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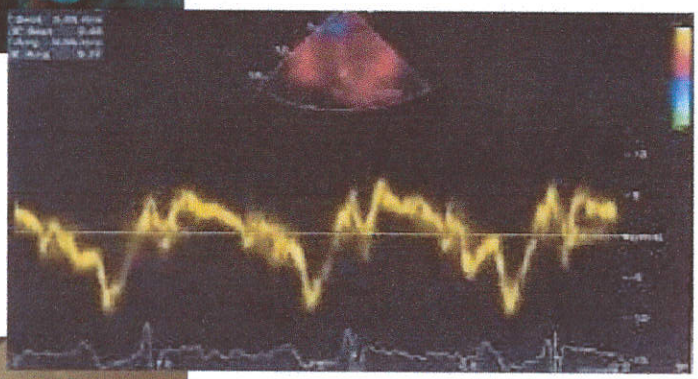

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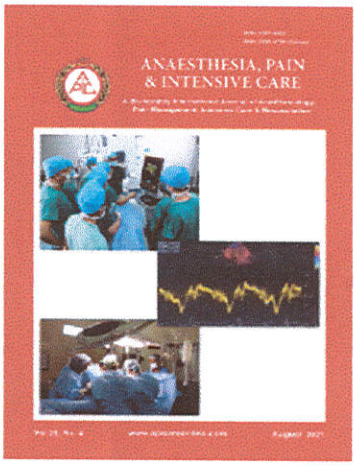

EDITORIAL VIEWS

The impact of corona pandemic on critical care medicine

Faraz Mansoor

PDF HTML

The COVID-19 babies are even more blue and lethal

Tariq Hayat Khan, Habib Md Reazaul Karim

PDF HTML

ORIGINAL RESEARCH

A retrospective cohort study of the risk factors and outcomes of antibiotic resistance in the intensive care unit

Mohd Tarmimi Mustapha, Wan Mohd Nazaruddin Wan Hassan, Ariffin Marzuki Mokhtar, Wan Fadzlina Wan Muhd Shukeri, Mohd Zulfakar Mazlan

PDF HTML

Development and validation of a 'Cancer Pain Assessment Scale' in leukemia patients

Sobia Ikram, Muhammad Rafiq

PDF HTML

Case fatality rate and survival functions of severe COVID–19 patients in intensive care unit of Bangabandhu Sheikh Mujib Medical University in Bangladesh: an observational study

Md. Shafiqul Islam, Dilip Kumar Bhowmick, Monira Parveen, Md Mostafa Kamal, Akhtaruzzaman AKM

PDF HTML

Fentanyl versus tramadol as an adjunct to bupivacaine in ultrasound-guided supraclavicular brachial plexus blockade: pros and cons

Huda F. Ghazaly, Ayman Mohamady Eldemrdash, Bahaa Eldeen Atito, Shaimaa S. Abdelrheem, Ahmed Alsaied A. Aly

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ORIGINAL RESEARCH REGIONAL ANESTHESIA

Relation of the successful block regional anesthesia with increased peripheral venous circumference and peripheral skin temperature at distal part of the block

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Abstract

Introduction: Evaluating the success rate of regional anesthesia is performed with pinprick test, Bromage score and pain scales, where they act as indicators of success or otherwise of motor, sensory and nociceptive blockade. The sympathetic system is also affected by the regional anesthesia blockade. The present study evaluated the relationship of peripheral venous dilatation and the skin temperature of the block area, to be used as an additional tool.

Methodology: An analytic, observational study was conducted in Dr. Soetomo Surabaya Hospital. 18 patients received peripheral nerve block (PNB) and 16 patients received subarachnoid block (SAB). Informed consent was obtained from all the participants. The peripheral venous circumference was measured by using linear probe of Sonosite® M–Turbo ultrasound, before the blocks and then one hour after PNB and SAB to assess the venous dilatation. The peripheral skin temperature was measured with a thermometer (Microlife NC-150 Bluetooth®) infrared thermometer before the blocks, and within the range of 5 min from the zero min after the block until the 30th min. The success rate of the blocks was performed with pain scale (VAS) and absence of motor, sensory and nociceptive response

Results: No relationship was found of sex, age, weight and type of block with increased peripheral venous circumference and peripheral skin temperature ($p > 0.05$). The block's success was associated with the increased peripheral venous circumference and peripheral skin temperature ($p \leq 0.001$) in both PNB and SAB blocks. The average PNB block succeeded in 20 min while SAB took only 5 min ($p < 0.05$) to affect both of the parameters. The delta value of the increased temperature's successful block was 0.7°C in the PNB, and 0.275°C in the SAB group.

Conclusions: The success of the peripheral nerve block and the subarachnoid block is associated with an increase in the peripheral venous circumference and in the peripheral skin temperature in the block area.

Key words: Regional anesthesia; Peripheral nerve block; Subarachnoid block; Sympathetic block.

Abbreviations: RA – Regional anesthesia; PNB – Peripheral nerve block; SAB – Subarachnoid block

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1. Introduction

The regional blocks have become more selective with the advent of new techniques like high sensitivity and high precision ultrasound equipment for peripheral nerve blocks as well as the introduction of new local anesthetic drugs, with improved safety margin and less motor block, such as ropivacaine and levobupivacaine.[1] Regional anesthesia is an anesthetic technique suitable for surgery on the extremities and abdomen, but it is less predictable in the case of unpredictable intraoperative surgical processes.[2]

At the Integrated Central Surgery Building of Dr. Soetomo General Hospital Surabaya, in 2016-17, 123 surgical operations were carried out with peripheral nerve block (PNB), while the number of patients operated with subarachnoid block (SAB) with short duration (30–60 min) was 288 patients in 2015-6 and 314 patients in 2016-7.

In regional anesthesia, local anesthetic drugs act on autonomic nerves and produce vasodilation of the blood vessels, disrupting the body's core temperature regulatory system. This vasodilation is caused by a sympathetic center block in the posterior hypothalamus, resulting in strong vasodilation in the peripheral blood vessels, which allows the transfer of the heat from the core of the body to the skin of the blocked area.[3] Block success can be assessed by special tests, such as thermography, plethysmography, and laser Doppler flowmetry as additional tests for sympathetic cholinergic fibers' activity.

Skin temperature measurements are used to evaluate the effectiveness of sympathetic blocks as the easiest clinical procedure.[4,5] Measuring the temperature in the sacral region of the body, and the toes and plantar surface and the dorsum of the foot, is very useful for assessing the sympathetic tone.[6] Ultrasound can also assess the degree of venodilatation in the distal block due to the effect on the blood vessels.[7]

According to Hingorani et al., 34 patients scheduled for AV fistula placement underwent regional blocks using lidocaine and mixed ropivacaine. Nerve stimulator was used to facilitate axillary, interscalene, or infraclavicular or combination blocks. Intraoperative duplex ultrasonography was used to assess venodilatation before and after the block. The result was that the level of venodilation noted as a percentage increase after block placement compared to after tourniquet application was 42% for cephalic distal, 19% for mid–cephalic, and 26% for mid–basilic vein, with a value of $p < 0.05$.[8]

Based on the description above, the researchers analyzed and observed the pattern of temperature changes and the pattern of circumference increase in the distal peripheral veins as a result of the success of the regional block.

2. Methodology

It was an analytic, observational, cross-sectional study. The study population was selected from the patients who underwent elective orthopedic surgery at operating rooms of our hospital.

Patients, who were willing to participate in this study and signed informed consent, aged ≥ 16 y, *ASA*–1 or II, with a maximum surgery time of 60 min under spinal anesthesia were included in the study. Patients with a history of allergy to local anesthetics, bleeding disorders or use of anticoagulant drugs, infection at the injection site or sepsis, neurological trauma and neuropathic disorders were excluded. Patients experiencing inadequate blocks feeling restlessness during the surgery were also excluded from the study. A total of 34 patients completed the study. They belonged to these two groups; 18 patients with anesthesia with PNB blocks and 16 patients with SAB blocks. It was statistically tested with paired t-test. SPSS version 20 was used for statistical analysis.

This study used a Microlife NC-150 Bluetooth® infrared thermometer (Microlife, Swiss) to measure peripheral skin temperature. We used Sonosite® M–Turbo (Fujifilm, US) type ultrasound and linear transducers to measure the circumference of peripheral venous blood vessels to assess the degree of dilatation. The images were measured using a caliper. The measurements of peripheral veins were noted early before the PNB or SAB were performed and 1 h after the blocks. Evaluating the success rate of regional anesthesia was performed with pain scale (VAS) and absence of motor, sensory and nociceptive response. The results were correlated with changes in peripheral skin temperature and the circumference of the distal peripheral veins. The feedback by the surgeons is not included.

In spinal anesthesia, the block site is usually chosen as

the interspace L3 and L4. In the operating room, the patient was positioned in the lateral decubitus position. The block area was disinfected with povidone-iodine and alcohol. Before blocking, all patients were given local anesthesia at the puncture site with lidocaine 2% 2-3 ml. Block was performed with a paramedian approach with a spinal needle 26G with the needle bevel facing laterally. After the loss of resistance, the spinal needle was pulled out slightly until the spinal fluid flow was observed, the bevel was turned cephalad or in cranial direction and a 3 ml syringe containing the drug lidocaine + dextrose + adrenaline 1 / 200,000 was attached. The drug was slowly injected alternating with a little aspiration to confirm the needle's position

There were four types of PNB blocks performed in this study. Three patients underwent axillary block (16.7%), three underwent supraclavicular block (16.7%), six underwent interscalene block (33.3%), and six patients underwent femoral sciatic block (33.3%). In PNB, the block area was disinfected with povidone-iodine, and 3 ml of lidocaine 2% was used to numb the area. The blocks were performed under ultrasound, with a nerve stimulator and a 50 mm 22G Teflon coated stimulating needle (Stimuplex® B Braun, Germany). The needle was inserted vertically against the skin, and stimulation was given at 1.0 mA. As soon as there was a contraction in the muscles, the stimulation was reduced to 0.3–0.5 mA, till there was still a visible contraction. After prior aspiration to ensure there was no intravascular injection, the anesthetic was injected slowly with periodical aspiration test, until all the target nerves were flooded. Before the block, the temperature was measured using a laser thermometer at the injection site and at several predetermined points. In postoperative spinal anesthesia (1-hour post block), the temperature was re-evaluated with a laser thermometer, while in PNB 5 min after the block we measured the temperature at the marked spot every 5 min, until 30 min.

3. Results

3.1. Peripheral Nerve Block Anesthesia

There were 11 (61.1%) male patients and 7 (38.9%) female patients. There was no significant difference between the gender of the subjects in PNB group with regard to the circumference of the distal peripheral veins and changes in peripheral skin temperature in this study, as evidenced by the $p = 0.497$ (> 0.05).

Based on the age of the research subjects, the youngest age obtained was 18 y, and the oldest was 74 y. In the study, there was an increase in the circumference of the distal peripheral vein and peripheral skin temperature changes in 16 people with an average age of 48.50 ± 28.99 y.

The body weight of the subjects ranged 53 kg to 90 kg (61.00 ± 11.31 kg). There was no difference in the increase in the study parameters in 16 people.

Of the 18 blocks of PNB carried out, 16 blocks were successful (88.88%), and two blocks were unsuccessful (11.12%).

The PNB was carried out in the same room with the recovery room with the set temperature of 27° to 28°C. There was no significant effect of the room temperature on increase in the circumference of the distal peripheral vein and changes in the peripheral skin temperature ($p = 0.621$).

Based on the results of this study, in all 16 (88.88%) patients, whose PNB were successful, there was an increase in the circumference of the peripheral veins distal to the block and no effect was found in two patients (11.12%) whose block was unsuccessful.

The lowest temperature before the blocks (0 min) was 35.5°C, and the highest temperature was 36.6°C ($36.04°C \pm 0.301$). On average, the block was successful at 20th min with a mean temperature rise to $36.77°C \pm 0.28$ ($p = 0.039$). Delta temperature increase where the PNB block was successful was $0.7°C \pm 0.27$.

3.2. Subarachnoid Block Anesthesia

There was no effect of gender in the subjects who had undergone SAB regarding increase in the circumference of peripheral veins and changes in peripheral skin temperature in this study ($p = 1.00$).

Based on this study, of the 15 patients (94%) whose blocks were successful, there was an increase in peripheral skin temperature in the distal part of the block. There was no increase in temperature in one patient (6%) whose block was unsuccessful. The block average was successful at 5th min with a rise in mean temperature to $36.15 \pm 0.28°C$ ($p = 0.001$). Delta temperature increase where the SAB block was successful was $0.28 \pm 0.15°C$.

Table 1: Demographic characteristics of patients

Characteristic		N (%)	Increased peripheral venous circumferential length and peripheral skin temperature		p-value
			Increase	No Increase	
Gender	Male	11 (61,1)	9 (56.2)	2(100%)	0.497
	Female	7 (38.9)	7 (43)	0(0%)	
Age		18(100%)	16 (48.50 ± 28.99)	2 (50.00 ± 17.24)	0.914
Weight		18(100%)	16 (61.00 ± 11.31)	2 (67.06 ± 9.33)	0.406
Types of Block	Axillary	3 (16.7)	3 (18.8)	0 (0)	0.176
	Interscalene	6 (33.3)	6 (37.5)	0 (0)	
	Sciatic Femoral	6 (33.3)	4 (25.0)	2 (100)	
	Supraclavicular	3 (16.7)	3 (18.8)	0 (0)	
Room temperature		18(100%)	16 (27.69 ± 0.48)	2 (27.50 ± 0.71)	0.621

Data given as Mean ± SD or n (%)

Table 2: The relation between the peripheral nerve blocks with increased peripheral skin temperature and increased peripheral venous circumference at distal part of block

Variable		Peripheral nerve blocks		Total	p-value
		Unsuccessful	Successful		
Peripheral skin temperature	No increase	2 (100)	0 (0)	2 (100)	0.001
	Increase	0 (0)	16 (100)	16 (100)	
Peripheral venous circumference	No increase	2 (100)	0 (0)	2 (100)	
	Increase	0 (0)	16 (100)	16 (100)	

Data given as n (%)

Table 3: The relation between the success of the subarachnoid blocks with increased peripheral skin temperature and increased peripheral venous circumference at distal part of block

Variable		Subarachnoid block		Total	p-value
		Unsuccessful	Successful		
Peripheral skin temperature	No increase	1 (100)	0 (0)	1 (100)	0.001
	Increase	0 (0)	15 (100)	15 (100)	
Peripheral venous circumference	No increase	1 (100)	0 (0)	1 (100)	
	Increase	0 (0)	15 (100)	15 (100)	

Data expressed as n (%)

4. Discussion

The study found no effect of age differences in the subjects who had undergone PNB with changes in peripheral veins and in peripheral skin temperature in this study (p = 0.914). There was no effect of differences in body weights of subjects who had undergone PNB in this study (p = 0.406). Nor there was any significant effect of differences in body weights of subjects who had undergone SAB (p = 0.176).

In this study, there was an increase in the peripheral skin temperature. This result was in line with research conducted by Frank et al. who received an average increase in temperature of 0.64 ± 0.09°C after the

block was successful.[9]

The study results found that the success of the block increased the peripheral skin temperature distal to the block ($p = 0.001$. This result was in line with previous studies conducted by Hermanns et al. obtained from 45 patients (43 blocks succeeded) and occurred at 20th min; there was an increase in the mean peripheral skin temperature of $1.5 \pm 0.4°C$ ($p < 0.05$).[10] This result was also in line with the previous research conducted by Jetzek-Jader et al. on 15 patients who received spinal anesthesia for surgery on the soles of the feet, in which there was an average increase in peripheral skin temperature of 1.7°C ($p = 0.001$).[11] The lowest temperature value before the block (0 min) was 35.6°C, and the highest temperature was 36.3°C, with means value of 35.82 ± 0.20.

From the study results, it was found that the success of the block increased the circumference of the distal peripheral veins ($p = 0.001$). This result was in line with previous studies conducted by Reynolds et al. which also found a significant effect on the block's success with an increase in peripheral vein circumference distal to the block, with an average increase of 21.4% ($p < 0.05$).[12] Aitken et al. also obtained similar results in their study giving brachial plexus block as the regional anesthesia, there was a significant increase of peripheral vein's circumference which was assessed immediately after administration of anesthesia ($p = 0.006$).[13]

5. Suggestions

1. As the operators' technical skill may affect the success of the block, so we recommended that further studies be carried out by a single operator or by operators with equivalent skills to reduce the possible bias.
2. Future studies might be carried out on the same type of block and type of surgical operations to reduce the bias.
3. For a more concrete assessment of the peripheral skin temperature and the effect on the peripheral veins, it is recommended that the assessment be carried out continuously to ascertain direct changes in this study.
4. Comparison of temperature and peripheral veins in both extremities at the same point, blocked and not blocked should be made.

6. Conclusions

The successful regional anesthesia has a direct relationship with an increased peripheral venous circumference and the peripheral skin temperature in the blocked area. Both of these parameters can be clinically assessed to judge the success of the block or otherwise.

7. Conflict of interest

None declared by the authors

8. Authors' contribution

CS: Concept

SSS, BW, HSP, A, HBH: Concept, manuscript writing

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