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Ultrasound-Guided Subparaneural Axillary Block in Sub-Saharan Africa: A Prospective Multicenter Study and Review of Literature

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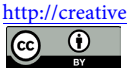

Abstract

Context: Subparaneural injection (under the nerve sheath) has reduced the onset of action and the effectiveness of local anesthetics in sciatic blocks. The objective of this work was to assess the effectiveness of this technique in axillary blocks in two hospitals in France and Gabon. **Method:** From January 1 to February 28, 2019, patients were included for upper limb surgery under xylocaine or Ropivacaine. The installation time, effectiveness, occurrence of paresthesia, and vascular breaches were assessed. **Results:** 141 patients were included, mostly male (64.55%), with an ASA 1 score (46.1%), hand surgery predominated (95%) most often performed as scheduled surgery (68.1%). Block was performed by the anesthesiologist in 39% of patients and by the anesthesiologist student in 61% of patients. The success rate was 88.66% with an installation time of 15 min, some paresthesias were noted. Despite the lack of expertise from a Gabonese hospital center, the data were compared to the literature. **Conclusion:** Ultrasound-guided subparaneural injection axillary block is an effective, safe technique with a rapid learning curve.

Keywords

Axillary Block, Perineural, Ultrasound, Guided

1. Introduction

Axillary block (Bax) is a technique of locoregional Anesthesia (LRA) allowing

the anaesthesia of the brachial plexus in the axillary fossa. It is the reference technique for surgery of the elbow, forearm, wrist, and fingers.

Previously, the surgeon, using an open nerve approach, injected cocaine derivatives directly into the nerve, then the anaesthetists performed percutaneous injections in search of paresthesias [1] and then trans-arterial blocks. All these "blind" techniques have been abandoned due to vascular-nervous complications and high failure rates [2] [3] in favour of neurostimulation.

Currently, locoregional anaesthesia under ultrasound has improved the efficiency and reduction of vasculo-nervous lesions.

In Africa and Gabon, axillary blocks have been performed for a long time, initially under neurostimulation alone [4] [5] then, more recently, under ultrasound by perineural infiltration coupled with the neurostimulator with acceptable success rates [6] [7]. Recently, an ultrasound-guided subparanasal injection technique (TISPE) has been described, *i.e.* an injection under the sheath surrounding the nerve [8]. This technique was initially used in sciatic blocks with satisfactory results in terms of the time taken to set up and the effectiveness of the sensory-motor block [9]. Analyses with magnetic resonance imaging showed a low rate of intrafascicular injection type nerve lesions with the perineural infiltration [10].

The objective of the study was to evaluate the axillary block by the technique of subparaneural injection under ultrasound (TISPE) in two hospitals in France and Gabon.

2. Materials and Methods

The study took place in the ambulatory anaesthesia unit of the operating theatre and surgical resuscitation unit of the Emile Muller regional hospital in Mulhouse (CHREMM) in France and in the operating theatre of the Hôpital d'Instruction des Armées Omar Bongo Ondimba (HIAOBO) in Libreville, Gabon. Prospective descriptive study over a two-month period, from 1 January to 28 February 2019.

Study population:

Patients are admitted to the outpatient surgery unit for upper limb surgery (Emile Muller regional hospital centre in Mulhouse), as outpatient care is underdeveloped at the HIAOBO, and patients are hospitalised for upper limb surgery in both hospitals.

Inclusion criteria:

- ✓ Scheduled or emergency upper limb surgery;
- ✓ Age over 17 years.

Non-inclusion criteria:

Patient refusal, loco-regional infection, pregnancy, neoplasia of the axillary region or upper limb, pre-existing peripheral neurological disorders, coagulation disorders and other truncal loco-regional anaesthetic techniques.

Protocol:

As the HIAOBO does not practice the technique, training of senior anesthesiologist was carried out by an anesthesiologist trained at the CHREMM, training

which took place over a period of one month.

Axillary block was performed in the pre-induction room (CHREMM) or in the recovery room (HIAOBO) in perfused and monitored patients. Pre-medication was not systematic, if necessary, Midazolam was administered.

1) The technique of subparaneural injection under ultrasound (TISPE) Patient in supine position with upper limb at 90˚ abduction and forearm in extension. The approach of the nerves in the plane and injection of local anaesthetic under the paraneurium up to 5 ml per peripheral nerve, injection with aspiration test. The aim was to administer a volume of between 25 and 30 milliliters for all the nerves in the axillary fossa.

The image sought was a "cocarde" image observable in the short axis with the paraneurium appearing as a hyperechoic sheet surrounding the local anaesthetic which appears hypoechoic while the peripheral nerve presents itself sonographically as a "honeycomb" image, in the long axis the "cocarde" image presents itself as a hypoechoic longitudinal perineural pool [9] (**Figure 1**). The local anaesthetics used were either lidocaine 1.5% and 2% adrenalized (HIAOBO and CHREMM), or ropivacaine 3.75 mg/ml (CHREMM).

2) After the axillary block:

After local anesthetics injection, the sensory and motor block were evaluated every 5 minutes for 40 minutes by an independent observer (author OKOUE ONDO), who was not present during block administration and was blinded to the injected volume. Using a 23-gauge needle and cold ice, the observer assessed the sensory block in the distributions of the radial nerve (the front of the thumb), and median nerve (the fingertips). Additionally, the presence of motor blockade was tested in the radial nerve (wrist and finger extension), median nerve (flexion of fingers or wrist) and musculocutaneous nerve (flexion of the forearm on the arm). The sensory and motor blockades were graded on a 4-point scale (**Table 1**).

The block was considered a success if anesthesia and paresis were achieved within 40 minutes (a score of 3 for both sensory and motor nerves). The anaesthesia was considered satisfactory if there was no pain perception or motor response to commands. In case of failure, a complementary trunk block was performed. If the anaesthesia failed, marked by pain at the tourniquet or incision, either sedation with Propofol-Remifentanil or General Anaesthesia with laryngeal mask or oro-tracheal intubation was performed. After surgery, the Post Interventional Monitoring Room (PIMR) was admitted for patients who failed. The other patients returned directly to the outpatient department or conventional surgery.

Studied variables:

Age, weight, sex, ASA classification, surgical indications, time to achieve locoregional anaesthesia, time to install and effectiveness of sensory-motor block. The volume of local anaesthetic administered, the success rate, the failure rate, the complications of the axillary block and the modalities of the return home.

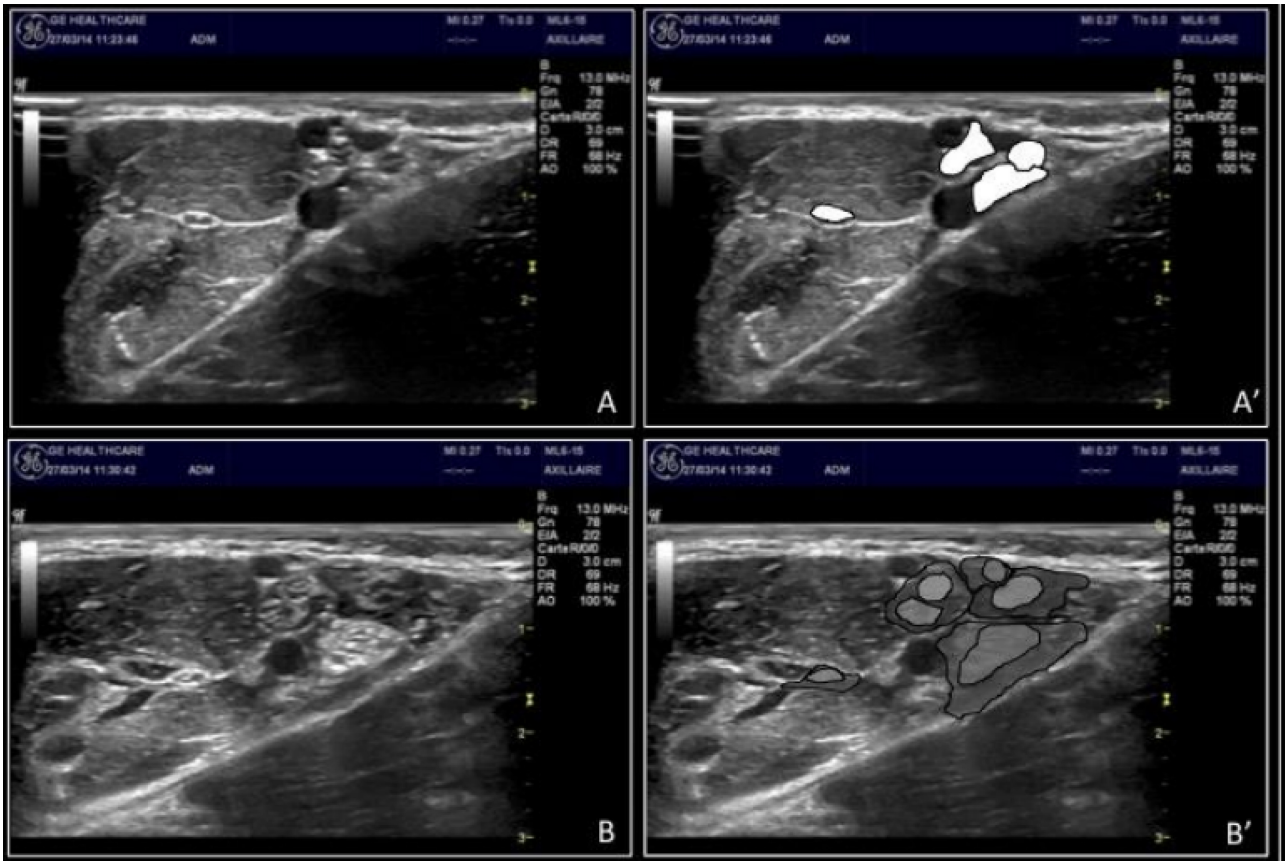

Figure 1. Ultrasound images of the axillary fossa before (A and A') and after (B and B') TISPE (nerves and pools of local anaesthetic superimposed on sections A' and B') [11].

Table 1. Assessments of sensory and motor blocks.

Sensory block	
0	Normal sensation (normal senses of cold, pain, and touch, same as on the opposite site)
1	Hypoalgesia (decreased senses of cold, pain, and touch compared with the opposite site)
2	Analgesia (no feeling of cold or pain, but the patient can feel touch)
3	Anesthesia (no sense of cold, pain, and touch)
Motor block	
0	Normal movement (the patient can move against resistance and gravity
1	Decreased movement (decreased strength compared with the opposite site)
2	Paresis (the patient can move against gravity, but not against resistance)
3	Paralysis (no movement)

Data analysis:

The primary outcome variable was the efficiency of motor and sensory block for surgical anesthesia.

The categorical variables are presented as a number with a percentage in parentheses. Summary statistics were calculated using SPSS 20.0.

No statistical analysis was carried out as the study is purely descriptive.

3. Results

Of 378 patients eligible for surgery, 141 were included in the study, with demographic characteristics of the study population summarized in Table 2.

The axillary block was performed by anaesthetists in 55 (39%) patients and by anaesthesia student in 86 (61%) patients. Table 3 shows the data for axillary block in TISPE.

The block was considered successful in 125 patients, a success rate of 88.66%. There were 16 failures. Return home after surgery in 78.7% of patients.

4. Discussion

The aim of the study was to evaluate the effectiveness of the axillary block using the technique of sub-perianal injection under ultrasound (TISPE) in the operating theatre of the Emile Muller regional hospital in Mulhouse and HIAOBO hospital.

Some studies have compared perineural and paraneural techniques (Table 4).

4.1. Time to Complete the TISPE

The time to perform an axillary block with TISPE was 8.62 minutes. For Genin, the TISPE block was performed in 4.9 minutes [11]. Vinuta found a longer time

Table 2. Demographic characteristics.

Variables	Numbers (%)
Men	91 (64.55%)
Women	60 (45.45%)
ASA score	
- ASAI	65 (46.11%)
- ASAII	58 (41.13%)
- ASAIII	18 (12.76%)
Context	
- Emergencysurgery	45 (31.91%)
- Scheduledsurgery	96 (68.08%)
Surgery	
- Hand'ssurgery	134 (95.04)
- Other upper limbsurgery	07 (4.96%)

Table 3. Axillary block results in TISPE.

Variables	values
Average completion time (min)	8.62
Average installation time (min)	15
Success rate (%)	88.66
Average volume of local anaesthetic (ml)	27.4
Paresthesias	02
Vascular Effraction	0

Table 4. Performance of perineural axillary block according to the literature review.

Variables	our study	GENIN [11]	VINUTA [12]	BERNUCCI [16]	UDAY [18]
Anaesthesia duration (min)	8.62	4.9	14.53	15.7	
Installation time (min)	15	12	13.86	13.8	14.62
Success (%)	88.66	100	94.53	96	96.66
Volume oflocal anaesthesic (ml)	27.4	20	NA	NA	NA
Paresthesias	02	0	0	0	0
Vascular effraction	0	0	0	0	0

NA: not available (non disponible).

to perform the block compared to the perineural technique [12]. Our result is linked to the learning curve, mainly at HIAOBO, where the interns and anaesthetists at the beginning of their training took longer to perform the block. In the study by Matsanga, the ultrasound-guided axillary block using the classic perineural technique was performed in 6.5 minutes compared with 10 minutes for the axillary block using neurostimulation alone [7] and 7 minutes for Casati [13].

4.2. Time to Installation

The installation time of our block in TISPE was 15 minutes. In a study comparing perineural and subparaneural axillary blocks, Génin found a significantly different time to action in favour of the subparaneural group (12 min, compared with 19 min) [11]. Vinuta found a significantly shorter installation time for the perineural route (13.86 versus 19.48) [12].

By comparison, the study by Matsanga in Gabon found an installation time of 8.87 minutes under conventional ultrasound guidance versus 15 minutes under neurostimulation alone [7] and 7 minutes for Casati [13] the study by Chan found 12.03 minutes [14].

4.3. The Sensory-Motor Block

Motor block was complete in 125 (88.66%) patients after 15 minutes; Genin found motor block in all patients after 15 minutes [11]. Results in relation to the number of failures. Thus, axillary block by TISPE would allow a rapid installation of motor block.

4.4. Volume of Local Anaesthetic

Our average volume of local anaesthetic was 27.4 ml. In Génin [11], it was 20 ml. Matsanga found a mean volume of 22.15 ml under ultrasound-guided perineural axillary block and 38 ml in exclusive neurostimulation [7], Gonzales found a mean volume of 23 ml [15], Casati found 20.5 ml [13].

4.5. Success Rate

It was 88.66% in our series. Genin found a success rate of 100% in the subparaneural group and 90% in the perineural group, a non-significant difference [11]. Vinuta and Francisca Bernucci did not find superiority over the perineural technique [12] [16]. The difference is certainly linked to failures and the learning curve, particularly at the HIAOBO where the technique is very recent.

4.6. Complications

Two patients (1.41%) had regressive paresthesia on the territory of radial and median nerves, these paresthesias benefited from regular neurologic exams and magnetic resonance imaging (normal in our cases). Génin reported transient and regressive paresthesias. No cases of intraneural injection were described in our series, as was the case for Génin [11].

By way of comparison, Orebaugh SL found 10% of paresthesias during axillary block with neurostimulation alone and 2% under ultrasound [17].

4.7. Return Home

The majority of patients (78.72%) went home after a few hours in the outpatient surgery unit, while 21.3% remained in the hospital because their schedules were not compatible with the opening hours of the outpatient surgery unit.

4.8. In Summary

The studies on axillary block by TIPSE point in the same direction in terms of safety, reduction of vascular punctures, but all present a high number of needle passages in the tissues increasing the theoretical risk of nerve damage (**Table 3**). Uday's study which compared the perineural and paraneural techniques using

Levobupivacaine shows that que the choice of local anesthetic does not seem to play a role in efficacy; he concluded that the position of the needle relative to the nerve fibers plays a major role [18].

5. Limitations of the Study

A randomised controlled study comparing the peri-neural and para-neural techniques would have allowed a better understanding of the possible superiority of one technique.

6. Conclusion

At the end of this work, it appears that the axillary block by echo-guided subparaneural injection has several advantages in terms of effectiveness and safety, with a rapid learning curve. The studies by Génin [11], Vinuta [12], and Bernucci [16] all show the superiority of the paraneural technique in terms of installation time and the reduction of vascular punctures, but the lengthening of anaesthesia time with efficiency similar to the perivascular technique. These data are close in terms of efficiency to the results obtained with the classic echo-guided axillary block. These results are clearly better than those obtained under exclusive neurostimulation, confirming the role of ultrasound in the improvement and prevention of accidents and incidents during perineural ALR. This technique is compatible with ambulatory surgery.

Authors' Contributions

G. Edjo Nkilly: principal investigator HIAOBO, drafting the manuscript.
A. Gombako: principal investigator CHR Mulhouse.
N. Saumier: investigator CHR Mulhouse.
R. Okoue Ondo: inclusion and follow-up of HIAOBO patients.
R. OBAME: reading of the manuscript.
R. Tchoua: reading and final approval of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

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