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EFFECT OF MEDIAN NERVE BLOCK ON RADIAL ARTERY DIAMETER FOR RADIAL ARTERY CANNULATION IN ELECTIVE OPERATION THEATRE AND ICU

Rajeev Kumar Dubey*, Achin Kumar Verma and G K Sinha
***Associate Professor, Department of Anaesthesiology, IMS, BHU, Varanasi-221005**

***Corresponding Author Email: rajeevdubeyrk@gmail.com**

ABSTRACT

Arterial blood pressure monitoring and blood-gas analysis are frequently being performed during major surgeries and in critically ill patients admitted in intensive care units. Apart from being painful, placement of intra-arterial cannula can, at times, be difficult due to radial artery spasm. As the median nerve plays an integral part in the autonomic control of the radial artery, this study was planned to determine the effect of median nerve block using a local anaesthetic agent on the diameter of the radial artery. A linear ultrasonographic transducer was placed on the ventral aspect of the mid-forearm, where the median nerve is visible in the fascial plane between the flexor digitorum superficialis and flexor digitorum profundus. After introducing a 22 G, 50 mm short bevel needle at the fascial plane next to the median nerve, an injection of 3-5 ml of 2% lignocaine was made so as to cover the nerve circumferentially. There was a significant statistical difference between radial artery diameter (measured either in the vertical direction or in the horizontal direction) after medial nerve blockade within 5 minutes of the block. The pre-block radial artery vertical diameter were 0.22±0.05 cm and increased to 0.25±0.03 cm(p=0.001) and pre-block radial artery horizontal diameter were 0.25±0.04cm and increased to 0.28±0.05cm(p<0.01). There was no significant change in radial artery diameter between 5 minutes post-block to 10 minutes post-block. To conclude, median nerve block by producing significant vasodilatation and sympathectomy-like effects, can increase the success rate of the arterial line cannulation.

KEY WORDS

Radial artery, median nerve, arterial cannulation

INTRODUCTION

Arterial line placement is often needed in various critical care settings. It is a basic procedure performed for continuous blood pressure (BP) monitoring and rapid access for repeated arterial blood gas samples, as it is considered to be more precise than measurement of BP by other noninvasive devices, especially in the critically ill patients or those on continuous infusions of vasoactive drugs.[1, 2] Arterial line placement is presumed to be a relatively safe procedure, with a rate of major complications that is below 1%.[3] The most common site of cannulation is the radial artery, primarily due to the ease of access owing to the superficial nature of the vessel and the ease with which the site can be maintained.[4] Additional advantages of radial artery cannulation include anatomical reliability and the less complications.[5] However placement of a radial artery catheter can, at times, be difficult because many patients who emergently need a catheter may have a weak arterial pulse due to dehydration or blood loss or may have some form of peripheral vascular disease. Although it is usually a well-tolerated procedure, it is considered more painful than intravenous (i.v.) cannula placement, particularly in case of multiple attempts of cannulation. It has already been established that inhibition of sympathetic innervation decreases

vasomotor activity in muscular arteries,[6,7] and that blockade of either stellate ganglion or axillary nerve increases blood flow to the radial artery.[8,9] Thus, the sympathetic nerves that supply the radial artery travel with the brachial plexus at least to the level of the axillary artery; but beyond that, the pathway of sympathetic innervation to the radial artery is unknown. The median nerve may play an integral part in the autonomic control of the radial artery.

The aim of the study was to determine the effect of median nerve block using a local anaesthetic agent on the diameter of the radial artery by blocking its sympathetic innervation.

MATERIALS AND METHODS

Following approval by the institutional ethical review board, 50 subjects undergoing elective surgery who required arterial cannulation prior to the induction of general anesthesia were enrolled in this study. The criteria for selection of the patients were as follows:

Inclusion criteria

- Patients pertaining to American Society of Anaesthesiologists (ASA) physical status 1 and 2.
- Age group between 22-62 years
- Body weight between 40 to 80 kg.
- Height between 140 to 180 cm.

Exclusion Criteria

- Pre-existing neurological deficit/peripheral neuropathy.
- Coagulation disorders.
- Local infection at the site of block.
- Pregnancy.
- Emergency surgical patients
- History of allergy to amide local anesthetics.
- Patient having cardio or respiratory system failure.
- Patient's refusal to participate in the study.
- Uncooperative patient.

Each subject had a peripheral i.v.cannula placed in the non-dominant forearm. All subjects were monitored with a pulse oximeter and intermittent noninvasive blood pressure recordings on the opposite arm. They received 2 liters of oxygen via a nasal cannula. Injection midazolam (0.05mg/kg) and fentanyl (1mcg/kg) i.v. to allay anxiety and provide mild sedation prior to arterial cannulation. A mark, 1 cm proximal to the styloid process, was made to ensure consistency with all measurements taken. Radial artery diameter was measured in two planes (horizontal and vertical) using a SonoSite Ultrasonography machine (Micromaxx™, P05353-01).

The subjects were positioned supine, with the upper limb to be blocked was kept straight and supinated. A linear transducer was placed on the ventral aspect of the mid-forearm, where the median nerve is visible in the fascial plane between the flexor digitorum superficialis and flexor digitorum profundus. Alternatively, the ulnar nerve at mid-forearm was identified first, and upon moving the transducer laterally at this level, the median nerve can be identified in the fascial plane between the flexor digitorum superficialis and flexor digitorum profundus.

A 22 G, 50 mm short bevel needle, after raising a skin wheal using local anesthetic, was introduced in-plane and aimed at the fascial plane next to the median nerve. An injection of 3-5 ml of 2% lignocaine was made after negative aspiration for blood so as to cover the nerve circumferentially. Any kind of undue vascular injury was carefully avoided.

Radial artery diameter was measured after 5, 10, 15 min of nerve block. Heart rate (HR), noninvasive blood pressure (NIBP) and oxygen saturation (SpO_2) were noted prior to and after 5,10,15 minutes of median nerve blockade. The success of median nerve blockade was assessed by confirming decreased sensation and weakness in the distribution of the median nerve. An arterial line was then placed in the usual fashion using a standard Arrow kit, which concluded the subject's participation in this study. The rest of the surgery was performed using the standard institutional protocol.

RESULTS

Fifty-five subjects were enrolled in this study. Subjects' age range was from 22-62 years, with a mean age of 42. Twenty-three were female, thirty-two were male. All fifty-five subjects had successful median nerve blockade by clinical examination. All data was analyzed using paired Student's T-Test.

Mean radial artery diameter measured vertically was 0.22±0.05 cm pre-block, 0.27±0.03 cm at 5 minutes post block and 0.25±0.03 cm 10 minutes post-block. *P*-value from pre-block to 5 minutes post-block was 0.01, from5 minutes post-block to 10 minutes post-block was 0.31. (Table 1, 3; Fig 1)

Table 1: Radial artery diameter (vertical)

Radial artery diameter (vertical)	Mean ± SD (cm)
Pre-block	0.22±0.05
Post-block at 5 min	0.27±0.03
Post-block at 10 min	0.25±0.03

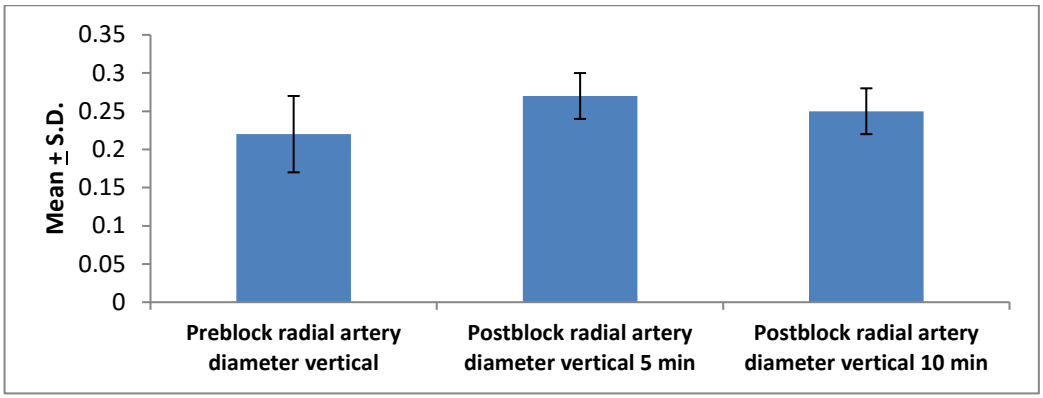

Fig 1: Mean radial artery diameter (Vertical)

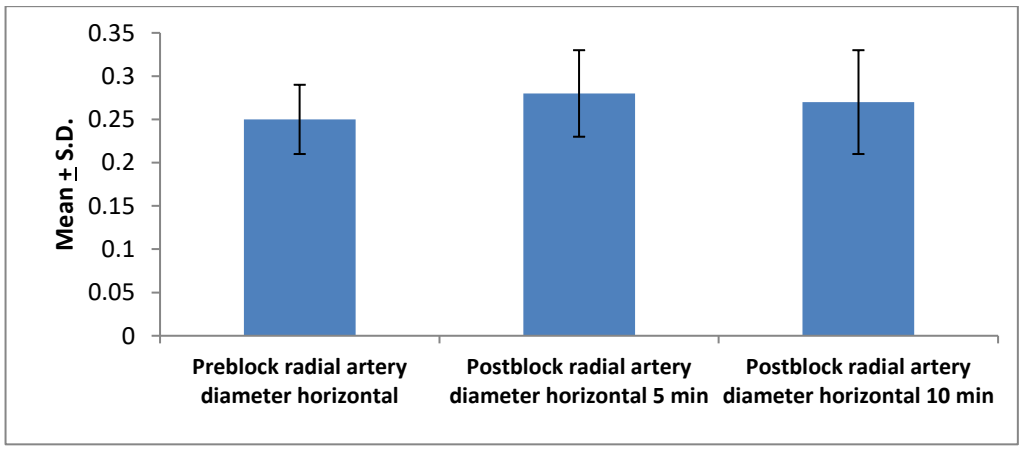

Fig 2: Mean radial artery diameter (Horizontal)

Table 2: Radial artery diameter (horizontal)

Radial artery diameter (horizontal)	Mean ± SD (cm)
Pre-block	0.25±0.04
Post-block at 5 min	0.28±0.05
Post-block at 10 min	0.27±0.06

Table 3: Radial artery diameter (vertical): Intragroup comparison

Radial artery diameter (vertical)	Mean ± SD (cm)
Pre-block	0.22±0.05
Post-block at 5 min	0.27±0.03
Post-block at 10 min	0.25±0.03
Intra group (Paired t-test)	t=-3.433 p=0.001 (HS)

Table 4: Radial artery diameter (horizontal): Intragroup comparison

Radial artery diameter (horizontal)	Mean ± SD (cm)
Pre-block	0.25±0.04
Post-block at 5 min	0.28±0.05
Post-block at 10 min	0.27±0.06
Intra group (Paired t-test)	t=-2.463
	p=0.017 (S)

Mean horizontal radial artery diameter was measured to be 0.25±0.04 cm pre-block, 0.28±0.05 cm at 5 minutes post block and 0.27±0.06 cm 10 minutes post-block. *P*-value from pre-block to 5 minutes post-block was< 0.01, from 5 minutes post-block to 10 minutes post-block was 0.7. (Table 2, 4; Fig 2)

DISCUSSION:

It has already been recognized that inhibition of sympathetic innervation reduces vasomotor activity in muscular arteries. Brachial plexus block (BPB) can lead to vasodilatation and increased blood flow in the ipsilateral arm,[10] which could be beneficial for vascular re-construction[11] and severe forearm ischaemia.[12] Few studies have examined the effect of regional nerve block on vessel diameter, blood flow, sympathetic block, and patency of vessel. Sympathetic block may have a direct effect on the vein to produce dilation. Alternatively, the sympathetic block may cause arterial dilation, which augments venous return and consequently produces venodilatation. Yidirim et al. observed that increased sympathetic activity and spasm of radial artery during the surgery could be responsible for high early failure ratio of radio-cephalic arteriovenous fistulas (AVFs). Diminished sympathetic tonus by preemptive stellate ganglion blockade improved arterial dilation and prevented radial artery spasm by lessening the reactivity of the arterial muscle that normally results from surgical manipulation, which consequently improved both early patency rate and fistula maturation rate.[13]

In one study, Ebert et al. demonstrated that an additional and immediate effect of axillary brachial plexus block was a significant rise in blood flow velocity with an increase in cross-section area.[14] They, therefore, concluded that in addition to producing pain relief and analgesia, brachial plexus block also prevents vasospasms and improves the circulation of the hand in patients undergoing re-implantation of limbs and those with nutritional disorders. Similarly, Mehta et al. have reported that sympathetic blockade produced by continuous axillary block is an effective alternative to stellate ganglion block in a patient with vascular ischemia after a failed radial artery cannulation.[15] The block alleviated the signs of radial artery ischaemia viz. absence of radial pulse, bluish discoloration of fingers and poor capillary refill. Likewise, Breschan et al. have reported a case of severe distal forearm ischemia after right radial and ulnar artery catheterization in a 700 g infant. While immediate removal of the arterial line did not improve ischemia, a brachial plexus block via the axillary approach instituted thirty-six hours later with 0.5 ml bupivacaine 0.125% resulted in rapid improvement.[9]

Thus, presumably sympathetic nerves that supply the radial artery travel with the brachial plexus at least to the level of the axillary artery, but beyond that, the pathway of sympathetic innervation to the radial artery is not precisely known. The preganglionic sympathetic innervation of the upper extremity originates from cell bodies located predominantly in upper-mid thoracic spinal segments (T2-T6). Their axons emerge from the ventral roots, course through the sympathetic chain, and synapse onto postganglionic cells located in the stellate ganglion. The postganglionic neurons heading to the upper limb leave the sympathetic chain, join the spinal roots, enter the brachial plexus and later travel through the different nerves to their end targets in blood vessels, sweat glands or hair follicles.[16,17,18]

Several human cadaveric studies reveal that the radial artery anatomically receives its sympathetic innervation from the radial, median, and musculocutaneous nerves. Moreover, the radial artery may receive variable innervation from these nerves in its proximal, middle, and distal portions.[19,20] Functionally while increase in radial artery blood flow following the median or radial nerves blockade has been observed, blockade of musculocutaneous nerve produces no similar effect. Precisely speaking, selective ulnar and median nerve block results in arterial dilatation, an increase in blood flow velocity and blood flow through the ulnar and radial arteries respectively. Selective radial nerve block

results in only a slight increase in blood flow through the radial artery. Selective musculocutaneous nerve block does not alter the flow dynamics of either radial or ulnar artery.[21]On the other hand, another study on human patients demonstrated an increase in hand temperature following blockade of the ulnar or median nerves, but not after blockade of the radial or musculocutaneous nerves.[22] These observations suggest that more than one nerve may be involved in carrying sympathetic fibres innervating the radial artery. Essentially in some cases, radial artery spasm may entail blockade of a variable combination the radial, musculocutaneous and median nerves for optimal benefit.[23,24] Furthermore, Hamilton showed that maximum blood flow in the hand could be secured by blocking the ulnar, median and radial nerves near the elbow with 4 per cent procaine.[25] Therefore, the median nerve may play an integral part in regulation of radial artery vasoconstriction and vasodilatation. Although ultrasound has been used for nerve blocks, only one controlled study has directly evaluated for increase in radial artery diameter and peak velocity in patients who have undergone median nerve block. Badal et al. found a significant increase in radial artery peak velocity measured before and after medial nerve blockade.[26] However they could not find any statistical difference between radial artery diameter (measured either in the vertical direction or in the horizontal direction) following medial nerve blockade. This could be either be attributed to the small sample size of only 8 subjects or selection of patients; 7 of the 8 subjects had risk factors for peripheral vascular disease, such as coronary artery disease, hypertension, diabetes mellitus, history of smoking. Therefore, it still remains inconclusive whether the arteries measurably dilate following a sympathetic block in the presence of significant peripheral vascular disease.

In the present study, there is statistical difference between radial artery diameter (measured either in the vertical direction or in the horizontal direction) after medial nerve blockade. It seems that the greatest effects of median nerve blockade occur within 5 minutes of the block given that pre-block radial artery vertical diameter were 0.22±0.05 cm and increased to 0.25±0.03 cm(p=0.001) and pre-block radial artery horizontal diameter were 0.25±0.04cm and increased to 0.28±0.05cm(p<0.01) The increase from 5 minutes post-block to 10 minutes post-block is not statistically significant (0.27±0.03cm and 0.25±0.03 cm respectively, *P*=0.31 for vertical & 0.28±0.05and 0.27±0.06cm respectively, p=0.7 for horizontal). There was a progressive increase in palpability of the radial pulse after the median nerve blockade. Although, considered as a subjective finding, it appears to be potentially appealing to institute median nerve blockade in patients with clinically poorly palpable, or impalpable radial arteries so as to help locating the artery. Apart from easy location of the radial artery, analgesia provided by median nerve blockade can also attenuate the pain and discomfort associated with arterial cannulation.

CONCLUSION:

Although radial artery is the first choice for arterial line cannulation, the procedure has a high rate of failure, due most likely to spasm of the radial artery in response to increased sympathetic activity. Median nerve blockade produces a significant increase in radial artery diameter, thereby improving blood flow through the radial artery by causing dilation in radial artery by regional sympathetic blockade while minimally altering blood pressure and heart rate. When applied under ultrasound (US) guidance, median nerve block has both a low risk of complications and a high rate of success. Therefore ultrasound-guided median nerve block, by producing significant vasodilatation with sympathectomy-like effects, can increase the success rate of the arterial line cannulation.

REFERENCES:

1. 1.Cohn JN. Blood Pressure Measurement in Shock: Mechanism of Inaccuracy in Auscultatory and Palpatory Methods. *JAMA*1967;199(13):972-76
2. Wax DB, Lin HM, Leibowitz AB. Invasive and concomitant non-invasive intraoperative blood pressure monitoring: observed differences in measurements and associated therapeutic interventions. Anesthesiology Nov 2011;115(5):973-78
3. Scheer B, Perel A, Pfeiffer UJ. Clinical review: complications and risk factors of peripheral arterial catheters used for haemodynamic monitoring in anaesthesia and intensive care medicine. Crit Care 2002;6(3):199-204
4. 4.Mitchell JD, WelsbyIJ. Techniques of arterial access**.** Surgery 2004;22(1):3 – 4
5. Brzezinski M, Luisetti T, London MJ. Radial artery cannulation: a comprehensive review of recent anatomic and physiologic investigations. Anesth Analg 2009;109(6):1763-81

6. Boutouyrie P, Lacolley P, Girerd X, Beck L, Safar M, Laurent S. Sympathetic activation decreases medium-sized arterial compliance in humans. Am J Physiol 1994;267:H1368-76
7. Arduino A. Mangoni, Luca Mircoli, Cristina Giannattasio, Giuseppe Manciaand Alberto U. Ferrari. Effect of Sympathectomy on Mechanical Properties of Common Carotid and Femoral Arteries. Hypertension 1997;30:1085-88
8. Soni KD, Sawhney C, Kaur M, Ramchandani S, Singhal M. Stellate ganglion block as a limb salvaging technique. Indian J Anaesth 2012; 56:307-8.
9. Breschan C, Kraschl R, Jost R, Marhofer P, Likar R. Axillary brachial plexus block for treatment of severe forearm ischemia after arterial cannulation in an extremely low birth-weight infant. Paediatr Anaesth2004;14(8):681–84
10. Hermanns H, Braun S, Werdehausen R, et al. Skin temperature after interscalene brachial plexus blockade. *Reg Anesth Pain Med* 2007; 32:481–487.
11. Sahin L, Gul R, Mizrak A, et al. Ultrasound-guided infraclavicular brachial plexus block enhances postoperative blood flow in arteriovenous fistulas. *J Vasc Surg* 2011; 54:749–753.
12. Breschan C, Kraschl R, Jost R, et al. Axillary brachial plexus block for treatment of severe forearm ischemia after arterial cannulation in an extremely low birth-weight infant. *Paediatr Anaesth* 2004; 14:681–684.
13. Yildirim V, Doganci S, Yanarates O, Saglam M, Kuralay E, Cosar A, Erdal Guzeldemi M. Does preemptive stellate ganglion blockage increase the patency of radiocephalic arteriovenous fistula?Scand Cardiovasc J. 2006 Dec;40(6):380-4
14. 14.Ebert B, Braunschweig R, Reill P. Quantification of variations in arm perfusion after plexus anesthesia with color doppler sonography. Anaesthesist 1995;44(12):859–62.
15. 15.Mehta Y, Juneja R. Continuous axillary block for ischemia following failed radial artery cannulation. J Cardiothorac Vasc Anesth 1994;8(2):257.
16. Schiller, Y. The anatomy and physiology of the sympathetic innervation to the upper limbs. Clin Auton Res 2003; 13(Suppl 1): i2-5.
17. Arslan O. Neuroanatomical Basis of Clinical Neurology. Section III: The Peripheral Nervous System. New York:CRC Press-Parthenon Publishers;2001
18. Parent A, Carpenter MB. Carpenter's Human Neuroanatomy. 9th Ed. New York: Lippincott, Williams & Wilkins; 1995
19. Coates AE. Observations on the distribution of the arterialbranches of the peripheral nerves. J Anat 1932; 66: 499-507
20. Pick J. The innervation of the arteries in the upper limb of man.Anat Rec 1958; 130: 103-23
21. Li T,Ye Q,Yeung J, et al. Regional hemodynamic changes afterselective block of the four principal nerves in the arm: a double-blind randomized controlled study. Eur J Anaesthesiol 2016; 33:588-609
22. Lange KH, Jansen T, Asghar S, et al. Skin temperature measured by infrared thermography after specific ultrasound-guided blocking of the musculocutaneous, radial, ulnar, and median nerves in the upper extremity. *Brit J Anaesth* 2011; 106:887–895
23. 23.Bhakta P, Zaheer H. Ultrasound-guided radial nerve block to relieve cannulation-induced radial arterial spasm. Can J Anesth 2017; 64: 1269-70
24. Sinha C, Kumar A, Kumar N.Radial artery spasm treatment by radial, median, or musculocutaneous nerve block? A potential therapeutic dilemma.Can J Anaesth 2018 May;65(5):590
25. Hamilton GTC. Results of Sympathectomy in the Upper Limb. Ulster Med J. 1947 May; 16(1): 18-26
26. Badal JJ, Kiesau A, Boyle P. Effects of median nerve block on radial artery diameter and peak velocity. Local Reg Anesth. 2010; 3:5-10

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***Corresponding Author:**
Rajeev Kumar Dubey*
Email: rajeevdubeyrk@gmail.com