Clinical Communication

Estimation of minimum effective local anaesthetic volume to block the lower trunk during selective truncal injection brachial plexus block

INTRODUCTION

High definition ultrasound imaging has made it possible to identify individual brachial plexus elements and target them using low volumes of local anaesthetics (LAs).[1] In a recent study on selective truncal injection brachial plexus block (STI-BPB), the minimum effective LA volume (MELAV) $_{50}$, $MELAV_{95}$, $MELAV_{99}$ to produce upper-limb anaesthesia was described as 7.4 ml, 10.4 ml, 12 ml, respectively.[2] Block failure with lower LA volumes is often due to sparing of the lower trunk (LT) while the other two trunks are consistently blocked. We designed this study to estimate the MELAV for the LT by keeping a 2 ml LA volume constant for the upper two trunks during STI-BPB in upper limb surgeries.

METHODS

This observational study was conducted in a tertiary care university hospital between April 2020 and December 2020. The study was approved by the institutional human ethics committee (P.G Dissertation/2019/02/62) and registered with the Clinical Trial Registry of India (CTRI/2020/03/024329). The study was conducted in accordance with the principles of the declaration of Helsinki. Seventeen American Society of Anesthesiologists physical status I and II patients, aged 20 to 40 years, undergoing elective distal elbow bony procedures were recruited by consecutive sampling. Patients were excluded if they refused informed consent, had body mass index >25 kg/m^2, had any contraindications for regional anaesthesia or if the ultrasound targets were not delineated.

Patient positioning, ergonomics and block technique employed was as described in a previous study.[2] Two seasoned anaesthesiologists with expertise in the technique performed all the blocks. 2% lignocaine with 1:200000 adrenaline mixture and 0.5% bupivacaine were used in equal volumes for the block. Hydrolocation was done with minimal amount of the LA mixture (0.2 ml) to ascertain appropriate placement of the needle tip. A fixed LA volume of 2 ml was used for the upper trunk and middle trunk. The first patient received 2 ml of LA for the lower trunk. In the subsequent patients, LA volume for the lower trunk was determined by Dixon and Mood's up and down study design. Based on the success or failure of blockade of the LT in the previous patient, the LA volume was increased or decreased by 1 ml in the subsequent patient.[3] This method was followed until five up-downs were recorded.

The Block Time was calculated from the insertion to the final removal of the needle. An independent observer performed block assessment at 10-min intervals. Sensory blockade was assessed in the distal-most areas of the four-terminal nerves [musculocutaneous nerve (MCN) lateral forearm, median nerve (MN)-tip of middle finger, ulnar nerve (UN) tip of little finger and radial nerve (RN) anatomical snuff box] using a 3-point qualitative scale: 0–presence of cold and touch; 1–loss of cold but not touch; 2–loss of cold and touch. The motor power was assessed (MCN–elbow flexion, MN–thumb opposition, UN–thumb adduction and RN–thumb abduction) on a 3point qualitative scale: 0–power 5/5 or 4/5; 1–power 3/5 or 2/5; 2–power 1/5 or 0/5. A total composite score of 16/16 at 30 min after block time indicated a complete conduction blockade (CCB), and was considered a successful block. In all patients with a successful block, surgery was started. In case of block failure, the further course of action, either administering additional volume to the LT or performing distal blocks of the respective nerves was decided by the primary anaesthesiologist. Any complications were also noted.

Midazolam 1 mg and fentanyl 1 μg/kg was used intravenously for procedural sedation. During surgery, any complaints of pain requiring supplementation of fentanyl, rescue blocks or sedation were also considered as failure of the block. The study ended when five ups and downs were noted. $MELAV_{50}$, $MELAV_{90}$ and $MELAV_{95}$ were estimated by Probit analysis and logistic regression.

RESULTS

Seventeen patients completed the study, of which nine patients had a successful block [Figure 1a]. None of the patients who had a CCB complained of intraoperative pain or required supplemental analgesia.

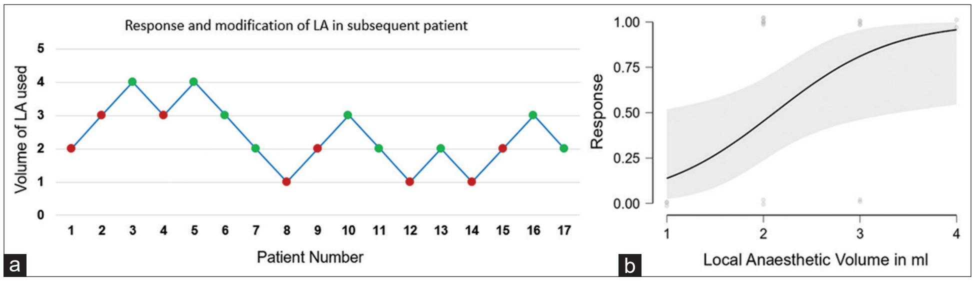

Figure 1: (a) Graph showing the sequence of successful and unsuccessful blocks performed. (LA–local anaesthetic), (b) Dose-response curve for the lower trunk (X-axis: volume of local anaesthetic in ml, Y-axis: response to a particular dose)

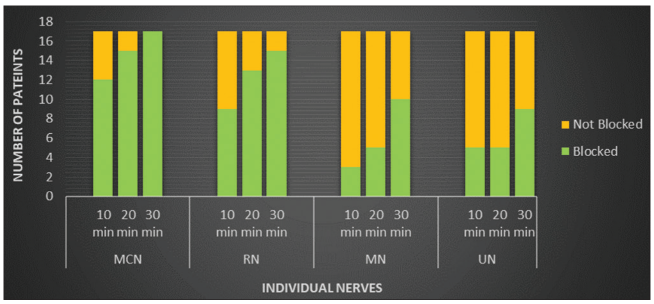

Figure 2: Proportion of patients having complete conduction block of the four-terminal nerves at the various time points. (MCN – musculocutaneous nerve, RN – radial nerve, MN – median nerve, UN – ulnar nerve)

The $MELAV_{50}$, $MELAV_{95}$ and $MELAV_{99}$ for the LT were estimated as 2.37 ml, 3.21 ml and 4.2 ml, respectively [Figure 1b]. Lower LA volume at the LT leads to incomplete blockade in the order of UN >MN >RN, both quantitatively as well as qualitatively. Among the block failures, UN, MN and RN were spared in eight, seven and two patients, respectively [Figure 2]. The individual nerve composite score at 30 min was lowest for UN [1.5 {interquartile range (IQR) 1 to 2}] followed by MN [2 (IQR 0.5 to 2.5)] and RN [3 (IQR 3 to 3)]. Even in patients with successful block, MN (21.5 ± 9.9 min) and UN (21.7 ± 10.3 min) took a long time for CCB when compared to MCN (15.7 ± 8.4 min) and RN (16.2 ± 8.6 min), $P = 0.113$. No complications were encountered in any patient.

DISCUSSION

The UN (inferior trunk) sparing is often the reported cause for block failure during BPB above the clavicle.[4] Through these years, technique related issues were thought of as the cause for inadequate drug delivery to the inferior trunk and the consequent UN sparing.[5] But, during STI, even after accurate identification and precise drug deposition within the epineurium (outermost hyperechoic line), the inferior trunk required approximately double the LA volume compared to the upper trunk (4 ml versus 2 ml) for a similar effect. Keeping 2 ml LA constant for the upper and middle trunk, the $MELAV_{99}$ could be achieved with 8.2 ml itself, while compared to 12 ml as described previously.[2]

The increased LA requirement for the LT cannot be attributed to the microanatomy as it is not bigger compared to the upper trunk either in terms of diameter (8.9 versus 12.23 mm respectively), the nerve fibres (69,100 versus 74,400, respectively) or fascicles (11 versus 8, respectively).[6,7] Potential implications of Zuckerkandl-Sebileau ligaments (a condensation of Sibson's fascia, that encloses the LT) in BPB have been recently highlighted.[8,9] We contemplate that at low LA volumes, these additional connective tissue coverings and the continuous bombardment of subclavian pulsation probably limit the proximal mass movement of the drug within the inferior trunk hindering a critical length exposure necessary for CCB.

Even though the $MELAV_{99}$ produced a CCB of all four terminal nerves at the end of 30 min, this may not ensure the desired duration of surgical anaesthesia or analgesia if the surgical procedure is complex and prolonged, or if the injection targets are not clear to enable precise drug deposition. Hence larger prospective trials are necessary to determine the dynamics of the block, so that the $MELAV_{99}$ offering a satisfactory duration of surgical anaesthesia/analgesia with minimal complications, especially that of phrenic nerve palsy, can be determined.

CONCLUSION

During STI- BPB, the MELAV at the LT was 2.37 ml, 3.21 ml and 4.2 ml to produce CCB in 50%, 95% and 99% of individuals, respectively. Considering the 2 ml LA for the upper and middle trunk, complete surgical anaesthesia for bony procedures of the upper limb could be achieved with 8.2 ml.

Acknowledgements

The authors want to acknowledge Dr. Sandeep Diwan and Prof. Georg C Feigl for providing insights into the Zuckerkandl-Sebileau ligaments and providing appropriate references for the same.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Sivashanmugam T, Sripriya R[1], John Paul S[2], Ravishankar M[3]

Department of Anaesthesiology, Mahatma Gandhi Medical College and Research Institute, Sri Balaji Vidyapeeth University, Pillaiyarkuppam, Puducherry, [1]Department of Anaesthesiology, All India Institute of Medical Sciences, Mangalagiri, Andhra Pradesh, [2]Department of Anaesthesiology, Ganga Medical Center, Saibaba Kovil, Coimbatore, [3]Mahatma Gandhi Medical College and Research Institute, Sri Balaji Vidyapeeth University, Pillaiyarkuppam, Puducherry, India

Address for correspondence:
Dr. Sripriya R,
Department of Anaesthesiology and Critical Care, All India Institute of Medical Sciences, Mangalagiri, Andhra Pradesh, India.
E-mail: docsripriya@gmail.com

Submitted: 22-Dec-2021
Revised: 07-Jul-2022
Accepted: 07-Jul-2022
Published: 12-Aug-2022

REFERENCES

1. Sivashanmugam T, Areti A, Selvum E, Diwan S, Pandian A. Selective blockade of supraclavicular nerves and upper trunk of brachial plexus “The SCUT block” towards a site-specific regional anaesthesia strategy for clavicle surgeries - A descriptive study. Indian J Anaesth 2021;65:656-61.
2. Sivashanmugam T, Sripriya R, Jayaraman G, Ravindran C, Ravishankar M. Truncal injection brachial plexus block: A description of a novel injection technique and dose finding study. Indian J Anaesth 2020;64:415-21.
3. Dixon WJ. The up-and-down method for small samples. J Am Stat Assoc 1965;60:967-78.
4. Luo Q, Yao W, Shu H, Zhong M. Double-injection technique assisted by a nerve stimulator for ultrasound-guided supraclavicular brachial plexus block results in better distal sensory-motor block: A randomised controlled trial. Eur J Anaesthesiol 2017;34:127-34.
5. Fredrickson MJ, Patel A, Young S, Chinchanwala S. Speed of onset of ‘corner pocket supraclavicular’ and infraclavicular ultrasound guided brachial plexus block: A randomised observer-blinded comparison. Anaesthesia 2009;64:738-44.
6. Liu Y, Zhou X, Ma J, Ge Y, Cao X. The diameters and number of nerve fibers in spinal nerve roots. J Spinal Cord Med 2015;38:532-7.
7. Bonnel F. Microscopic anatomy of the adult human brachial plexus: An anatomical and histological basis for microsurgery. Microsurgery 1984;5:107-17.
8. Nguyen H, Vallée B, Person H, Nguyen HV. Anatomical bases of transaxillary resection of the first rib. Anat Clin 1984;5:221-33.
9. Feigl GC, Litz RJ, Marhofer P. Anatomy of the brachial plexus and its implications for daily clinical practice: Regional anesthesia is applied anatomy. Reg Anesth Pain Med 2020;45:620-7.

Access this article online	
Quick response code	Website: www.ijaweb.org
	DOI: 10.4103/ija.ija_1087_21

How to cite this article: Sivashanmugam T, Sripriya R, John Paul S, Ravishankar M. Estimation of minimum effective local anaesthetic volume to block the lower trunk during selective truncal injection brachial plexus block. Indian J Anaesth 2022;66:S281-3.