Scientific
Research
Publishing

Locoregional Anesthesia in a Resource-Limited Country: Can Lidocaine 1.5% with Adrenaline Be an Alternative to Ropivacaine 0.5% for Ultrasound-Guided Axillary Blocks?

J. Donamou[1*], M. L. Camara[1], A. Bangoura[2], A. D. Traoré[1], M. L. Bah[3]

[1]Anesthesia Department of Donka National Hospital, Conakry, Guinea
[2]Anaesthesia Department of the Ignace Deen National Hospital, Conakry, Guinea
[3]Orthopaedics Department of the Ignace Deen National Hospital, Conakry, Guinea
Email: *donamoujoseph@yahoo.fr

Abstract

Background: The ultrasound-guided axillary block is a block commonly used in upper limb surgery. Several local anaesthetics can be used to obtain an effective block. These include ropivacaine 0.5% and lidocaine 1.5% with adrenaline. **Objective:** To evaluate lidocaine 1.5% with adrenaline as an alternative to ropivacaine 0.5% for ultrasound-guided axillary blocks. **Methodology:** This was a 6-month prospective and randomized study (July 15, 2019 to January 15, 2020) conducted in the Department of Anesthesia at Ignace Deen National Hospital in Conakry, Guinea. **Results:** A total of 38 patients were enrolled: 19 in each group. The mean age was 45.8 ± 16.9 years in the lidocaine with adrenaline group compared to 43.9 ± 20 years in the ropivacaine group. The mean onset time in the lidocaine group was 6.8 ± 2.1 minutes compared to 8.3 ± 2.4 minutes in the ropivacaine group (p = 0.04). The mean duration of axillary block was 233.3 ± 57.5 minutes in the lidocaine group versus 260.4 ± 74 minutes in the ropivacaine group (p = 0.21). The performance was identical in both groups with 89.5% of the effective blocks in the lidocaine group and in the ropivacaine group (p = 1). The cost of consumables for the ropivacaine group was 60 euros compared to 15 euros for the lidocaine group. **Conclusion:** Lidocaine 1.5% with adrenaline is a good alternative to ropivacaine 0.5% for ultrasound-guided axillary blocks in resource-limited countries.

Keywords

Lidocaine, Ropivacaine, Resources-Limited Country, Guinea

1. Introduction

Ultrasound-guided axillary blocks are commonly used for upper extremity surgeries [1]. Several local anesthetics can be used to achieve an effective block. These include ropivacaine and lidocaine with adrenaline. In clinical practice, these local anesthetics differ in their pharmacokinetics properties [2]. Ropivacaine is a local anesthetic of high anesthetic potency. It is characterized by a short onset of action, a long duration of action and low neurotoxicity and cardiotoxicity [3] [4]. Lidocaine, on the other hand, is a medium-potency local anesthetic. Its duration of action varies depending on the injection site and whether or not a vasoconstrictor is added [3] [4]. Its onset time is short and depends on the concentration of the anesthetic solution [4]. These two local anesthetics are frequently used for locoregional anesthesia [1] [2]. Bouaziz H. *et al.* [5] in a study that compared the efficacy of two anesthetics in the axillary block reported an advantage of lidocaine 1.5% adrenaline over mepivacaine. Another study by Hickey R. *et al.* [6] showed that the action of ropivacaine is as effective as bupivacaine in terms of anaesthesia but the onset of block is faster with ropivacaine. Moreover, the differential block is superior to that of Bupivacaine while the sensory block is the same and motor block is slightly less than that of Bupivacaine. In the literature, studies comparing ropivacaine and lidocaine adrenaline in ultrasound-guided axillary block are rare. The objective of this study was to evaluate 1.5% lidocaine adrenaline as an alternative to 0.5% ropivacaine for ultrasound-guided axillary block.

2. Patients and Methods

This was a prospective, randomized, single-blind study conducted over a period of 6 months (July 15, 2019 to January 15, 2020) in the anesthesia department of the Ignace Deen National Hospital in Conakry. After obtaining the informed consent of all patients in this study, we included 38 ASA I and II patients aged 12 - 80 years who had an ultrasound-guided axillary block for osteosynthesis of the 2 bones of the forearm. We excluded all forearm osteosynthesis performed under general anesthesia. Other exclusion criteria were suspected or known allergy to local anesthetics and patient refusal. The number of patients in the two groups was defined according to the availability of ropivacaine. Patients were divided into two groups: 19 patients in the lidocaine adrenaline group and the remaining 19 in the ropivacaine group. The nature of the local anesthetic injected was determined by randomization from a list proposing the protocol of the lidocaine group or the ropivacaine group. The ultrasound-guided axillary blocks were performed by the same anesthesiologist. All patients had a pre-anesthetic consultation 24 hours before the procedure. They were admitted to the operating room on an empty stomach with a peripheral venous line and pre-medicated with Atarax at a dosage of 1 mg per kg. Patients were monitored for blood pressure, SpO2, and heart rate. After surgical hand washing of the operator, wearing of sterile gloves and the patient on the operating table, the puncture site was ex-

tensively aseptic and gel was applied at the site of application of the ultrasound probe (SonoSite Nano Maxx® ultrasound scanner). All blocks were performed in with a B BRAUN needle, Stimuplex® Ultra 0.7 × 50 mm 22 G and a 12 - 15 Hz linear ultrasound probe. The nerves were ultrasonographically located, the needle was inserted laterally to the probe in the plane and ultrasonically guided to the nerves to be anesthetized. Once at this level, a defined volume of the local anesthetic solution (lidocaine 1.5% adrenalin 1/200,000 or ropivacaine 0.5%) was injected. Patients were not provided with information on the type of local anesthetic used for their block.

For lidocaine 1.5% adrenaline 1/200,000, a total of 30 ml was injected as follows: 8 ml for the median nerve, 8 ml for the ulnar nerve, 8 ml for the radial nerve and 6 ml for the musculocutaneous nerve.

For ropivacaine 0.5%, a total of 23 ml was injected as follows: 6 ml for the median nerve, 6 ml for the ulnar nerve, 6 ml for the radial nerve and 5 ml for the musculocutaneous nerve.

In both groups, subcutaneous infiltration was performed with the corresponding local anesthetic (3 ml) to anesthetize the medial cutaneous nerve of the arm and forearm. The onset of the block was evaluated by a cold test carried out in the territories covered by the different nerves. The block was scored as "perfect" or "effective" if all the corresponding nerve areas were anesthetized; it was scored as "partial", requiring additional anesthesia by sedation with diazepam 5 mg and 100 micrograms of intravenous fentanyl when certain nerve areas were not perfectly anesthetized; it was scored as "failure", requiring conversion to general anesthesia when the block was not installed.

Postoperative analgesia was provided in all patients by a concomitant prescription of acetaminophen and nonsteroidal anti-inflammatory drugs.

The cost of anesthesia consumables was 60 euros for the ropivacaine group versus 15 euros for the lidocaine group.

Patient satisfaction was assessed through a satisfaction score specific to our department which was rated from 0 to 10 and divided into 4 items: Score 10: very satisfied, Score 7 - 9: satisfied, Score 5 - 6: moderately satisfied, Score < 5: dissatisfied.

Data were collected on a pre-established survey form including questionnaires that were completed pre-operatively, intraoperatively and postoperatively. For each patient, the following parameters were evaluated: onset time, duration of block action, block efficiency, duration of the operation, patient satisfaction. The onset time was defined as the time required to obtain the sensory block after injecting the local anesthetic on all nerves. The duration of block action was defined as the time elapsed from the onset of the sensory block to its removal, and was evaluated post-operatively in this study.

Qualitative data were described as proportions and quantitative data as mean ± standard deviation and median with interquartile ranges. The Chi-square or Fisher's Exact test was used to compare proportions, as appropriate. For conti-

nuous variables, the Student's test was used to compare means. The significance threshold was set at 5% and a value of p < 0.05 was considered significant. The data were analyzed using SPSS version 21 software (SPSS Inc, Chicago, Illinois).

3. Results

The mean age of patients in the lidocaine-adrenaline group was 45.8 ± 16.9 years and 43.9 ± 20 years in the ropivacaine group (p = 0.77). Male sex was predominant in both groups with a sex ratio of 5.3 in the lidocaine-adrenaline group and 3.7 in the ropivacaine group (p = 0.6). The majority of patients in both groups were ASA I (p = 0.66) (Table 1). The mean block completion time was 7.5 ± 1.9 minutes in the adrenaline lidocaine group and 8.7 ± 2.1 minutes in the ropivacaine group (P = 0.07). The mean block onset time was 6.8 ± 2 minutes in the lidocaine-adrenaline group versus 8.3 ± 2.4 minutes in the ropivacaine group (P = 0.04) (Table 2). The mean duration of the block was 233.3 ± 57.5 minutes in the lidocaine-adrenaline group and 260.4 ± 74.8 minutes in the ropivacaine group (p = 0.21) (Table 3). The mean duration of intervention was 73 ± 10 minutes in the lidocaine-adrenaline group and 84.5 ± 51.3 minutes in the ropivacaine group (p = 0.34). The block efficacy was identical in both groups with 89.5% of the effective blocks in the lidocaine-adrenaline group and in the ropivacaine group (p = 1.00). In the series, 4 patients had additional sedation and no patients received general anesthesia (Table 4). The majority of patients in both groups were very satisfied with rates of 73.7% in the lidocaine-adrenaline group and 94.7% in the ropivacaine group (p = 0.55). The cost of anesthesia consumables was 60 euros for the ropivacaine group versus 15 euros for the lidocaine-adrenaline group.

Table 1. Characteristics of patients in different groups.

Characteristics	Group Lidocaine 1.5% with adrenaline n = 19	Group Ropivacaine n = 19	p-value
Age (Years)	45.8 ± 16.9	43.9 ± 20	0.77
Sex (M/F)	15/3	18/1	0.60
ASA Class			0.66
ASA I (%)	17(53.1)	15(46.9)	
ASA II (%)	2(33.3)	4(66.7)	

Table 2. Distribution of patients according to the block onset time.

Onset time of block (min)	Group Lidocaine 1.5% with adrenaline n = 19	Ropivacaine n = 19	p-value
Mean time	6.8 ± 2.0	8.3 ± 2.4	0.04
Median	6.0 (5 - 9)	8.0 (6 - 10)	
Extremes	4 - 10	5 - 13	

Table 3. Distribution of patients according to the duration of the block.

Group Block duration (min)	Lidocaine 1.5% with adrenaline n = 19	Ropivacaine n = 19	p-value
Mean duration	233.3 ± 57.5	260.4 ± 74.8	0.21
Median	225 (198 - 280)	255 (210 - 325)	
Extremes	95 - 198	342 - 580	

Table 4. Distribution of patients according to block efficiency.

Group Block efficiency	Lidocaine 1.5% with adrenaline n = 19	Ropivacaine n = 19	p-value
Perfect Block (effective)	17 (89.5%)	17 (89.5%)	1.00
Partial block	02 (10.5%)	02 (10.5%)	

4. Discussion

Our study showed that lidocaine 1.5% adrenaline at 1/200,000 may be a good alternative to ropivacaine 0.5% for the realization of ultrasound-guided axillary blocks in resource-limited countries. The efficacy of lidocaine 1.5% adrenaline is almost identical to that of ropivacaine. Indeed, no statistical difference was observed between the two local anasthetics regarding the efficacy of the block (p = 0.66). However, pharmacologically, ropivacaine 0.5% has a higher anesthetic potency than lidocaine 1.5% adrenaline [3] [4], which makes it a better quality block than lidocaine 1.5% adrenaline. Our observation is due to the fact that we did not investigate which of these two local anesthetics was more powerful, but rather whether the surgical intervention was feasible without the need for general anesthesia or additional sedation. We observed that the vast majority of surgical interventions in both groups were performed under the best conditions regardless of the local anesthetic used. This efficiency was appreciated by the patients in both groups through their satisfaction. Indeed, the majority of patients in both groups were very satisfied. Their satisfaction could be explained by the quality of the anesthetics and the efficiency of the block using ultrasound in both groups. Actually, the ultrasound allowed to see nerve structures, anatomical variations and the diffusion of local anesthetic, thus improving the success rate of the block. Moreover, the observation of partial blocks somewhat altered the satisfaction of some patients in both groups without significant difference. These partial blocks observed in our study were due to a failure to identify nerves on ultrasound or to poor diffusion of the local anesthetic, rather than to the nature of the local anesthetic used. Our study also showed some pharmacological differences between these two local anesthetics, particularly in terms of the time required for onset and the duration of the block. These pharmacological data are important to consider in clinical practice in the choice of local anesthetic. Concerning the time to onset of action, we found that lidocaine 1.5% adrenaline settles more rapidly than ropivacaine. Our results can be explained by the pharmacology of these local anesthetics. Indeed, the onset of the block in an isolated

nerve depends on the physio-chemical properties of the local anesthetic and in particular on its pKa (which determines the time of action). Thus, a local anesthetic such as lidocaine with a pKa close to the ambient pH will have a lower ratio of ionized form to non-ionised form compared to a local anesthetic with a higher pKa such as ropivacaine. However, it is the un-ionized form that diffuses more easily through the membranes of nerve cells. The dose and concentration of the local anesthetic also play a role *in vivo*.

Thus, at a standard dose of 2%, the onset time for lidocaine is 2 to 3 minutes. Of course, this time depends also on the diameter of the nerve to be blocked and therefore on the injection site [7]. The mean duration of the block was significantly longer in the ropivacaine group compared to the adrenaline lidocaine group (260 versus 233 minutes). This is because non-adrenaline lidocaine is a local anesthetic with a medium duration of action (90 - 120 minutes), and the addition of an adjunct such as adrenaline (vasoconstrictor) can overcome the problem of block duration by extending it to 180 minutes [3] [4] [8] [9]. The reason for the longer block duration may be that the addition of adrenaline slows the rate of absorption with a decrease in peak plasma concentration, thereby increasing the duration of action of lidocaine. However, despite the addition of adrenaline, the duration of action of lidocaine 1.5% adrenaline 1/200,000 is still shorter than that of ropivacaine which is 150 - 210 min according to the literature [1] [2] [4] [9]. This superiority of ropivacaine is due to its fat solubility as it has a high affinity for plasma proteins. It then remains attached to the receptor site for a longer time, which gives it a prolonged duration of action [3] [8] [10].

The cost of anesthesia consumables is an important variable in resource-constrained countries because it is the patients themselves who purchase these consumables for their procedure after the anesthesiologist's prescription. The high cost of anesthesia consumables is a factor that very often delays patient management in resource-limited countries. The anesthetist in his prescription must therefore make the connection between the effectiveness of the anesthetic product and its cost. We found that the cost of consumables in the ropivacaine group was four times higher than that of the adrenalinated lidocaine group. This significant cost factor combined with the effectiveness of lidocaine 1.5% adrenaline in achieving ultrasound-guided axillary blocks could make it a good alternative to ropivacaine 0.5%.

The main weakness of our study is its lack of strength due to the small sample size. However, the results observed by the prospective method in direct observation provide precise information that could not be obtained in retrospective study.

5. Conclusion

Our study showed that ropivacaine 0.5% and lidocaine 1.5% adrenaline are local anesthetics that have comparable effects in terms of efficacy and reliability in the

performance of ultrasound-guided axillary block. However, the additional cost of prescribing ropivacaine is to its disadvantage as it costs four times more than lidocaine 1.5% adrenaline. The use of the latter could then be a good alternative to ropivacaine 0.5% for the realization of ultrasound-guided axillary block in countries with limited resources.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Nefzi, I., Raies, K., Kouka, J., *et al.* (2014) Comparative Study: Ultrasound-Guided Axillary Block, Perivascular Technique, Double Injection versus Triple Injection. *Annales Françaises d'Anesthésie et de Réanimation*, **33S**, 214-219. https://doi.org/10.1016/j.annfar.2014.07.364

[2] Kuntz, F., Bouaziz, H., Bur, M.L., Boileau, S., *et al.* (2001) Comparison of Lidocaine 1.5% Adrenaline and Mepivacaine 1.5% in the Axillary Block of the Brachial Plexus. *Annales Françaises d'Anesthésie et de Réanimation*, **20**, 693-698. https://doi.org/10.1016/S0750-7658(01)00453-1

[3] Mazoit, J.X. and Baujard, C. (2006) Local Anesthetics: What Do Levogyric Forms Bring? *Annales Françaises d'Anesthésie et de Réanimation*, **25**, 408-412. https://doi.org/10.1016/j.annfar.2005.10.016

[4] Beloeil, H. and Mazoit, J.-X. (2010) Pharmacology of Local Anaesthetics. *EMC-Anestesia-Reanimación*, **36**, 1-18. https://doi.org/10.1016/S1280-4703(10)70431-X

[5] Bouaziz, H., Kuntz, F., Paqueron, X., Bur, M.L., Benhamou, D., Merle, M. and Laxenaire, M.C. (1998) Comparison between Mepivacaine 1.5% and Lidocaine 1.5% Adrenaline in the Axillary Block. *Annales Françaises d'Anesthésie et de Réanimation*, **17**, R015. https://doi.org/10.1016/S0750-7658(98)80135-4

[6] Hickey, R., Hoffman, J. and Ramamurthy, S. (1991) A Comparison of Ropivacaine 0.5% and Bupivacaine 0.5% for Brachial Plexus Block. *Anesthesiology*, **74**, 639-642. https://doi.org/10.1097/00000542-199104000-00002

[7] Rutschmann, B. and Albrecht, E. (2015) Local Anaesthetics. In: *Manuel Pratique d'anesthésie*, Elsevier Masson Paris, 154-161.

[8] Sztark, F. (2009) Toxicity of Local Anaesthetics. *Revue d'Anesthésie-Réanimation et de Médecine d'Urgence*, **1**, 1-7.

[9] Cuvillon, P., Zoric, L. and Ripart, J. (2011) How Do I Manage the Duration of a Block (Dose, Concentration, Catheter)? Update in Anesthesia Resuscitation, 83-92.

[10] Hadzic, A., Vloka, J.D. and Kuroda, M.M. (1998) The Practice of Peripheral Nerve Blocks in the United States: A National Survey. *Regional Anesthesia & Pain Medicine*, **23**, 241-246. https://doi.org/10.1097/00115550-199823030-00002