired and shown hand surgeons of our country that arthroscopy can be done with WALANT.

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