



# Plating of clavicle fracture using the wide-awake technique

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**Background:** Fixation of clavicle fractures has now become a more popular option as it provides better outcome compared with conservative management. Wide-awake local anesthesia no tourniquet (WALANT) has been effectively used in plating of distal radius and olecranon fractures. This paper expands the usage of WALANT into the shoulder girdle, namely plating of the clavicle that has not been described. The operation is typically performed under general anesthesia.

**Methods:** We report a case series of 16 patients who successfully underwent fixation of the clavicle under the wide-awake technique. The clavicle fractures were grouped under the AO Fracture Classification. The WALANT solution comprised 1% lidocaine, 1:100,000 epinephrine, and 10:1 sodium bicarbonate. A total of 40 mL was injected in each patient with 10 mL subcutaneously along the clavicle followed by 30 mL subperiosteally at multiple intervals and directions.

**Results:** The Numerical Pain Rating Score was 0 during WALANT injection and during surgery except for 2 patients with Numerical Pain Rating Scores of 1 and 2, respectively, during reduction.

**Conclusion:** We conclude that clavicle plating under WALANT is a good alternative option of anesthesia.

**Level of evidence:** Level IV; Case Series; Treatment Study

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**Keywords:** WALANT; local anesthesia; lignocaine; adrenaline; shoulder girdle; plating

Clavicle fractures occur in 2%-5% of adult fractures and 44%-66% of shoulder fractures.<sup>16,17</sup> Approximately 70% of the fractures reported occur in male patients.<sup>12</sup> It is often sustained as a sports injury or a road traffic accident injury.<sup>7</sup>

The fracture commonly involves the midshaft of the clavicle (69%-82%). Lateral and medial clavicle fractures constitute 12%-26% and 2%-6%, respectively.<sup>7,12</sup>

Traditional management to clavicle fractures, regardless of type, frequently employs a conservative approach. Various studies in the 1960s described favorable functional outcomes and lower nonunion rates for clavicle fractures that were treated nonoperatively as compared with those that had primary open reduction done.<sup>7,15</sup> In contrast,

Institutional review board approval was not required for this case series.

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**Figure 1** Planned surgical incision (.....) over the outline of the fractured clavicle. The dotted line denotes the area for tumescent anesthesia. “X” denotes the deep periosteal injection sites.

studies conducted in recent years showed that fixation of clavicle fractures provided better outcome.<sup>3,6,13,14,18</sup>

Fixation of clavicle fracture is typically performed under general anesthesia. For a patient with associated chest injuries compounded with multiple comorbidities, surgery may be delayed allowing optimization of the patient for safe general anesthesia.

The wide-awake local anesthesia no tourniquet (WALANT) approach provides an alternative for these groups of patients. The approach allows the operation to be performed while the patient remains awake and without sedation. Anesthesia is provided with the WALANT solution that comprises large volumes of diluted neutralized lidocaine and epinephrine injected into the surgical field area.

This tumescent anesthesia concept, together with the proper administration of the WALANT solution, results in a comfortable and painless surgery.<sup>8,9</sup>

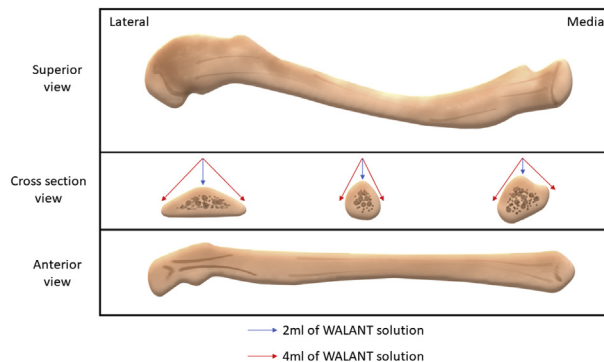
The objective of this study is to demonstrate the possibility of plating a clavicle under wide-awake surgery as another option to general anesthesia.

## Methods

The study was conducted in a tertiary hospital in Malaysia between January 2019 and April 2019. Sixteen patients with clavicle fracture indicated for surgery were enrolled into our study. The inclusion criterion was adults above 18 years old. The exclusion criteria were the presence of open fractures, fractures in other bones, polytrauma, and unstable cases. Informed consent regarding the surgical and anesthetic procedure was obtained from all patients. This study was approved by our hospital committee.

## Anesthetic technique

Preoperatively, the surgical approach was determined based on the fracture configuration. We opted for the superior approach for



**Figure 2** Superior, cross-sectional, and anterior views of the right clavicle bone depicting the angle of WALANT injection. WALANT, wide-awake local anesthesia no tourniquet.

better soft tissue coverage after clavicular fixation. An interrupted line was drawn along the planned skin incision (Fig. 1).

The WALANT solution was prepared with the combination of 1% lidocaine, 1:100,000 epinephrine, and 10:1 8.4% sodium bicarbonate. From this concoction, we used 7 mg/kg of lidocaine with epinephrine to strictly adhere to the recommended maximum safe dose.

For the wide-awake anesthesia technique, initially we administered a total of 10 mL of subcutaneous WALANT solution with a 27-gauge needle along the planned incision site. This was followed by another layer of WALANT solution injected at 3 multiple intervals along the clavicle under the periosteum using a 23-gauge needle. At each site, 2 mL of the solution was injected in a vertical manner subperiosteally followed by another 4 mL directed anteriorly and a further 4 mL directed posteriorly amounting to 10 mL (Fig. 2). Thus, 30 mL was injected subperiosteally. This step will ensure a painless surgery especially during the reduction and plating of the clavicle. In total, 40 mL of WALANT solution was injected. This is similar to our previous technique we used in distal radius and olecranon plating.<sup>1,2</sup>

Objective and quantitative assessments are performed on the patient during the injection as well as during the perioperative period by evaluating Numerical Pain Rating Score (NPRS).<sup>4</sup> The presence of the side effects of lidocaine and epinephrine is monitored cautiously throughout the procedure. The presence of pain is assessed before skin incision by palpating the fracture site. An NPRS rating of 0 indicates adequate anesthesia and allows the surgery to be performed (Supplementary Video 1). If pain is present, an additional WALANT solution can be added until the NPRS is 0.

Lalonde and Martin<sup>9</sup> described that the time to maximal vasoconstriction after injection of lidocaine and epinephrine is 25 minutes. Under WALANT, patients were able to lift up their arm without any pain during painting and draping (Fig. 3).

A stack of drapes was placed posterior to the scapular to protrude the clavicle for easier fixation. We did not use a sandbag as that was too hard and firm for our patients. The head of the patient was then tilted and rotated to the unaffected side. This positioning was done after the WALANT injection to ensure painless manipulation of the fracture side.

Epinephrine minimizes bleeding at the surgical field resulting in a clear intraoperative picture (Fig. 4). No additional WALANT solution is introduced if the NPRS remains 0 throughout



**Figure 3** Preoperative picture of the patient lifting his right upper limb after WALANT injection showing no pain (Numerical Pain Rating Score 0) during the povidone iodine application. WALANT, wide-awake local anesthesia no tourniquet.

operation. If the patient complains of pain during the procedure, the WALANT solution is injected to the targeted pain area without exceeding the toxic dose of lidocaine and epinephrine (7 mg/kg). After the fixation, the patient is able to actively move his affected shoulder to check the stability of our fixation intraoperatively ([Supplementary Video 2](#)).

### Postoperative management

NPRS are recorded at 2 hours and 24 hours postoperatively, with continued monitoring for the adverse effects of epinephrine and lidocaine. Postoperative analgesia includes subcutaneous opioids and nonsteroidal anti-inflammatory drugs until the patient is allowed for discharge.

Before discharge, the patient is counseled for shoulder range of motion exercise. On discharge, the patient is prescribed with oral analgesics and given an appointment date for wound inspection and removal of external stitches.

### Pearls and pitfalls

On administering the WALANT solution to the subperiosteal layer, ensure that the needle tip lies under the periosteum. Without withdrawing the needle, it is then directed to the posterior border and anterior border of the clavicle. This is to ensure adequate anesthesia to the periosteum, endosteal, and bone marrow.

If a patient has a displaced and rotated transverse fragment of the midshaft clavicle, an extra 5-10 mL of WALANT solution must be injected intraoperatively during fracture reduction to ensure that the deepest part of the fragment is well anesthetized.

Aching of the neck and shoulder girdle is commonly encountered during the procedure. If the patient complains of aching, temporarily stop the surgery to allow the patient to stretch out his neck and shoulder.

Careful administration of local anesthesia requires a keen familiarity of the anatomical structures surrounding the clavicle. This precaution is necessary to minimize the risk of injury to the lung apex lying deep to the clavicle as well as divisions of the



**Figure 4** Intraoperative picture showing a clear surgical field after WALANT injection. WALANT, wide-awake local anesthesia no tourniquet.

trunks of the brachial plexus and subclavian vessels passing behind the medial two-thirds of the clavicle.

### Results

All 16 patients successfully underwent clavicle fixation under the wide-awake technique without sedation or conversion to general anesthesia. The longest operative time was 150 minutes and the shortest was 50 minutes (mean, 108 minutes). The most common fracture pattern was AO Classification 15.2C with 5 patients and 15.2B with 4 patients.

The intraoperative NPRS were 0 for all patients except for patients 5 and 11 ([Table I](#)). They had a displaced and rotated transverse fragment that had moved inferiorly. Both had an NPRS of 0 at the beginning of the operation but had NPRS of 1 and 2 during reduction. A further 5 mL of WALANT solution was injected at the displaced fragment as it was much deeper than the other fragments. The NPRS returned to 0 during fixation.

Surgery under wide-awake anesthesia offers a shorter waiting time duration compared with general anesthesia, as evidenced in 5 patients—patients 2, 5, 7, 11, and 14 ([Table I](#)). All 5 patients presented in the emergency department



**Table I** Demographic of patients who underwent clavicle fixation under WALANT

Patient no.	Age	Sex	AO Fracture Classification	Indication for surgery	Duration before surgery (d)	Operation	Duration of surgery (min)
1	35	Male	15.2A	Floating shoulder	19	Locking compression plate	65
2	24	Male	15.3A	Displaced fracture	4	Hook plate	90
3	54	Male	15.2B	Displaced fracture	18	Lag screws and locking compression plate	100
4	25	Female	15.3Ab	Delayed union	64	Hook plate	125
5	19	Male	15.2B	Comminuted fracture with a displaced and rotated transverse fragment	2	Locking reconstruction plate	95
6	25	Male	15.2B		Delayed union	57	Locking compression plate
7	29	Male	15.2B	Displaced fracture	5	Locking compression plate	75
8	18	Female	15.3Ab	Displaced fracture	10	Hook plate	150
9	20	Male	15.2A	Displaced fracture	11	Locking compression plate	145
10	23	Male	15.2C	Displaced fracture	20	Lag screw and locking compression plate	50
11	23	Male	15.2C	Comminuted fracture with a displaced and rotated transverse fragment	21	Locking compression plate	120
12	44	Male	15.2C		Comminuted fracture	54	Locking compression plate
13	22	Male	15.2C	Displaced fracture	44	Locking compression plate	155
14	22	Male	15.2C	Displaced fracture with skin tenting	7	Locking compression plate	135
15	23	Male	15.3Ac	Displaced fracture	14	Hook plate	130
16	21	Male	15.3Aa	Displaced fracture	9	Hook plate	68

WALANT, wide-awake local anesthesia no tourniquet.

and were subsequently offered for surgical fixation under wide-awake anesthesia. The surgery was performed within 7 days of their trauma date compared with the other patients referred from other hospitals with a post-trauma date of more than 7 days and up to 64 days.

Figure 5 shows the NPRS scoring for each patient during the perioperative period. The NPRS is constantly 0 for all phases of the procedure except in patients 5 and 11, with the NPRS of 1 and 2, respectively.

Two hours after the surgery, the anesthesia effect began to diminish and the patients started experiencing pain. We prescribed nonsteroidal anti-inflammatory drugs and opioids beginning at 2 hours postsurgical wound closure. Reassessment was done at 2 and 24 hours postoperatively (Fig. 6).

Anecdotally, we specifically enquired our patients whether they would agree with the same WALANT procedure in the event of a similar surgery and all of them answered positively. All our patients were able to start doing range of motion exercises within 24 hours after operation. Abduction of the shoulder was up to a minimum of 90° in all patients.

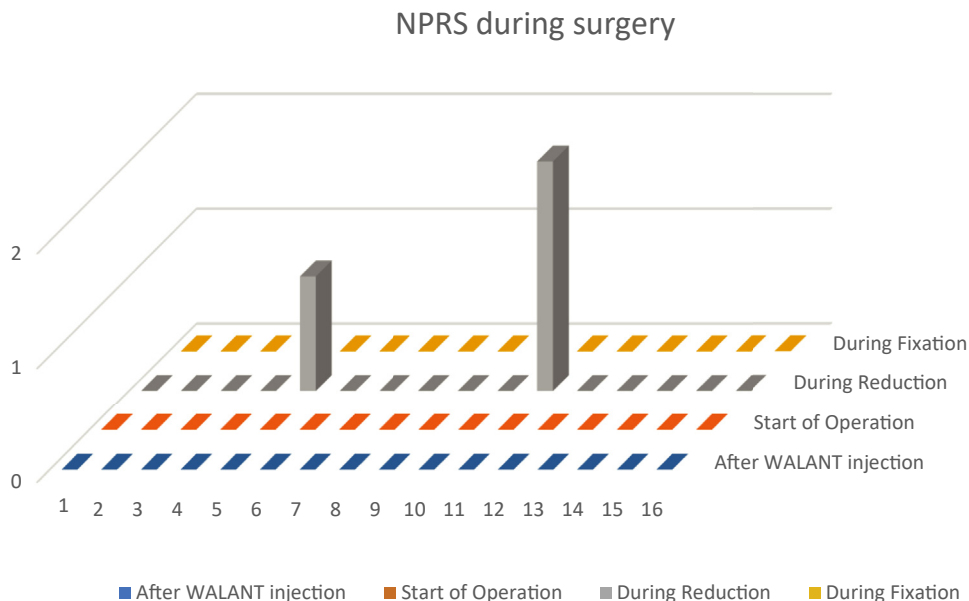
## Discussion

There is a remarkably rich and heterogeneous sensory innervation at the bone marrow, mineralized bone, and periosteum. The periosteum has the densest sensory innervation, followed by the bone marrow and then mineralized bone.<sup>10</sup>

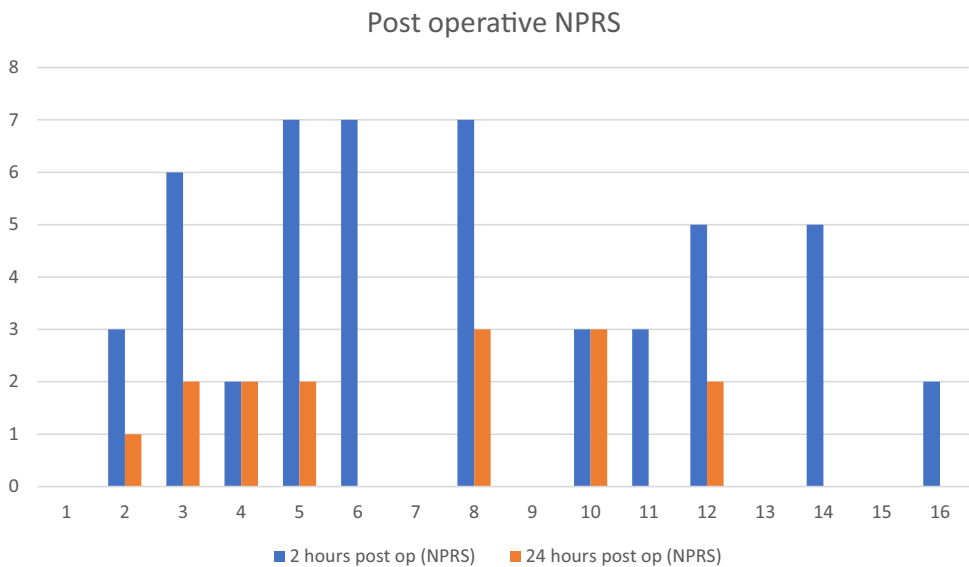
In our opinion, the technique of giving injection subperiosteally blocks the substance P-immunoreactive fibers together with calcitonin gene-related peptide-immunoreactive fibers. Recent studies show that there are hundreds of capillaries from named transcortical vessels discovered along the entire bone shaft that cross the cortical bone perpendicularly and form a direct connection between the endosteal and periosteal circulation.<sup>5</sup>

By injecting subperiosteally, lignocaine will go through transcortical vessels to the endosteal and bone marrow circulation, subsequently blocking the sensory fibers.

Fracture fixation under wide-awake surgery has proven to be safe for distal radius fracture.<sup>1</sup> However, there is no known English-language literature describing fracture fixation under WALANT for fractures proximal to the distal



**Figure 5** NPRS during surgery. *NPRS*, Numerical Pain Rating Score; *WALANT*, wide-awake local anesthesia no tourniquet.



**Figure 6** Postoperative NPRS. *NPRS*, Numerical Pain Rating Score.

radius, nor the shoulder girdle. WALANT surgery has expanded its limits to large areas of soft tissue injuries, tendon transfers, and spaghetti wrists. We now have successfully expanded it to the clavicle region.

The technique of injection and amount of WALANT solution into the radius and olecranon<sup>1,2</sup> is similar to the clavicle. In fact, usage of WALANT in the clavicle is much

easier as it is very superficial with much less surrounding muscle and neurovascular structures.

In cases of clavicle fractures with a rotated displaced segmental fracture, we found that the deepest part can only be adequately anesthetized after exposing the fracture site. These are our only 2 cases with the NPRS of 1 and 2 during reduction.

Patient 1 (Table I) had a floating shoulder and traumatic chest injury. His definitive surgery for clavicle fracture was delayed until he was deemed medically fit. Even so, the general anesthesia was deemed as high risk by the anesthesiologist. As an alternative to obviate the risks of general anesthesia, the wide-awake local anesthesia technique was offered to him.

In our setting, the availability of general anesthesia is limited due to the high volume of trauma patients needing surgery. This usually leads to delay in providing surgical care for a closed fracture of the upper limb as in clavicle fractures. As an example, patient 4 (Table I) was initially planned for surgical fixation under general anesthesia. Unfortunately, her surgery was postponed multiple times because of the lack of operating time. She was offered surgical fixation under the wide-awake local anesthesia technique to avoid further delays. Patient 6 (Table I) initially opted for conservative management. However, after 8 weeks of post-trauma, he complained of pain over his fracture site with moderate tenderness on palpation. He was offered surgery under wide-awake local anesthesia, and the procedure was arranged within 2 weeks. The same situation occurred for patients 3, 10, 12, and 13 (Table I) where they initially opted for conservative management but changed their minds a few weeks later.

The comfort and painless experience while maintaining the patient's consciousness and minimizing hemodynamic disturbance is a huge advantage of this method of anesthesia. All our patients were comfortable during the surgery and made good recovery postoperatively.

Although we did not measure minute by minute the return of pain of each patient, we are aware that at 2 hours after surgery, the patient began to experience pain. This would be approximately 4-6 hours after the initial WALANT injection. A study of WALANT in trigger fingers has a duration of pain relief lasting for 6.86 hours.<sup>11</sup> We suggest starting the postoperative analgesia immediately after the surgery before the pain begins. A further study focusing on pain perception after WALANT surgery would be beneficial to compare with traditional surgery under general anesthesia.

A stack of drapes has to be placed posterior to the scapula to protrude the clavicle for easier fixation. Although this positioning is done after the WALANT injection, the patient commonly feels discomfort with the head tilted toward the unaffected side usually after about an hour of surgery. Under general anesthesia, it is common to place a sandbag; however, this is too hard and uncomfortable for awake patients.

Once patients experience discomfort during surgery, we withhold surgery for 5-10 minutes to allow the patients to stretch their neck and shoulder to relieve the discomfort. We then proceed to complete the surgery. We have never had to resort to this more than once during surgery.

## Conclusion

We recommend clavicle plating under WALANT as an alternative option to general anesthesia in selected patients or in settings with limited anesthetic facilities. Clavicle plating under WALANT has proven to be reliable and effective in our case series. The only limitation is possible patient discomfort in prolonged surgeries lasting more than an hour.

## Disclaimer

The authors, their immediate families, and any research foundations with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

## Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jse.2020.03.003>.

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